368 CUBIC INCH DISPLACEMENT ENGINE—MECHANICAL

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ENGINE DESCRIPTION – 368 CUBIC INCH DISPLACEMENT ENGINE

The 1957 Turnpike Cruiser 290 horsepower engine is an eight cylinder valve-in-head 90° V-type which has a displacement of 368 cubic inches using a 4.00″ bore and a 3.66″ stroke. The compression ratio is 9.75 to 1. Consult figures 6C-1, 6C-2 and 6C-3 for views of the complete engine assembly.

The cylinder block and upper crankcase are cast in one piece with cored passages for cooling the entire length of the cylinder barrels. This unit forms the major section of the engine as it is fitted with the crankshaft, camshaft, pistons, and various related parts.

The fully counterbalanced crankshaft is supported by five copper lead steel backed replaceable main bearing inserts with the center bearing, number 3, absorbing the end thrust. The crankshaft has six counterweights for precise balance and superior resistance to torsional vibration.

The camshaft, which is supported by five replaceable babbitt lined steel backed bearing inserts, is driven with a silent timing chain which requires no adjustment.

The centrifugal and vacuum operated distributor, mounted at the top right rear of the cylinder block assembly, is gear driven by the camshaft.

The fuel pump is operated by an eccentric cam that is mounted on the camshaft.

Camshaft end thrust of the 368 cubic inch displacement engine is controlled by spring and oil pressure exerted behind a plunger housed in the front end of the camshaft.

The 368 cubic inch displacement engine uses aluminum alloy slipper type pistons. The pistons are of

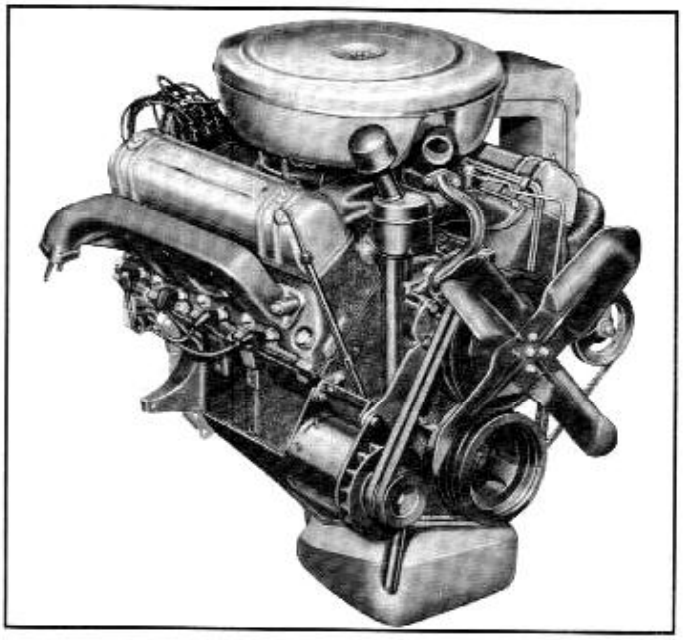


Fig. 6C-1—Right Front 3/4 View — 368 Cubic Inch Engine

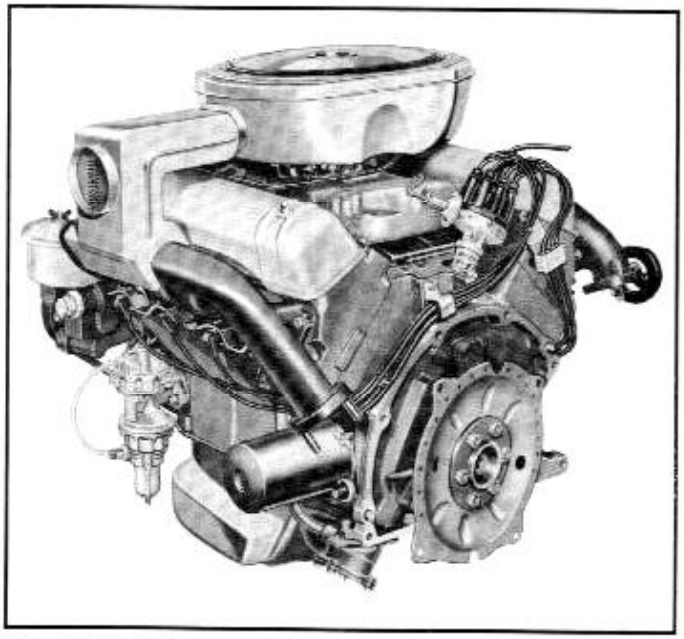


Fig. 6C-2—Left Rear 3/4 View — 368 Cubic Inch Engine

the auto-thermic design which provides for controlled piston expansion thus resulting in closer initial piston fits without binding or excessive friction, consequently eliminating cold engine piston slap and assuring longer piston life.

The selective fit piston pin is prevented from moving axially in the piston by two steel retaining rings in the piston pin bore of the piston.

The forged steel "I" beam section connecting rods contain a bronze bushing at the upper end for installation on the piston pin, while the lower end and bearing cap contain the locking type selective fit bearing inserts. Each respective connecting rod bearing cap is attached to the connecting rod with two heat treated steel bolts.

Hydraulic tappets made of steel are used in the 368 cubic inch displacement engine. The tappets are housed in bores located in the cylinder block tappet chamber. The tappets operate directly on the camshaft lobes thereby transmitting the thrust of the camshaft lobes, by the means of mechanical and hydraulic pressure, to the push rods that actuate the valve train. Hydraulic pressure within the tappets maintains zero clearance throughout the valve train assuring quiet operation with no valve lash.

In addition to the parts that are housed in the cylinder block, are many that are attached externally to complete the engine assembly. These are, the intake manifold, exhaust manifolds, cylinder head assemblies, water pump, oil pump, generator, distributor, fuel pump, starter, carburetor, oil pan, and other related parts.

The cylinder head assemblies feature combustion characteristics that produce very high volumetric and thermal efficiences.

Both cylinder heads contain intake and exhaust valve assemblies. Valve rocker arm assemblies mounted on the respective cylinder heads complete the valve train.

The rotatable intake and exhaust type valves in each cylinder head are inclined toward the manifold ports, making the breathing of the engine easier. Valve rotation, while the engine is running, 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 valve guide opening. The seal controls lubrication of the valve stem. Calibrated valve springs provide positive valve action at high engine speeds. Self locking adjusting screws in the rocker arms allow easy maintenance of valve clearance.

The intake manifold, which is mounted to the cylinder heads, supplies both cylinder banks with vaporized fuel from the carburetor.

A thermostatic choke control heat tube is located in the intake manifold, directly below the carburetor. The heat tube is heated by exhaust gases in the intake manifold riser passage. Carburetor vacuum draws fresh air into the heat tube and the air is thus warmed before it reaches the thermostatic choke control located on the carburetor. Refer to the "Fuel" section of this manual for the description and operation of the themostatic choke.

Two exhaust manifolds, one on the right bank and one on the left bank, are mounted to the respective cylinder heads. Compression pressure in the cylinder heads forces engine exhaust through the exhaust manifolds into the exhaust system.

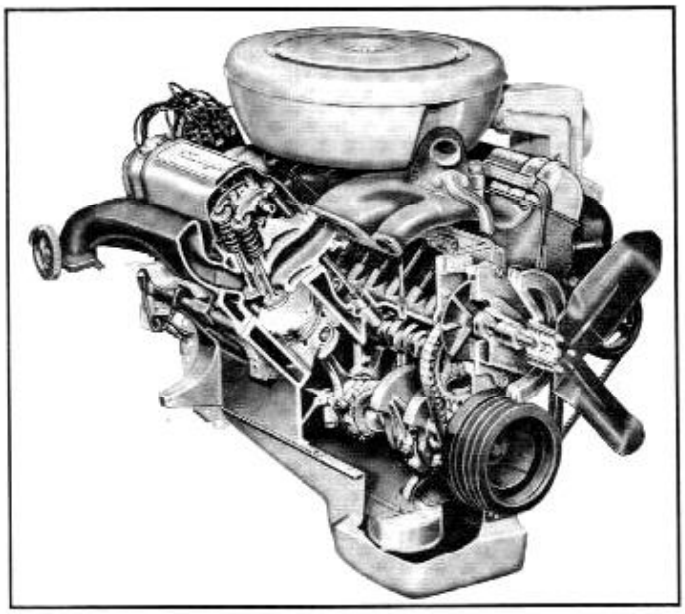


Fig. 6C-3—Right Front 3/4 Section — 368 Cubic Inch Engine

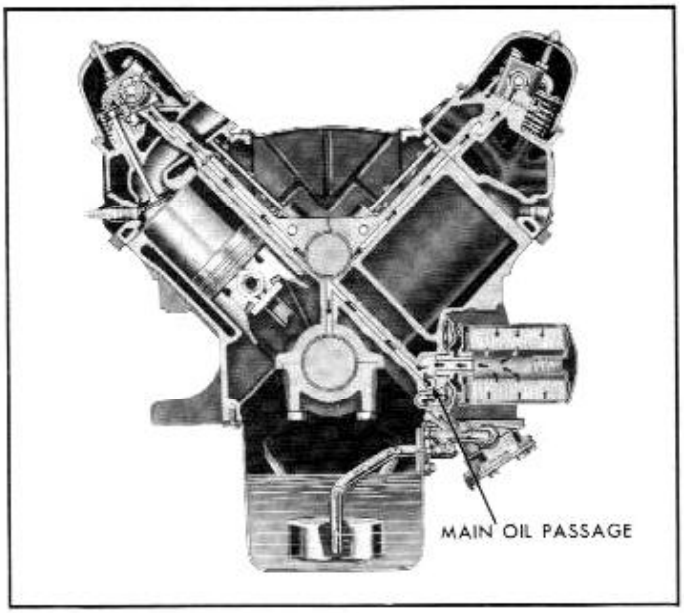


Fig. 6C-4—Lubrication System — 368 Cubic Inch Engine

The right exhaust manifold outlet is connected to a thermostatically controlled exhaust valve which governs the flow of hot exhaust gases. When the engine is cold, or idling at normal temperature, the exhaust valve is closed (heat on position). A portion of the exhaust gases, thus restricted, are directed through the right cylinder head into the intake manifold heat riser passage. The exhaust gases then pass through the intake manifold into the left cylinder head exhaust passage. From this point the gases flow through cylinder head into the left exhaust manifold and out through the left muffler inlet pipe. This diversion of hot exhaust gases allows a faster engine warm up.

As the engine warms up, the thermostatically controlled exhaust valve gradually opens to the fully open position (heat off position) allowing the exhaust gases to flow through the exhaust system in a normal manner.

Two "V"-type fan belts, driven by a three sheave damper on the crankshaft, drives the water pump-fan combination and the generator of the 368 cubic inch engine.

The water pump is mounted integral with the front cover and supplies both cylinder banks with adequate cooling.

The generator is mounted at the lower right side of the engine with an adjustable arm to permit proper belt tension adjustment.

A flex-type flywheel which is mounted on, and is secured to, the rear shoulder of the crankshaft, drives the Merc-O-Matic transmission converter assembly.

Cylinder Numbering — 368 Cubic Inch Engine

When viewing the engine from the rear, the right bank of cylinders are numbered 1, 2, 3, and 4, number 1 being at the front. Similarly, the left bank of cylinders are numbered 5, 6, 7 and 8. Number 5 being at the front. For easy reference, each cylinder number is cast on the intake manifold directly over its respective cylinder.

The engine firing order is 1-5-4-8-6-3-7-2. This information is also cast on the top surface of the intake manifold.

Engine Lubricating System — 368 Cubic Inch Engine

A pressure lubricating system employing a full flow disposable oil filter is incorporated in the 368 cubic inch engines. See figure 6C-4.

The rotor type oil pump, mounted externally at the lower left rear of the cylinder block is driven by the distributor through an intermediate shaft. Thus the oil pump and distributor are driven at camshaft speed.

The oil supplied to the oil pump passes from the intake screen assembly of the oil pan into the oil pump inlet tube which is mounted on the left side of the oil pan. A spring loaded relief valve in the oil pump controls the pressure of the system. The oil relieved by the relief valve is directed back to the intake side of the pump.

The oil leaves the pump directly through a passage in the block which directs the oil to the filter assembly. This means that all the oil delivered by the oil pump is directed immediately into the filter where it is filtered before entering the main oil passage for circulation throughout the engine. See figure 6C-4.

A filter by-pass valve, located in the filter is provided to operate only when the oil flow is restricted

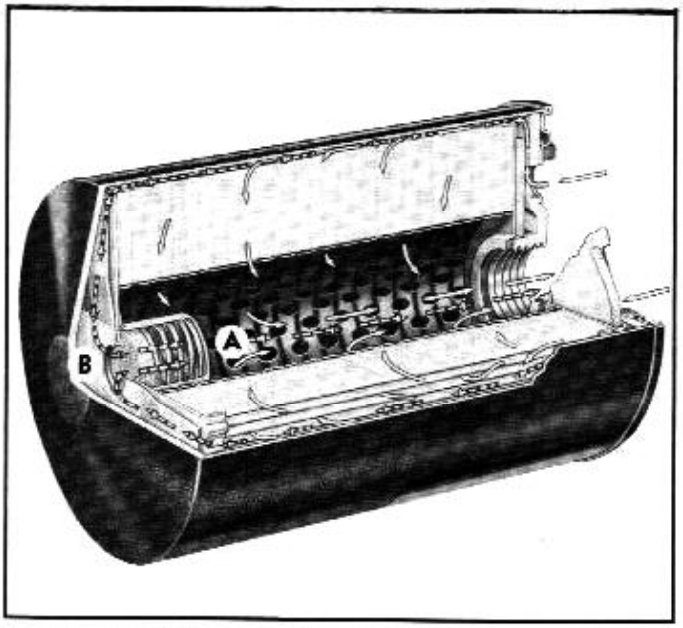


Fig. 6C-5—Cross Section of Oil Filter Assembly

because of dirt or other foreign materials. Figure 6C-5 is presented to illustrate the operation of this by-pass valve. First, the solid arrows denote the path the oil flows through the filter when the element is relatively clean, thus, very little resistance is present to restrict the flow of the oil. Under this condition, the pressures of the oil at points "A" and "B" are almost equal, therefore, the by-pass valve remains closed and filtered oil is supplied to the main oil passage.

As dirt or foreign materials accumulate in the filter, resistance to normal oil flow is increased. This means that the pressure of the oil at point "A" will be lowered. As soon as the pressure of the oil at point "A" drops to a value less than the value of the pressure of point "B" the by-pass valve will open. The path the oil flows is then illustrated by the dotted arrows. It should be noted that when the by-pass valve is open, that portion of the oil flowing through the by-pass valve does not travel through the filter but is supplied directly to the main oil passage.

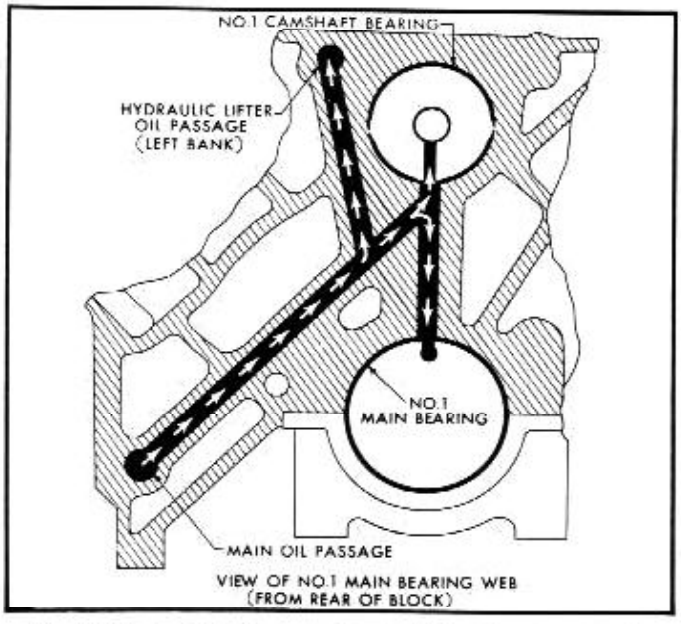


Fig. 6C-6—Lubrication at No. 1 Main Bearing Web

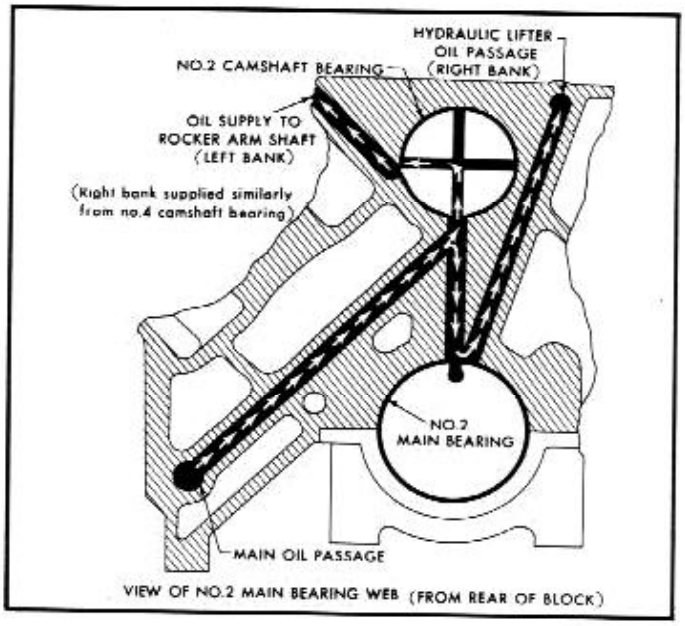


Fig. 6C-7—Lubrication at No. 2 Main Bearing Web

Lubrication Circuit — 368 Cubic Inch Engine

The main oil passage which receives the oil from the filter assembly extends the full length of the left side of the cylinder block. This passage supplies oil to all camshaft bearings, main bearings and hydraulic lifter supply lines.

Through a drilled passage in the No. 1 main bearing web (front of engine), the oil is supplied to the number 1 main and cam bearings as shown in figure 6C-6. From this passage, oil is also directed to supply the hydraulic lifters of the left bank.

The hydraulic lifters of the right bank receive their oil in a similar manner, only the drilled passage is in the No. 2 main bearing web. See figure 6C-7. Located at the front end of each hydraulic lifter oil passage is a vent plug. This allows air in the line to escape, assuring the lifters a supply of air free oil.

The rocker arm assembly of the right bank receives oil through a drilled passage in the cylinder block at the No. 4 cam bearing which lines up with a hole in the cylinder head that directs the oil through the No. 2 rocker shaft support. The left bank rocker arm assembly is supplied similarly from the No. 2 cam bearing, and No. 3 rocker shaft support. See figure 6C-7.

The oil from the rocker shaft support flows into the rocker arm shaft where it is directed through small

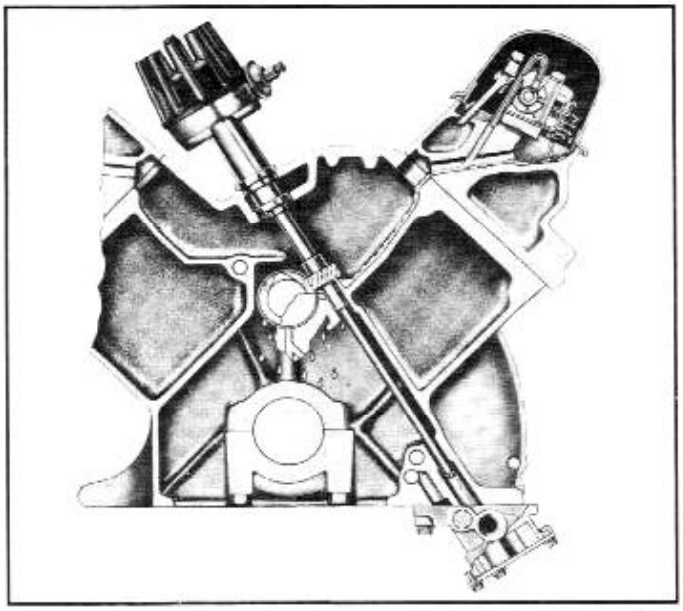


Fig. 6C-8—Lubrication of Rocker Arm Assembly and Distributor Shaft Bushing

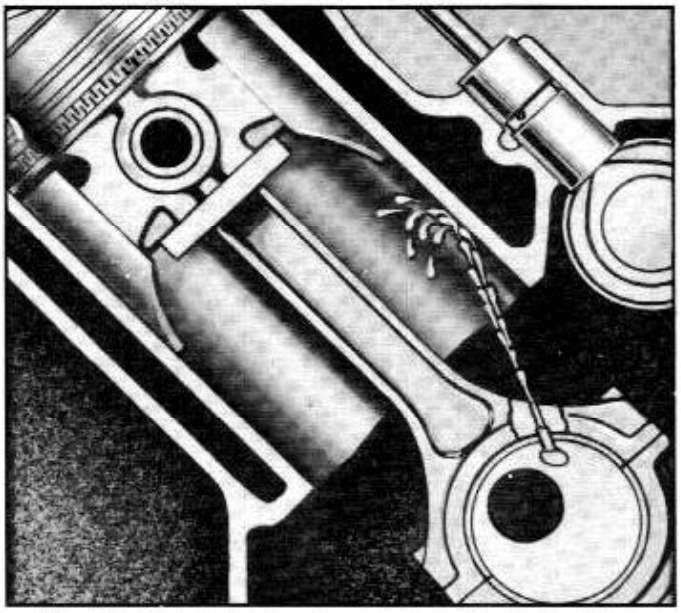


Fig. 6C-9—Lubrication of Connecting Rod Bearings and Cylinder Wall

holes to lubricate each rocker arm at the valve and ball joint ends. Each rocker arm shaft has an overflow pipe which exhausts excess oil directly into the push rod chamber. See figure 6C-8. The overflow pipes are located at the front of the right bank and at the rear of the left bank rocker arm assemblies. The oil sprayed from each rocker arm drains into the push rod chamber through holes provided at the lower front and rear corners of the cylinder heads.

The connecting rod bearings receive their lubrication through passages drilled from the main bearing journals to the crankpins of the crankshaft. The cylinder walls are lubricated by oil sprayed from a hole drilled in each connecting rod. When the hole in the rod lines up with the hole in the crankpin, oil is sprayed into each cylinder wall. See figure 6C-9.

Camshaft end thrust is controlled by spring and oil pressure behind a plunger housed in the front end of the camshaft. The oil is supplied from the No. 1 camshaft bearing which lines up with passages drilled in the camshaft. Directly behind the plunger, another passage is drilled in the camshaft to direct oil to lubricate the camshaft fuel pump drive eccentric sleeve. See figure 6C-10.

The oil, as it bleeds past the plunger and camshaft bearing sleeve, collects in a small trough which directs the oil to lubricate the timing chain and sprockets. Oil from the hydraulic lifter oil supply passage vent plugs also lubricates the timing chain and sprockets. From this point, the oil drains into the oil pan. See figure 6C-10.

The oil in the push rod chamber collecting from the rocker arm overflow pipes, hydraulic lifters, etc., drains back into the pan through a large hole at the rear of the block and lubricates the distributor drive gears. The distributor shaft lower end bushing is lubricated by metered oil supplied from the No. 5 camshaft bearing through drilled passages. See figure 6C-8.

Engine Cooling System — 368 Cubic Inch Displacement Engine

The coolant is drawn from the lower tank of the radiator by the centrally mounted water pump which delivers the coolant to an equalizing chamber in the front cover. The equalizing chamber distributes the coolant to both cylinder banks. See figure 6C-11.

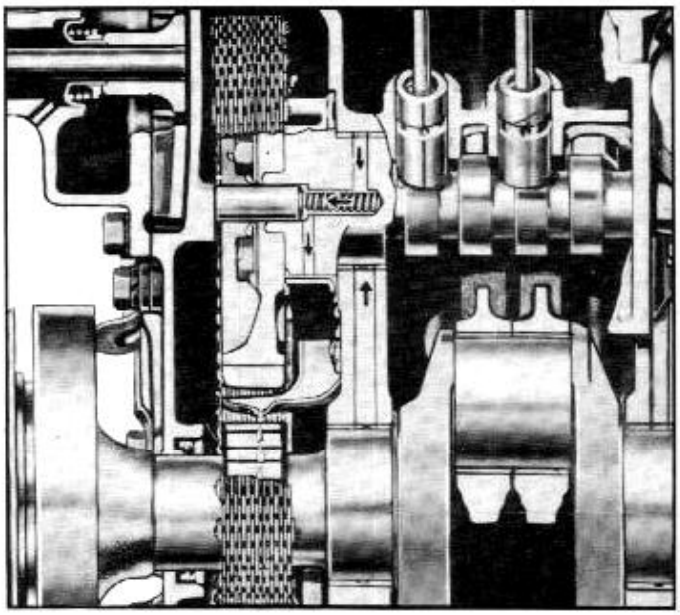


Fig. 6C-10—Lubrication of Camshaft End Thrust Plunger and Timing Chain

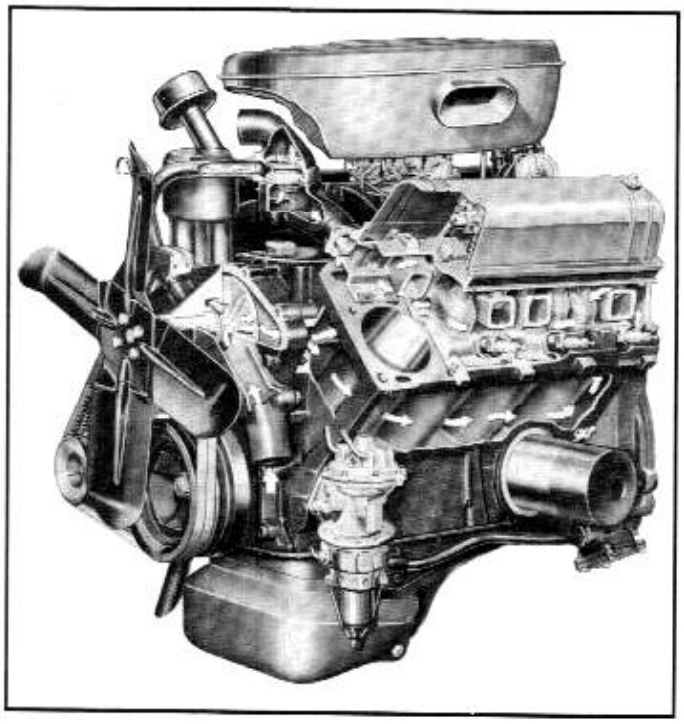


Fig. 6C-11—Cooling System

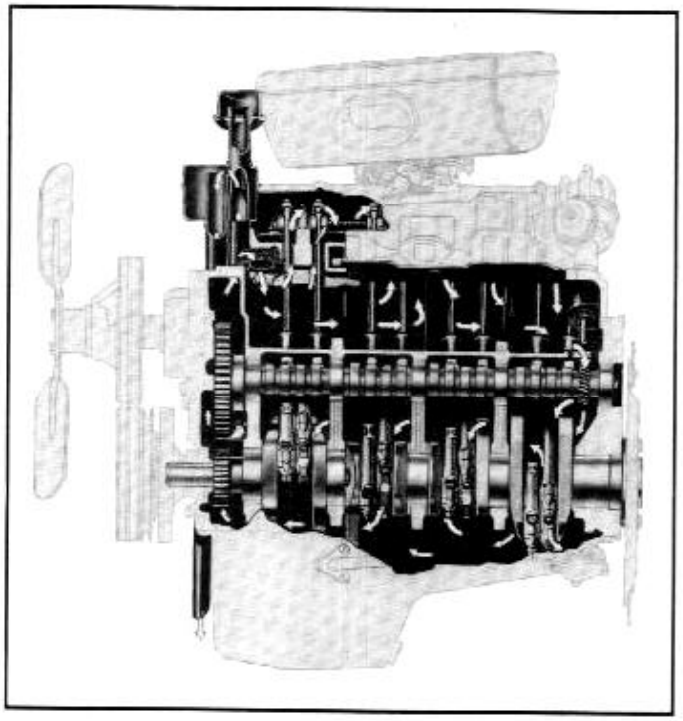


Fig. 6C-12—Crankcase Ventilation System

As the coolant enters the cylinder 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 redirected up into the cylinder heads where it cools the combustion chambers valves, valve seats, etc., on its return to the front of the engine.

At this point, the coolant from each cylinder head flows into the water outlet connection, past the thermostat if it is open, into the upper tank of the radiator. When the thermostat is closed, coolant is by-passed through a pipe which returns the coolant directly to the water pump for recirculation throughout the engine. The function of the by-pass system is to assure uniform engine warm up, and reduce cooling system pressure. When the thermostat is open the flow through the by-pass system is reduced due to reduced coolant pressure.

The entire system is under a positive pressure of 12 to 15 P.S.I. by the use of a pressure type radiator cap. The complete cooling system is more fully described in the "Cooling System" section of this manual.

After overhauling an engine and at intervals throughout the service life of the vehicle, the entire cooling system should be thoroughly cleaned and a rust inhibitor added to the coolant, or if anti-freeze is required, use one that contains a rust inhibitor. A rust colored coolant is a warning that the system should be cleaned. Flushing of the radiator and also the cylinder block will generally bring the system back to top efficiency.

Crankcase Ventilating System — 368 Cubic Inch Displacement Engine

The crankcase ventilating system incorporated in the Turnpike Cruiser engine is designed to provide positive circulation of ventilating air whenever the engine is in operation and at all road speeds.

Air entering the engine through an inlet air filter cap, located at the front of the valve push rod cover passes through a filtering material in the cap. See figure 6C-12. The filtered air flows into the front section of the valve push rod chamber where it is directed by a baffle, located on the chamber cover, upward into the front area of both rocker arm chambers. From this point the ventilating air is forced to the rear and down into the rear section of the valve push rod chamber. The ventilating air is then forced downward through an opening in the block to the engine crankcase. The air circulates throughout the crankcase and is then directed to the bottom of the camshaft sprocket chamber. The air then moves up through the camshaft sprocket chamber to the combination oil filler and road draft tube assembly. Any oil vapor carried by the ventilating air is trapped in the cannister of the oil filler and road draft tube and drains back into the camshaft sprocket chamber. The air then moves down the road draft tube and is exhausted into the atmosphere.

In addition to providing positive ventilation, the ventilating air is permitted to normalize its temperature before contacting contaminating vapors originating in the crankcase. This warm ventilating air minimizes formation of crankcase sludge.

For the system to function properly and provide adequate ventilation, it is necessary that the filtering material located in the inlet air filter cap be periodically cleaned by rinsing the element in a suitable solvent and saturating with engine oil.

PERIODIC MAINTENANCE

To maintain maximum engine performance, it is recommended that the following service items be periodically performed at each of the mileage intervals indicated:

2,000 MILES

1. Inspect and adjust tension of drive belts.
2. Clean crankcase inlet breather cap and ventilation screen.
3. Change oil in crankcase every 2,000 miles or every three months, whichever occurs first.
4. Lubricate exhaust thermostat valve shaft.

4,000 MILES

1. Replace oil filter.

6,000 MILES

ENGINE DIAGNOSIS. Check starter system, distributor spark advance, coil, generator, generator regulator, carburetor and choke adjustments. Adjust Merc-O-Matic transmission linkage and check shift points.

10,000 MILES

1. Install new spark plugs.

SEASONAL SERVICES

1. Flush radiator, Spring and Fall.
2. Inspect all hoses and replace if necessary.
3. Add rust inhibitor to coolant each spring.

VALVE CLEARANCE ADJUSTMENT

Valve clearance is adjusted by means of self locking adjusting screws located on the push rod ends of the rocker arms. The adjusting screws have 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 center portion of screw threads are in full contact with the threads in rocker arms. When point of interference is reached, it should take a minimum of 3 lbs. ft. torque to turn the screw further. Replace rocker arm and screw if torque is below specifications.

If a cylinder head, rocker arm and shaft assembly or any component part of the valve train has been removed, it will be necessary to make a valve clearance adjustment before starting the engine.

If, during a vehicle's operation, a lifter becomes noisy the condition may sometimes be alleviated by turning the adjusting screw ± 1/2 turn from the original 2½ turn setting.

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. Perform valve clearance adjustment as follows:

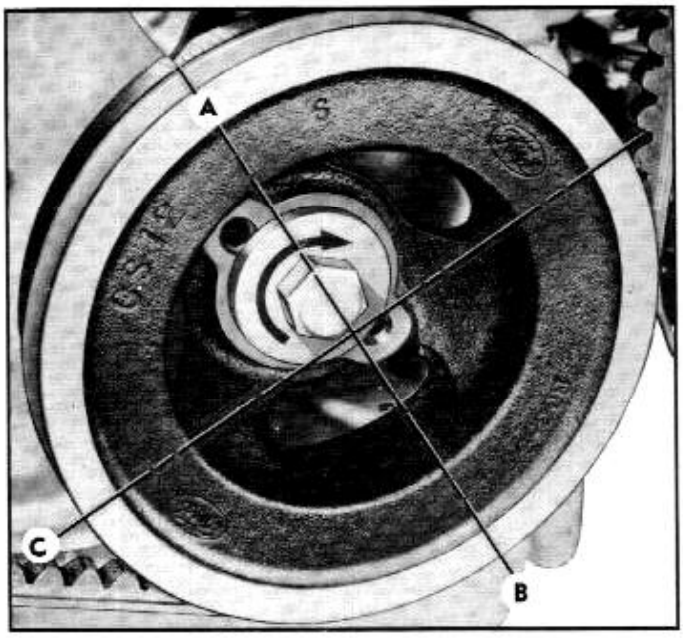


Fig. 6C-13—Quadrant for Valve Clearance Adjustment

1. Turn all the tappet adjusting screws until interference is noted, then check the torque required to turn the screw further.
2. If the torque required to turn the screw is less than 3 lbs. ft. (36 lbs. in.). Replace the rocker arm and adjusting screw.
3. Make three chalk marks on the crankshaft damper. Space the marks approximately 90° apart so that with the timing mark, the damper is divided into four equal parts (90° represents 1/4 of the distance around the damper circumference). See figure 6C-13.
4. Rotate the crankshaft until No. 1 piston is near T.D.C. at the end of the compression stroke. To adjust valve clearance of the following valves, shown in the table which follows, turn adjusting screw clockwise while moving push rod up and down as shown in figure 6C-14, until slack is removed.

   IMPORTANT: Plunger unit of hydraulic lifter should not be forced down into lifter body during this operation. With the slack removed, turn adjusting screw clockwise an additional 2½ turns. Repeat until all lifters are adjusted.

   CAUTION: *To eliminate any possibility of bending a push rod, force each tappet to leak down after adjustment, by pressing on the push rod end of the rocker arm.*

   NOTE: If lifter is noisy during vehicle's operation, adjustment can be varied by turning adjusting screw ± 1/2 turn from the original 2½ turn setting.

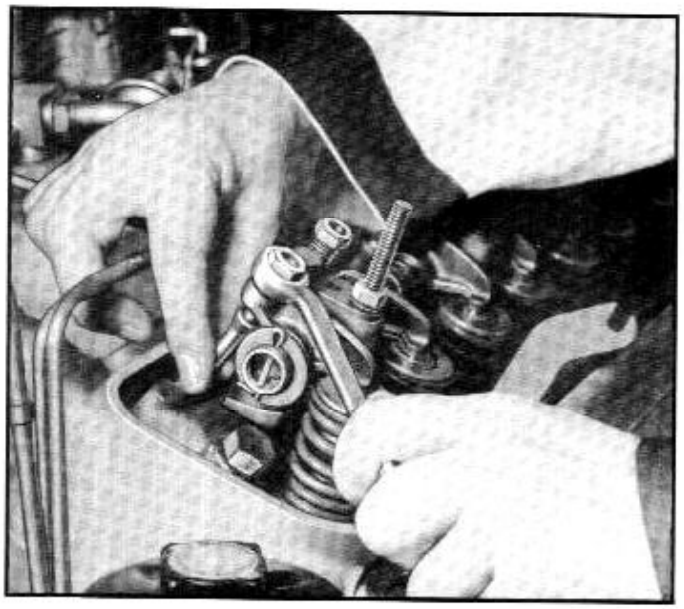


Fig. 6C-14—Valve Clearance Adjustment

No. 1 – Exhaust	No. 1 – Intake
No. 4 – Exhaust	No. 2 – Intake
No. 5 – Exhaust	No. 7 – Intake

5. Rotate the crankshaft 180° or 1/2 turn (this puts No. 4 piston on T.D.C.), then adjust the following valves:

No. 6 – Exhaust	No. 4 – Intake
No. 8 – Exhaust	No. 5 – Intake

6. Rotate the crankshaft 270°, or 3/4 turn from 180° (this puts No. 3 piston on T.D.C.), then adjust the following valves:

No. 2 – Exhaust	No. 3 – Intake
No. 3 – Exhaust	No. 6 – Intake
No. 7 – Exhaust	No. 8 – Intake

CHECKING CAMSHAFT LOBE LIFT—ENGINE IN VEHICLE

This procedure is similar to the procedure for checking valve timing. Check the lobe lift in consecutive order and note the readings.

1. Remove nuts securing valve rocker arm cover to cylinder head. Remove seals and rocker arm cover.
2. Disconnect high tension coil lead wire at coil. Disconnect wire at "S" terminal of starter relay switch. Connect an auxiliary starter cable to the positive terminal of battery and "S" terminal of starter relay switch.
3. Loosen the valve rocker arm adjusting screw, then slide the rocker arm assembly to one side and secure it in this position.
4. Make sure the push rod is in the tappet socket, then install a dial indicator, using Tool 4201-A or C, in such a manner as to have the actuating point of the indicator in the push rod socket and in the same plane as push rod movement. See figure 6C-15.

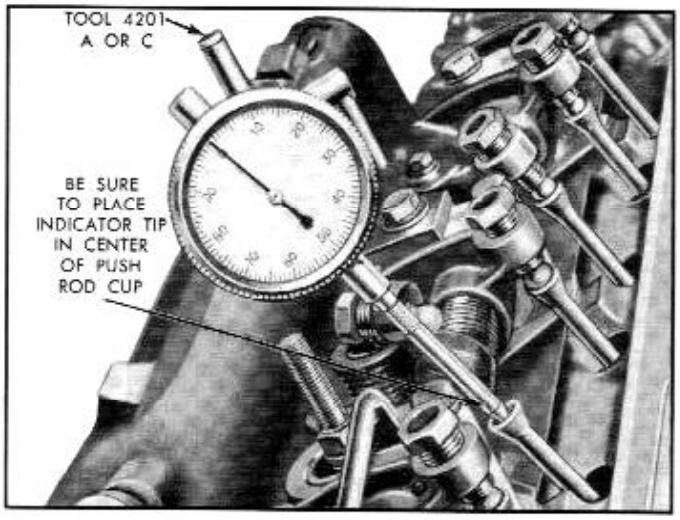


Fig. 6C-15—Checking Camshaft Lobe Lift

5. Using the auxiliary starter switch, "bump" the engine over until the tappet rests on the heel of the camshaft lobe. At this point the push rod is in its lowest position.
6. Set the dial indicator on zero, then "bump" the engine over until the push rod is in its fully raised position, and note the total lift recorded on the indicator. Using the starter switch, continue to rotate the camshaft until the indicator reads zero. This is a check on the accuracy of the original indicator reading. If the camshaft reading on any of the lobes is below the specification limits of .256", the camshaft and/or tappets must be replaced. To replace a camshaft, refer to "Removal and Installation of Camshaft–Engine in Vehicle" in this section of manual.
7. If the camshaft readings for all lobes are within specifications, remove dial indicator and perform valve clearance adjustments. Refer to "Valve Clearance Adjustment" in this section of manual.
8. Connect high tension coil lead wire to coil. Disconnect auxiliary starter cable from "S" terminal of starter relay switch and battery terminal. Connect the previously removed wire to "S" terminal of starter relay switch.
9. Install rocker arm cover, seals and retaining nuts. Tighten nuts to 2-2½ lbs. ft. torque.

VALVE TIMING

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

To check the valve timing with the engine in vehicle proceed as follows:

1. Remove nuts securing right hand valve rocker arm cover to cylinder head. Remove seals and cover.
2. Disconnect high tension coil lead wire at coil. Disconnect wire at "S" terminal of starter relay switch. Connect an auxiliary starter cable to the positive terminal of battery and "S" terminal of starter relay switch.
3. Loosen the number 2 intake valve rocker arm adjusting screw, then slide rocker arm toward rear and secure it in this position.
4. 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 push rod movement. See figure 6C-15.
5. Install a quadrant on the crankshaft damper.
   NOTE: Before checking valve timing, check for a bent timing pointer. Replace pointer if damaged.
6. Using auxiliary starter switch, "bump" the engine over until the tappet rests on the heel of the camshaft lobe. At this point the push rod is in its lowest position. Set the dial indicator on zero, then "bump" the camshaft over until the dial indicator registers the specified cam lobe lift as indicated in the following table of valve timing specifications.

INTAKE VALVE			
Opens		Closes	
Crankshaft Degrees	Cam Lift	Crankshaft Degrees	Cam Lift
18° BTDC	.002	16° ABDC	.100
EXHAUST VALVE			
Opens		Closes	
Crankshaft Degrees	Cam Lift	Crankshaft Degrees	Cam Lift
59° BBDC	.002	31° ATDC	.004

7. Compare the crankshaft degrees indicated on the quadrant with specifications in the above table. Continue to rotate the engine to check the valve closing.
8. If the valve timing is not within specifications, check the timing chain, camshaft sprocket, camshaft and tappets and crankshaft in their order of accessibility.

REMOVAL AND INSTALLATION OF REAR ENGINE SUPPORT INSULATOR AND RETAINER — ENGINE IN VEHICLE

Removal

1. Remove support retainer to extension housing attaching screws and washers.
2. "Jack-up" extension housing slightly to relieve the pressure on the support assembly.
3. Remove the retainer and insulator assembly.

Installation

1. "Jack-up" the extension housing just enough to position the support assembly and retainer.
2. Install insulator in retainer. Place insulator and retainer assembly in position on frame crossmember. Install retainer to frame crossmember attaching washer and screws.
3. Remove the jack from housing and tighten attaching screws to 34-42 lbs. ft. torque.
   NOTE: Make sure the retainer does not contact crossmember.

REMOVAL AND INSTALLATION OF FRONT ENGINE SUPPORT BRACKETS AND INSULATORS — ENGINE IN VEHICLE

Removal

1. Raise front of vehicle with a floor jack.
2. Remove screws securing engine splash shield to frame.
3. Loosen, but do not remove, the screws securing rear engine mount retainer and insulator to frame crossmember.
4. Remove nuts securing both front engine support brackets to frame side member.
5. Place a block of wood on an engine floor stand, then place stand under front end of oil pan.
6. Lower vehicle with floor jack until floor stand raises engine enough to allow clearance for removal of support insulators.

Installation

1. Remove retaining screws securing each respective support bracket to engine block. Replace insulator and/or bracket and tighten retaining screws.
   NOTE: Replace insulator and bracket on one respective side before proceeding to the next.
2. Raise front end of vehicle and guide engine as necessary to make certain bracket studs enter holes in frame side member. When engine support insulator is properly seated, secure engine support bracket to frame side member with retaining nuts.
3. Tighten bolts securing rear engine mount insulator and retainer to frame crossmember to 34-42 lbs. ft. torque.
   NOTE: Be sure retainer does not contact frame crossmember.
4. Install and secure engine splash shield to frame.
5. Lower vehicle.

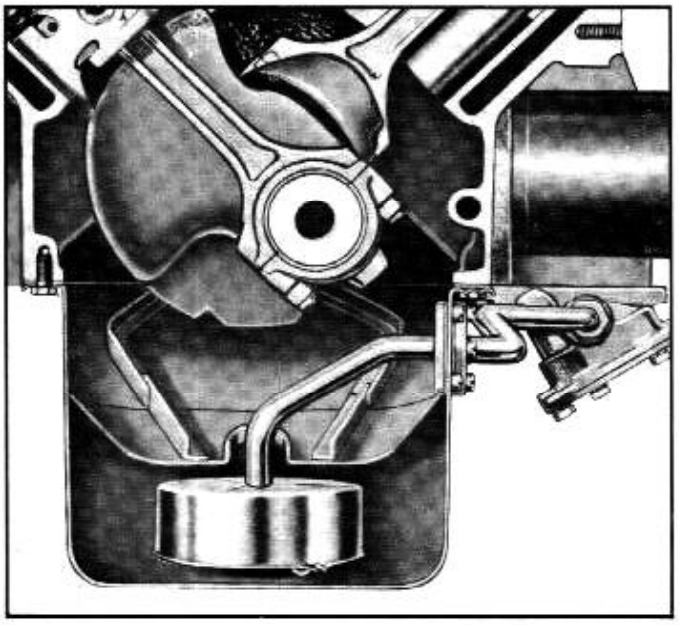


Fig. 6C-16—Front Section View of Oil Pan Assembly

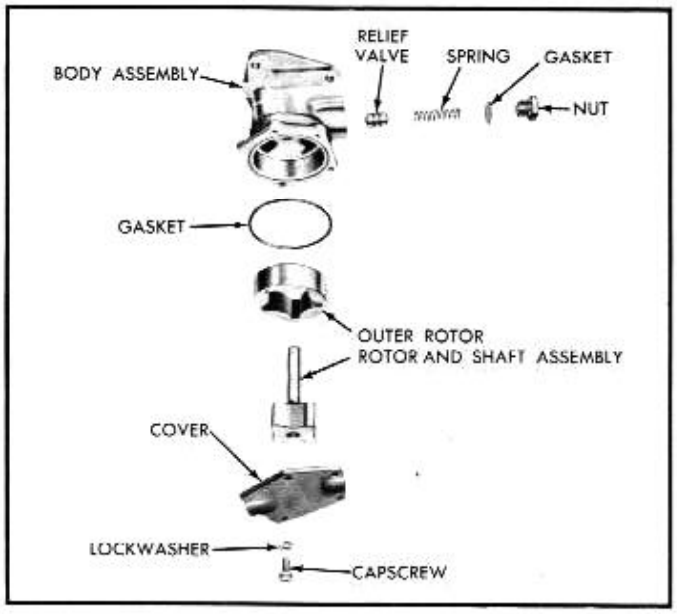


Fig. 6C-17—Disassembled Oil Pump

REMOVAL AND INSTALLATION OF OIL PAN — ENGINE IN VEHICLE

Removal

1. Position number 6 piston on T.D.C. to allow clearance between oil pan and crankshaft.
2. Raise vehicle. Drain the oil from crankcase.
3. Remove retaining screws securing engine splash shield to frame. Remove splash shield.
4. Disconnect stabilizer bar at right and left lower suspension arms. Pull stabilizer arms forward to allow clearance for oil pan removal.
5. Disconnect the nut securing oil pump inlet tube to the oil pump. Remove screws securing the inlet tube to oil pan. See figure 6C-16.
6. Remove oil pan retaining screws, then remove oil pan. Remove two screws securing screen cover and inlet tube assembly to oil pan.

Cleaning and Inspection

Remove gasket material from surfaces of oil pan and cylinder block. Clean oil pan, screen cover and inlet tube assembly in a suitable solvent.

Inspect oil pan, and screen cover assembly for damage and replace if necessary. Make sure the gasket surfaces of the cylinder block and oil pan are free of burrs.

Installation

1. Coat inlet tube flange to oil pan gasket with oil resistant sealer and secure inlet tube and screen cover assembly to oil pan with two screws.
2. Coat the cylinder block gasket surface with oil resistant sealer. Position a new gasket on oil pan, making sure all holes are aligned.
3. Carefully position oil pan against the cylinder block. Install two of the retaining screws on each side of pan. Install the remaining screws, then tighten screws in sequence from the center outward. Tighten screws to 12-15 lbs. ft. torque.
4. Install a new seal in front of jam nut on oil inlet tube. Install inlet tube in oil pump. Coat a new oil pan to inlet tube flange gasket with oil resistant sealer, install inlet tube on oil pan and secure with three screws.
5. Tighten retaining screws at oil pan to 28-32 lbs. ft. torque. Tighten nut at oil pump to 10-12 lbs. ft. torque.
   NOTE: Do not overtighten the inlet tube nut.
6. Install stabilizer bar. Install engine splash shield on frame. Lower vehicle.
7. Fill crankcase with the proper amount and grade of lubricant. Start engine; check for leaks.

REMOVAL AND INSTALLATION OF OIL PUMP — ENGINE IN VEHICLE

Removal

1. Raise vehicle. Remove screws securing oil inlet tube to oil pan. Disconnect oil inlet jam nut at oil pump. Remove oil pump to cylinder block retaining screws. See figure 6C-16.
2. Pull oil pump inlet tube out of oil pump. Remove oil pump, intermediate shaft and gasket. Remove seal from inlet tube.

Disassembly

1. Refer to figure 6C-17. Remove retaining screws

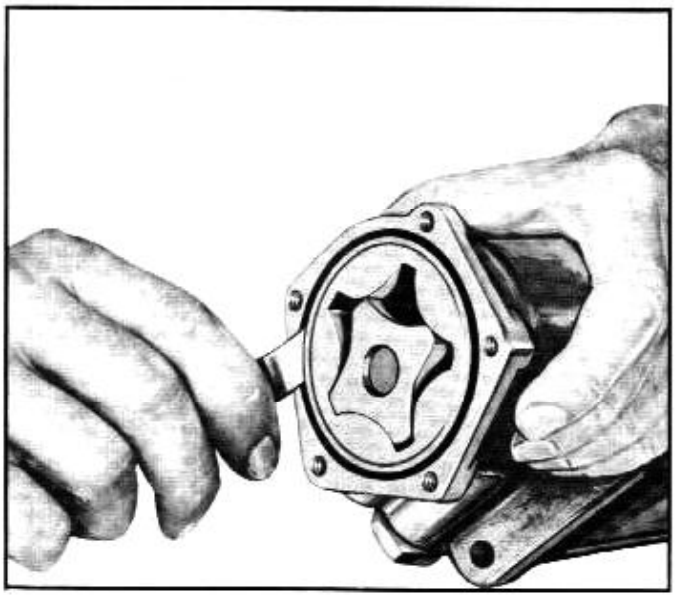


Fig. 6C-18—Checking Outer Rotor to Pump Body Clearance

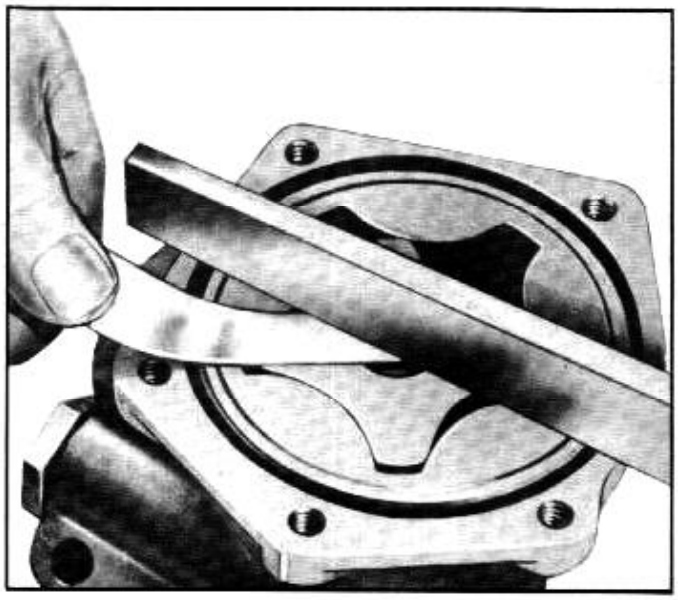


Fig. 6C-19—Checking Rotor End Play Clearance

securing cover to body assembly. Remove cover and gasket.
2. Remove rotor and shaft assembly. Remove relief valve nut, gasket, spring, and relief valve.

Cleaning and Inspection

1. Clean cylinder block and oil pump mounting surfaces. Clean all parts in a suitable solvent. Be sure all dirt and foreign material is removed.
2. Check pump housing, outer race, and rotor shaft for damage or excessive wear. Check mating surface of pump cover for wear. If plate is worn, scored or grooved, replace plate.
3. Inspect relief valve spring for a collapsed or worn condition. Check relief valve spring tension. The spring should exert a pressure of 7.83 pounds at 1.40 inches. If spring tension is not within specifications or it is defective, replace spring.
4. Check the relief valve piston for scores and free operation in the bore. The specified piston clearance is .002 to .004 inch.
5. Check rotor shaft to housing bearing clearance by measuring O.D. of shaft and I.D. of housing bearing. Clearance limits are .0015 to .0029 inch.
6. Measure the outer rotor race to body clearance as shown in figure 6C-18. The clearance should be .006 to .009 inch.
7. With the rotor and shaft assembly installed in the housing, place a straight edge over the rotor assembly pump body. Measure the clearance between the pump and straight edge at the rotor. The clearance should be .0015 to .0029 inch. See figure 6C-19. NOTE: The outer rotor and shaft and rotor assembly are replaceable only as an assembly.

Assembly

1. Oil all parts thoroughly. Install oil pressure relief valve, spring, new gasket and nut.
2. Install outer race and the inner rotor and shaft assembly. Install gasket in groove on pump body assembly. Install cover and retaining screws, torque screws 12 to 15 lbs. ft.

Installation

1. Insert intermediate shaft into oil pump drive shaft. Position a new gasket on pump housing. Install pump and shaft on cylinder block as an assembly. NOTE: Do not force pump assembly into position if it will not seat readily, for the intermediate shaft hex and distributor shaft may be misaligned. Rotate intermediate shaft into a new position to align.
2. Tighten oil pump to cylinder block retaining screws to 12-15 lbs. ft. torque.
3. Install new seal on pump end of inlet tube. Install tube and seal in oil pump. Do not tighten jam nut at this time.
4. Coat oil pump inlet tube flange gasket with oil resistant sealer. Install gasket and inlet tube on oil pan and tighten screws to 23-28 lbs. ft. torque.
5. Tighten oil pump jam nut to 10-12 lbs. ft. torque. DO NOT OVERTIGHTEN NUT.
6. Lower vehicle. Start engine, observe the oil pressure indicator performance. Check oil system for leaks.

REMOVAL AND INSTALLATION OF OIL FILTER (DISPOSABLE TYPE) — ENGINE IN VEHICLE

Figure 6C-20 shows a disassembled view of the oil

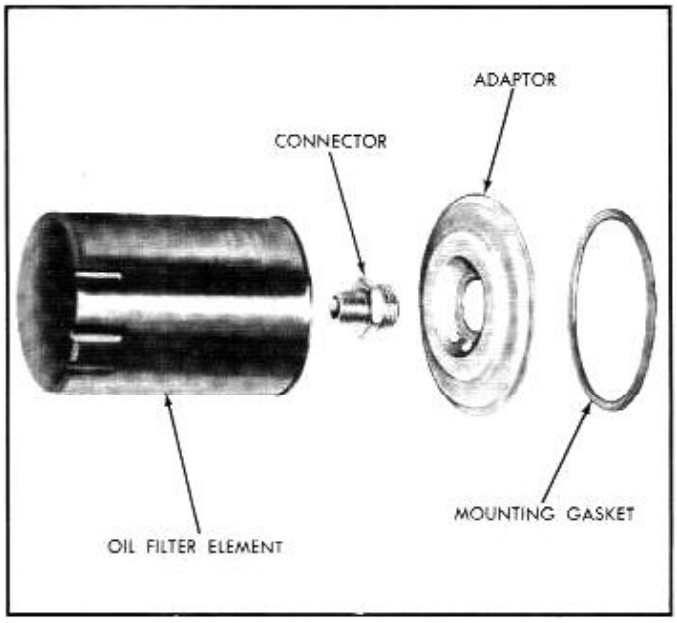


Fig. 6C-20—Disassembled View of Disposable-Type Oil Filter Assembly

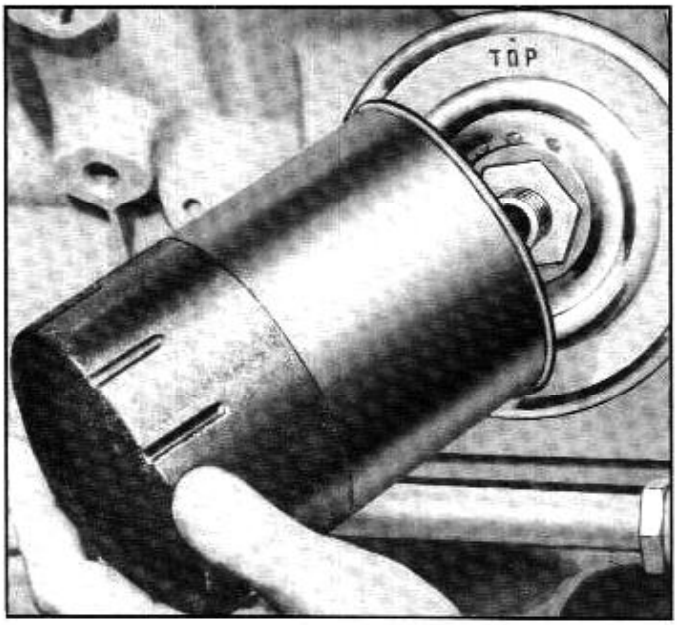


Fig. 6C-21—Oil Filter Replacement

filter assembly and component parts. The gasket, adaptor and connector are not removed or replaced during an oil filter replacement unless leakage or damage is evident. Disregard steps three (3) and four (4) of the following procedure if it is not necessary to replace these parts.

1. Raise vehicle. Place a drip pan under filter assembly.
2. Turn filter assembly counterclockwise and remove from cylinder block. Discard filter if its condition warrants replacement.
3. If it is necessary to remove connector, adaptor, and gasket, turn connector counterclockwise to remove.
4. Clean cylinder block recess. Install a new gasket in recess, making sure it is properly seated around the outside edge. Install adaptor with the word "TOP" in the uppermost position. See figure 6C-21. Install the connector and tighten it to 50-70 lbs ft. torque.
   NOTE: Be sure adaptor does not rotate.
5. Coat the filter gasket face with engine oil. Check to see if adaptor is properly positioned with the word "TOP" in the uppermost position. Install filter on connector; hand tighten until filter gasket contacts adaptor face, then advance filter one-half (1/2) turn. DO NOT OVERTIGHTEN.
6. Lower vehicle. Refill crankcase with proper amount and grade of lubricant if necessary. Start the engine; operate it at fast idle and check for oil leaks. If leakage is indicated perform necessary repairs to correct the condition.

REMOVAL AND INSTALLATION OF FLYWHEEL, REAR OIL PASSAGE PLUGS AND CAMSHAFT REAR BEARING PLUG — ENGINE IN VEHICLE

Removal

1. Remove converter housing to cylinder block upper attaching bolts.
2. Raise vehicle. Remove converter lower access plate and converter front access plate.
3. Remove transmission filler pipe and drain transmission.
4. Disconnect rear universal at rear axle and remove drive shaft.
5. Remove clip and pin retaining parking brake equalizer to equalizer bracket. Remove nut retaining the equalizer to parking brake cable. Allow cable to hang loosely below car.
6. Remove transmission control linkage shield. Disconnect throttle linkage arm at throttle lever. Remove manual cable access cover plug to disconnect manual cable. Remove manual cable clamp screw. Disengage manual cable spring clip through access plug hole in transmission and lift cable up to remove. Disengage park release cable from arm.
7. Remove clip securing parking brake cable to rear engine support crossmember. Remove parking brake cable.
8. Disconnect wire at reverse lockout assembly. Disconnect speedometer cable from transmission.
9. Disconnect transmission oil transfer lines at transmission. Disconnect starter cable at starter. Remove spark plug wiring loom grommet. Remove starter assembly.

10. Remove nuts securing the left muffler exhaust inlet pipe to the exhaust manifold. Remove left muffler outlet pipe from support bracket and insulator assembly at rear of muffler. Move exhaust system away from area of frame crossmember.
11. Remove two screws securing the transmission rear engine support to the transmission. Install a transmission support stand under transmission. Remove bolts securing engine support crossmember to frame side rails. Remove support crossmember.
12. Remove screws retaining flywheel to converter cover. (Early production flywheels are attached to converter with six cap screws. The new type flywheels are secured with four cap screws.)
    NOTE: To prevent damage to converter assembly, when transmission is removed, make sure the converter is retained within the converter housing with a clip (fabricate a clip for this purpose). Remove remaining screws securing converter housing to cylinder block, then move the transmission back far enough to clear the flywheel.
13. Remove the flywheel to crankshaft retaining screws and remove the flywheel (Flex-Type).
14. To remove and replace the converter cover assembly, refer to the "Lincoln and Mercury Automatic Transmission Repair and Adjustment Manual" Form LM-4613–Nov., 1954.
15. REAR OIL PASSAGE PLUG REPLACEMENT:
    a. Remove six screws securing flywheel to crankshaft. Remove flywheel.
    b. If oil leakage is indicated at rear oil passage plugs, remove plug. Inspect bore for stripped or improperly machined threads.
    c. If threads are stripped, thread the hole a little deeper into the bore with a tap. This will allow the plug to seat further in the cylinder block.
    d. Coat a new plug with an oil resistant sealer and install plug.
16. CAMSHAFT REAR BEARING PLUG REPLACEMENT:
    If oil leakage is indicated at camshaft bearing plug, replace plug as follows:
    a. Drill a 1/2" hole in center of camshaft bearing plug, then remove plug with Clutch Pilot Bearing Removing Tool 7600-E.
    b. Clean the camshaft bearing bore to remove scale, rust and old sealing compound. Check the bore for cracks or sand holes.
    c. Coat edges of new camshaft bearing plug with a suitable oil resistant sealing compound. Install the plug, with flange side facing in, using Tool 6266-C.
17. REAR OIL LINE PLUG REPLACEMENT:
    If oil leakage is indicated at rear oil line plug, replace plug as follows:
    a. Drill a 1/2" hole in center of plug. Pry out remnant of plug with a screwdriver.
    b. Clean the bore to remove scale, rust and old sealing compound. Check the bore for cracks or sand holes.
    c. Coat edges of new plug with a suitable oil resistant sealing compound. Install the plug, with flange side facing in, using Tool 6015-H.

Installation

1. Install flywheel on crankshaft. Tighten attaching screws 75-85 lbs. ft. torque.
2. Align converter housing mounting screw holes with the dowels in cylinder block. Align converter drain plugs with access slots in the flywheel. Install two lower cylinder block to converter housing mounting bolts. Tighten bolts 40-50 lbs. ft. torque.
3. Remove clip securing converter assembly in the housing. Install flywheel to converter attaching bolts. Tighten bolts to 25-28 lbs. ft. torque.
4. Install rear engine support crossmember on frame side rails. Secure the transmission to rear engine support insulator and crossmember.
5. Clean gasket surfaces of muffler exhaust inlet pipe and exhaust manifold. Using a new gasket, secure the exhaust inlet pipe to exhaust manifold. Tighten nuts to 34-42 lbs. ft. torque.
6. Connect reverse lockout switch wire to reverse lockout switch. Install speedometer cable.
7. Route manual brake cable through frame crossmember and secure to crossmember with retaining clip. Connect parking brake cable to equalizer lever. Secure lever to crossmember with a clevis pin. Install spring and adjust cable.
8. Install drive shaft in transmission. Install drive shaft on rear universal joint. Tighten retaining nuts to 15-18 lbs. ft. torque.
9. Install dust seal and starter. Install spark plug wiring loom grommet. Install starter cable.
10. Connect oil filler tube to transmission. Tighten jam nut to 40-50 lbs. ft. torque. Install oil filler tube bracket. Connect transmission oil transfer lines to transmission fittings. Tighten jam nut to 15-20 lbs. ft. torque.
11. Install transmission front cover and lower access cover.
12. Install and adjust transmission manual cable, park release cable and throttle linkage. Make complete linkage and cable adjustments. Refer to "Merc-O-Matic Transmission" section of manual for correct adjustment procedures. Install transmission linkage splash shield.

13. Lower vehicle. Remove dowel pins from cylinder block, then install two upper transmission to cylinder block mounting bolts. Tighten bolts to 40-50 lbs. ft. torque.
14. Fill transmission to required level on dipstick with type "A" transmission fluid. Start engine to fill torque converter. Add fluid to bring the fluid level to the correct height on dipstick.
15. Operate engine at fast idle and check for leaks. Shift transmission through all ranges including "Park". Check and adjust transmission linkage, throttle linkage, engine idle speed and carburetor dashpot.

REMOVAL AND INSTALLATION OF INTAKE MANIFOLD — ENGINE IN VEHICLE

Removal

1. Drain cooling system. Remove air cleaner and air duct as an assembly. Disconnect battery ground cable.
2. Disconnect distributor vacuum line at distributor and carburetor. Disconnect fuel inlet line at carburetor.
3. Disconnect upper radiator hose from water outlet connector. Disconnect water by-pass hose from water outlet connector.
4. Disconnect windshield wiper hose at vacuum booster line. Disconnect temperature sending unit wire at sending unit.
5. Disconnect vacuum line from automatic starter cut-out switch and intake manifold connector fitting. Disconnect brake vacuum booster line at intake manifold connector.
   NOTE: If vehicle is equipped with power brake unit, disconnect power brake vacuum line at manifold connector.
6. Disconnect carburetor to control shaft rod at carburetor. Remove accelerator retract springs. Remove screws securing control shaft assembly and accelerator shaft bracket to intake manifold.
7. Remove screws, nuts and washers securing intake manifold to cylinder head. Remove intake manifold and gaskets.

Disassembly, Inspection and Assembly

If replacement of the intake manifold is necessary (or inspection in greater detail is required), the following bench operations are required before installation of a new assembly.

1. Remove water outlet connection housing. Remove thermostat.
2. Remove carburetor, gaskets and spacer. Remove four carburetor mounting studs from manifold.
3. Remove automatic choke inlet and outlet fittings from manifold. Remove vacuum booster connector from manifold.
4. Remove water temperature sending unit.
5. Clean old gasket material from cylinder heads and intake manifold. Inspect for cracks, leaks or blocked passages. Replace manifold if necessary.
6. Clean new intake manifold and inspect all passages for leaks and cracks.
7. Install vacuum booster connector in intake manifold (use sealer).
8. Install automatic choke inlet and outlet fittings in intake manifold.
9. Install four carburetor mounting studs in the intake manifold riser. Install spacer and two new gaskets (one on each side of spacer).
10. Install carburetor.
    NOTE: When tightening mounting nuts, first snug down all nuts, then tighten them alternately in a criss-cross pattern to 12-15 lbs. ft. torque.
11. Install water temperature sending unit (use sealer on threads).
12. Install thermostat and water outlet connection housing. Tighten screws to 23-28 lbs. ft. torque.

Installation

1. Install new intake manifold gaskets and intake manifold.
   NOTE: When installing manifold and gaskets, make up pilot studs to hold gaskets in position. Use 3/8"-16 screws to make pilot studs.
2. Position the manifold clamps and washers; install manifold retaining screws and nuts, tighten to 23-28 lbs. ft. torque, working on each side alternately from center toward ends.
3. Install and secure control shaft assembly and accelerator shaft bracket to intake manifold. Install accelerator retract springs. Connect carburetor to control shaft rod to carburetor.
4. If vehicle is equipped with power brake unit, connect power brake vacuum line to intake manifold connector. Connect vacuum booster line to intake manifold connector. Connect vacuum line to starter cut-out switch and intake manifold connector.
5. Connect temperature sending unit wire to sending unit.
6. Connect windshield hose to vacuum booster line.
7. Install a new gasket and connect water by-pass hose to water outlet connector. Connect upper radiator hose to connector.
8. Connect fuel inlet line to carburetor. Connect distributor vacuum line to carburetor and distributor. Connect battery ground cable to battery.
9. Close petcocks and fill cooling system with cool-

ant. Start engine and run it until it is thoroughly warm. While engine is running check for leaks.
10. With engine running, check timing and timing advance. Make necessary carburetor adjustments, then adjust transmission linkage.
11. Install air cleaner and air duct assembly.

REMOVAL AND INSTALLATION OF AUTOMATIC CHOKE CONTROL HEAT TUBE – ENGINE IN VEHICLE

If the automatic choke control fresh air heat tube in the intake manifold is cracked or broken, the automatic choke will not function properly.

To check for a broken or cracked heat tube; remove carburetor air cleaner; remove choke cover and look inside. If parts appear burned or covered with carbon, the heat tube should be replaced. In some cases dust will be found in the choke cover. This is normal and does not mean the choke is defective or the heat tube is leaking.

Removal

1. Remove intake manifold. (Refer to steps 1 through 7 of "Intake Manifold Removal" procedures in this section of manual.)
2. Remove carburetor and choke assembly from manifold. Refer to "Fuel Section" of this manual for instructions regarding the cleaning and repair of automatic choke and carburetor. Remove fittings at each end of heat tube (pry or twist out).
3. Drive the small end of the heat tube, located on the right hand side of manifold, back into the manifold with a flat end pin punch.
   NOTE: If the large end of the tube does not come out the opposite side of manifold, the tube is probably bent or broken off. In this case, the large end should also be driven into the manifold. Remove the tube, or pieces out through the manifold heat riser chamber. This can usually be accomplished by shaking the manifold. If it does not fall out, make a hook out of wire and remove pieces.

Installation

NOTE: Before installing the new heat tube, check manifold right hand bore to see if small end of the new tube fits easily. If the hole is too small, it should be reamed to provide a slip fit. A 5/16 inch expansion reamer, with the adjusting screw removed, can be used for the operation. It is important not to ream the hole too large or there will be an exhaust leak.

1. Insert the small end of thc heat tube through the large bore in the left side of manifold. Line the tube up using a 1/4 inch pin punch in the small bore in the right side. Drive the tube in place.
   NOTE: The tube ends will stick out approximately 1/16 inch on each side of manifold.
2. To check installation, adjust a vacuum pump to three inches of vacuum. Block off one opening of heat tube with a moistened finger, then connect the vacuum 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.
3. Install fittings on each side of heat tube. Do not dislodge the heat tube when these fittings are installed.
4. Using new gaskets, install carburetor, spacer and automatic choke assembly. Alternately torque retaining nuts in a criss-cross pattern to 12-15 lbs. ft. torque. Connect carburetor fuel and vacuum line.
5. Install intake manifold. Refer to "Removal and Installation of Intake Manifold" in this section of manual and perform steps 1 though 11 of "Intake Manifold Installation" procedures.

REMOVAL AND INSTALLATION OF VALVE PUSH ROD CHAMBER COVER – ENGINE IN VEHICLE

Removal

1. Remove intake manifold assembly. Refer to "Removal and Installation of Intake Manifold – Engine in Vehicle" in this section of manual.
2. Clean top of valve push rod chamber cover to prevent foreign material from falling into push rod chamber. Remove cover and gasket.

Inspection

1. If oil leakage is indicated, inspect valve push rod chamber cover for a warped or bent condition. Replace cover if damaged.
2. Clean crankcase ventilation screen.
3. Remove old gasket material from chamber cover and cylinder block mounting surface.

Installation

1. Install a new valve push rod chamber cover gasket on cylinder block. Install push rod chamber cover and new seals. Tighten retaining nut to 2-2½ lbs. ft. torque.
2. Install intake manifold. Refer to "Installation of Intake Manifold" in this section of manual.

REMOVAL AND INSTALLATION OF RIGHT EXHAUST MANIFOLD –ENGINE IN VEHICLE

Removal

1. Disconnect the muffler inlet pipe from exhaust manifold. Remove exhaust manifold to cylinder

head retaining screws, washers, spacers and heat shields.
2. Remove exhaust manifold, exhaust gas control valve and gaskets as an assembly.
3. Clean the exhaust manifold, cylinder head, exhaust control valve, and inlet pipe mating surfaces. Replace stripped or broken studs. Inspect manifold for sand holes, cracks, restricted passages, and improperly machined surfaces. If damaged condition cannot be corrected, replace manifold.

Installation

1. Clean and inspect new manifold. Coat mating surfaces of the manifold with a light film of graphite grease. Start the rear retaining screw and lockwasher into the cylinder head. Install the manifold on the rear retaining screw, then install the remaining screws, spacers, washers and heat shields.
2. Tighten the retaining screws, working alternately from the center to the ends, to 23-28 lbs. ft. torque.
3. Using new gaskets on both sides, install exhaust control valve. Connect the muffler inlet pipe. Tighten nuts to 34-42 lbs. ft. torque. Start engine; check for leaks.

REMOVAL AND INSTALLATION OF LEFT EXHAUST MANIFOLD — ENGINE IN VEHICLE

Removal

1. Remove screws securing fresh air heat duct connector to fender apron. Loosen nut securing heat duct to bracket on exhaust manifold. Loosen screw securing air cleaner. Remove duct and air cleaner as an assembly.
2. Disconnect muffler inlet pipe from exhaust manifold.
3. Remove exhaust manifold to cylinder head retaining screws, lockwashers, spacers, spark plug heat shields and air duct mounting bracket. Remove exhaust manifold.
4. Clean the exhaust manifold, cylinder head and inlet pipe mating surfaces. Replace broken or stripped studs. Inspect manifold for sand holes, cracks, restricted passages and improperly machined surfaces. If damaged condition cannot be corrected, replace manifold.

Installation

1. Clean and inspect new manifold. Coat mating surfaces of manifold with a light film of graphite grease. Start the exhaust manifold to cylinder head rear retaining screw and lockwasher into the cylinder head. Install the manifold on rear retaining screw, then install the remaining screws, washers, spacers, spark plug heat shields, and air duct mounting bracket.
2. Tighten the retaining screws, working alternately from the center to the ends, to 23-28 lbs. ft. torque.
3. Using a new gasket between manifold and muffler inlet pipe, connect inlet pipe and tighten nuts to 34-42 lbs. ft. torque. Start engine; check for leaks. Stop engine.
4. Install air cleaner and duct.
5. Start engine. Check system for leaks.

REMOVAL AND INSTALLATION OF HYDRAULIC TAPPETS — ENGINE IN VEHICLE

Removal

1. Drain cooling system. Remove air cleaner and air duct as an assembly. Disconnect battery ground cable.
2. Disconnect distributor vacuum line at distributor and carburetor. Disconnect fuel inlet line at carburetor.
3. Disconnect upper radiator hose from water outlet connector. Disconnect water by-pass hose from water outlet connector.
4. Disconnect windshield wiper hose at vacuum booster line. Disconnect temperature sending unit wire at sending unit.
5. Disconnect vacuum line from automatic starter cut-out switch and intake manifold connector fitting. Disconnect vacuum booster line at intake manifold connector.
   NOTE: If vehicle is equipped with power brake unit, disconnect power brake vacuum line at manifold connector.
6. Disconnect carburetor to control shaft rod at carburetor. Remove accelerator retract springs. Remove screws securing control shaft assembly and accelerator shaft bracket to intake manifold.
7. Remove screws, nuts and washers securing intake manifold to cylinder head. Remove intake manifold and gaskets.
8. Remove rocker arm covers and gaskets.
9. Remove valve push rod chamber cover and gasket.
10. Loosen rocker arm adjustment screws to remove tension on push rods.
    NOTE: It is necessary to remove the tension to prevent the possibility of bending the push rods or damaging rocker arm shaft.
11. Remove six screws and two nuts securing rocker arm and shaft assembly to cylinder head. Remove oil overflow pipe from the assembly.
12. Lift up rocker arm assembly to remove it from cylinder head.
13. Remove push rods from cylinder heads. Index the

push rods to their respective bores for inspection and replacement purposes.

14. Remove hydraulic tappets from cylinder block using Tool 6500-D.
    NOTE: Keep tappets in order as removed so they may be reinstalled in their original bores if inspection reveals a satisfactory condition.

Cleaning and Inspection

The hydraulic lifter assembly consists of a lock-ring body plunger, valve disc, retainer, springs, and push rod cup. A disassembled view is shown in figure 6C-22.

When the tappet assemblies were removed from the engine, it was stated to keep the assemblies in proper sequence so they could be reinstalled in their original position, providing, of course, their condition proves to be satisfactory when inspected. It is recommended therefore, that each unit be disassembled, inspected and tested separately so as not to mix the internal parts, as each assembly is a matched set. Mixing these parts will likely cause improper operation.

The operation of these hydraulic tappet assemblies is similar in principle to the type in previous models. See figure 6C-23.

All tappet assemblies should be immersed in clean solvent to remove all traces of carbon or varnish. Varnish or carbon ring in the top of the body can be removed by soaking unit and wiping deposit to remove. Never cut or scrape carbon to remove. Discard tappet if body shows evidence of pitting, scoring, galling or evidence of non-rotation and/or irregular rotation.

Using needle nose pliers, remove the lock ring from top of lifter body. Remove push rod cup. Remove plunger using Tool 6500-F. Remove valve disc and spring, then remove remaining spring from body. Soak all parts in solvent.

After cleaning each assembly, inspect all surfaces of parts for scratches or other defects. Do not lubricate the surface of the parts.

To assemble unit, place push rod cup upside down on bench. Install plunger on push rod cup. Next, place valve disc, spring, and retainer on plunger, then set large spring on valve disc retainer. Place body over assemblies and push body down over plunger. Pick assembly up (still upside down) and push plunger and push rod cup up into body. After units are positioned, turn assembly right side up and install lock-ring using Tool 6500-C. See figure 6C-24.

Assembled tappets can be tested with a tappet tester to check the leak down rate. This test will determine if the unit will operate satisfactory in the engine.

1. Place the tappet in the tester with plunger facing up. Special hydraulic test fluid is then poured into

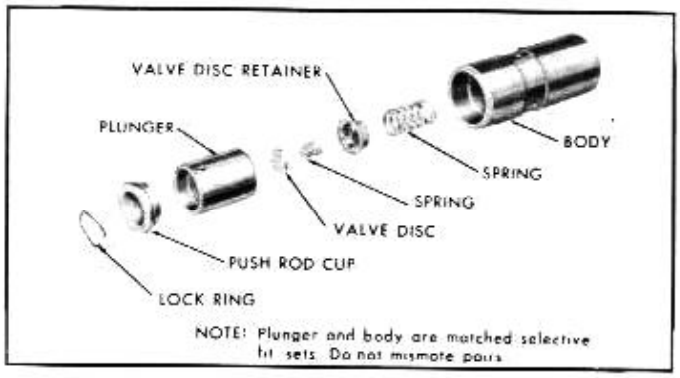


Fig. 6C-22—Disassembled Hydraulic Tappet Assembly

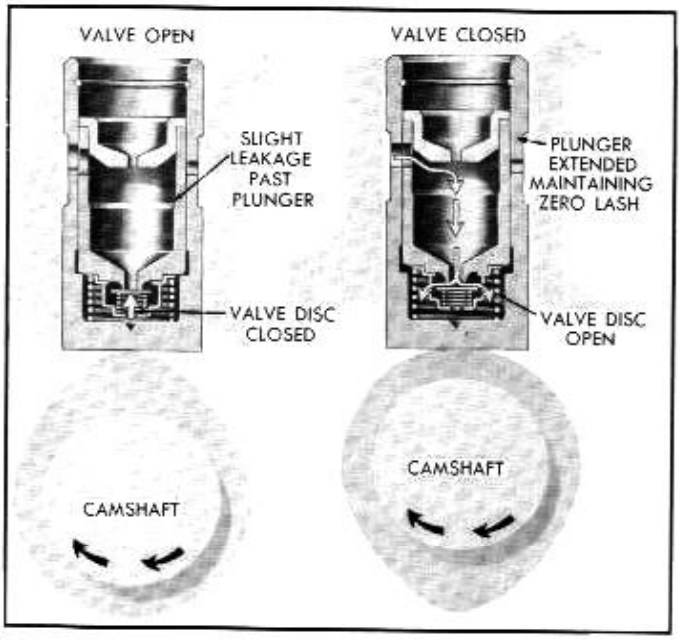


Fig. 6C-23—Operation of Hydraulic Tappet Assembly

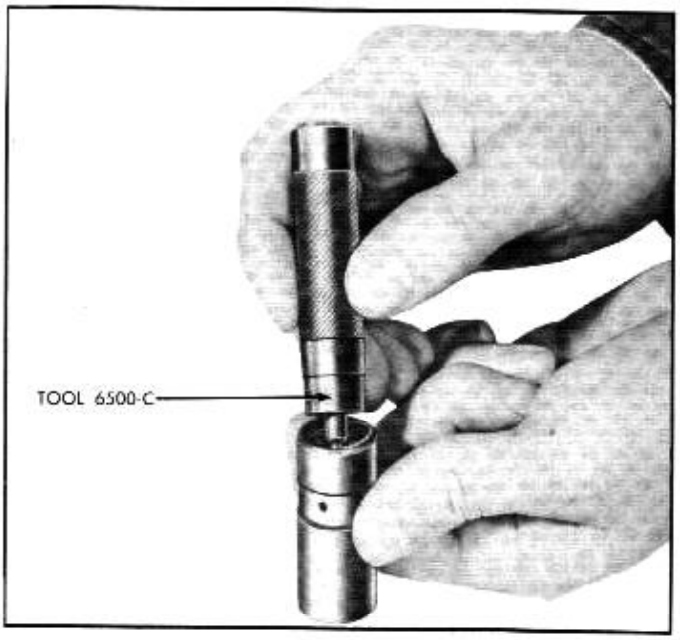


Fig. 6C-24—Installing Snap Ring

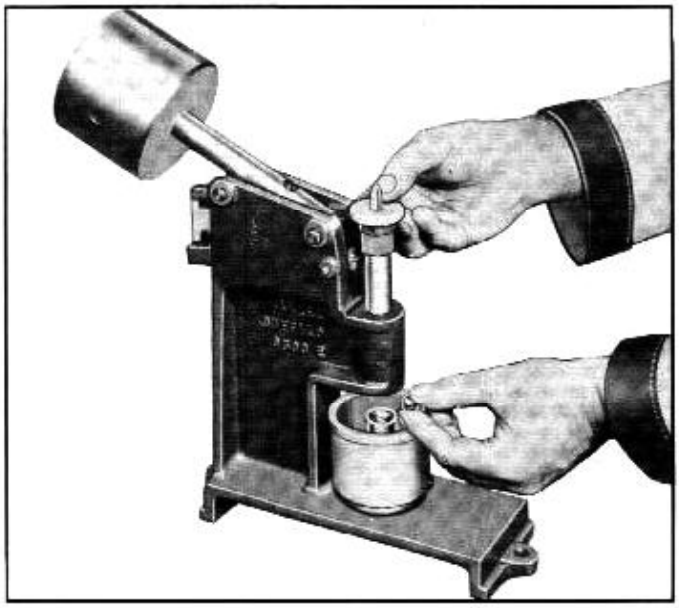


Fig. 6C-25—Placing Steel Ball on Plunger — Typical

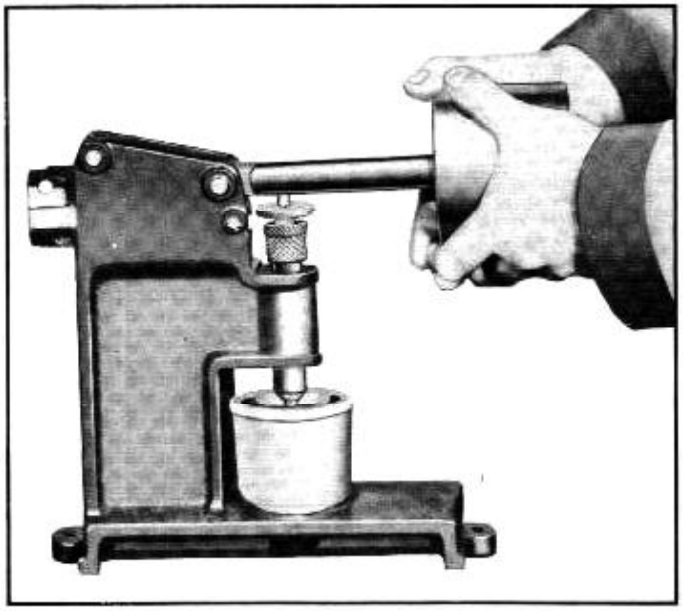


Fig. 6C-27—Working Plunger Until Air Bubbles Disappear

the cup to a level that will cover the tappet assembly. (Fluid can be purchased from Manufacturer of Tester.)

NOTE: Do not use kerosene as it will not provide an accurate test.

2. Place a five-sixteenth inch steel ball in the plunger cup. See figure 6C-25.
3. Adjust the length of the ram so that the pointer is in line with the starting mark when the ram just contacts the tappet plunger. See figure 6C-26.
4. Work the tappet plunger up and down until it fills with fluid. Repeat this operation until all traces of air bubbles disappear. See figure 6C-27.
5. Then let the ram and the weight force the plunger downward and measure the exact time it takes for the pointer to travel from the "START TIMING" mark to the "STOP TIMING" mark. See figure 6C-28.
6. A used tappet that is satisfactory must take at least 6 seconds to leak down but not more than 45 seconds, while a new tappet requires at least 10 seconds, but not more than 45 seconds to leak down.

There are three contributing factors to hydraulic tappet failure.

1. DIRT
2. DEPOSITS OF GUM AND VARNISH
3. AIR BUBBLES IN THE LUBRICATING OIL

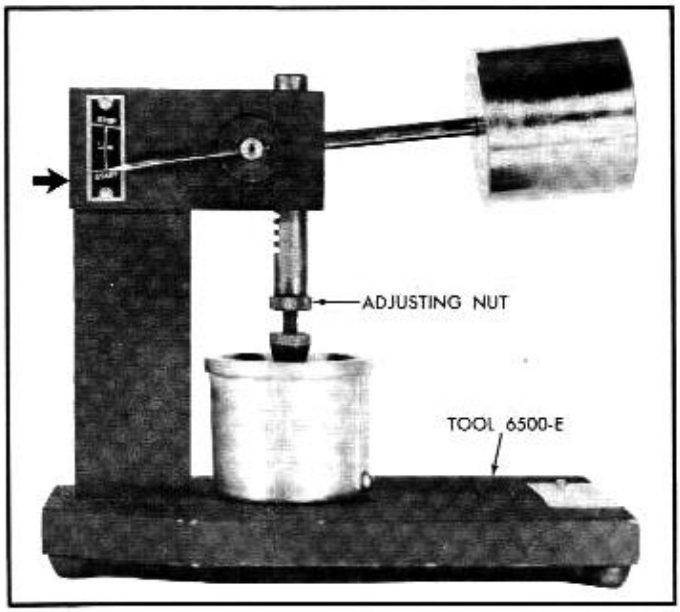


Fig. 6C-26—Adjusting Length of Ram — Typical

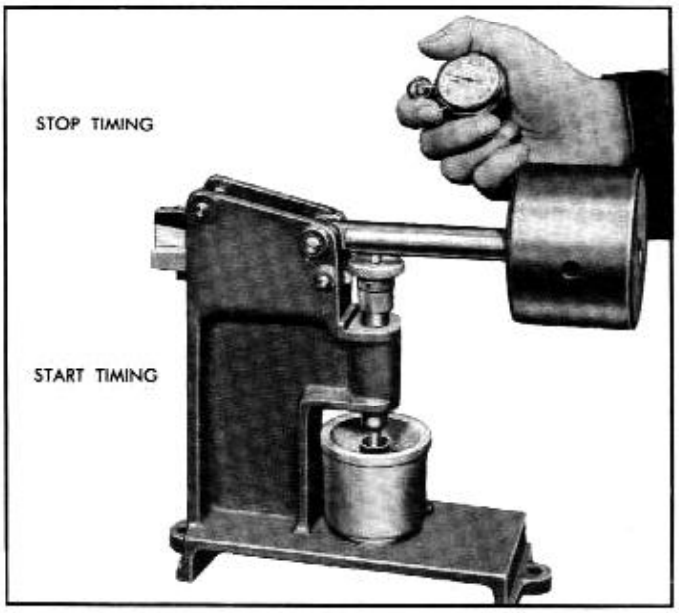


Fig. 6C-28—Checking Leak Down Rate

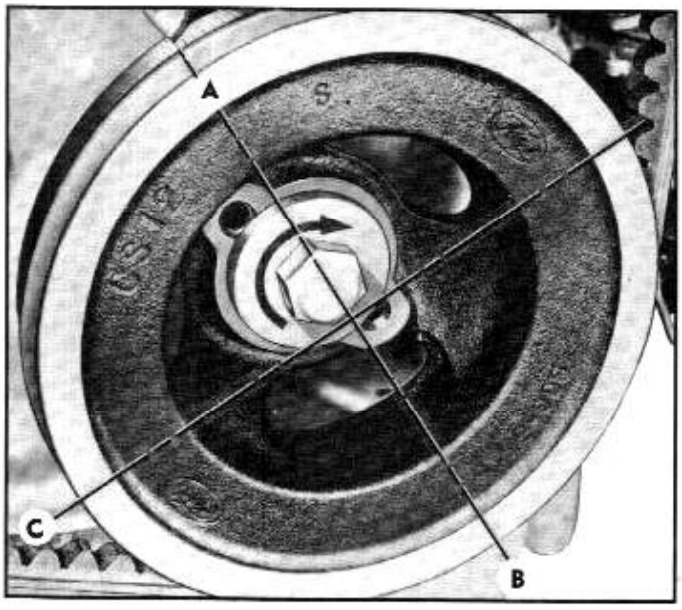


Fig. 6C-29—Quadrant for Valve Clearance Adjustment — Typical

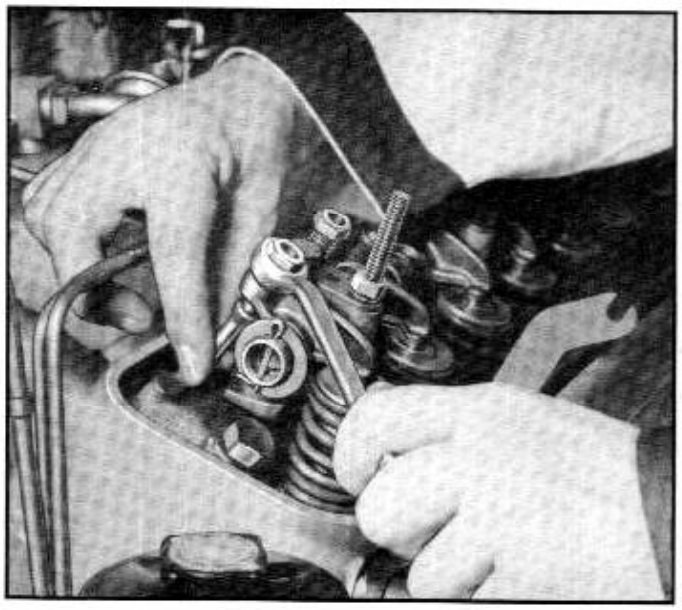


Fig. 6C-30—Valve Clearance Adjustment

Dirt can keep a check valve from seating, causing the plunger to force oil back into the tappet reservoir during the time the push rod is being lifted to force the valve from its seat. Thus the tappet would lose its hydraulic pressure and could not maintain zero tappet clearance.

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

A check for air in the oil system can be made by observing the oil flow from the rocker arm oil outlet tubes of each bank while the engine is running.

NOTE: When installing assemblies into the engine, do not fill lifter body cylinder with oil. The tappets will fill with oil much quicker after the engine is started, if they are free of an oil film which may cause an oil seal between the plunger and body cylinder.

It is recommended to run the engine during the time that the hydraulic tappets are being filled, about the equivalent of an ordinary fast idle. The tappets will fill more quickly if you avoid excessive engine speeds.

Installation

1. Install the respective hydraulic tappets into the bores from which they were removed or fitted to. NOTE: Coat outside of tappets with engine oil before installation to furnish initial lubrication.
2. Install push rods in cylinder block bores from which they were removed. Make certain they are properly seated in the tappets.
3. Install respective rocker arm and shaft assemblies. Install stiffener plates and tighten retaining screws and nuts to 22-23 lbs. ft. torque. When installing oil overflow pipes, right bank pipe goes to the front and left bank pipe goes to rear of respective rocker arm supports.

   CAUTION: *Make sure pipe enters hole in rocker arm support and shaft.*
4. Remove wire from "S" terminal of starter relay switch. Connect an auxiliary starter cable on "S" terminal of starter relay and positive terminal of battery.
5. 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. Adjust valve clearance as follows:
   a. Check rocker arm adjusting screw torque by turning all tappet adjusting screws until interference is noted, then check the torque required to turn the screw further.
   b. If the torque required to turn the screw is less than 3 lbs. ft. (36 pounds inch), replace the rocker arm and adjusting screw.
   c. Make three chalk marks on the crankshaft damper, space the marks approximately 90° apart so that with the timing mark, the damper is divided into four equal parts (90° represents 1/4 of the distance around the damper circumference). See figure 6C-29.
   d. Rotate the crankshaft, using the auxiliary starter switch, until number 1 piston is near T.D.C. at the end of the compression stroke. To adjust valve clearance of the following valves, shown in the table which follows, turn adjusting screw clockwise while moving push rod up and down, until slack is removed. See figure 6C-30.

IMPORTANT: Plunger unit of tappet should not be forced down into tappet body during this operation.

With the slack removed, turn adjusting screw clockwise an additional 2½ turns. Repeat operation until all tappets are adjusted.

CAUTION: *To eliminate any possibility of bending a push rod, force each tappet to leak down after adjustment by pressing on the push rod end of the rocker arm.*

Number 1 piston on T.D.C.

No. 1 – Exhaust	No. 1 – Intake
No. 4 – Exhaust	No. 2 – Intake
No. 5 – Exhaust	No. 7 – Intake

Rotate the crankshaft 180° or 1/2 turn (this puts number 4 piston on T.D.C.), then adjust the following valves:

No. 6 – Exhaust	No. 4 – Intake
No. 8 – Exhaust	No. 5 – Intake

Rotate the crankshaft 270° or 3/4 turn from 180° mark (this puts number 3 piston on T.D.C.), then adjust the following valves:

No. 2 – Exhaust	No. 3 – Intake
No. 3 – Exhaust	No. 6 – Intake
No. 7 – Exhaust	No. 8 – Intake

NOTE: If tappet is noisy during vehicle's operation, adjustment can be varied by turning adjusting screw ± 1/2 turn from the original 2½ turn setting.

6. Install a new valve push rod chamber cover gasket on cylinder block. Install push rod chamber cover and new seals. Tighten retaining screws to 2-2½ lbs. ft. torque.
7. Install new rocker arm cover gaskets in covers. Install rocker arm covers on cylinder head using new seals. Tighten nuts to 2-2½ lbs. ft. torque.
8. Remove auxiliary starter cable from starter relay switch and battery. Connect previously removed wire to "S" terminal of starter relay switch.
9. Install new intake manifold gaskets and intake manifold.
   NOTE: When installing manifold and gaskets, make up pilot studs to hold gaskets in position. Use 3/8"-16 screws to make pilot studs.
10. Position the manifold clamps and washers; install manifold retaining screws and nuts and tighten them to 23-28 lbs. ft. torque, working on each side alternately from center toward ends.
11. Install and secure control shaft assembly and accelerator shaft bracket to intake manifold. Install accelerator retract springs. Connect carburetor to control shaft rod to carburetor.
12. If vehicle is equipped with power brake unit, connect power brake vacuum line to intake manifold connector. Connect vacuum booster line to intake manifold connector. Connect vacuum line to starter cut-out switch and intake manifold connector.
13. Connect temperature sending unit wire to sending unit.
14. Connect windshield wiper hose to vacuum booster line.
15. Install a new gasket and connect water by-pass hose to water outlet connector. Connect upper radiator hose to connector.
16. Connect fuel inlet line to carburetor. Connect distributor vacuum line to carburetor and distributor. Connect battery ground cable to battery.
17. Close petcocks and fill cooling system with coolant. Start engine and run it until it is thoroughly warm. While engine is running check for leaks.
18. With engine running, check timing and timing advance. Make necessary carburetor adjustments, then adjust transmission linkage.
19. Install air cleaner and air duct assembly.

REMOVAL AND INSTALLATION OF CYLINDER FRONT COVER, TIMING CHAIN, CAMSHAFT AND CRANKSHAFT SPROCKETS – ENGINE IN VEHICLE

Removal

1. Raise vehicle, drain oil and remove oil pan. Refer to "Removal and Installation of Oil Pan–Engine in Vehicle" in this section of manual.
2. Lower vehicle. Open radiator and cylinder block petcocks and drain cooling system.
3. Remove hood assembly from hood hinge.
   NOTE: If hood assembly is properly aligned, index hood hinge to hood assembly for installation purposes.
4. POWER STEERING EQUIPPED VEHICLES:
   a. Without disconnecting hoses, remove power steering pump assembly from mounting bracket.
   b. Remove belt and position power steering unit against fender apron in a manner that will prevent fluid from draining out of reservoir.
5. Disconnect lower radiator hose from water pump. Disconnect transmission inlet and outlet oil transfer lines at lower radiator tank.
6. Disconnect upper radiator hose at connector. Disconnect water by-pass tube at connector.
7. Place a piece of heavy cardboard or fibre board over radiator core to prevent damage when removing radiator. Remove attaching screws and remove radiator assembly.
8. Remove screws securing fan assembly, spacer, and water pump pulley to water pump pulley

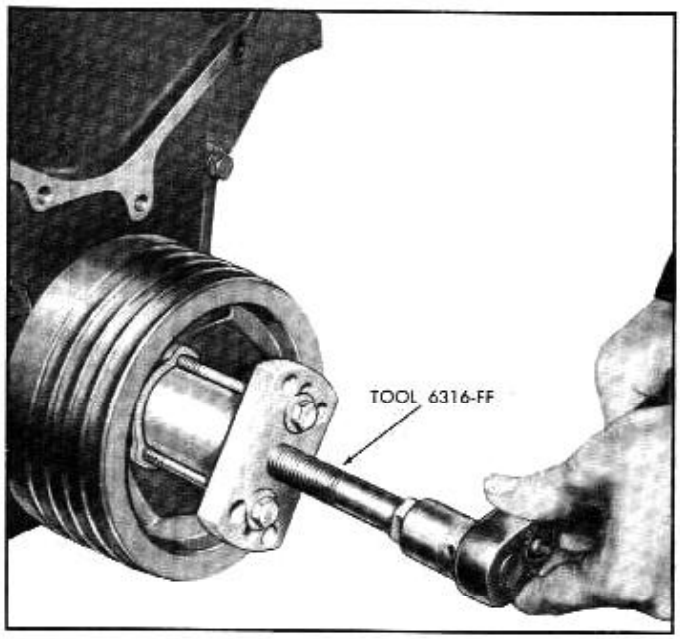


Fig. 6C-31—Removing Crankshaft Damper Assembly

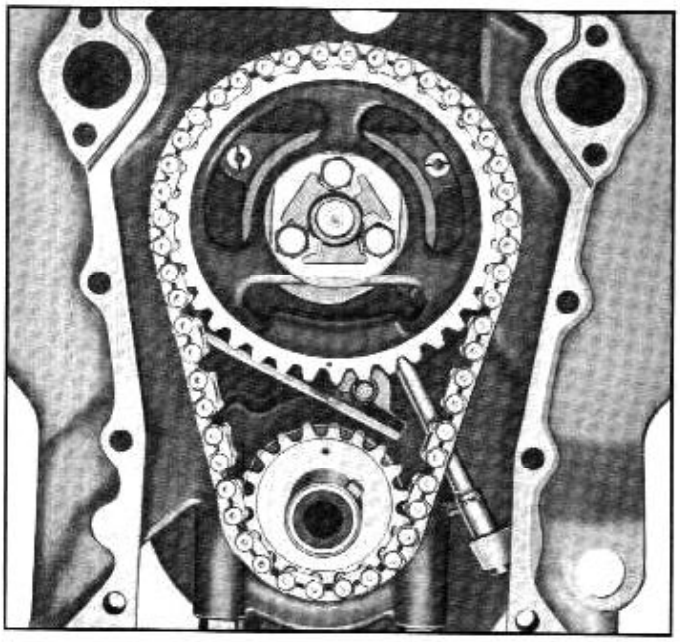


Fig. 6C-32—Alignment of Timing Marks

hub. Remove component parts as a unit. Remove fan-generator belts.

9. Remove screw and washer securing crankshaft damper to crankshaft. Remove crankshaft damper with Tool 6316-FF. See figure 6C-31. Remove Woodruff key from crankshaft.
10. Disconnect the vacuum lines, gas line and flexible fuel line from fuel pump, then remove fuel pump from block.
11. Disconnect and remove generator brackets, oil filler and road draft tube mounting bracket, and timing indicator from front cover.

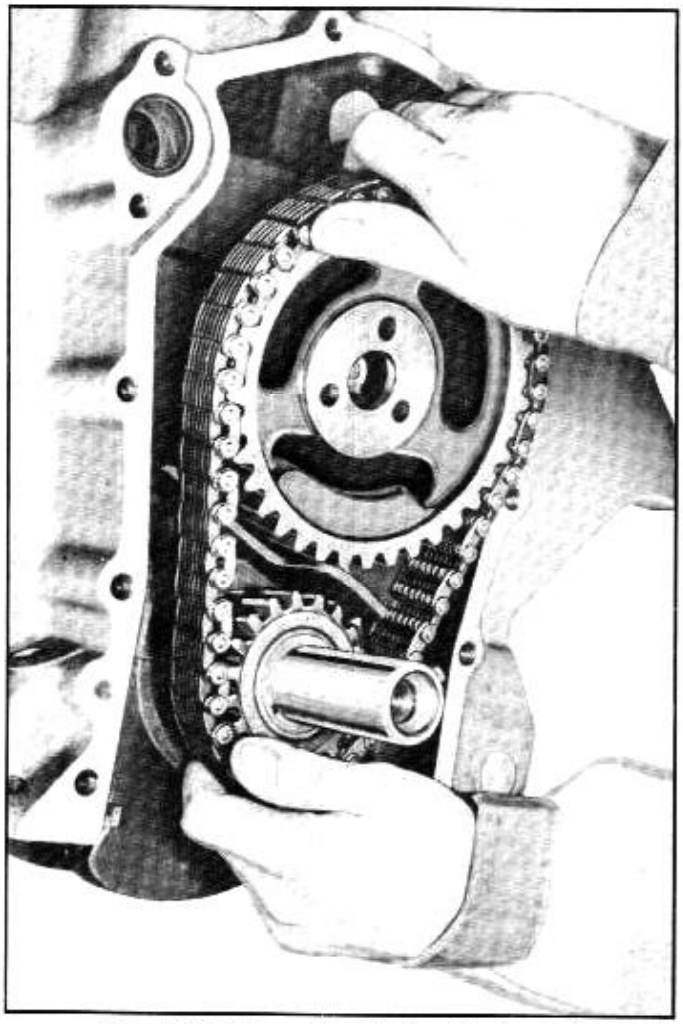


Fig. 6C-33—Removing Timing Chain and Camshaft Sprocket

12. Remove oil filler and road draft tube.
13. Remove water pump retaining screws, then remove water pump and power steering pump mounting bracket (if vehicle is so equipped) from cylinder front cover.
14. Remove cylinder block front cover and gasket.
    NOTE: When removing front cover, use care to prevent damage to cylinder front cover seal.
15. Remove camshaft thrust plunger and thrust spring from front end of camshaft.
16. Align timing mark on crankshaft sprocket with that of the camshaft sprocket. See figure 6C-32. Remove screws and lock plate from camshaft sprocket. Remove camshaft sprocket and timing chain. See figure 6C-33. Remove crankshaft sprocket using Tool 6306-AE. See figure 6C-34.
17. Remove camshaft eccentric sleeve from camshaft.
18. Using Tool 9400-B, remove snap ring retainer from fuel pump push rod and remove rod. See figure 6C-35.
    NOTE: Adjust tool opening by setting screw so snap ring just clears push rod.

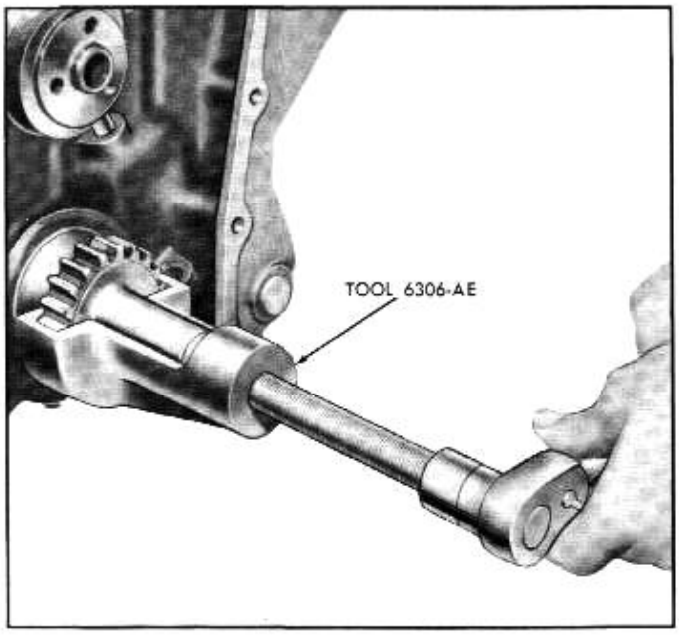


Fig. 6C-34—Removing Crankshaft Sprocket

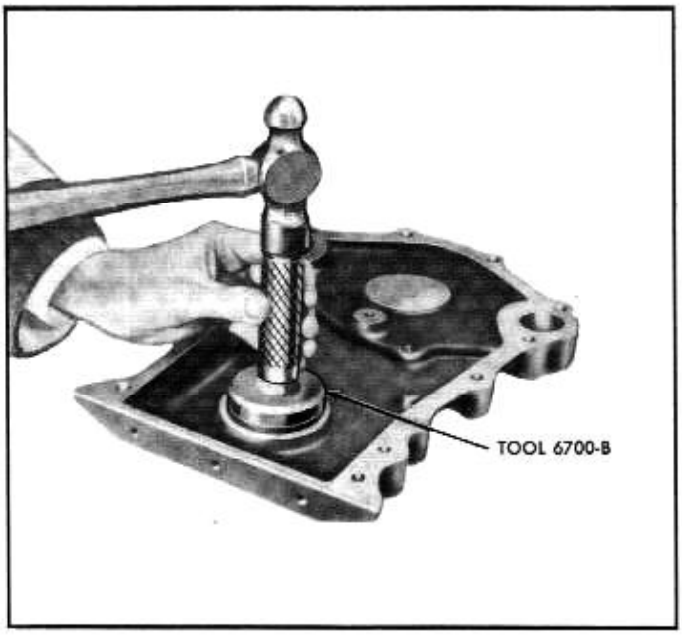


Fig. 6C-36—Installing Front Cover Seal

Inspection

1. Inspect camshaft sprocket, crankshaft sprocket and timing chain for signs of wear, chipped teeth or other damage.
   NOTE: It is recommended that all parts be replaced when either of the sprockets or the chain require replacement.
2. Inspect cylinder front cover for cracks, sand holes, nicks or burrs. Replace front cover if it is damaged beyond repair.
3. If front cover leaked at seal, install new crankshaft front oil seal using Tool 6700-B. See figure 6C-36. Coat seal with lubricant to facilitate installation. NOTE: When installing the new seal, place seal on tool. Center seal and tool over front cover boss and drive in until seated. Make sure spring on inside of seal is properly seated.
4. If water leakage at front cover is indicated, it will be necessary to replace the oil previously drained from crankcase. Clean oil pan, clean gasket mating surface of cylinder block and oil pan.
5. Inspect fuel pump push rod and camshaft eccentric sleeve for damage. Replace damaged parts.

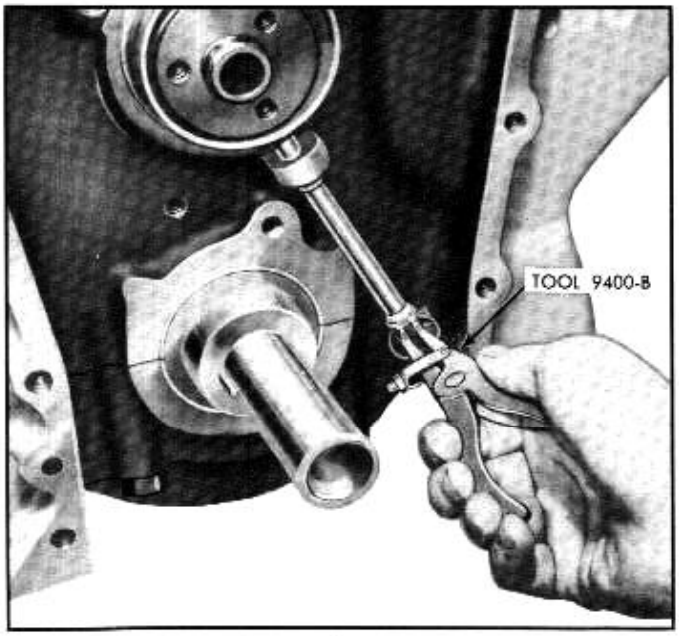


Fig. 6C-35—Removing Fuel Pump Snap Ring Retainer

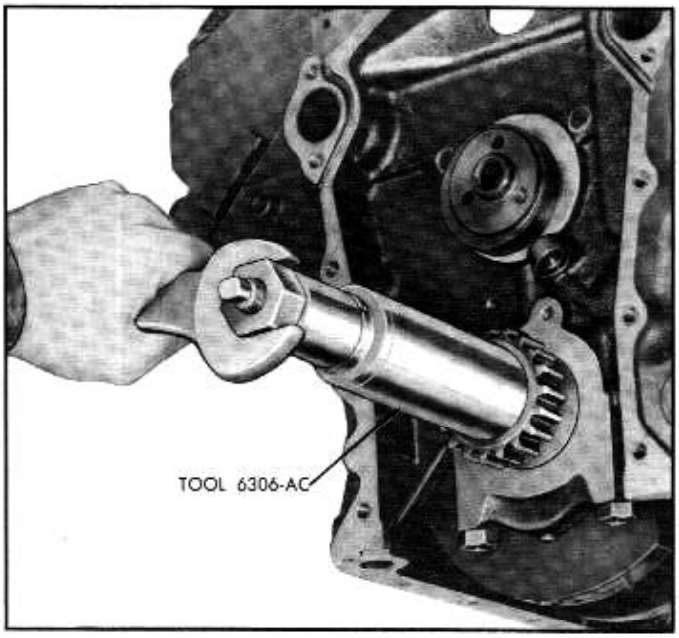


Fig. 6C-37—Installing Crankshaft Sprocket

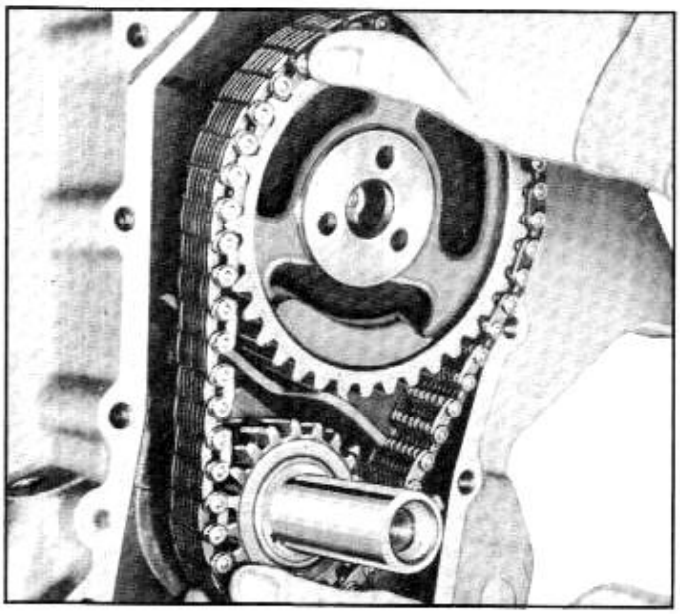


Fig. 6C-38—Installing Timing Chain and Camshaft Sprocket

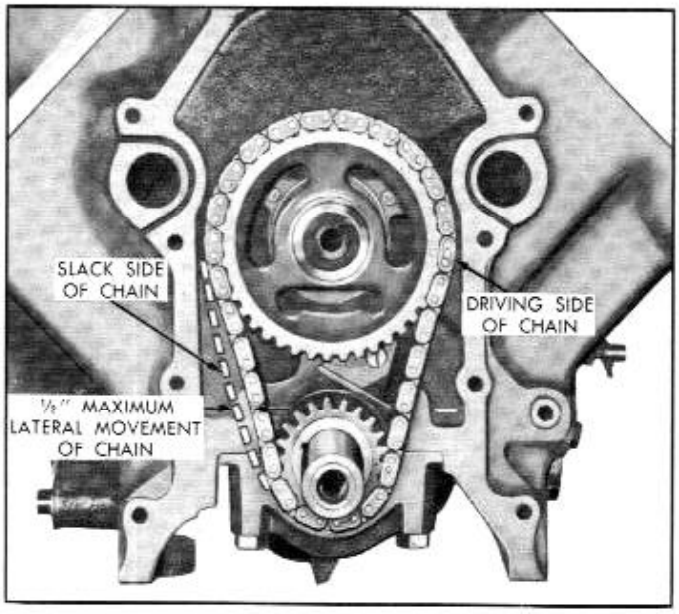


Fig. 6C-40—Timing Chain Deflection

Installation

1. Insert Woodruff key in crankshaft and install crankshaft sprocket using Tool 6306-AC. See figure 6C-37. Timing mark on gear should be toward front of engine.
2. Install fuel pump push rod and snap ring retainer using Tool 9400-B.
3. Install camshaft eccentric sleeve over camshaft eccentric hub so flange is against the cylinder block.
4. Turn crankshaft so number 1 piston is on T.D.C.

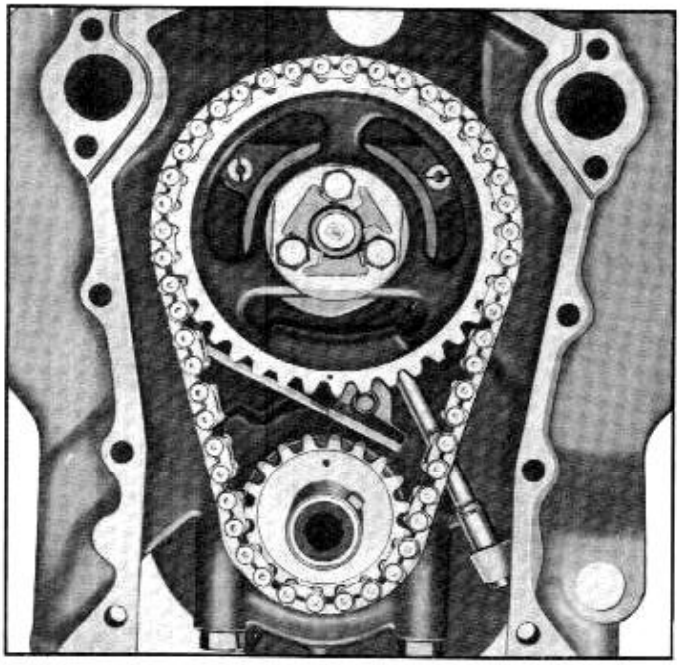


Fig. 6C-39—Alignment of Timing Marks

and timing mark is on vertical center line of crankshaft.

5. Place camshaft sprocket on camshaft to align holes in sprocket with those of camshaft. (Do not install bolts at this time.) Rotate camshaft and sprocket until timing marks on sprockets are adjacent and in same vertical line. Remove camshaft sprocket and install on timing chain so timing mark remains in same relative position. Holding the camshaft sprocket and timing chain as shown in figure 6C-38, position chain around crankshaft sprocket and install camshaft sprocket on camshaft. Install new lock plate and tighten three bolts to 15-18 lbs. ft. torque. Bend lock tabs against flat side of bolt heads.
   NOTE: Timing marks must be on crankshaft vertical center line as shown in figure 6C-39. If these marks are not positioned as shown, remove sprocket and reassemble correctly.
6. Check timing chain outward deflection. Rotate crankshaft to take up slack on driving side of chain and establish straight position. Rotate crankshaft in opposite direction to take up slack on opposite side of chain. Pull chain outward with fingers. Measure outward deflection of chain. See figure 6C-40. There should not be more than 1/2" difference between the chain straight position and the position of chain when deflected outward.
7. Install camshaft spring and thrust plunger in front end of camshaft with radius end outward.
8. Install fuel pump assembly using new gasket. Tighten screws to 23-28 lbs. ft. torque.
   NOTE: Fuel pump assembly is installed at this

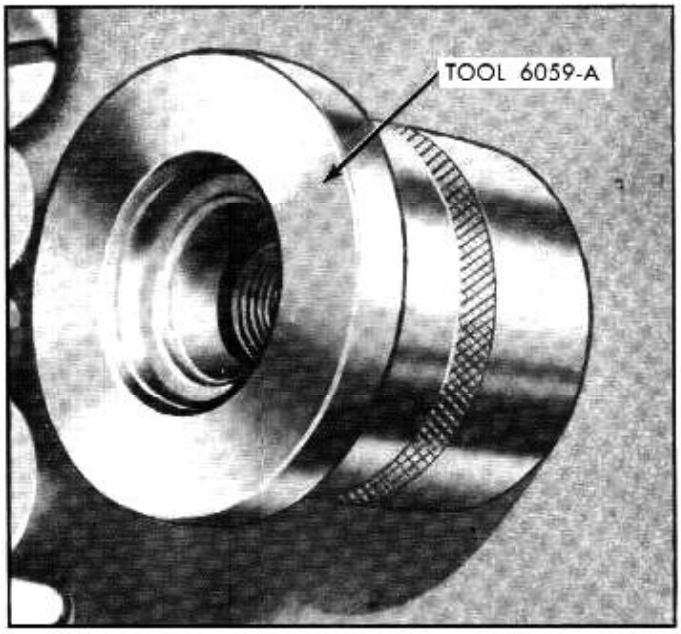


Fig. 6C-41—Aligning Front Cover

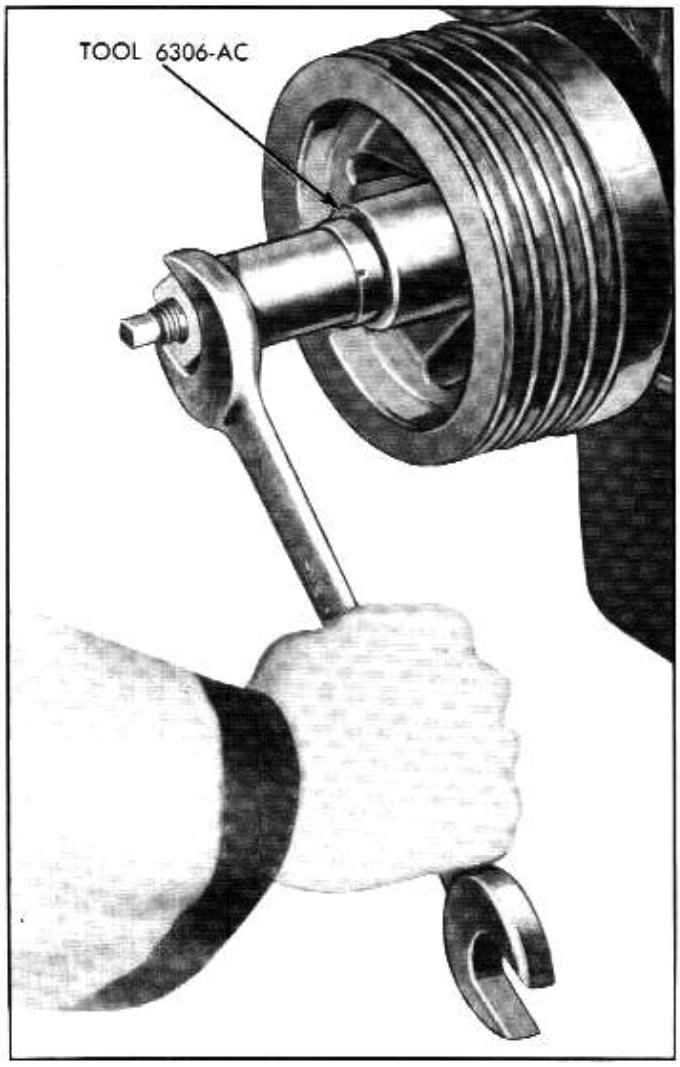


Fig. 6C-42—Installing Crankshaft Damper

time because of low position of cam eccentric.

9. Install new front cover gasket. Use sealer on gasket. Install front cover assembly, do not tighten cap screws.
10. Position Tool 6059-A over crankshaft as shown in figure 6C-41 and align front cover to tool. Hold tool inward and tighten cap screws to 23 to 28 lbs. ft. torque.
11. Raise vehicle. Install oil pan and tighten retaining screws to 12-15 lbs. ft. torque. Install drain plug. Install stabilizer bar and engine splash shield.
12. Lower vehicle.
13. Coat a new water pump gasket with sealer, then install gasket and water pump. Tighten screws to 23-28 lbs. ft. torque.
14. Install oil filter and road draft tube, timing pointer and generator brackets.
15. Install Woodruff key in crankshaft. Install crankshaft damper assembly using Tool 6306-AC. See figure 6C-42. Install washer and retaining screw. Tighten screw to 130-145 lbs. ft. torque.
16. POWER STEERING EQUIPPED VEHICLES: Install power steering pump on mounting bracket. Install drive belt on crankshaft damper rear sheave and pump pulley, then adjust tension to 1/2" deflection.
17. Install water pump pulley, spacer and fan assembly and tighten retaining screws to 10-13 lbs. ft. torque. Install fan-generator drive belts and adjust belt tension to 1/2" deflection.
18. Place a piece of heavy cardboard or fibre board over radiator core to prevent damage when installing radiator. Install radiator and tighten retaining screws to 10-13 lbs. ft. torque.
19. Connect transmission inlet and outlet oil transfer lines to lower tank of radiator.
20. Connect lower radiator hose to water pump. Connect upper radiator hose to connector. Coat a new gasket with sealer and connect by-pass tube to connector.
21. Close petcocks. Fill cooling system with coolant. Add engine oil. Start engine and bring up to normal operating temperature. Check all connections for leaks. Check and set timing.
22. Install hood assembly. Align hood hinge with index marks on hood. Tighten retaining screws.

REMOVAL AND INSTALLATION OF CAMSHAFT — ENGINE IN VEHICLE

Removal

1. Remove hood assembly. If hood is properly aligned, index hood hinge to hood for installation purposes.
2. Remove right and left parking lamp assemblies.

Do not disconnect wires. Remove right and left radiator grille mouldings. Remove radiator center grille moulding.

3. Drain cooling system at radiator and cylinder block.
4. Remove intake manifold. Refer to "Removal and Installation of Intake Manifold – Engine in Vehicle".
5. Remove right and left rocker arm covers and the valve push rod chamber cover.
6. Remove the right and left rocker arm assembly as follows:
   a. Loosen rocker arm adjustment screws to remove tension on push rods.
   b. Remove screws and nuts securing rocker arm and shaft assembly to cylinder head. Remove oil overflow pipe.
   c. Lift up the rocker arm assembly to remove it from cylinder head.
7. Remove push rods from cylinder head. Index the push rods to their respective bores for inspection and installation purposes.
8. Remove hydraulic valve tappets from cylinder bores using Tool 6500-D.
   NOTE: Keep lifters in order as removed so they may be reinstalled in their original bores if inspection reveals their condition is satisfactory.
9. Raise vehicle. Remove oil pan drain plug and drain engine oil. Remove oil pan. Refer to "Removal and Installation of Oil Pan – Engine in Vehicle".
10. Lower vehicle.
11. Remove spark plug wires from spark plugs. Remove spark plugs.
12. POWER STEERING EQUIPPED VEHICLES:
    a. Without disconnecting hoses, remove power steering pump assembly from mounting bracket.
    b. Remove belt and position power steering pump against fender apron in a manner that will prevent fluid from draining out of reservoir.
13. Disconnect lower radiator hose from water pump. Disconnect transmission inlet and outlet oil transfer lines at lower radiator tank.
14. Disconnect upper radiator hose at connector. Disconnect water by-pass tube at connector.
15. Place a piece of heavy cardboard or fibre board over radiator core to prevent damage when removing radiator. Remove attaching screws and remove radiator assembly.
16. Remove screws securing fan assembly, spacer and water pump pulley to water pump pulley hub. Remove component parts as an assembly. Remove fan-generator belts.

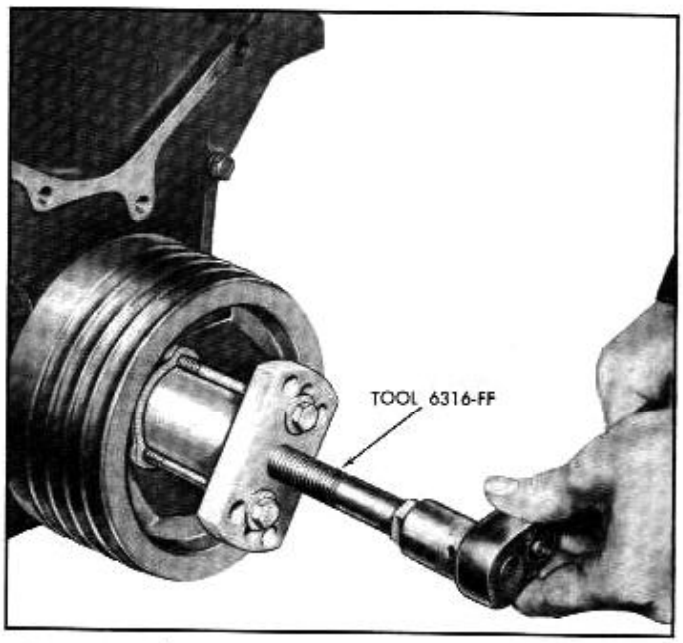


Fig. 6C-43—Removing Crankshaft Damper Assembly

17. Remove screw and washer securing crankshaft damper to crankshaft. Remove crankshaft damper with Tool 6316-FF. See figure 6C-43. Remove Woodruff key from crankshaft.
18. Disconnect the vacuum lines, gas line and flexible fuel line from fuel pump, then remove fuel pump from cylinder block.
19. Disconnect and remove generator brackets, oil filter and road draft tube mounting bracket, and timing indicator from front cover.
20. Remove oil filler and road draft tube.
21. Remove screws securing water pump and power steering pump mounting bracket (if vehicle is so equipped) to cylinder front cover. Remove pump and bracket.
22. Remove cylinder block front cover and gasket. NOTE: When removing front cover use care to prevent damage to front cover seal.
23. Remove wire from "S" terminal of starter relay switch. Install auxiliary starter cable to "S" terminal of starter relay switch and positive terminal of battery.
24. Using auxiliary starter switch, "bump" engine over until timing mark on crankshaft sprocket is aligned with that of the camshaft sprocket (number 1 piston on T.D.C.). See figure 6C-44.
25. Remove distributor cap. Scribe a line on the distributor housing to mark the relative position of the rotor to the distributor housing. (This will aid when reinstalling distributor unit.)
26. Remove tachometer cable from distributor (if vehicle is so equipped). Remove distributor retaining nut, washer and clamp, then remove distributor.

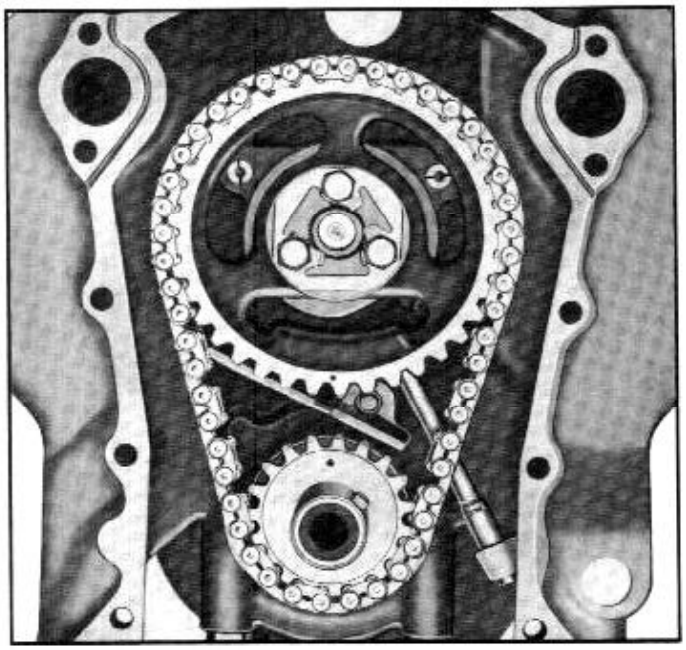


Fig. 6C-44—Alignment of Timing Marks

NOTE: Observe the amount and direction of rotor movement when removing distributor. This will aid when reinstalling distributor unit.

27. Remove camshaft thrust plunger and thrust spring from front end of camshaft.
28. Remove screws and lockplate from camshaft sprocket. Remove camshaft sprocket and timing chain as a unit. Remove crankshaft sprocket using Tool 6306-AE. See figure 6C-45.
29. Remove camshaft eccentric sleeve from camshaft.
30. Using Tool 9400-B, remove snap ring retainer from fuel pump push rod and remove rod. See figure 6C-46.

NOTE: Adjust tool opening by setting screw so snap ring just clears push rod.

31. Remove timing chain lubrication trough.
32. Remove camshaft.

NOTE: When removing camshaft use extreme care to prevent the camshaft lobes from damaging the camshaft bearings.

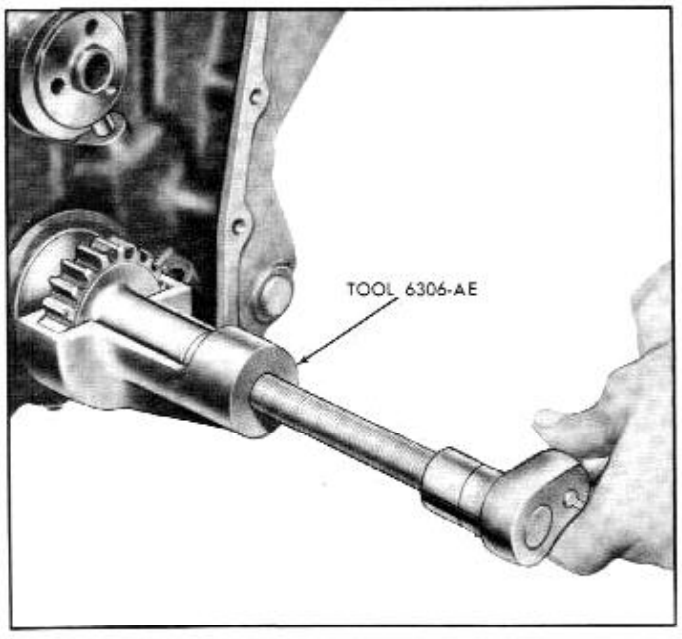


Fig. 6C-45—Removing Crankshaft Sprocket

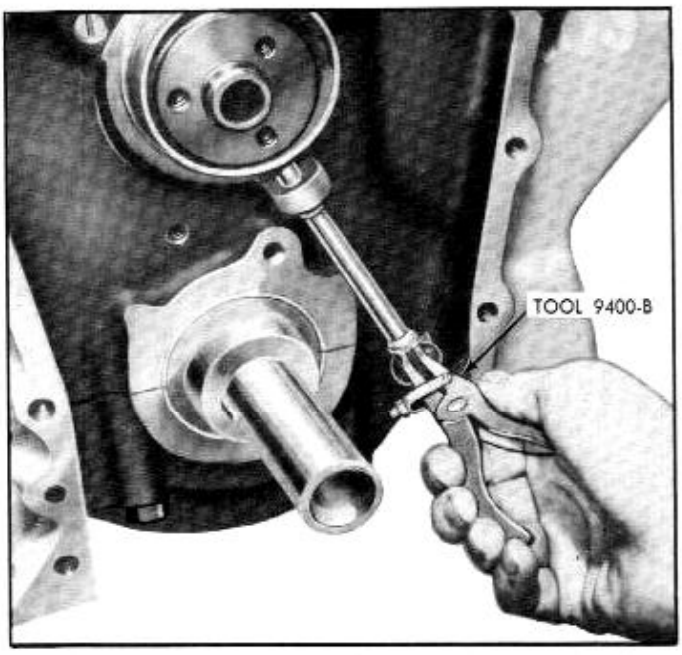


Fig. 6C-46—Removing Fuel Pump Snap Ring Retainer

Inspection

Clean the camshaft in solvent and wipe dry. Check the camshaft journal to bearing clearances by measuring the diameter of the journals and the I.D. of the bearings. The camshaft journal diameter specification is 2.1240″-2.1247″. The camshaft bearing inside diameter specification is 2.1263″-2.1268″. The recommended clearance wear limit is .006 inch. If the clearance approaches the wear limit, the camshaft and/or camshaft bearings must be replaced.

NOTE: It will be necessary to remove the engine from the vehicle to replace the camshaft bearings.

Check camshaft for out-of-round condition. If out-of-round exceeds .001″ the camshaft must be replaced.

Check camshaft run-out. If run-out exceeds .005″ T.I.R. the camshaft should be straightened or replaced.

Check the distributor driven gear for broken or chipped teeth. Replace camshaft if drive gear teeth are damaged.

NOTE: If the mating teeth on the distributor driven gear are damaged, this gear will have to be replaced. Refer to "Engine Electrical" Section for proper replacement procedures.

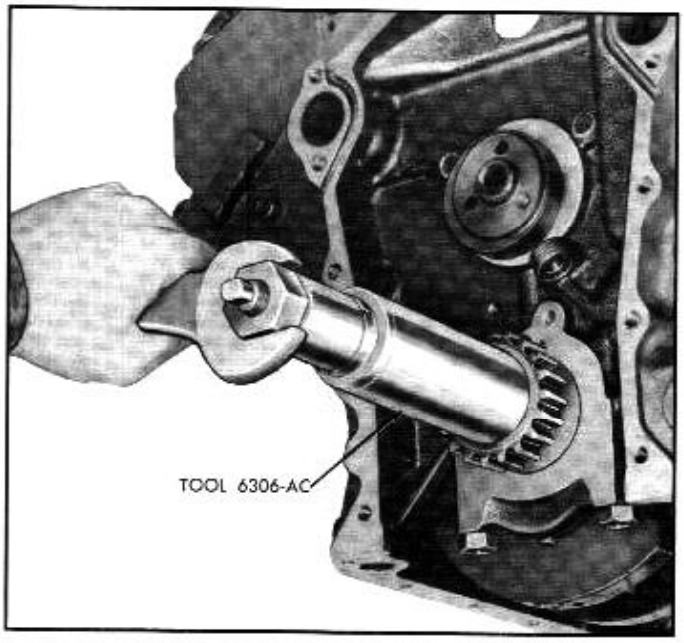


Fig. 6C-47—Installing Crankshaft Sprocket

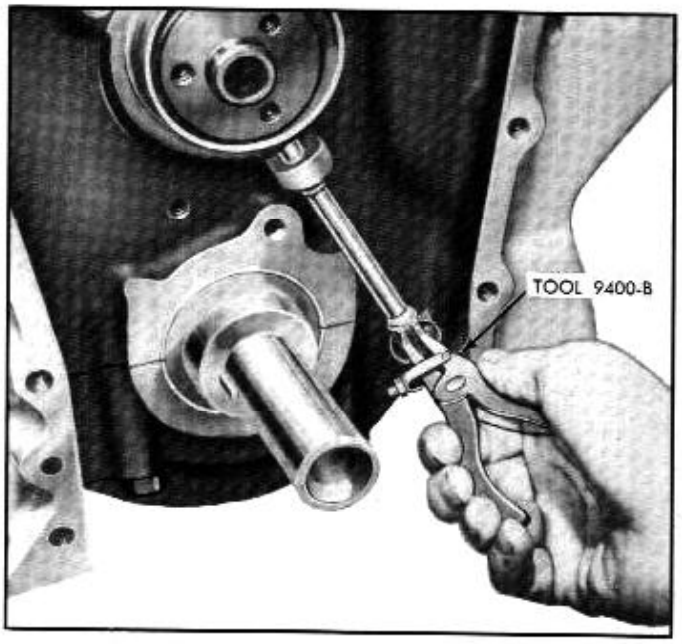


Fig. 6C-48—Installing Fuel Pump Snap Ring Retainer

Inspect the cam lobes for pitting, scoring, and signs of 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 camshaft should not be replaced if this condition exists.

If a cam lobe is scored or worn below specifications, the camshaft must be replaced. The lift of all cam lobes should be checked for wear by measuring over the top of the lobe with a micrometer and subtracting the measurement of the base circle diameter. The camshaft lobe lift wear limit for the intake valve lobes is .256". The camshaft lobe limit for the exhaust valve lobes is .256". If the camshaft lobe lift is less than this specification or closely approaches the wear limit, the camshaft should be replaced. If camshaft replacement is warranted, replace only the tappets that have been operating on cam lobes worn to a degree exceeding wear specifications.

Inspect the remaining tappets. Any tappets showing evidence of pitting, scoring, galling or evidence of non-rotation and/or irregular rotation, must be replaced.

NOTE: Following a camshaft replacement, the oil pan should be thoroughly cleaned as small particles of metal may be found due to the wearing action. The oil filter and oil must be replaced.

Inspect ball and socket ends of push rods for signs of wear. Replace all push rods that are worn.

NOTE: If the ends are worn, the push rod may not rotate and thus cause noise.

Check push rods for a bent condition. If the push rod run-out exceeds .020" maximum T.I.R., replace push rod.

NOTE: Do not attempt to straighten a push rod.

Installation

1. Remove light scuffs, scores or nicks from camshaft machined surfaces with a smooth oilstone. Oil the camshaft journals, then install camshaft in cylinder block.
   NOTE: While making the installation, be extremely careful that camshaft journals and lobes do not damage bearings.
2. Insert Woodruff key in crankshaft and install crankshaft sprocket using Tool 6306-AC. See figure 6C-47.
   NOTE: Timing mark on gear should be toward front of engine.
3. Install fuel pump push rod and snap ring retainer using Tool 9400-B. See figure 6C-48.
4. Install timing chain lubrication trough. Install camshaft eccentric sleeve over camshaft so eccentric hub flange is against the cylinder block.
5. Place camshaft sprocket on camshaft to align holes in sprocket with those of camshaft (do not tighten bolts at this time). Rotate camshaft and sprocket until timing marks on sprockets are adjacent and in same vertical line. Position timing chain around camshaft sprocket. While holding chain and sprocket in position, remove sprocket and chain, then install chain around crankshaft sprocket while keeping timing marks on both sprockets aligned. Install camshaft sprocket on camshaft. See figure 6C-49. Install lock plate and tighten three retaining screws to 15-18 lbs. ft. torque. Bend lock tabs against flat side of screw heads.

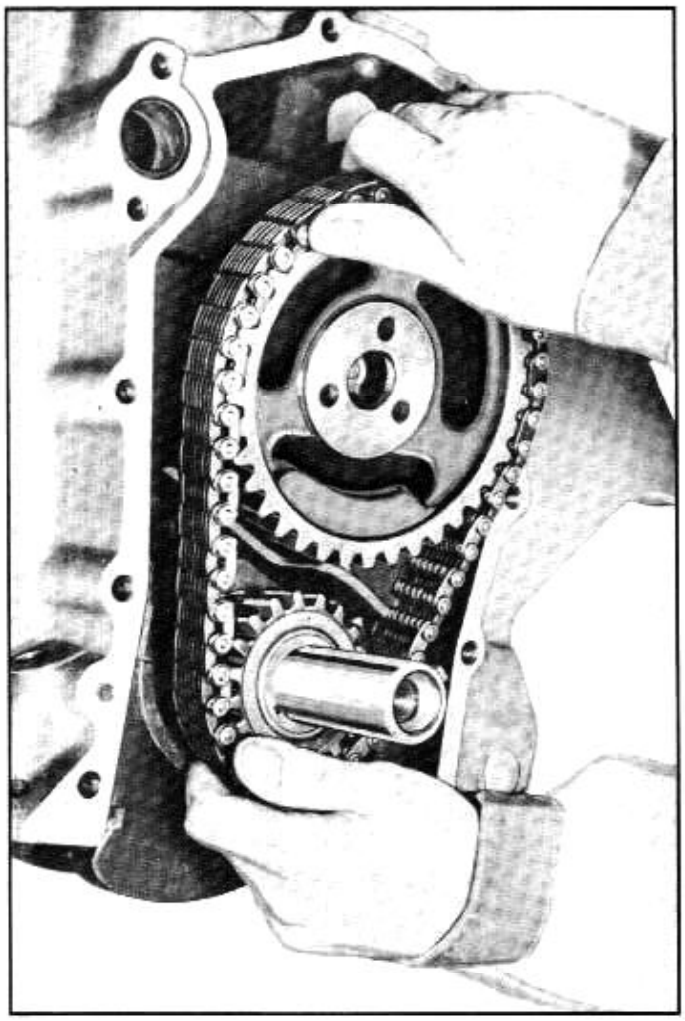


Fig. 6C-49—Installing Timing Chain and Camshaft Sprocket

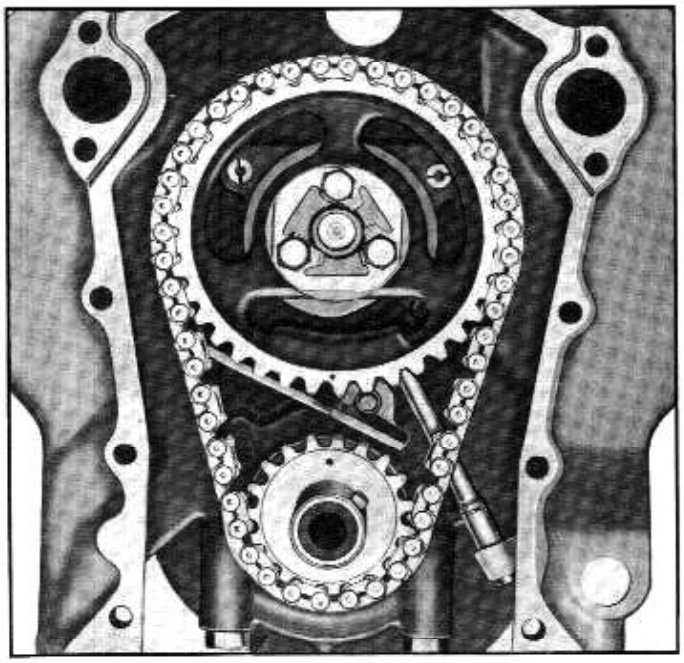


Fig. 6C-50—Alignment of Timing Marks

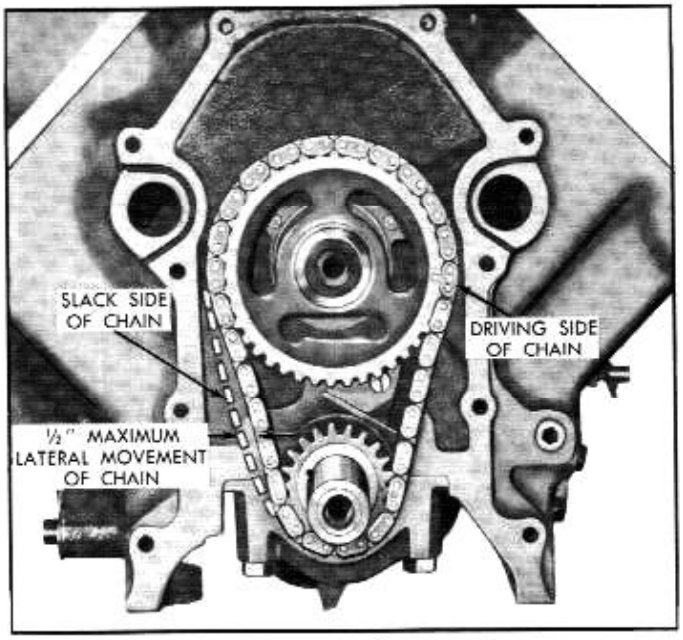


Fig. 6C-51—Timing Chain Deflection

NOTE: Timing marks must be adjacent on crankshaft and camshaft vertical center line. See figure 6C-50. If these marks are not positioned as shown, remove camshaft sprocket and reassemble correctly.

6. Check timing chain outward deflection. Rotate crankshaft to take up slack on driving side of chain and establish straight position. Rotate crankshaft in opposite direction to take up slack in opposite side of chain. Pull chain outward with fingers. Measure outward deflection of chain. See figure 6C-51. There should not be more than 1/2" difference between the chain straight position and the position of the chain when deflected outward.
7. Install camshaft spring and thrust plunger in front end of camshaft with radius end outward.
8. Install fuel pump assembly using new gasket. NOTE: Fuel pump assembly is installed at this time because of low position of cam eccentric.
9. If seal is damaged, install new crankshaft front seal in front cover using Tool 6700-B. See figure 6C-52. Coat seal with engine oil to facilitate driving operation.
   NOTE: When installing the new seal, place seal on tool. Center seal and tool over front cover boss and drive in until seated. Make sure spring on inside of seal is properly seated.
10. Install new front cover gasket (use sealer on gasket). Install front cover assembly but do not tighten retaining screws. Position Tool 6059-A over crankshaft and align front cover to tool. See figure 6C-53. Hold tool inward and tighten retaining screws to 23-28 lbs. ft. torque.

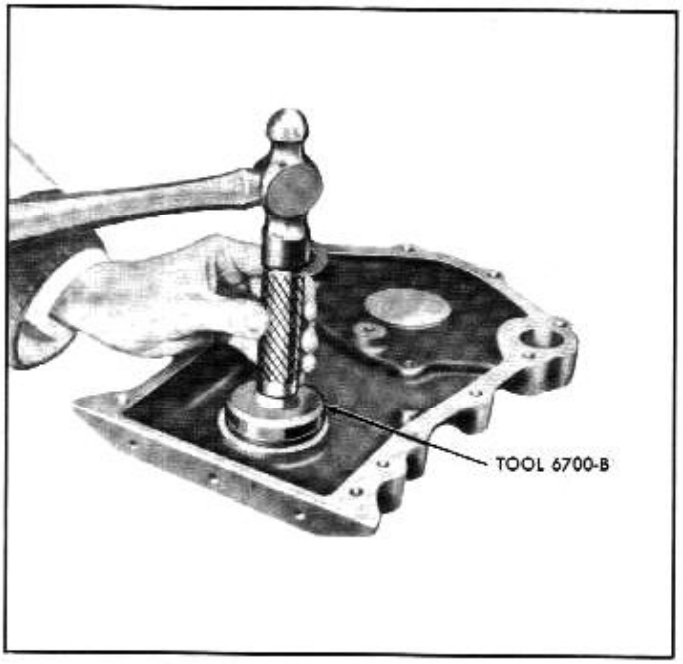


Fig. 6C-52—Installing Front Cover Seal

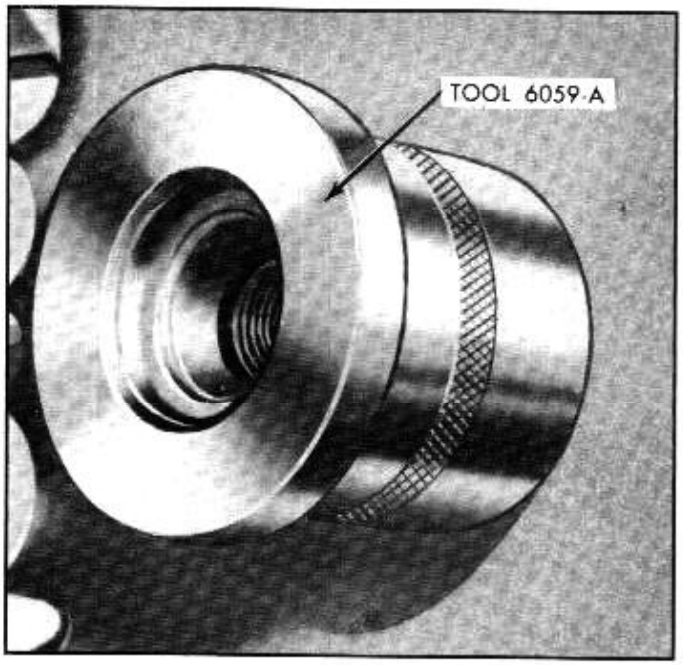


Fig. 6C-53—Aligning Front Cover

11. Raise vehicle.
12. Install oil pan assembly and tighten retaining screws to 12-15 lbs. ft. torque. Install oil drain plug. Install stabilizer bar and engine splash shield. Refer to "Installation of Oil Pan—Engine in Vehicle" in this section of manual.
13. Lower vehicle.
14. Coat a new water pump gasket with sealer, then install gasket and water pump. Tighten screws to 23-28 lbs. ft. torque.
15. Install oil filler and road draft tube, timing pointer and generator brackets.
16. Install Woodruff key in crankshaft. Install crankshaft damper assembly using Tool 6306-AC. See figure 6C-54. Install washer and retaining screw. Tighten screw to 130-145 lbs. ft. torque.
17. POWER STEERING EQUIPPED VEHICLES:
    a. Install power steering pump on mounting bracket.
    b. Install drive belt on crankshaft damper rear sheave and pump pulley, then adjust belt tension to 1/2" deflection.
18. Install water pump pulley, spacer and fan assembly, then tighten retaining screws to 10-13 lbs. ft. torque. Install fan-generator drive belts and adjust belt tension to 1/2" deflection.
19. Place a piece of heavy cardboard or fibre board over radiator core to prevent damage when installing radiator. Install radiator and tighten retaining screws to 10-13 lbs. ft. torque.
20. Connect transmission inlet and outlet oil transfer lines to lower tank of radiator.
21. Connect lower radiator hose to water pump. Con-

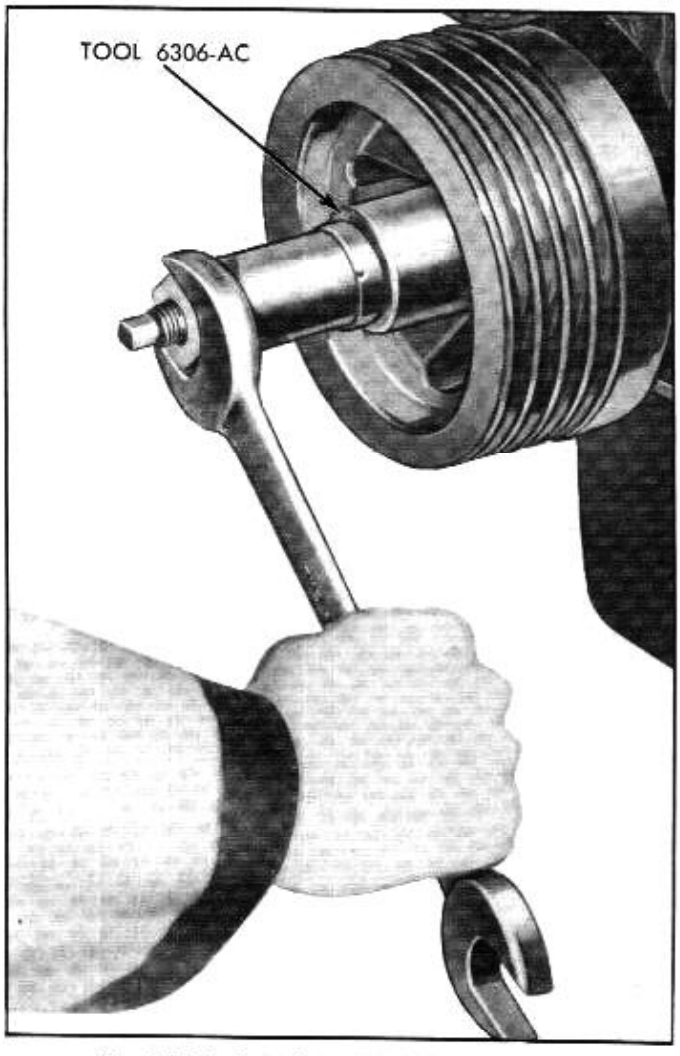


Fig. 6C-54—Installing Crankshaft Damper

nect upper radiator hose to connector. Coat a new gasket with sealer and connect by-pass tube to connector.

22. Place engine oil on hydraulic tappets, then install hydraulic tappets in the respective bores from which they were removed.
23. Install push rods in their respective bores being sure they are properly seated in the tappets.
24. Install rocker arm and shaft assemblies and tighten screws and nuts to 22-23 lbs. ft. torque. When installing oil overflow pipes, right bank pipe goes to the front rocker arm support and left bank pipe goes to rear rocker arm support. CAUTION: *Make sure pipe enters hole in rocker arm support and shaft.*
25. Perform valve clearance adjustment. Refer to "Valve Clearance Adjustment" in this section of manual.
26. Install push rod chamber cover assembly using new gasket and bolt seals. Tighten retaining screws to 2-2½ lbs. ft. torque. Do not overtighten.
27. Install new gaskets on rocker arm covers. Install rocker covers, seals and retaining nuts. Tighten nuts to 2-2½ lbs. ft. torque.
28. Turn crankshaft to position No. 1 piston on T.D.C. of compression stroke. Hold thumb over spark plug hole to determine the compression stroke (timing pointer should be aligned with T.D.C. mark on damper). Set distributor rotor in position to fire No. 1 cylinder spark plug with points just breaking. Mark this location by scribing line on distributor housing. Turn rotor counterclockwise a distance equal to amount observed during the disassembly procedure (approximately 1/8 turn). Install distributor. Shaft and rotor will turn clockwise as distributor gear meshes with camshaft gear. Recheck position of rotor with scribed line on housing. Install the distributor cap. If installation is correct, install grommet, retain the distributor with clamp, nut and lockwasher. Install tachometer drive gear and cable if vehicle is so equipped. Final timing of the distributor must be made after the engine is operating in the vehicle. See "Engine Electrical" section of this manual for proper procedures.
29. Clean cylinder head and intake manifold gasket surfaces, then install new gaskets and intake manifold. Tighten screws and nuts to 23-28 lbs. ft. torque working from center toward ends.
30. Install and secure control shaft assembly and accelerator shaft bracket to intake manifold. Install accelerator retract springs. Connect carburetor to control shaft rod to carburetor.
31. If vehicle is equipped with power brake unit, connect power brake vacuum line to intake manifold connector.
32. Connect vacuum booster line to intake manifold connector. Connect vacuum line to starter cut-out switch and intake manifold connector.
33. Connect temperature sending unit wire to sending unit.
34. Connect windshield wiper hose to vacuum booster line.
35. Connect fuel inlet line to carburetor. Connect distributor vacuum line to carburetor and distributor.
36. Remove auxiliary starter cable from battery and starter relay. Connect previously removed wire to "S" terminal of starter relay.
37. Install spark plugs and tighten to 15-20 lbs. ft. torque. Install spark plug wires.
38. Install battery ground cable.
39. Install radiator center grille, upper grille mouldings and parking lamps.
40. Install hood assembly on hood hinge. Align hinge with index mark on hood and tighten retaining screws.
41. Close petcocks and fill cooling system with coolant. Check oil level with dipstick to make certain crankcase is filled to the required level.
42. Start engine and bring it up to normal operating temperature by operating at 1200 R.P.M. for approximately 30 minutes.
43. While engine is running during warm-up period, check for oil, fuel and water leaks.
44. Check distributor timing, then check advance timing. For proper procedure, refer to "Engine Electrical" section of this manual.
45. Check and set carburetor linkage. Adjust engine idle and carburetor air-fuel mixture.
46. Install air cleaner and duct assembly. Make a final check of all connections.

REMOVAL AND INSTALLATION OF CYLINDER HEAD ASSEMBLIES – ENGINE IN VEHICLE

Removal

1. Remove intake manifold. Refer to "Removal and Installation of Intake Manifold–Engine in Vehicle" in this section of manual.
2. RIGHT BANK CYLINDER HEAD:
   a. Remove screw securing oil dipstick tube and battery ground cable to cylinder head.
   b. Remove exhaust manifold. Refer to "Removal and Installation of Exhaust Manifolds–Engine in Vehicle" in this section of manual.
   c. Remove ignition wires from spark plugs. Remove spark plugs.
   d. Remove heater inlet hose from heater control

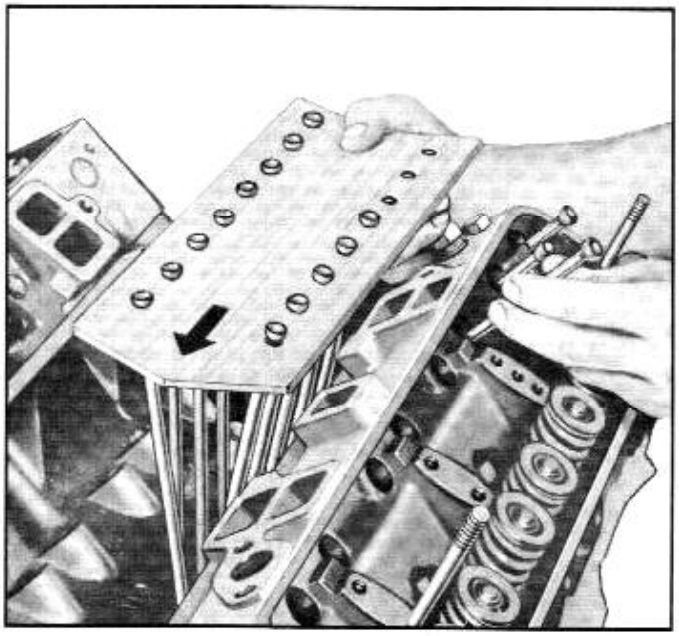


Fig. 6C-55—Valve Push Rod Removal

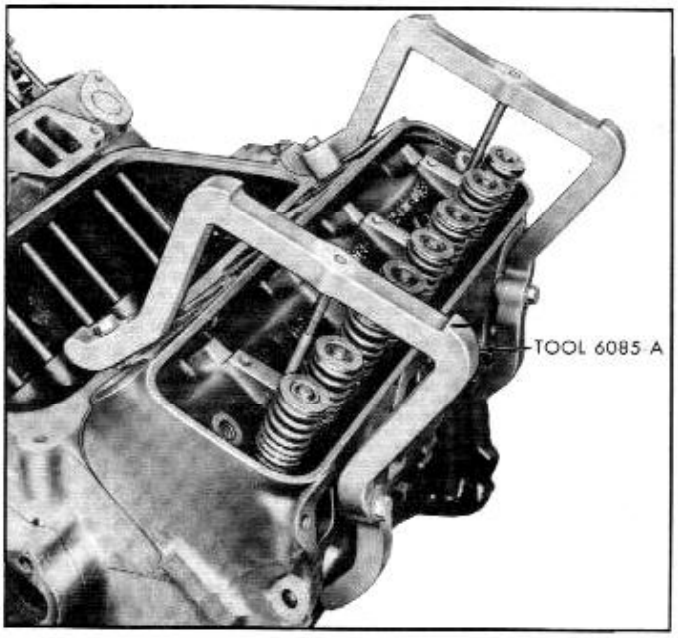


Fig. 6C-56—Cylinder Head Holding Fixture

valve. Remove heater control valve and fitting from cylinder head.

e. Remove rocker arm cover and gasket.

f. Loosen rocker arm adjustment screws to remove tension on push rods.
NOTE: It is necessary to remove the tension to prevent the possibility of bending the push rods or damaging the rocker arm shaft when removing the rocker arm and shaft assembly support screws and nuts.

g. Remove six screws and two nuts securing rocker arm and shaft assembly to cylinder head. Remove oil overflow pipe from the assembly.

h. Lift up the rocker arm assembly to remove it from cylinder head.

i. Remove push rods from cylinder head. Index the push rods to their respective bores for inspection and replacement purposes. See figure 6C-55.

j. Install cylinder head holding fixture Tool 6085-A to cylinder head using four 3/8"-1½ N.C. screws and flat washers. See figure 6C-56.
NOTE: Cylinder head holding fixture tool must be attached securely to cylinder head.

k. Remove cylinder head cap screws, then lift cylinder head off the two locating dowels on cylinder block.
CAUTION: *Use extreme care when handling to prevent damage to gasket surfaces. Never pry between cylinder head and cylinder block as they both have a finished surface and must not be damaged.*

3. LEFT BANK CYLINDER HEAD:

a. Remove cap screw and lockwasher securing engine ground strap and wiring loom clip to cylinder head.

b. Remove exhaust manifold. Refer to "Removal and Installation of Exhaust Manifolds—Engine in Vehicle" in this section of manual.

c. Remove ignition wires from spark plugs. Remove spark plugs.

d. Remove rocker arm cover and gasket.

e. Loosen rocker arm adjustment screws to remove tension on push rods.
NOTE: It is necessary to remove the tension to prevent the possibility of bending the push rods or damaging the rocker arm shaft, when removing the rocker arm and shaft assembly support cap screws and nuts.

f. Remove six screws and two nuts securing rocker arm and shaft assembly to cylinder head. Remove oil overflow pipe from assembly.

g. Lift up the rocker arm assembly to remove it from cylinder head.

h. Remove push rods from cylinder head. Index the push rods to their respective bores for inspection and replacement purposes. See figure 6C-55.

i. Install cylinder head holding fixture Tool 6085-A to cylinder head using four 3/8"-1½ N.C. Screws and flat washers. See figure 6C-56.
NOTE: Cylinder head holding fixture must be attached securely to cylinder head.

j. Remove cylinder head retaining screws, then lift head off the two locating dowels on cylinder block.

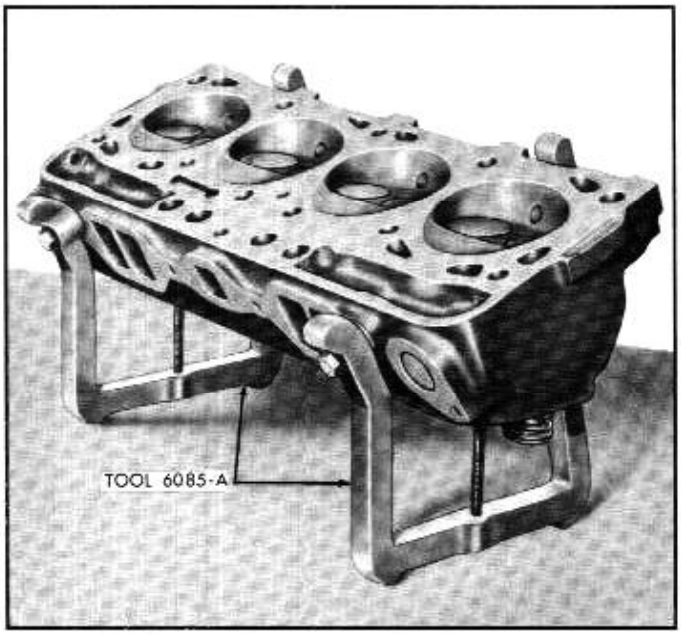


Fig. 6C-57—Cylinder Head Positioned for Carbon Removal

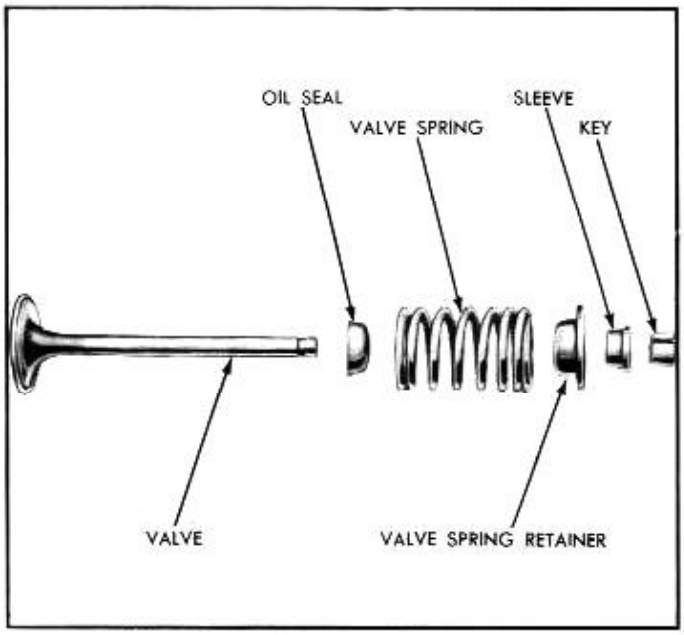


Fig. 6C-59—Valve Assembly

CAUTION: *Use extreme care when handling to prevent damage to gasket surfaces. Never pry between cylinder head and cylinder block as they both have a finished surface and must not be damaged.*

Cleaning, Inspection, Reconditioning Cylinder Heads

The cylinder head, as removed from the engine, contains the valve assemblies and holding fixture Tool 6085-A. The rocker arm assembly was removed prior to installation of the holding fixture so that fixture would never have to be removed while the heads are off the engine. Thus, the machined surfaces of the cylinder heads are protected at all times while work operations are being performed. See figure 6C-57.

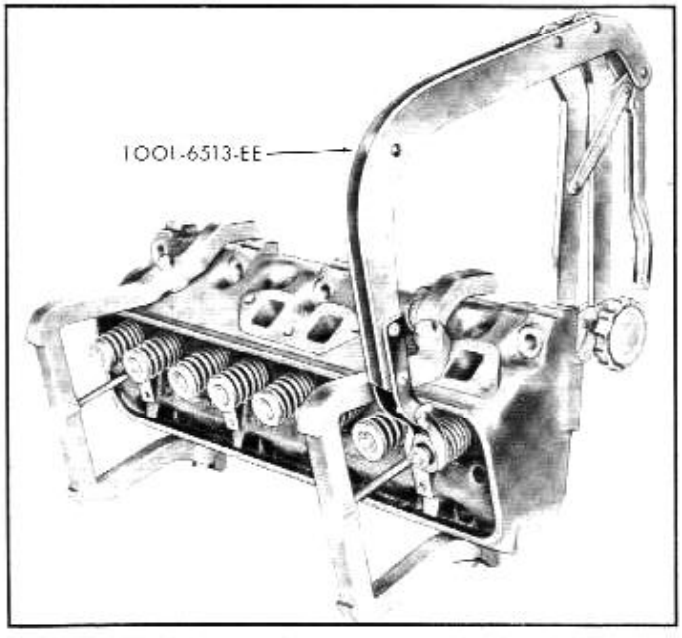


Fig. 6C-58—Compressing Valve Spring

Clean, inspect, and recondition the cylinder head assemblies as follows:

With the valves installed in the cylinder head to protect the valve seats, clean carbon deposits from combustion chambers and valve heads with a wire brush and scraper. Wash the cylinder head in cleaning solvent to remove grease and dirt from surfaces and dry thoroughly.

Disassemble and remove valve assemblies from cylinder heads as follows:

1. Turn cylinder head, with Tool 6085-A attached, so it rests on its side and compress valve spring with Tool 6513-EE. See figure 6C-58.
2. Tap retainer gently with a soft hammer, then remove valve keys. See figure 6C-59.
3. Remove valve compressor Tool 6513-EE, then remove valve spring retainer, inner sleeve, valve spring, valve stem seal, and valve.
4. Repeat steps 1 through 3 for remaining valves. NOTE: Keep each valve and its related parts together so they may be reinstalled in their respective bores.

Clean valve guide bores using Valve Stem Guide Cleaning Tool 6510-F. Check all water passages to make sure they are open.

Examine the cylinder heads for water leaks or cracks in the combustion chambers, exhaust ports, or around the valve seats. Inspect the gasket surfaces for

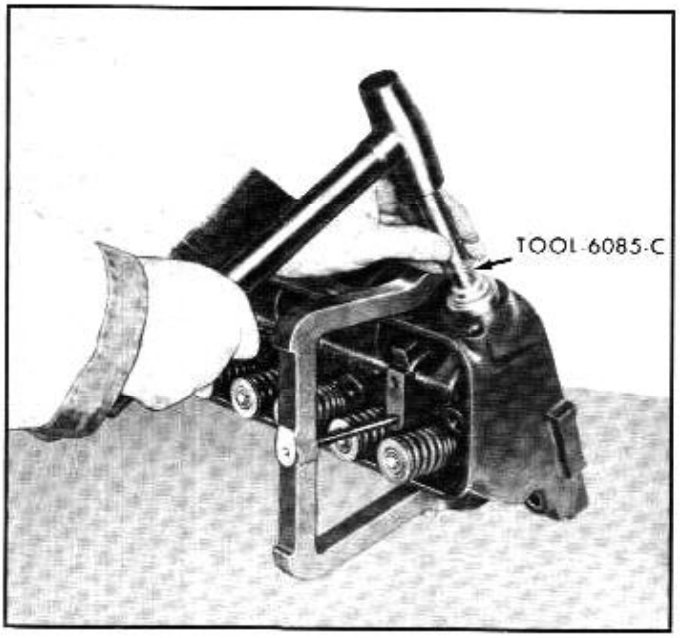


Fig. 6C-60—Installing Cylinder Head

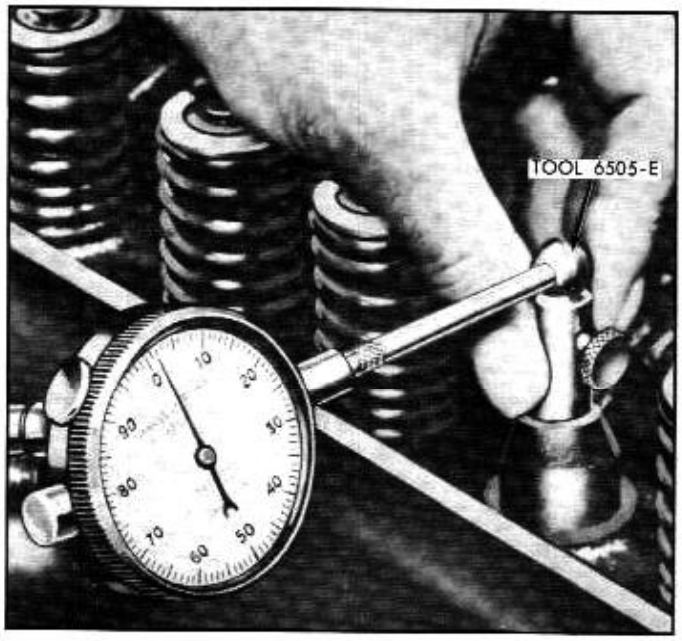


Fig. 6C-61—Checking Valve Stem Clearance

scratches or mars of any type. This is very important as any damage to this surface may cause a leak when installed with the thin steel gasket.

NOTE: The chances of scratching or marring the gasket surfaces of the head are greatly reduced when holding fixture tools are used.

The cylinder head assemblies are completely interchangeable from one cylinder bank to another providing the water outlet coincides with the water opening in the front section of the intake manifold. It may be necessary to remove the water outlet plug on one section of the cylinder head and install a new plug in the rear section. When installing a new plug, coat edges with a light coat of water resistant sealer. Install plugs with flange facing inward, using Tool 6085-C. See figure 6C-60.

Valve, Valve Seats and Valve Springs

Remove all carbon from valve stems and heads using a fine wire brush or buffing wheel. Inspect each valve, discarding any that show evidence of burned, warped, bent or cracked condition.

Check valve stem clearance of each valve in its respective valve guide using Tool 6505-E. See figure 6C-61. To properly use tool, install on valve stem until fully seated and tighten knurled set screw firmly, then permit valve to drop away from its seat until tool contacts the upper surface of the valve guide.

Position dial indicator, Tool 4201-C or 6565, with flat tip against the center portion of tool spherical section at approximately 90° to the valve stem. In order to ascertain actual valve stem clearance, tool should be moved back and forth on an axis at a right angle to the rocker shaft. Take a reading on dial indicator without removing the tool from valve guide upper surface, then divide reading by two, the division factor of the tool.

If the clearance exceeds the service limits of .0045" on the intake or .0065" on the exhaust, it is recommended to ream the valve guides with Tool Kit 6085 to the next oversize diameter as shown in figure 6C-62. Tool Kit 6085 is made up of three reamer (cutter) pilot combinations, which are as follows:

1. Tool 6085-1 — Std. Diameter Pilot Plus .003" O.S. Reamer.

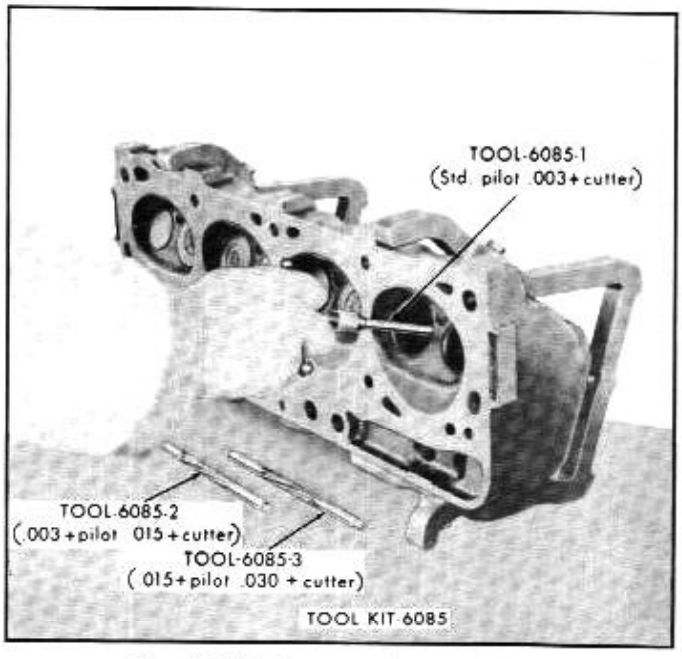


Fig. 6C-62—Reaming Valve Guide

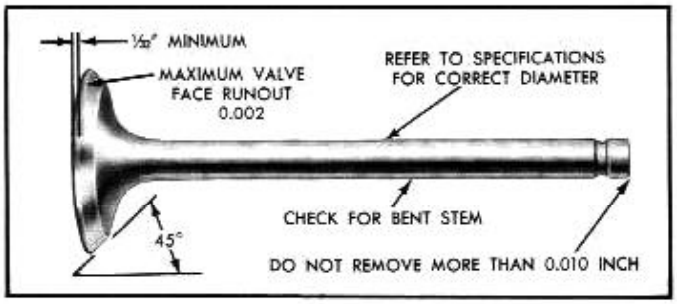


Fig. 6C-63—Valve Tolerances

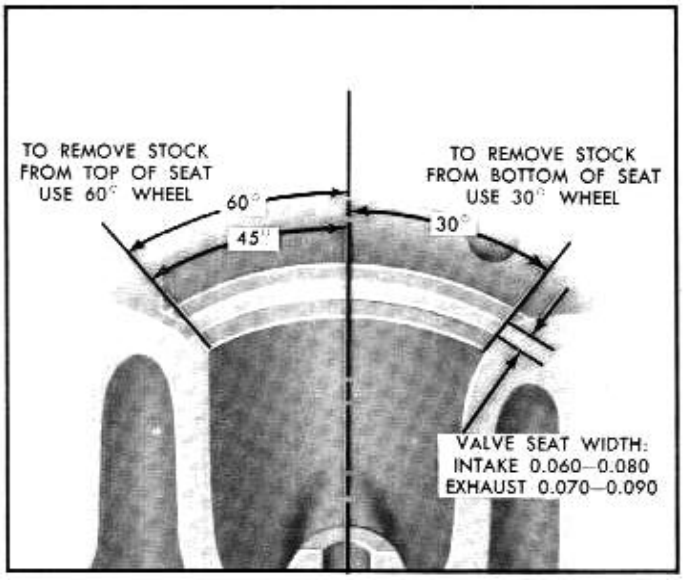


Fig. 6C-64—Valve Seat Refacing

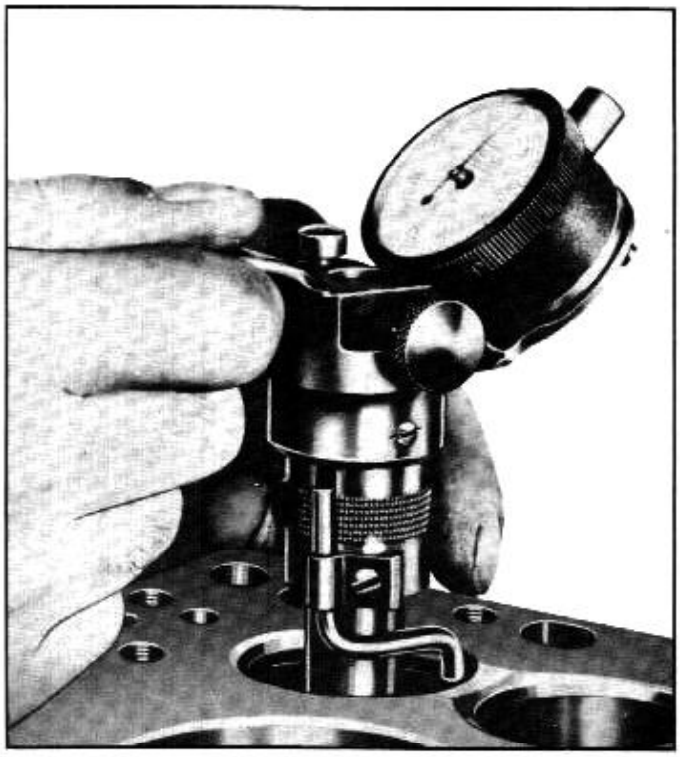


Fig. 6C-65—Checking Valve Seat Run-out—Typical

2. Tool 6085-2 – .003" O.S. Pilot Plus .015" O.S. Reamer.
3. Tool 6085-3 – .015" O.S. Pilot Plus .030" O.S. Reamer.

IMPORTANT: Always use the reamers in sequence when reaming from standard to O.S. (oversize) diameter to accommodate oversize valve stems. Valves having oversized stems are available for service. The valve seats must be reground whenever the valve guides are reamed.

Refacing the valves and valve seats must be done with precision equipment to insure a good compression tight fit between parts. The grinding wheels of the refacers should be carefully dressed to the proper angles. The valve face seat should be ground at a 45° angle (both intake and exhaust) with a minimum thickness of 1/32" on the outer edge of valve head. If thickness is less than 1/32", replace valve. Valve face run-out must not exceed .002". See figure 6C-63. The end of the valve stem may be ground if grooved. Do not remove more than .010" stock.

The valve seats in the cylinder head should also be ground to a true 45° angle maintaining a seat width of between .060-.080 inch intake valve and .070-.090 inch exhaust valve. Only remove enough stock to clean up pits or grooves. If seat is wider than specified it will be necessary to grind either the bottom of valve seat with a 30° angle grinder or the top of the seat with a 60° angle grinder until proper seat width is obtained and the seat contact with the valve is centrally located. See figure 6C-64.

It is important to have the finished seat face contact the approximate center of the valve face. This can be checked by placing prussian blue on the valve seat and installing the valve. If contact is indicated near the top edge of the valve face, lower the seat by using the 60° angle grinder. If the contact is lower than the center of the valve face, raise the seat by using the 30° angle grinder. Make sure all metal particles are thoroughly cleaned from the cylinder head. A light lapping operation is recommended after refacing valves and seats using a fine grit lapping compound.

Check the valve seat run-out with an accurate gauge. Run-out should not exceed .002" total indicator reading (wear limit .0025"). See figure 6C-65.

Examine the valve springs, discarding any that show signs of rust or pit marks. Check springs for squareness with a square and surface plate (a piece of plate glass may also be used). Discard any springs that are out of square more than 1/16". See figure 6C-66. Check pressure of each spring with Tool LM-106 as shown in figure 6C-67. The springs should exert a minimum pressure of 60 lbs. when compressed to a height of 1.800 inches or 165 lbs. when compressed to a height of 1.380 inches. If Tool

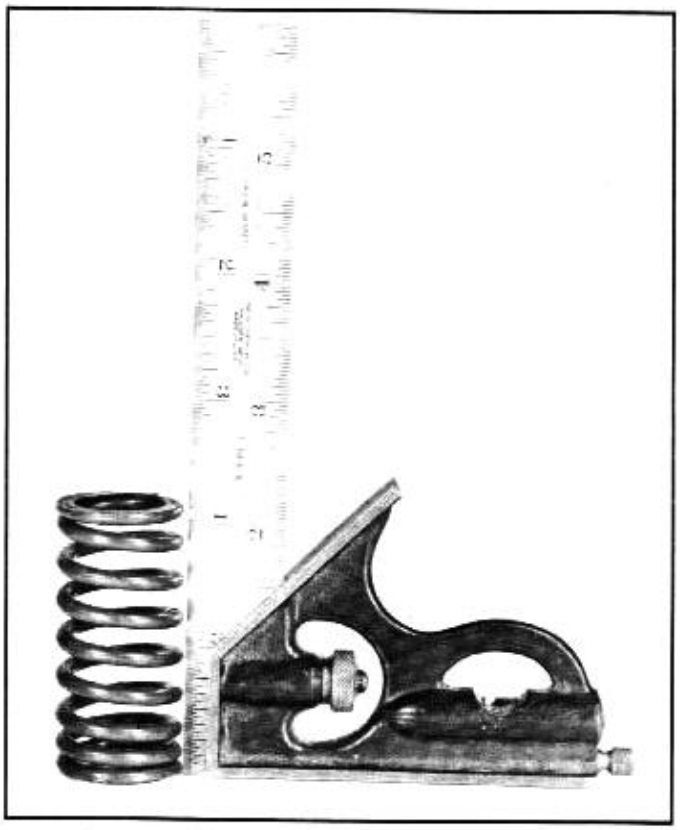


Fig. 6C-66—Testing Spring for Squareness

6513-DD is used, set knob on calibrated screw to compressed length of valve spring and pull torque wrench until click is heard. Multiplying reading on torque wrench by two gives pressure exerted by spring. If spring is not within specified limits it is recommended that spring be replaced.

Install the exhaust and intake valve assemblies in in the cylinder head as follows:

1. Install valves in their respective guides and install valve stem seal. Install valve springs (closed end of spring must be toward the cylinder head) and valve spring retainer.
   NOTE: Coat stems with engine oil to furnish initial lubrication.
2. Position Compressor Tool 6513-EE over valve spring retainer and valve head.
3. Compress valve spring and install spring retainer sleeve, and position valve keys on valve stem. Release Tool 6513-EE slowly and check position of valve keys.
4. Install all the respective valves in same manner.
5. Correct valve spring load is necessary for efficient high speed engine operation. Due to variance in the valve seats, the assembled height of the spring installed on the cylinder head should be measured as follows:
   a. Use dividers to measure the assembled height from the surface of the cylinder head spring pad to underside of the spring retainer. See figure 6C-68.
   b. Check the dividers against a scale. If the valve closed assembled height is 1.800" or greater, install the necessary spacer or spacers between the cylinder head spring pad and the valve spring to bring the assembled height to the recommended dimension of 1.800". See figure 6C-69.
   NOTE: The spacers available for service are .030 inch thick. Never use more than two spacers to bring the assembled height to speci-

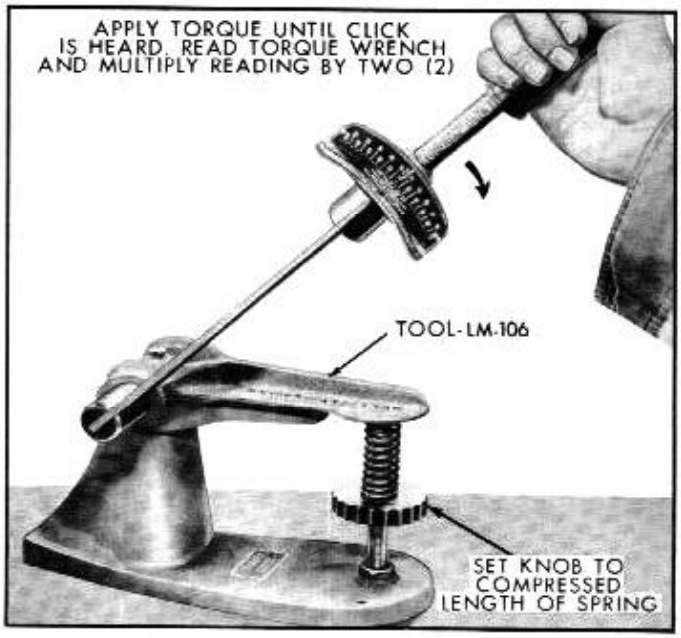


Fig. 6C-67—Testing Valve Spring Tension

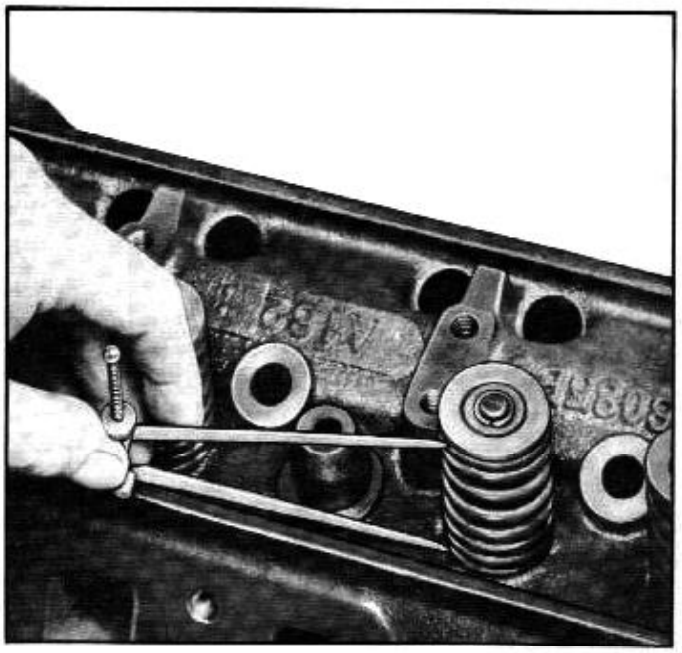


Fig. 6C-68—Measuring Valve Spring Assembled Length

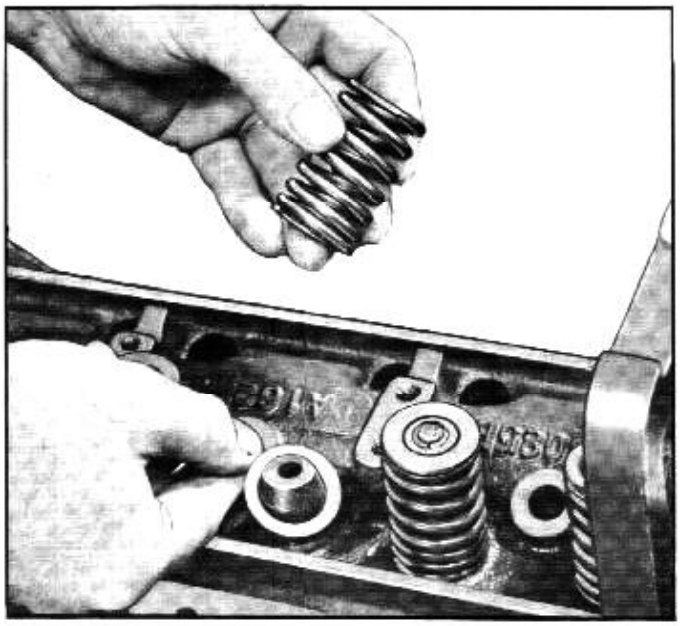


Fig. 6C-69—Adding Spacers to Correct Valve Spring Height

fications. Replace the spring if more than two are required. Do not use 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.

Rocker Arm Assemblies and Push Rods

Since the rocker arm assemblies are removed from the engine as a unit, the disassembly and assembly procedures are presented as follows. Figure 6C-70 shows a disassembled view of the complete assembly:

1. Remove cotter keys, flat and "wave" washers from ends of shaft.
2. Remove rocker arms, springs and supports from shaft. Keep parts in order so that they may be replaced in original position if in satisfactory condition.
3. Remove plugs from end of shaft as follows:
   a. Drill a hole in plug at one end of shaft.
   b. Insert metal rod through hole and knock out plug at other end of shaft.
   c. Knock out remaining plug in opposite end of shaft.
4. When rocker arm assemblies are completely disassembled, clean all parts thoroughly making sure all oil passages are open.
5. Inspect shaft for sign of wear. Check rocker arm to shaft clearance. If clearance exceeds .006" wear limit, replace rocker arm. Replace any parts showing excessive wear. If rocker arm pad radius is grooved excessively at valve end, replace part. Do not true this surface by grinding. A slight dressing of the rocker arm pad is permissible to clear up minor imperfections, however, contour of rocker

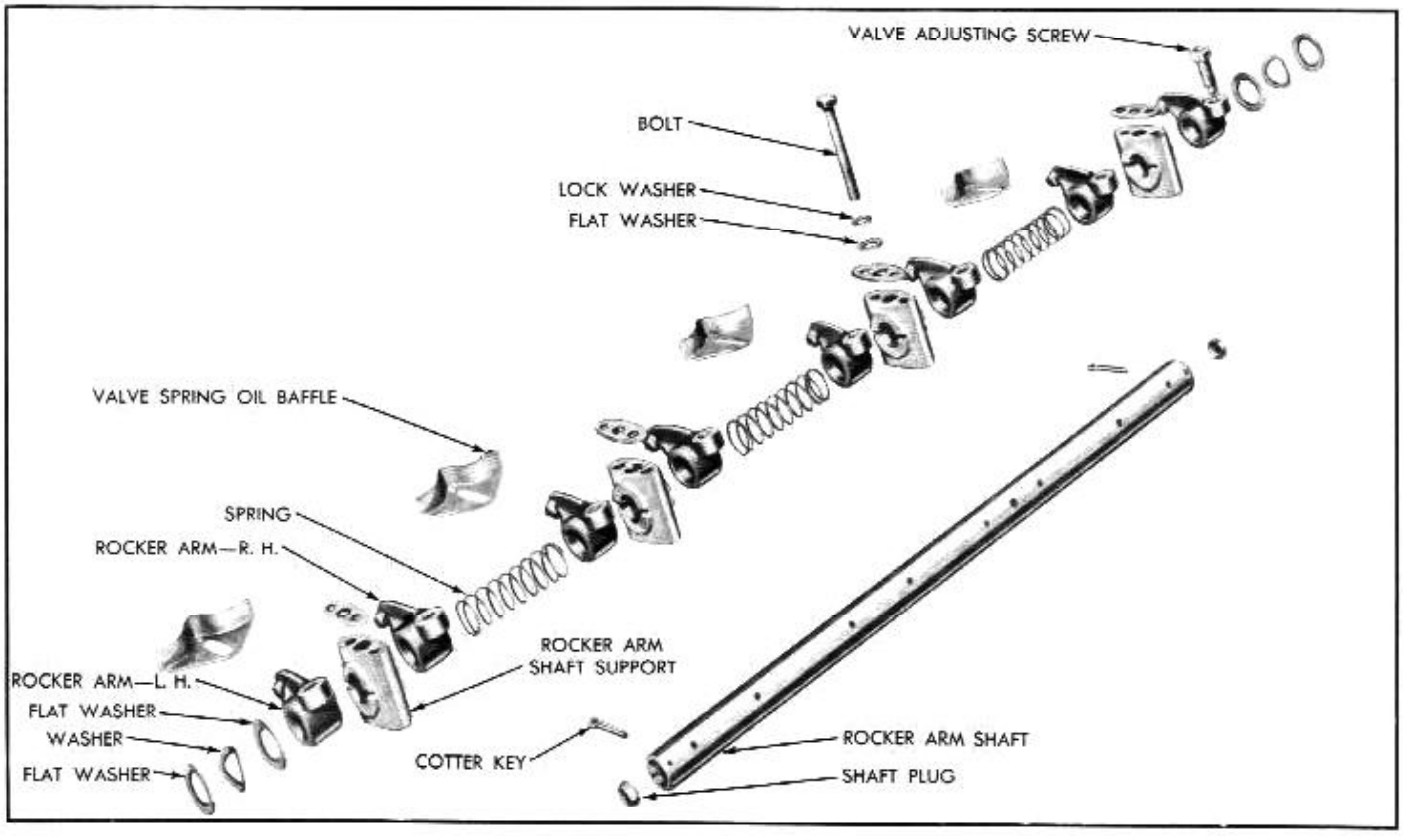


Fig. 6C-70—Rocker Arm Mechanism

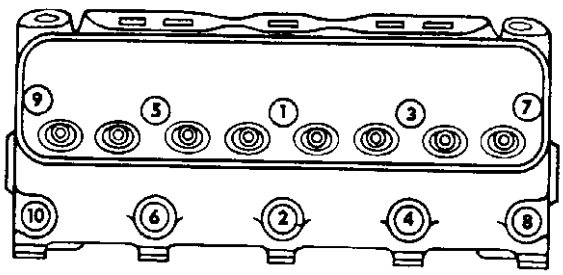
arm pad must be maintained.

6. Check each push rod for bent or damaged condition. Replace with new parts if bent more than .020" total indicator reading.
7. To assemble the rocker arm assemblies, reverse the removal procedure. Reverse the disassembly procedure using new plugs in the rocker arm shaft. NOTE: Make sure rocker arms are correctly positioned to actuate valves. The oil overflow pipe hole in shaft should be seen through the center hole of front support on right bank and rear support on left bank. If hole cannot be seen, turn shaft until holes line up.

Installation

NOTE: It is advantageous to use pilot studs (Tool 6051-A) when installing cylinder head assemblies. Pilots can be made from two long cylinder head retaining screws. This may be done by cutting the head from the screw, then round edges with a file and cut a slot for screwdriver.

1. Coat both sides of cylinder head gasket with gasket sealer and install on cylinder block. NOTE: Cylinder head gaskets are interchangeable on either bank. Gaskets are properly installed when the word "FRONT" is at the forward end with water passage holes lined up.
2. INSTALL RIGHT BANK CYLINDER HEAD AS FOLLOWS:
   a. Install right cylinder head assembly in position on cylinder block with plugged water jacket to rear of block. Remove Cylinder Head Holding Fixture Tool 6085-A and pilot studs.
   b. Install cylinder head retaining screws and make three torque applications, two cold and one hot (the final "hot" application will be made after the engine is assembled) following procedure outlined in figure 6C-71. When torquing screws it is recommended that Snap-On Tool S-8663-A and P-8675 be used with the torque wrench.
   c. Install exhaust manifold and spark plug heat shields, washers and spacers. Torque screws 23 to 28 lbs. ft.
   d. Coat heater control valve fitting threads with water resistant sealer and install fitting in cylinder head, connect heater control valve to fitting and connect heater inlet hose to control valve.
3. INSTALL LEFT BANK CYLINDER HEAD AS FOLLOWS:
   a. Install left bank cylinder head assembly in position on cylinder block with plugged water passage to the rear. Remove Cylinder Head Holding Fixture Tool 6085-A and pilot studs.
   b. Install cylinder head cap screws and make three torque applications, two cold and one hot (the final "hot" application will be made after the engine is assembled) following procedure outlined in figure 6C-71. When torquing cap screws it is recommended that Snap-On Tool S-8663-A and P-8675 be used with the torque wrench.
   c. Install engine ground strap and wiring loom clip on cylinder head.
   d. Install exhaust manifold and spark plug heat shields, air duct mounting bracket, spacers and washers. Torque cap screws 23 to 28 lbs. ft.
4. Install push rods in cylinder block being sure they are properly seated in the tappets.
5. Install rocker arm and shaft assembly. When installing oil overflow pipes, right bank pipe goes to the front and left bank pipe goes to rear rocker arm support.
   CAUTION: *Make sure pipe enters hole in rocker arm support and shaft.*
6. Perform valve clearance adjustment as follows: NOTE: 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.
   a. Turn all the tappet adjusting screws until interference is noted, then check the torque required to turn the screw further.
   b. If the torque required to turn the screw is less than 3 lbs. ft. (36 lbs. in.). Replace the rocker arm and adjusting screw.



TORQUING OF ALL CYLINDER HEAD BOLTS, IN THE ABOVE SEQUENCE, TO BE PROGRESSIVELY INCREASED IN THREE STEPS:

	EARLY PRODUCTION	"FT" ON BOLT HEAD
1ST STEP ENGINE COLD	60-70	65-80
2ND STEP ENGINE COLD	70-80	80-95
3RD STEP ENGINE HOT—STABILIZED AT 160°—180° F.	80-90	95-105

Fig. 6C-71—Torque Sequence and Values

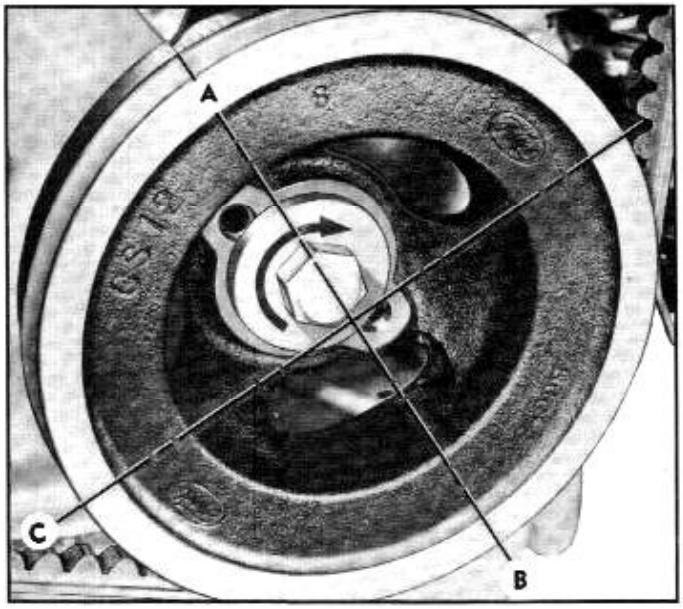


Fig. 6C-72—Quadrant for Valve Clearance Adjustment — Typical

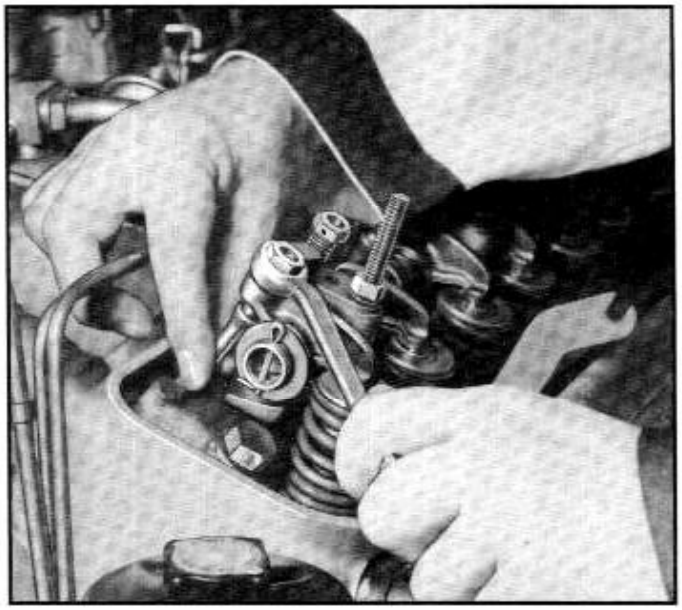


Fig. 6C-73—Valve Clearance Adjustment

c. Make three chalk marks on the crankshaft damper. Space the marks approximately 90° apart so that with the timing mark, the damper is divided into four equal parts (90° represents 1/4 of the distance around the damper circumference). See figure 6C-72.

d. Rotate the crankshaft until No. 1 piston is near T.D.C. at the end of the compression stroke. To adjust valve clearance of the following valves, shown in the table which follows, turn adjusting screw clockwise while moving push rod up and down as shown in figure 6C-73, until slack is removed.

IMPORTANT: Plunger unit of hydraulic tappet should not be forced down into tappet body during this operation. With the slack removed, turn adjusting screw clockwise an additional 2½ turns. Repeat until all tappets are adjusted.

CAUTION: *To eliminate any possibility of bending a push rod, force each tappet to leak down after adjustment, by pressing on the push rod end of the rocker arm.*

NOTE: If lifter is noisy during vehicle's operation, adjustment can be varied by turning adjusting screw ± 1/2 turn from the original 2½ turn setting.

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

e. Rotate the crankshaft 180° or 1/2 turn (this puts No. 4 piston on T.D.C.), then adjust the following valves:

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

f. Rotate the crankshaft 270° or 3/4 turn from 180° (this puts No. 3 piston on T.D.C.), then adjust the following valves:

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

7. Clean, check and install spark plugs. Torque 15 to 20 lbs. ft. Install spark plug ignition wires on spark plugs.
8. Install new intake manifold gaskets and intake manifold.

   NOTE: When installing manifold and gaskets, make up pilot studs to hold gaskets in position. Use 3/8"-16 screws to make pilot studs.
9. Position the manifold clamps and washers; install manifold retaining screws and nuts and tighten them to 23-28 lbs. ft. torque, working on each side alternately from center toward ends.
10. Install and secure control shaft assembly and accelerator shaft bracket to intake manifold. Install accelerator retract springs. Connect carburetor to control shaft rod to carburetor.
11. If vehicle is equipped with power brake unit, connect power brake vacuum line to intake manifold connector. Connect vacuum booster line to intake manifold connector. Connect vacuum line to starter cut-out switch and intake manifold connector.
12. Connect temperature sending unit wire to sending unit.
13. Connect windshield wiper hose to vacuum booster line.

14. Install a new gasket and connect water by-pass hose to water outlet connector. Connect upper radiator hose to connector.
15. Connect fuel inlet line to carburetor. Connect distributor vacuum line to carburetor and distributor. Connect battery ground cable to battery.
16. Install rocker arm cover using new gaskets. Tighten retaining nuts 2-2½ lbs. ft. torque.
17. Close petcocks and fill cooling system with coolant. Start engine and run it until it is thoroughly warm. Turn off engine and tighten cylinder retaining screws to proper torque. Refer to figure 6C-71. Start engine. While engine is running check for leaks.
18. With engine running, check timing and timing advance. Make necessary carburetor adjustments, then adjust transmission linkage.
19. Install air cleaner and air duct assembly.

REMOVAL AND INSTALLATION OF PISTONS, PISTON PINS, PISTON RINGS AND CONNECTING RODS – ENGINE IN VEHICLE

Removal

1. Raise vehicle and remove oil pan. Refer to "Removal of Oil Pan – Engine in Vehicle" in this section of manual.
2. Lower vehicle and remove cylinder head. To remove cylinder head, refer to "Removal of Cylinder Heads – Engine in Vehicle" in this section of manual.
3. Disconnect high tension lead wire at coil. Disconnect wire at "S" terminal of starter relay switch. Connect an auxiliary starter cable to the positive terminal of battery and the "S" terminal of starter relay switch.
4. Remove cylinder ridge from cylinder bores as follows:
   a. Using the auxiliary starting switch "bump" engine over until the respective piston to be removed is at approximately B.D.C.
   b. Remove cylinder ridge using Tool 6011-A or equivalent. See figure 6C-74.
   NOTE: Insert a clean cloth into cylinder bore to prevent chips and carbon from falling on piston and rings. Remove cloth and wipe bore clean after removing the ridge.
5. Raise vehicle.
6. Using auxiliary starter switch, rotate crankshaft to position the respective journals at approximately B.D.C. for removal of connecting rod and piston assembly.
7. Remove connecting bearing cap and bearing inserts. Using a wood hammer handle, push connecting rod and piston assembly out of cylinder bore.

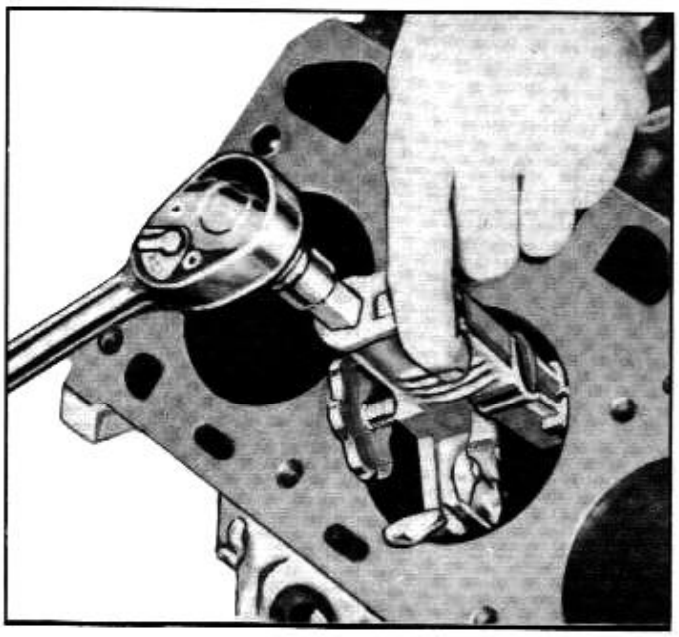


Fig. 6C-74—Removing Cylinder Ridge—Typical

CAUTION: *Use care to prevent connecting rod from striking cylinder bore. If cylinder bore is scored or nicked while removing the assembly, the cylinder bore will have to be honed or bored to repair the damage.*

8. Replace bearing inserts and cap on connecting rod so that the numbered sides match.
   NOTE: Each assembly is numbered so that it can be reinstalled in its respective cylinder bore.
9. If more than one piston and connecting rod assembly is to be removed, repeat Steps 6 through 8 for each respective assembly.

Cleaning, Inspection and Reconditioning

CYLINDER BLOCK

One of the most important phases of reconditioning is the thorough cleaning and inspection of the cylinder block.

Each machined surface of the cylinder block should be cleaned of all old gasket material.

Inspection of the cylinder block should be done carefully to detect any scoring of the cylinder bores, cracks or water leaks. Minute cracks may be found by coating suspected areas with a mixture of 75% light motor oil and 25% kerosene. After wiping area dry, immediately apply a coating of zinc oxide dissolved in wood alcohol. If any cracks are present, the white coating of the zinc-oxide wood alcohol mixture will discolor at the defective area.

Each cylinder bore should be checked for taper and out-of-round conditions. Use an accurate gauge following the manufacturer's directions. Measure the diameter of the cylinder bore at the top of the piston

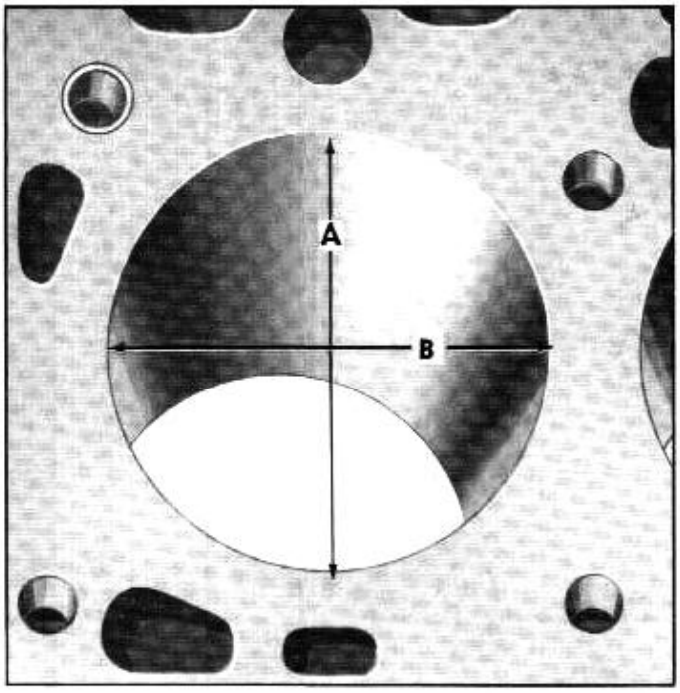


Fig. 6C-75—Measurement of Cylinder Out-of-round

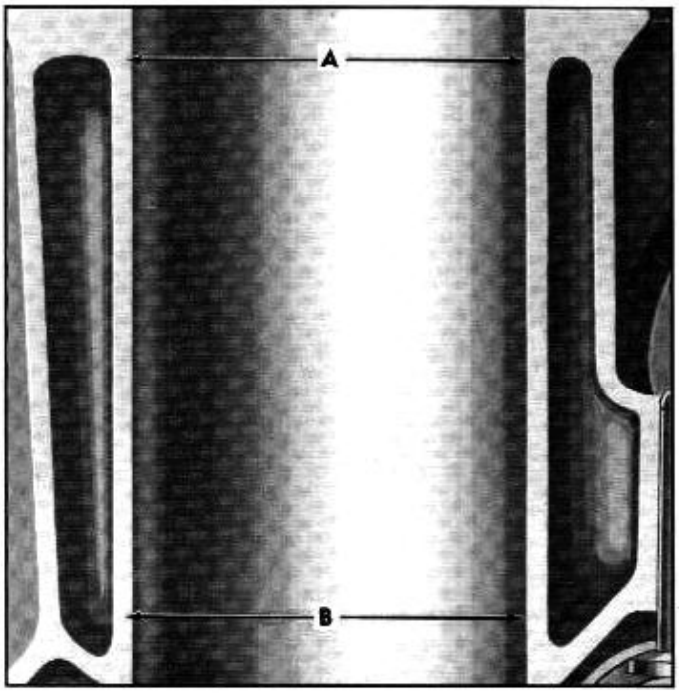


Fig. 6C-76—Measurement of Cylinder Taper

ring travel at right angles to the centerline of the crankshaft (A) see figure 6C-75. Record readings. Next, measure each bore so gauge reading coincides with centerline of crankshaft (B). The difference between the readings is the out-of-round condition at the top of the cylinder bore. Repeat this same procedure at the bottom of the ring travel to check for out-of-round. The difference between the diameters measured at the top (A) and bottom (B) of the bore (at right angles to the centerline of the crankshaft) is the taper of the bore. See figure 6C-76.

If the cylinder bore wear does not exceed the limits of .0005" out-of-round (wear limit .005") and .001" taper (wear limit .008"), new service piston rings will give satisfactory performance provided the piston clearance is not excessive.

However, if the wear exceeds the limits it will be necessary to rebore the cylinder or cylinders to within .0015" of the required oversize diameter. This will allow enough stock for the final step of honing the bores so the exact clearance and surface finish may be obtained for the selected oversize pistons.

NOTE: After the honing operation is completed, cylinder bores and block should be thoroughly cleaned.

Each piston thus fitted should immediately be marked with the respective cylinder number it was fitted to. It is recommended that the clearance between the fitted piston and the cylinder wall be held to the mean limit.

Piston fit should be checked by positioning a length of 1/2" wide feeler stock, of the recommended thickness for the existing condition, between the inverted piston and the cylinder wall. The feeler should extend the entire length of the piston at 90° from the piston pin holes. Hold the piston in the cylinder bore so the end is about 1½" below the top of the block and the piston pin bore is parallel to the crankshaft. Then pull feeler stock from cylinder while noting reading on Pull Scale Tool FLM-6110-A as shown in figure 6C-77.

If reading on scale conforms to limits presented in the following chart for the existing condition, the piston clearance is satisfactory.

Fit New Piston in New Bore		Fit New Piston in Used Bore		Fit Used Piston in Used or New Bore	
Feeler Thickness (Inches)	Pull (lbs.)	Feeler Thickness (Inches)	Pull (lbs.)	Feeler Thickness (Inches)	Pull (lbs.)
.002	5-10	.0025	5-10	.003	5-10

If reading on scale is greater than maximum pull limit, check piston for any damage that may affect the pull reading. If no damage is evident then try another piston. Recheck fit of new piston.

Prior to installing a piston with new rings in a used cylinder bore, it is necessary to remove the high glaze from the wall to aid seating of the rings.

PISTONS AND PISTON PINS

From the inspection and measurements of the cylinder bores, it has been determined that the pistons to be installed are either new pistons or that the original pistons are to be re-used with new piston rings.

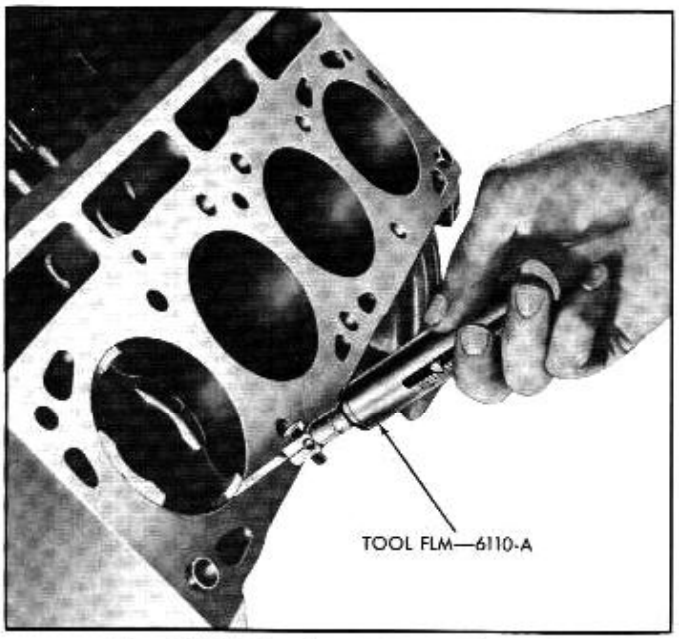


Fig. 6C-77—Checking Piston Clearance

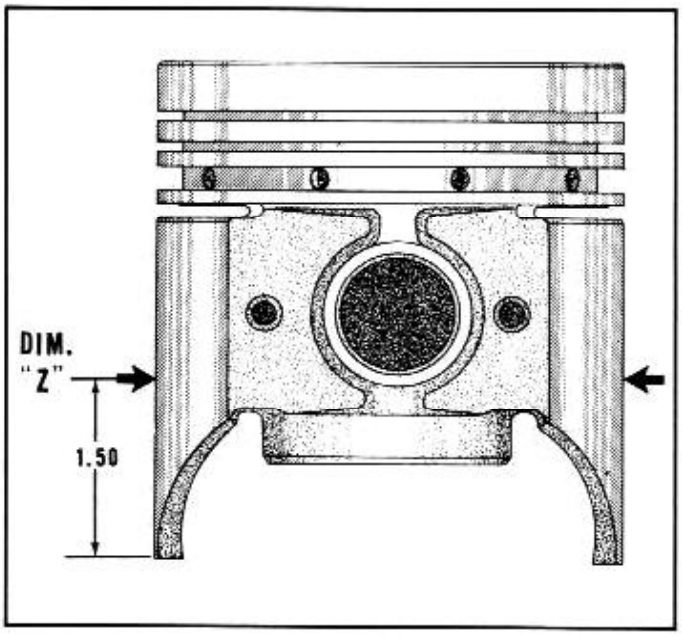


Fig. 6C-78—Measuring Piston Diameter

If the original pistons are to be used with new rings, the pistons must be thoroughly cleaned of all carbon. Tool LM-6110-A is provided for cleaning the piston ring grooves. Soaking the pistons in cleaning solvent will loosen the carbon for removal. NEVER USE A WIRE BRUSH ON A PISTON, this will round off the ring lands. Clean oil holes or slots, being careful not to remove any metal.

Inspect the pistons for scuffed or scored skirts, worn or cracked ring lands, and discard any that show such conditions. When the condition is in doubt, replace the piston.

There are actually two different sizes of pistons which can be fitted to a STANDARD size cylinder bore. By this, we mean that a standard size cylinder bore has a production tolerance between the limits of 4.0000" to 4.0024", as determined by the point at which the proper cylinder bore finish is reached. Pistons used in a standard size cylinder bore are marked No. 2 and No. 6 and are assigned different part numbers for service.

The numbers correspond to the following sizes (See figure 6C-78):

Piston Number on Dome	Dimension "Z" (See figure 6C-78)
2	3.9988"-3.9991"
6	4.0000"-4.0003"

From the above it can be seen that a standard size cylinder bore may measure up to a diameter of 4.0024". However, it is still considered standard and it is not necessary to use an oversize piston. If one of the standard size pistons will not fit with the proper clearance (ribbon pull) then it will be necessary to rebore the cylinder as required and use an oversize piston.

Use Tool 6135-B or equivalent to ream the pistons if oversize piston pins are to be used. The specified clearances between piston and pin is 0.0001"-0.0003" (wear limit—loose—.0008"). The piston pin should be a light thumb press fit and should be installed in the piston and rod when the piston is at a normal room temperature (70°). Two retainers are used to hold the pin in place; one at each end of pin. When installing the retainer rings make sure they are properly seated in grooves provided in piston pin boss. Always use new pin retainer.

Assemble rod to piston so the indentation embossed on piston head will face the front of the engine while the numbered side of the rods on the right bank will face the right side of engine and the rods for the left bank will face the left side of the engine when viewed from the rear.

CONNECTING RODS

Each connecting rod should be thoroughly cleaned and visually inspected for defects. If condition is satisfactory, the rod should be assembled to the piston for installation in the cylinder from which it was removed. See figure 6C-79.

The connecting rod should be checked for proper clearance with piston pins. The specified clearance is .0002"-.0004" (wear limit—loose—.0008"). The piston pin should be able to move through the bushing with a light thumb press. If loose, oversize piston pins of .001" and .002" are available.

After the rods are assembled to the pistons, the complete assembly should be checked with suitable

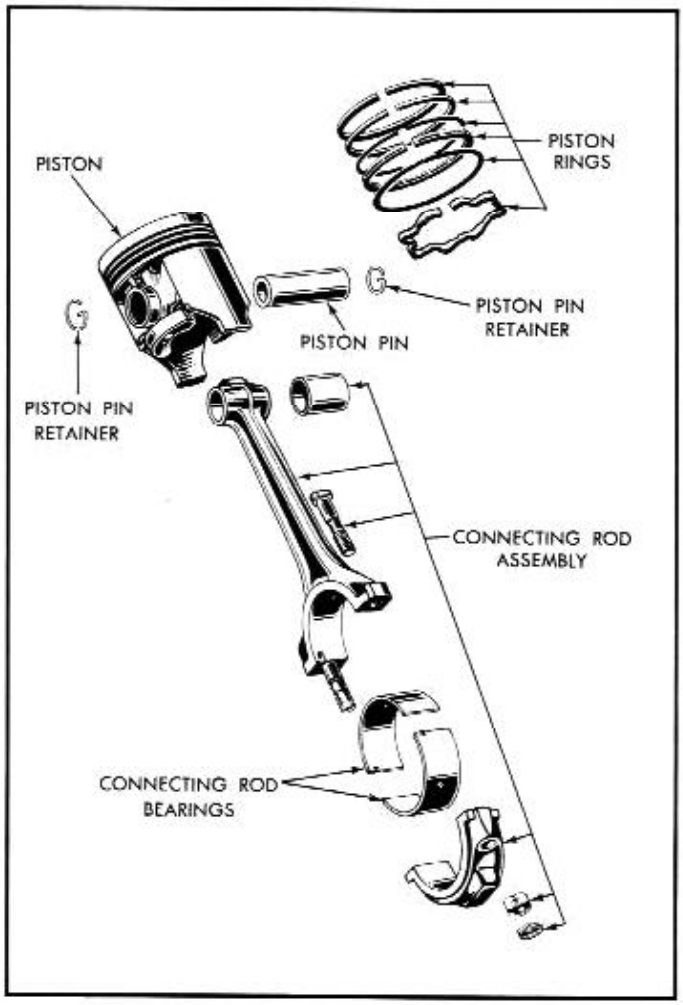


Fig. 6C-79—Piston and Connecting Rod Assembly

Fig. 6C-80—Checking Piston Ring Gap

aligning equipment. Since many makes are in use, it is recommended that the manufacturer's instructions be followed to assure that the rod is not bent or twisted. Bending the connecting rod to obtain correct alignment is permissible. The following specifications apply when checking connecting rod alignment:

Twist Total Difference – Maximum* . . .	.004″
Bend Total Difference – Maximum* . . .	.004″

*Finished piston pin bushing and crankshaft bearing bore must be parallel and in same vertical plane within the specified total difference at ends of eight (8) inches long bar measured four (4) inches of each side of rod.

An oil squirt hole is provided in each connecting rod to direct a stream of oil on the cylinder wall as the piston approaches top center. The oil is supplied through a hole drilled in the crankpin end of the rod which intermittently lines up with the hole in the crankpin. Thus, it may be seen that the squirt of oil is of short duration and occurs only once at each cylinder for each revolution of the crankshaft at low engine speeds only. Make sure these oil squirts holes are open. Also, make sure the rod bearings are provided with a hole that is clear of obstructions to allow the oil from the crankpin to flow through the bearing to the squirt hole.

PISTON RINGS

Each piston has three piston rings located above the piston pin. The compression rings are located in the two top grooves while the lower groove accommodates the expander type oil control ring. Select the proper rings for the size of the pistons to be used.

Prior to installing the rings on the piston, each ring must be checked for the proper ring gap. Push the ring down into the cylinder bore about two inches using the head of a piston, so that the ring is square with the cylinder wall. Extreme caution should be used during this operation. Check the space or gap between the ends of the ring with a feeler gauge. See figure 6C-80. The gap should be within the limits of .013″ to .030″ for both compression rings and .015″ to .062″ for the oil control ring.

If gap is less than limit, try another ring for fit. Each ring should be fitted and checked in the cylinder in which it is going to be used and marked accordingly.

Piston rings should also be checked for side clearance in the groove of the piston on which they are to be installed. This is done by placing the outer edge of the ring in the piston groove and rolling the ring entirely around the piston to make sure that there is no binding and the ring is free in groove. With a thickness gauge, check the side clearance of each ring in its

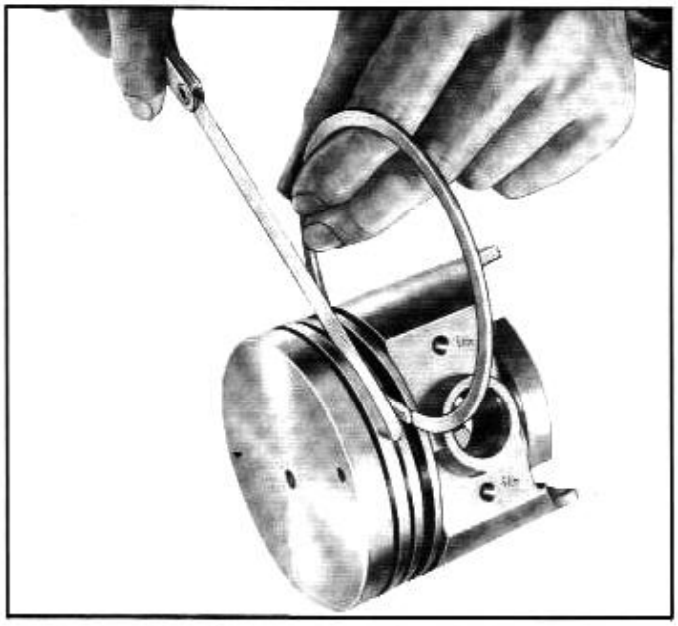


Fig. 6C-81—Checking Piston Ring Side Clearance

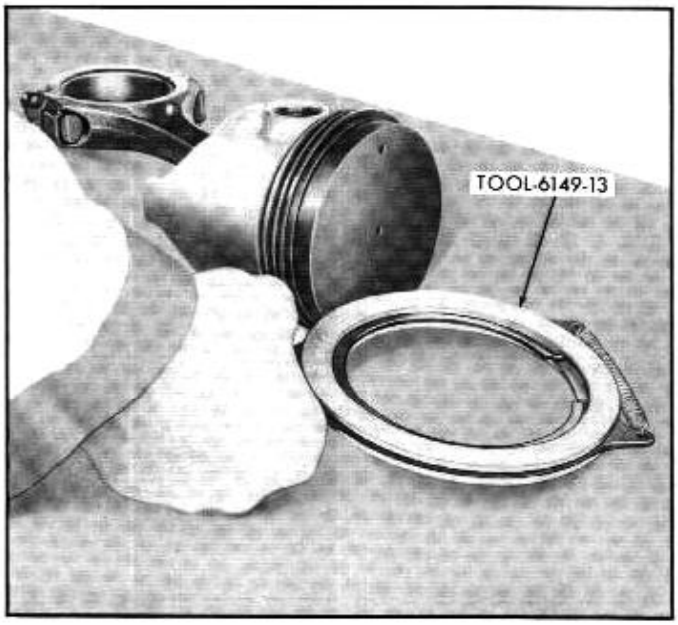


Fig. 6C-82—Piston Ring Expander Tool

respective groove. See figure 6C-81. The side clearance of upper compression ring is .0015"-.0030". The side clearance of lower compression ring is .001"-.003". The wear limit for both upper and lower rings is .006".

Assemble rings on pistons to which they were fitted by using a piston ring expander Tool 6149-13. This type tool is recommended to avoid over-expanding and to expand the ring to a true circle to avoid distortion. See figure 6C-82. Space ring gaps 120° apart and coat with engine oil prior to installing. When spacing oil ring on piston, the ring gap should be positioned so that it will be on the inside of the "V" (high side of cylinder bore) when piston is installed in cylinder bore.

Installation

1. Turn crankshaft so crankpin for No. 1 and No. 5 cylinders is at approximately B.D.C.
2. Coat cylinder bores, crankshaft journals, pistons, piston pins, and piston rings with engine oil. (Check ring gap spacing. Oil ring gap should be positioned to the inside of the "V" of engine and the remaining ring gaps spaced 120° apart.) Insert piston into Ring Compressor Tool FLM-6149 and install piston assembly into respective cylinder bore, as shown in figure 6C-83. Install connecting rod bearings and caps, coating each with engine oil. The numbered side of the cap must match and be on the numbered side of the rod. Secure with hex nuts and pal nut. Torque hex nuts 45-50 lbs. ft. Install pal nuts and torque 3 to 3½ lbs. ft. or finger tight plus 1/3 turn. Repeat above operation for remaining cylinders, turning crankshaft so crankpin for each set of cylinders is at approximately B.D.C. for installation of remaining piston assemblies. The numbered side of the rods must face towards the outside of the block and dimple embossed or slot cut on the top of the piston must face the front of the engine. See figures 6C-84 and 6C-85.

CAUTION: *When installing piston assemblies, be extremely careful that the connecting rod bolts do not strike the crankshaft journals. If this should happen, remove burr using fine oilstone. DO NOT HAMMER ON TOP OF PISTON when installing*

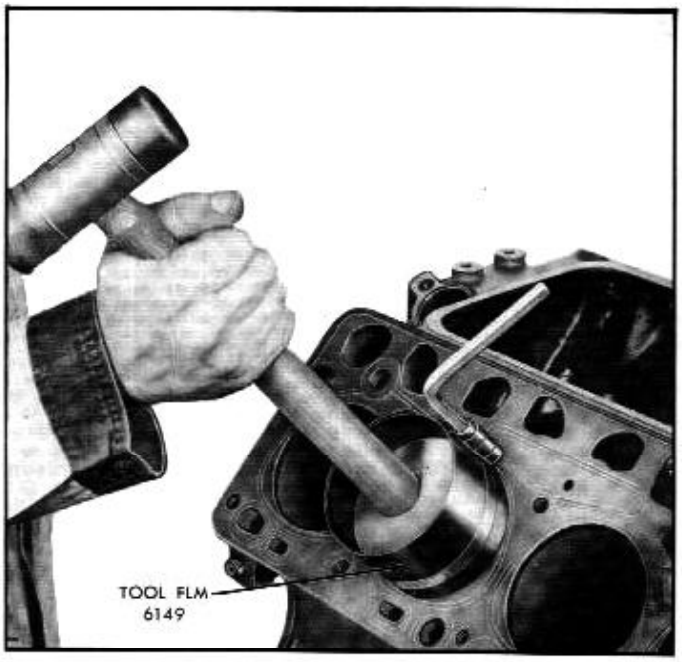


Fig. 6C-83—Installing Piston — Typical

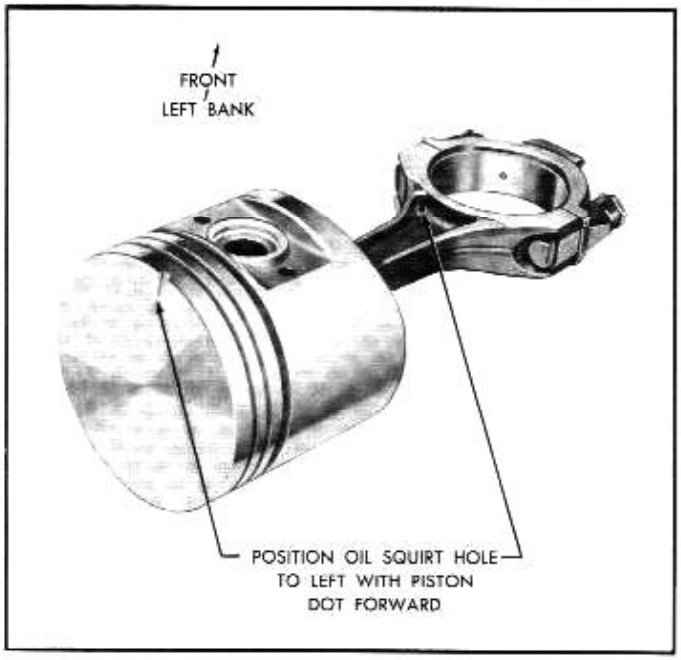


Fig. 6C-84—Position of Piston and Connecting Rod Squirt Hole — Left Bank — Typical

assembly in cylinder bore. Apply even pressure to wood hammer handle. See figure 6C-83. By applying a continuous pressure to the piston, any obstruction will be immediately indicated. The piston assembly can then be removed and rings checked and reinstalled correctly, if obstruction is present.

3. Check connecting rod side clearance using feeler gauge. See figure 6C-86. The limits are .006" to .014" (wear limit .017"). Replace bearings if side clearance exceeds this limit.

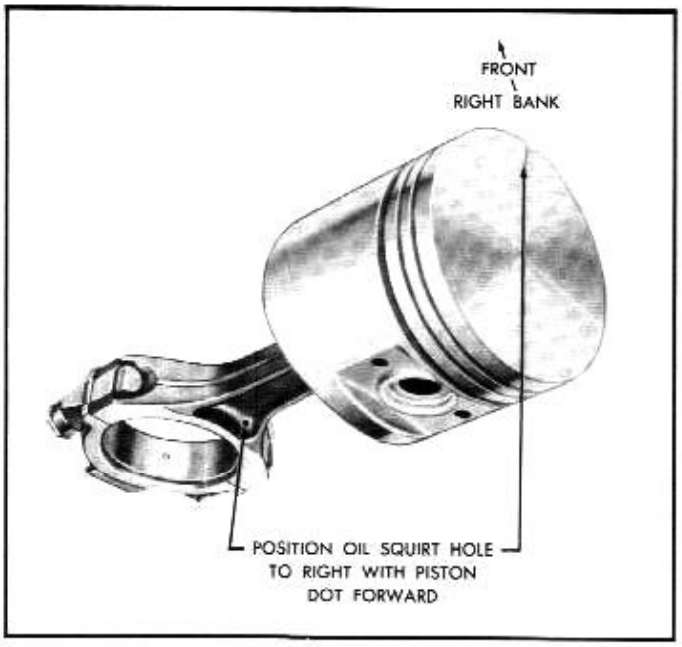


Fig. 6C-85—Position of Piston and Connecting Rod Squirt Hole — Right Bank — Typical

Fig. 6C-86—Checking Connecting Rod Side Clearance

4. Install oil pan. To install oil pan, refer to "Installation of Oil Pan — Engine in Vehicle" in this section of manual.
5. Install cylinder head. Refer to "Installation of Cylinder Head — Engine in Vehicle" in this section of manual.
6. Perform engine compression test.

REMOVAL AND INSTALLATION OF MAIN AND CONNECTING ROD BEARINGS — ENGINE IN VEHICLE

Removal

1. Remove spark plug wires and spark plugs.
2. Disconnect high tension coil lead wire at coil. Disconnect wire at "S" terminal of starter relay switch. Connect an auxiliary starter cable to the positive terminal of battery and "S" terminal of starter relay switch.
3. Remove oil pan. Refer to "Removal and Installation of Oil Pan — Engine in Vehicle" in this section of manual.

Inspection

It is necessary to ascertain the condition of all main crankshaft journals and connecting rod journals before proceeding with the bearing replacement procedures. If a crankshaft has journals that are badly nicked or scored, or the journals are grooved, out-of-round or tapered beyond specification limits, the engine must be removed from the vehicle. The crankshaft will then have to be removed for grinding or replacement purposes.

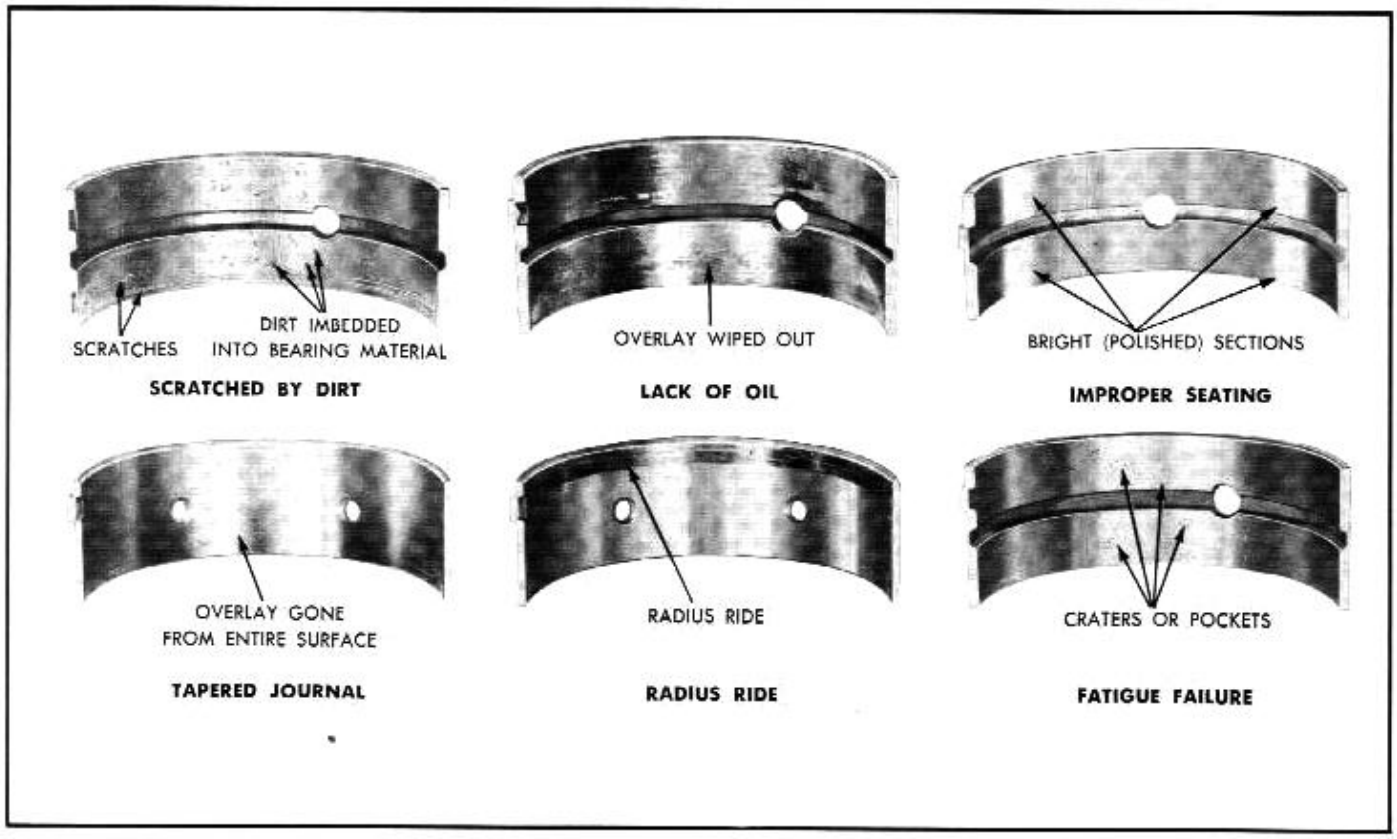


Fig. 6C-87—Bearing Failures — Typical

1. Check the condition of each main bearing one at a time, leaving the other bearings securely fastened. Remove bearing cap and insert. Clean and inspect each bearing carefully. Bearings that have a scored, chipped or worn surface will have to be replaced. Typical examples of bearing failures and their causes are shown in figure 6C-87.
2. Clean and inspect main bearing journals for cracks, scratches, grooves or scores. Dress minor imperfections with an oilstone. Replace or regrind badly damaged journals.
3. Using the auxiliary starter switch, rotate crankshaft to position the respective connecting rod journals at B.D.C. for removal of connecting rod bearing caps and inserts. Remove pal nuts and nuts securing bearing cap to connecting rod. Remove cap and bearing insert. Refer to figures 6C-87 and 6C-88 for typical examples of bearing failures. Bearings that have a scored, chipped or worn surface will have to be replaced. If wear pattern on connecting rod indicates a bent rod or improperly ground crankshaft, inspect crankshaft for cause of failure. Remove the crankshaft for replacement or regrinding if it is the cause of failure. If crankshaft is not the cause of failure, replace connecting rod. Refer to "Removal and Reconditioning of Pistons, Piston Pins, Connecting Rods and Bearings."
4. Clean and inspect connecting rod journals for cracks, scratches, grooves or scores. Dress minor imperfections with an oilstone. Replace or regrind badly damaged crankshafts.
5. Measure the diameter of each journal in at least four (4) places to determine out-of-round, taper or undersize condition. The connecting rod journal

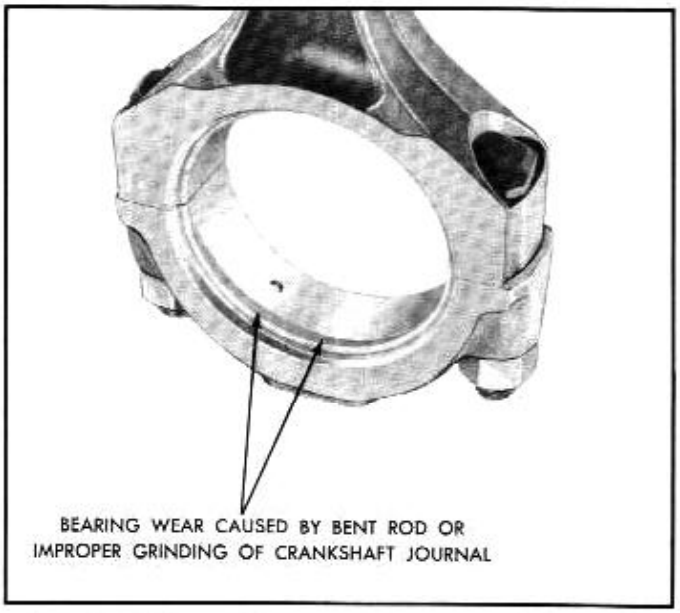


Fig. 6C-88—Wear Pattern on Connecting Rod Bearing

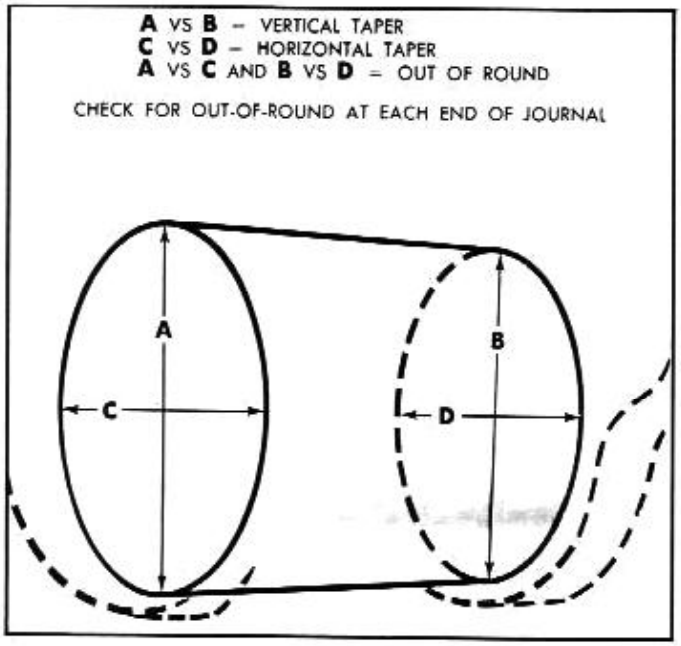


Fig. 6C-89—Crankshaft Journal Measurement

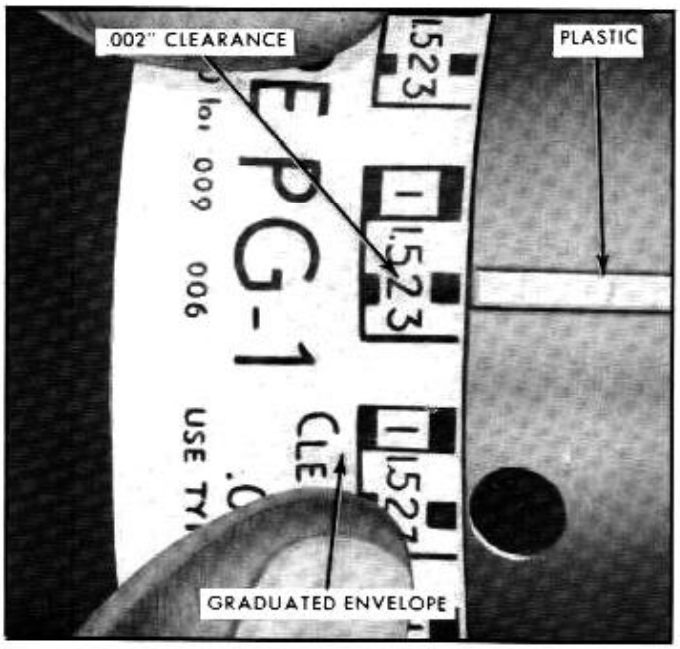


Fig. 6C-90—Checking Bearing Clearance

diameter specification is 2.2482"-2.2490". See figure 6C-89. The out-of-round and taper limits for the connecting rod journals are, .00025" out-of-round (wear limit .0005"), and .0005" taper (wear limit .001").

6. If the journals approach the taper or out-of-round wear limits, they should be reground to size for the next undersize bearing. If the journal diameters are less than specified, the crankshaft must be reground for the next undersize bearing.

Fitting Main Bearings

To obtain an accurate reading of main bearing to crankshaft clearance, using the Plastigage method of checking, all bearing caps must be in place and torqued to 120 to 130 lbs. ft. Then follow procedure outlined below:

1. It will be necessary to support the weight of the crankshaft. This can be done with a small jack positioned to bear against the crankshaft counterweight adjoining the bearing which is being checked for clearance.
   NOTE: Crankshaft support is necessary when checking main bearing clearances in order to prevent the crankshaft weight from compressing the Plastigage, which would provide an erroneous reading.
2. Remove one bearing cap and bearing insert at a time. Remaining caps are left tight while checking the bearing clearance.
3. The upper half of the bearing can be removed from the cylinder block by using Tool 6331 inserted into the crankshaft oil hole and rotating the crankshaft opposite to engine rotation. This tool will push the bearing insert out.
   CAUTION: *Use Tool 6331 with care to avoid the possibility of damaging bearing.*
4. Wipe the oil from all contacting surfaces of the crankshaft and bearing inserts, bearing cap, etc.
5. Install upper half of bearing insert. Place plain end of insert over crankshaft on the locking tang side of crankshaft main bearing web and rotate the insert into position as far as possible, then use Tool 6331 to further seat the insert.
6. Place a piece of Plastigage, the full width of the bearing surface, on the crankshaft journal about 1/4" off center. Install bearing insert and cap. Tighten retaining screws to 120-130 lbs ft. torque.
   CAUTION: *Do not rotate crankshaft while making checks with Plastigage.*
7. Remove bearing cap and insert, but do not disturb Plastigage.
8. Compare the width of the flattened Plastigage at its widest point with the scale printed on the Plastigage envelope. See figure 6C-90. This reading indicates the minimum bearing clearance in thousandths of an inch. Clearance should be from .0008" to .0036".
9. If the clearance is less than .0008" or more than .0036", try another bearing insert to bring the clearance within the desired specification.
   NOTE: Standard size bearing inserts are divided into two sizes carrying different suffixes to the part number. They can be identified by a daub of either red or blue color dye. Red bearing inserts will increase the clearance, blue bearing inserts

will decrease the clearance.
Any combination or red and/or blue bearing inserts may be used to bring the desired results.
If the various selective fit bearings do not bring the clearance within the desired limits it will be necessary to regrind the crankshaft journals and install undersize bearing inserts.

Fitting Connecting Rod Bearings

1. Using the auxiliary starter switch, rotate crankshaft to position the No. 1 connecting rod journal at B.D.C. Remove connecting rods secured to the respective journal.
   NOTE: Fit the connecting rod bearings to one journal at a time before proceeding to the next.
2. Remove bearing cap and separate bearing from cap and rod.
3. Clean oil from connecting rod journal, connecting rod and bearing cap bores, and bearing contact surfaces.
4. Install upper bearing into the rod and pull rod assembly into firm contact with the crankshaft journal.
5. Install lower bearing into connecting rod cap. Place a piece of Plastigage on the bearing surface the full width of bearing about 1/4" off center.
6. Install cap and tighten to 45-50 lbs. ft. torque.
   CAUTION: *Do not turn crankshaft while Plastigage is in place.*
7. Remove bearing cap and compare the width of the flattened Plastigage at its widest point with the scale printed on the Plastigage envelope. See figure 6C-90.
   If clearance is less than .0007" or more than .0026" (wear limit .0036") try another selective fit bearing to bring the clearance within the desired limits.
8. Check connecting rod side clearance using a feeler gauge. See figure 6C-91. The specified limits are .006" to .014" (wear limit .017"). Replace bearing inserts if side clearance is greater than specified.

Installation

1. Install oil pan. Refer to "Removal and Installation of Oil Pan – Engine in Vehicle" in this section of manual.
2. Lower vehicle. Disconnect auxiliary starter cable from starter relay switch and battery. Connect wire to "S" terminal of starter relay switch.
3. Connect high tension coil lead wire to coil.
4. Install spark plugs and tighten them to 15-20 lbs. ft. torque.
5. Start engine and check for oil leaks.

Fig. 6C-91—Checking Connecting Rod Side Clearance

REMOVAL OF 368 CUBIC INCH ENGINE (LESS TRANSMISSION)

1. Mask edge of hood, fenders and cowl to protect paint. Place fender covers on fenders.
2. Drain coolant from radiator and cylinder block. Remove battery. Remove hood assembly.
3. Remove the carburetor air cleaner and air duct as an assembly.
4. Disconnect heater outlet hose at water pump. Disconnect heater inlet hose at heater control valve. Remove heater control valve and fitting from cylinder head.
5. Disconnect generator field and ground wires.
6. Disconnect distributor primary and secondary wires from distributor.
7. Disconnect upper radiator hose from radiator.
8. POWER STEERING EQUIPPED VEHICLES: Remove power steering pump from mounting bracket. Position power steering pump, with lines connected, against front of fender apron in a position that will prevent oil from draining out of reservoir filler cap.
9. Disconnect flexible fuel line at fuel pump.
10. Disconnect wires from automatic starter cut out switch, coolant temperature sending unit, and the oil pressure sending unit wire connector.
11. Disconnect vacuum and water hoses from windshield washer container. Remove windshield washer container and mounting bracket from fender apron. Disconnect windshield wiper hose at vacuum booster line.
12. POWER BRAKE EQUIPPED VEHICLES: Disconnect power brake vacuum hose at intake

manifold connector.

13. Remove two accelerator shaft retracting springs. Disconnect accelerator shaft at the control shaft rod. Remove screws securing control shaft assembly and accelerator shaft bracket to engine. Wire the control shaft assembly to dash panel.
14. Disconnect ground wire at left rear of cylinder head.
15. TACHOMETER EQUIPPED VEHICLES: Disconnect and remove tachometer cable and driven gear from distributor.
16. POWER BRAKE EQUIPPED VEHICLES:
    a. Remove bolts securing power brake booster to mounting bracket.
    b. Disconnect power brake actuating rod from brake linkage.
    c. Position the power brake booster against the rear fender apron in a manner that will allow clearance for the removal of engine.
17. Disconnect lower radiator hose at water pump. Disconnect transmission coolant lines at lower radiator tank. Remove screws securing radiator to radiator support. Remove radiator assembly. NOTE: Position a piece of fibre board or heavy cardboard between fan and radiator to protect radiator core from damage.
18. Remove fan, spacer, water pump pulley and drive belts.
19. Raise vehicle. Remove engine splash shield. Disconnect stabilizer bar at left and right lower suspension arms. Remove screws securing stabilizer to frame crossmember. Pull stabilizer forward to allow clearance between stabilizer and oil pan.
20. Disconnect generator armature wire at generator. Remove screw securing spark plug wiring loom grommet to cylinder block. Disconnect starter cable and remove starter. Disconnect transmission coolant line bracket from cylinder block.
21. Drain engine oil from crankcase. Remove oil filter assembly from cylinder block. Remove oil pressure sending unit.
22. Disconnect and remove muffler inlet pipes from exhaust manifolds. Remove transmission filler tube mounting bracket and exhaust thermostat from right hand exhaust manifold.
23. Remove converter housing cover and the converter access cover from transmission. Remove the flywheel to converter cover retaining nuts.
24. Remove lower converter housing to cylinder block retaining screws.
25. Remove nuts securing front engine support brackets to the front engine supports.
26. Lower vehicle and support transmission with a support jack.
27. Attach Engine Hoisting Sling Tools 6000-BA and 6000-C to engine. Position sling on the exhaust manifolds to lift engine, less transmission. Remove upper converter housing to cylinder block attaching screws.
28. Lift engine slightly. Have a second mechanic push engine forward to clear dash panel. Continue to lift engine until it is clear of engine compartment while second mechanic guides the engine to prevent damage to engine or vehicle.

DISASSEMBLY OF ENGINE

For the purpose of this manual, it would be impractical to attempt to group all the service operations that may be performed on this engine while it is installed in the vehicle. Therefore, the engine has been removed from the car and installed on an engine stand for the complete teardown procedures.

From these procedures, the mechanic can obtain the information necessary to perform a specific repair operation.

1. Prior to installing engine on the repair stand remove the spark plugs.
2. Install engine on engine repair stand with repair stand adaptor Tool 6005-BK or CA. Use special tool steel bolts provided with the adaptor when mounting engine in engine repair stand.
3. Make sure all oil and water has been drained from cylinder block. Remove petcocks.
4. Disconnect fuel and vacuum lines from fuel pump, intake manifold, and carburetor, then remove fuel pump.
5. Remove vacuum lines from carburetor and distributor.
6. Remove distributor cap and wiring harness brackets. Wires, cap, and brackets may be removed as unit.
7. Disconnect automatic choke heat tube connections at carburetor. Remove tubes and carburetor.
8. Disconnect water by-pass tube from water pump and outlet connection.
9. Loosen generator adjusting arm and remove generator-fan belts.
10. Remove generator adjusting arm screws from generator; remove bolts securing generator to cylinder block and generator mounting brackets. Remove generator.
11. Remove water pump and power steering bracket from front cover.
12. Remove exhaust manifolds and spark plug heat shields.

    CAUTION: *Do not scratch or damage surfaces of ports since gaskets are not used at these locations.*
13. Remove combination oil filler and road draft

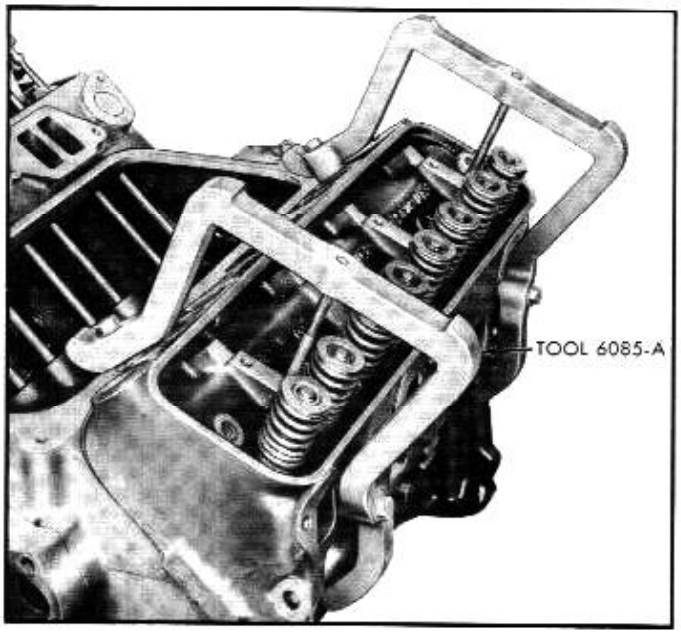


Fig. 6C-92—Cylinder Head Holding Fixture

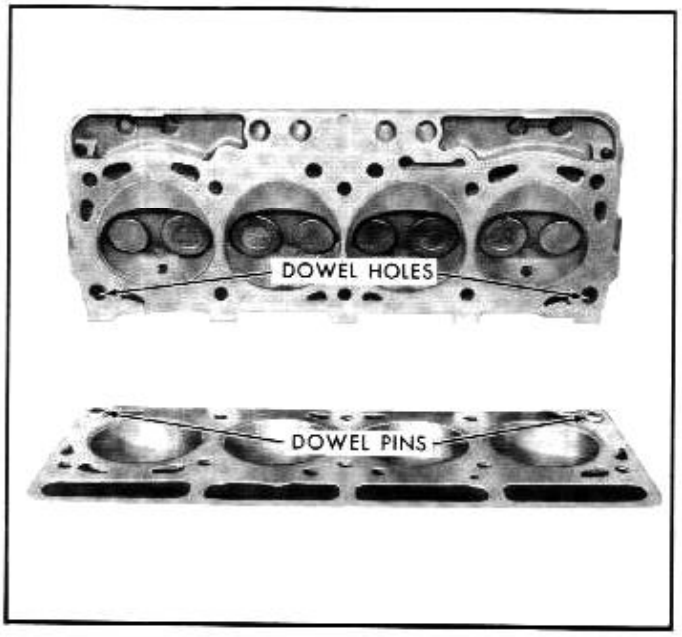


Fig. 6C-93—Location of Cylinder Head Dowels

tube attaching screw from front cover. Remove road draft tube. Remove oil dipstick and tube assembly.

14. Remove rocker arm chamber cover and gaskets.
15. Remove distributor retaining clamp nut and lockwasher, and wiring loom grommet then pull distributor gently from block.
    NOTE: Notice distance rotor turns as distributor is removed. This will be very helpful when distributor is reinstalled, as the helical gears turn the shaft.
16. Remove intake manifold and gaskets. Remove valve push rod chamber cover.
    CAUTION: *When this operation is performed, make sure the cover is cleaned first so dirt does not fall into the push rod chamber. This is particularly important when this operation is done with the engine in the vehicle.*
17. Loosen oil inlet pipe nut at oil pump. Remove three (3) inlet pipe attaching screws at oil pan. Remove inlet pipe.
18. Remove oil pump (Two cap screws on bottom and one above.). Remove intermediate shaft from block if it did not come out with oil pump.
19. Remove oil filter connector, adaptor and gasket so that area behind the adaptor can be cleaned.
20. REMOVAL OF CYLINDER HEADS:
    a. Loosen push rod adjusting screws to remove tension on push rods.
       CAUTION: *It is necessary that the tension be removed to prevent the possibility of bending the push rods or damaging the rocker arm shaft when removing rocker arm and shaft assembly support cap screws and nuts.*
    b. Remove six screws, two nuts, lockwashers, flat washers and stiffener plates securing rocker arm assemblies to cylinder heads.
    c. Remove oil overflow pipe from end support, at front on right bank and at rear on left bank.
    d. Lift rocker arm assembly up over studs to remove.
    e. Remove 8 push rods from each cylinder bank. Retain push rods in order of removal for reinstallation. Remove 4 oil baffle plates from rocker arm pads.
    f. Install and secure cylinder head holding fixture, Tool 6085-A, to cylinder head using intake manifold bolts. See figure 6C-92.
       NOTE: This tool has been designed to facilitate head removal and all work operations may be performed with the fixture in place. Thus, the machined surfaces of the cylinder head are protected at all times.
    g. Remove cylinder head cap screws and lift heads off the two locating dowels. See figure 6C-93. Remove steel gasket.
       NOTE: Never pry between cylinder heads and block.
21. Remove hydraulic tappets using Tool 6500-D.
    NOTE: Keep tappets in order as removed, so they may be reinstalled in their original bores if inspection reveals satisfactory condition.
22. Remove screws from flywheel. Rock flywheel back and forth gently while pulling outward to remove.
23. Remove oil pan retaining screws, then remove oil pan and gasket.
24. Turn engine block on repair stand so bottom

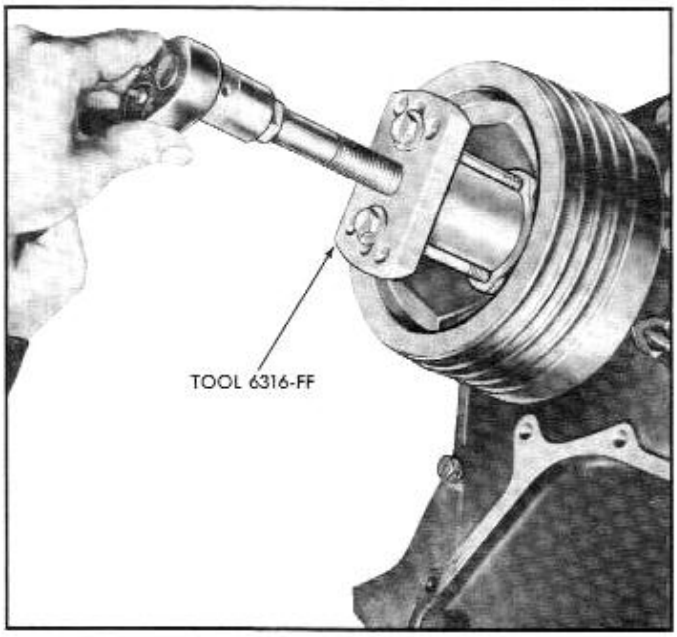


Fig. 6C-94—Removing Crankshaft Damper

faces upward. Remove screw and washer from front of crankshaft. Using Tool 6316-FF, remove crankshaft dampener assembly. Remove Woodruff key. See figure 6C-94.

25. Remove front cover and timing pointer by removing remaining screws. Remove gasket.
26. Remove thrust plunger and spring from front end of camshaft.
27. Remove screws and lock plate from camshaft sprocket. Remove camshaft sprocket and timing chain together. See figure 6C-95.
28. Remove fuel pump drive sleeve from camshaft eccentric and remove timing chain oil trough.
29. Using Tool 9400-B, remove snap ring retainer from fuel pump push rod and remove rod.
30. Remove crankshaft sprocket using Tool 6306-AE. See figure 6C-96. Remove Woodruff key.
31. Turn block to vertical position, front end facing upward. Remove camshaft being careful not to damage camshaft bearings.
32. Rotate crankshaft to position crankshaft journals for removal of Pal nuts and hex head nuts securing connecting rod caps to crankshaft. Remove cap and push connecting rods and piston assembly from cylinder bore.

    NOTE: Prior to removing piston assemblies, always remove ridge from top of cylinder bore using Tool 6011-A. See figure 6C-97.
33. Place caps and bearing inserts on connecting rods so numbered sides match. These assemblies are

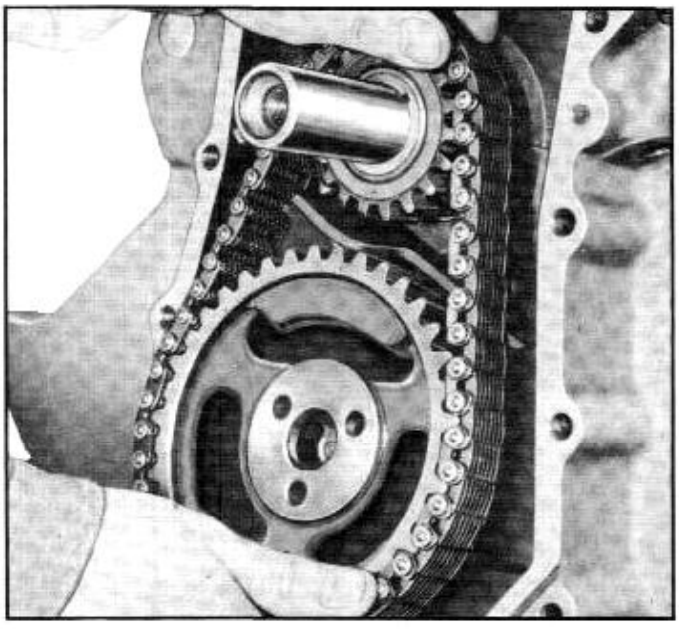


Fig. 6C-95—Removing Camshaft Sprocket and Timing Chain

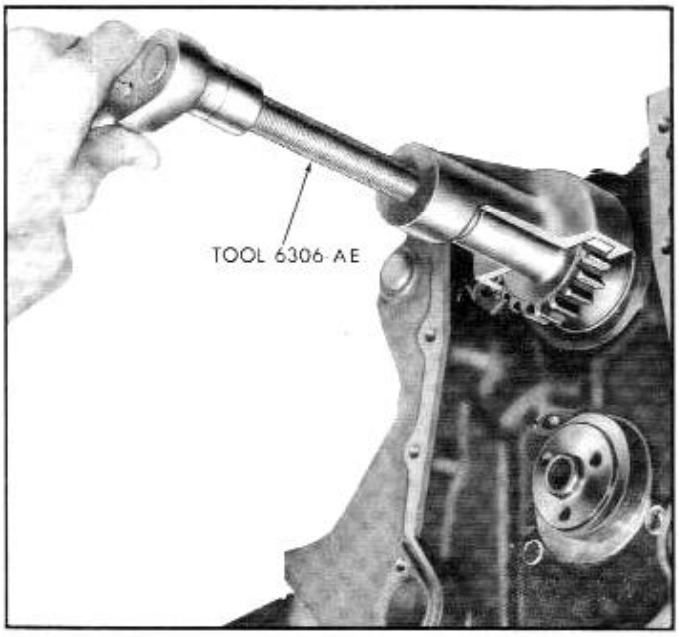


Fig. 6C-96—Removing Crankshaft Sprocket

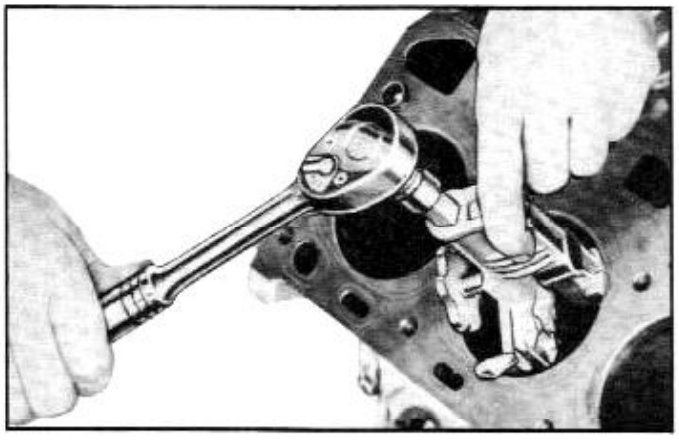


Fig. 6C-97—Removing Cylinder Ridge — Typical

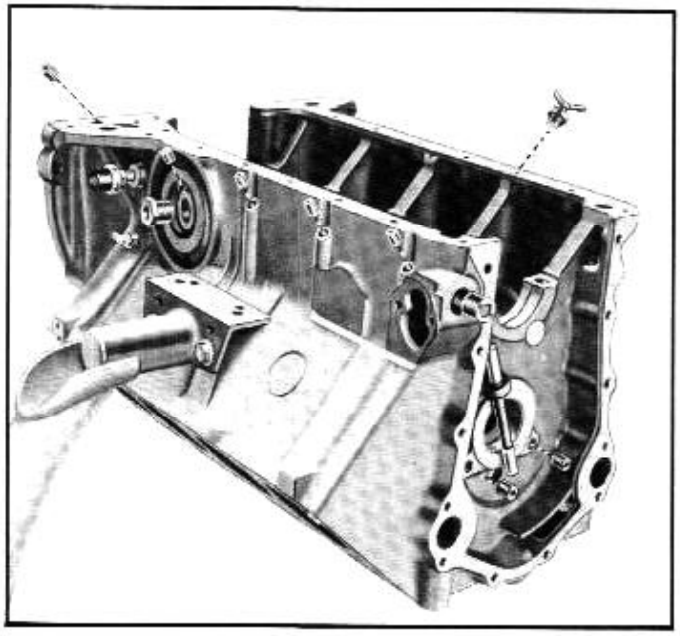


Fig. 6C-98—Location of Cylinder Block Plugs and Fittings

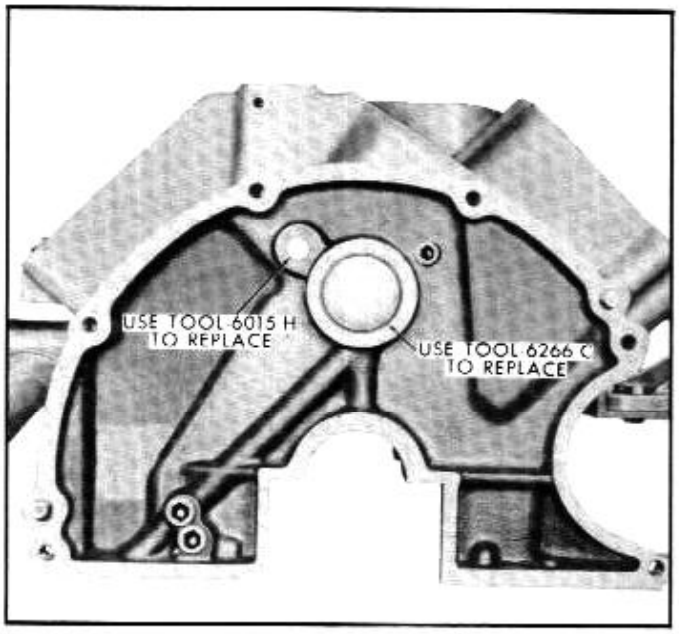


Fig. 6C-99—Location of Cylinder Block Plugs and Fittings

numbered so they can be reinstalled in their respective cylinders.

34. Turn block so bottom faces upward. Remove main bearing caps. Keep all bearing inserts in order, as they are selective fit bearings.
35. Remove crankshaft and upper bearing inserts. Keep these in order of removal. Remove rear oil seal packing.

CLEANING, INSPECTION AND RECONDITIONING OF ENGINE ASSEMBLY

Cylinder Block

One of the most important phases of engine reconditioning is the thorough cleaning and inspection of the cylinder block.

Each machined surface of the cylinder block should be cleaned of all old gasket material. The pipe plugs, which seal the oil passages, should be removed and all passages thoroughly cleaned. The location of the various plugs and fittings used in the cylinder block are presented in figures 6C-98 and 6C-99.

If it becomes necessary to remove an expansion type plug due to water or oil leaks; drill 1/2" hole in the center of plug and remove by using Clutch Pilot Bearing Removing Tool 7600-E. The tools used to drive in new plugs are listed in figures 6C-98 and 6C-99 at their respective plug locations. Install the plugs with the flange side facing in and drive the plugs flush or slightly below the casting surface.

NOTE: Coat edges of plugs with suitable sealing compound prior to installation.

Inspection of the cylinder block should be done carefully to detect any scoring of the cylinder bores, cracks or water leaks. Minute cracks may be found by coating suspected areas with a mixture of 75% light motor oil and 25% kerosene. After wiping area dry, immediately apply a coating of zinc oxide dissolved in wood alcohol. If any cracks are present, the white coating of the zinc oxide-wood alcohol mixture will discolor at the defective area.

Each cylinder bore should be checked for taper and out-of-round conditions. Use an accurate gauge following the manufacturer's directions. Measure the

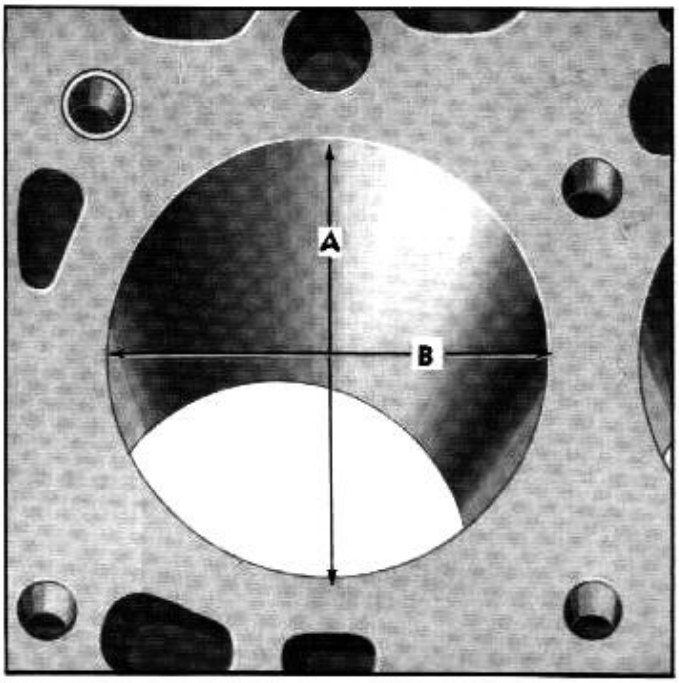


Fig. 6C-100—Measurement of Cylinder Out-of-round

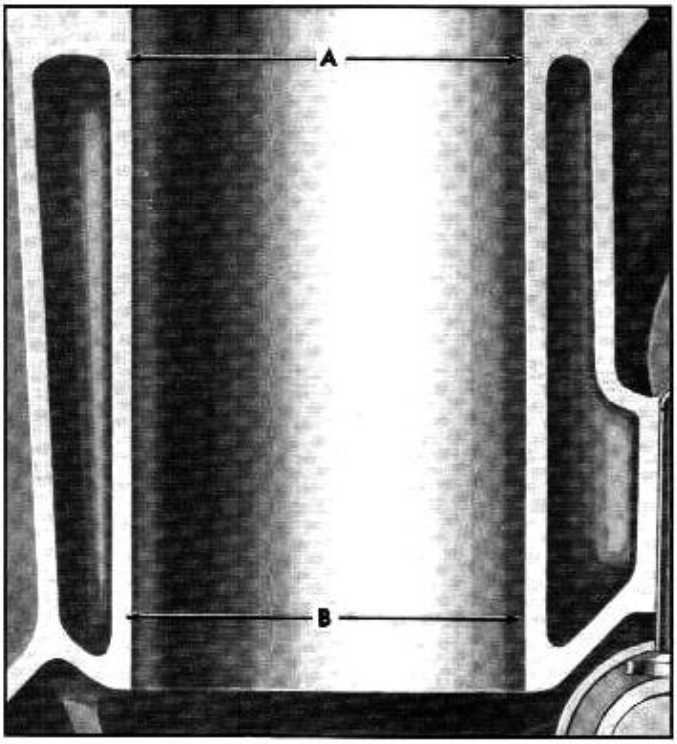


Fig. 6C-101—Measurement of Cylinder Taper

diameter of the cylinder bore at the top of the piston ring travel at right angles to the centerline of the crankshaft (A). See figure 6C-100. Record readings. Next, measure each bore so gauge reading coincides with centerline of crankshaft (B). The difference between the readings is the out-of-round condition at the top of the cylinder bore. Repeat this same procedure at the bottom of the ring travel to check for out-of-round.

Fig. 6C-102—Checking Piston Clearance

The difference between the diameters measured at the top (A) and bottom (B) of the bore (at right angles to the centerline of the crankshaft) is the taper of the bore. See figure 6C-101.

If the cylinder bore wear does not exceed the limits of .0005" out-of-round (wear limit .005") and .001" taper (wear limit .008"), new service piston rings will give satisfactory performance provided the piston clearance is not excessive.

However, if the wear exceeds the limits it will be necessary to rebore the cylinder or cylinders to within .0015" of the required oversize diameter. This will allow enough stock for the final step of honing the bores so the exact clearance and surface finish may be obtained for the selected oversize pistons.
NOTE: After the honing operation is completed, cylinder bores and block should be thoroughly cleaned.

Each piston thus fitted should immediately be marked with the respective cylinder number it was fitted to. It is recommended that the clearance between the fitted piston and the cylinder wall be held to the mean limit.

Piston fit should be checked by positioning a length of 1/2" wide feeler stock, of the recommended thickness for the existing condition, between the inverted piston and the cylinder wall. The feeler should extend the entire length of the piston at 90° from the piston pin holes. Hold the piston in the cylinder bore so the end is about 1½" below the top of the block and the piston pin bore is parallel to the crankshaft. Then pull feeler stock from cylinder while noting reading on Piston Pull Scale Tool FLM-6110-A as shown in figure 6C-102.

If reading on scale conforms to limits presented in the following chart for the existing condition, the piston clearance is satisfactory.

Fit New Piston in New Bore		Fit Used Piston In Used Bore		Fit New Piston in Used or New Bore	
Feeler Thickness (Inches)	Pull (lbs.)	Feeler Thickness (Inches)	Pull (lbs.)	Feeler Thickness (Inches)	Pull (lbs.)
.002	5-10	.0025	5-10	.003	5-10

If reading on scale is greater than maximum pull limit, check piston for any damage that may affect the pull reading. If no damage is evident then try another piston. Recheck fit of new piston.

Prior to installing a piston with new rings in a used cylinder bore, it is necessary to remove the high glaze from the wall to aid seating of the rings.

Pistons and Piston Pins

From the inspection and measurements of the cylinder bores, it has been determined that the pistons to be installed are either new pistons or that the original pistons are to be re-used with new piston rings.

If the original pistons are to be used with new rings, the pistons must be thoroughly cleaned of all carbon. Tool LM-6110-A is provided for cleaning the piston ring grooves. Soaking the pistons in cleaning solvent will loosen the carbon for removal.

NEVER USE A WIRE BRUSH ON A PISTON, this will round off the ring lands. Clean oil holes or slots being careful not to remove any metal.

Inspect the pistons for scuffed or scored skirts, worn or cracked ring lands, discarding any showing such conditions. When the condition is in doubt, replace the piston.

There are actually two different sizes of pistons which can be fitted to a STANDARD size cylinder bore. By this, we mean that a standard size cylinder bore has a production tolerance between the limits of 4.0000″ to 4.0024″, as determined by the point at which the proper cylinder bore finish is reached. Pistons used for service in a standard size cylinder bore are marked No. 2 and No. 6 and are assigned different part numbers for service.

The numbers correspond to the following sizes (see figure 6C-103):

Piston Number on Dome	Dimension "Z" (See Figure 6C-103)
2	3.9988″ to 3.9991″
6	4.0000″ to 4.0003″

From the above it can be seen that a standard size cylinder bore may measure up to a diameter of 4.0024″. However, it is still considered standard and it is not necessary to use an oversize piston. If one of the standard size pistons will not fit with the proper clearance (ribbon pull) then it will be necessary to rebore the cylinder as required and use an oversize piston.

Use Tool 6135-B or equivalent to ream pistons if oversize piston pins are to be used. Use Tool 6135-C to remove old pin from piston and connecting rod. The specified clearance between piston and pin is .0001″-.0003″ (wear limit—loose—.0008″): The specified clearance between piston pin and connecting rod bushing is .0002″-.0004″ (wear limit—loose—.0008″). The piston pin should be a light thumb press fit and should be installed in the piston and rod when the piston is at a normal room temperature (70° F.). Two retainers are used to hold the pin in place, one at each end of pin. When installing the retainer rings make sure they are properly seated in grooves provided in piston pin boss. Always use new pin retainer after removal from piston.

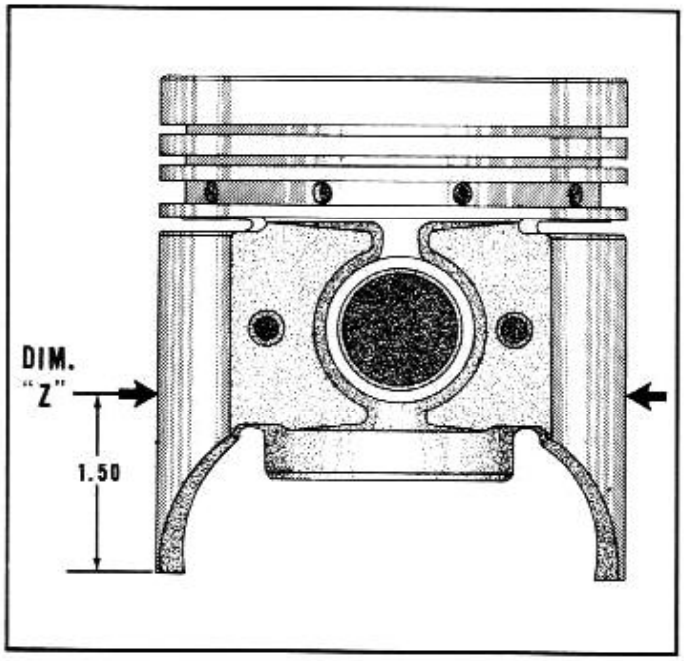


Fig. 6C-103—Measuring Piston Diameter

Connecting Rods

Each connecting rod should be thoroughly cleaned and visually inspected for defects. If condition is satisfactory, the rod should be assembled to the piston for installation in the cylinder from which it was removed. See figure 6C-104.

The connecting rod bushings should be checked for proper clearance with piston pins. Piston pin to connecting rod bushing clearance specification is .0002″-.0004″ (wear limit—loose—.0008″). The pin should be able to move through the bushing with light thumb pressure. If loose, oversize piston pins of .001″ and .002″ are available.

Assemble rod to piston so the indentation embossed on piston head will face the front of the engine while the numbered side of the rods on the right bank will face the right side of engine and the rods for the left bank will face the left side of the engine when viewed from the rear.

After rods are assembled to the pistons, the complete assembly should be checked with suitable aligning equipment. Since many makes are in use, it is recommended that the manufacturer's instructions be followed to assure that the rod is not bent or twisted. Bending the connecting rod to obtain correct alignment is permissible.

The correct alignment specification is as follows:

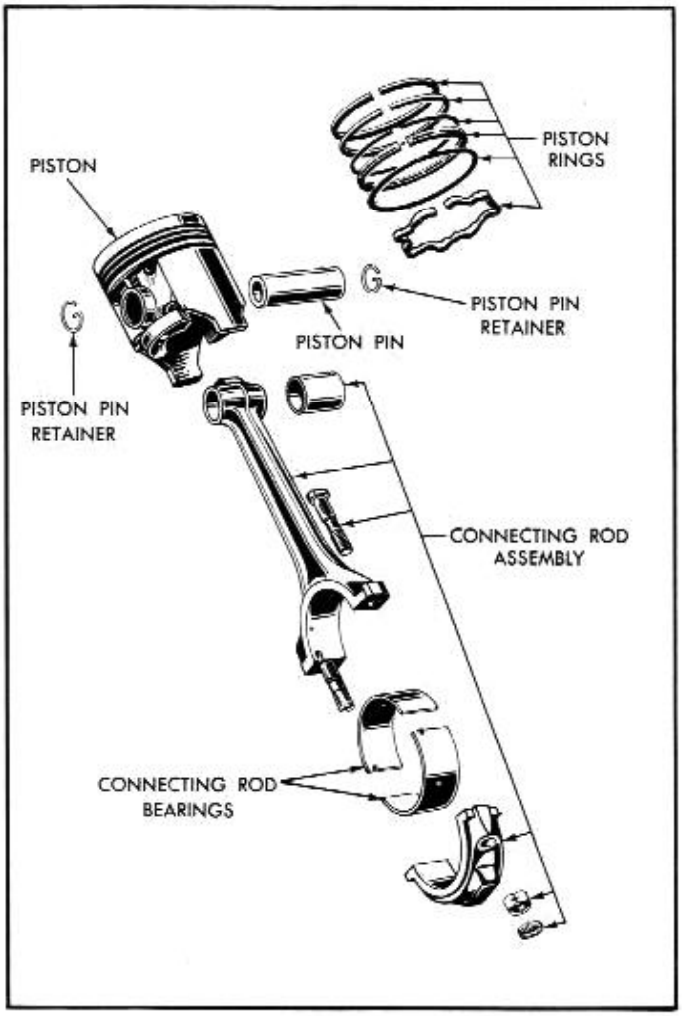


Fig. 6C-104—Pistons and Connecting Rod Assembly — Typical

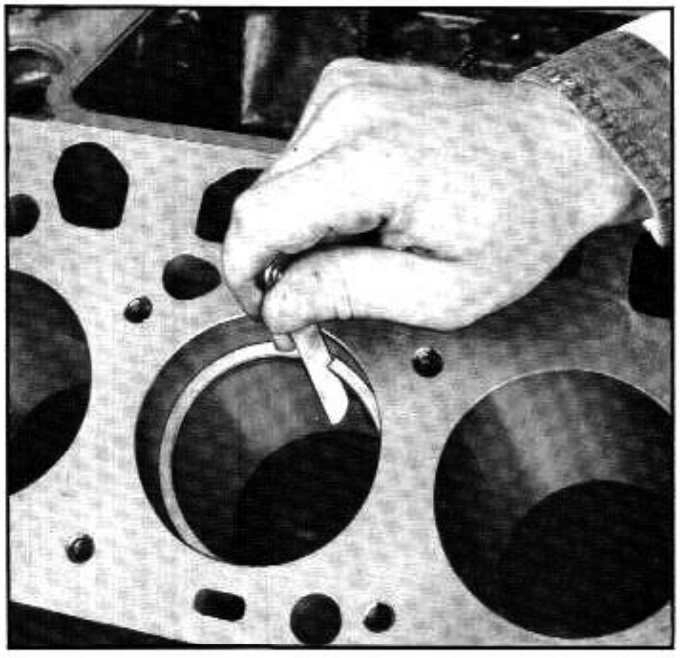


Fig. 6C-105—Checking Piston Ring Gap

Twist Total Difference–Maximum* . . . . .004″
Bend Total Difference–Maximum* . . . . .004″
*Finished piston pin bushing and crankshaft bearing bore must be parallel and in same vertical plane within the specified total difference at ends of eight (8) inches long bar measured four (4) inches of each side of rod.

An oil squirt hole is provided in each connecting rod to direct a stream of oil on the cylinder wall as the piston approaches top center. The oil is supplied through a hole drilled in the crankpin end of the rod which intermittently lines up with the hole in the crankpin. Make sure these oil squirt holes are open. Also, make sure the rod bearings are provided with a hole that is clear of obstructions to allow the oil from the crankpin to flow through the bearing to the squirt hole.

Piston Rings

Each piston has three piston rings located above the piston pin. The compression rings are located in the two top grooves while the lower groove accommodates the expander type oil control ring. Select the proper rings for the size of the pistons to be used.

Prior to installing the rings on the piston, each ring must be checked for the proper ring gap. Push the ring down into the cylinder bore about two inches using the head of a piston so that the ring is square with the cylinder wall. Caution should be used during this operation. Check the space or gap between the ends of the ring with a feeler gauge. See figure 6C-105. The gap should be within the limits of 0.013″-0.030″ for both compression rings and 0.015″-.0.062″ for the oil control ring.

If gap is less than limit, try another ring for fit. Each ring should be fitted and checked in the cylinder in which it is going to be used and marked accordingly.

Piston rings should also be checked for side clearance in the groove of the piston on which they are to be installed. This is done by placing the outer edge of the ring in the piston groove and rolling the ring entirely around the piston to make sure that there is no binding and the ring is free in the groove. With a thickness gauge, check the side clearance of each ring in its respective groove. See figure 6C-106. The side clearance for the upper compression ring is .0015″ to 0.003″. The side clearance for the lower compression ring is 0.001″ to 0.003″. The side clearance wear limit for both upper and lower rings is .006″.

Assemble rings on pistons to which they were fitted by using Piston Ring Expander Tool 6149-13. This type of tool is recommended to avoid over-expanding and to expand the ring to a true circle to avoid distortion. See figure 6C-107. Space ring gaps 120° apart

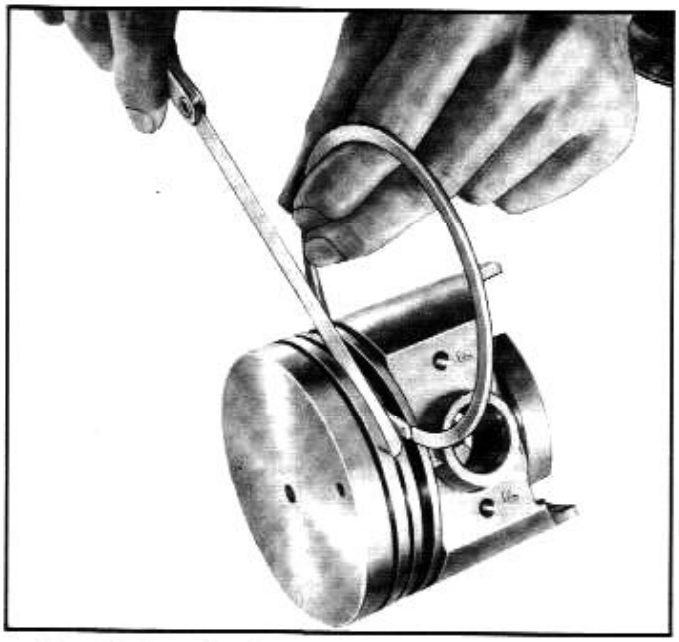


Fig. 6C-106—Checking Piston Ring Side Clearance

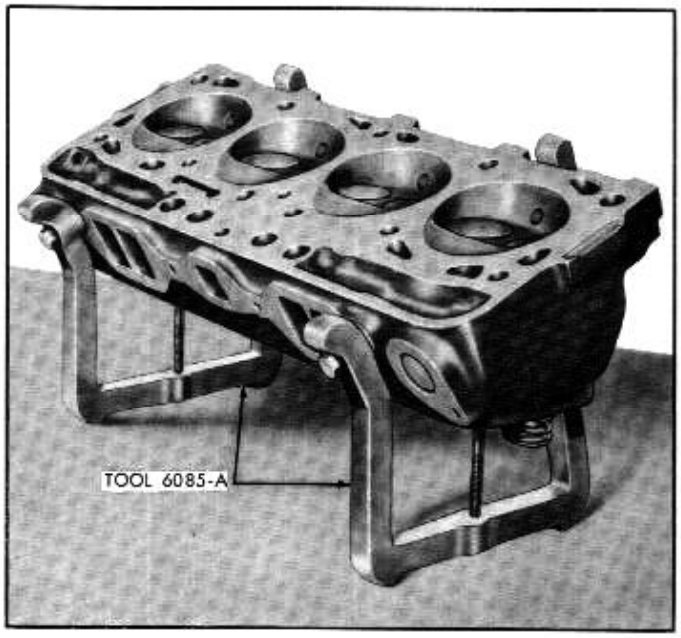


Fig. 6C-108—Cylinder Head Positioned for Carbon Removal

and coat with engine oil prior to installing. When spacing oil ring on piston, the ring gap should be positioned so that it will be on the inside of the "V" (high side of cylinder bore) when piston is installed in cylinder bore.

Cylinder Head

The cylinder head as removed from the engine contains the valves and holding fixture Tool 6085-A as shown in figure 6C-108. The rocker arm assembly was removed prior to installation of holding fixtures so the fixture would never have to be removed while the heads are off the engine, thus, the machined surfaces of the cylinder heads are protected at all times as all work operations can be performed with the fixtures installed.

With the valves installed to protect the valve seats, clean carbon deposits from combustion chambers and valve heads with a wire brush and scraper. Wash heads in cleaning solvent to remove dirt and grease from surfaces and dry thoroughly.

DISASSEMBLE VALVES AS FOLLOWS:

1. Turn cylinder head, with Tool 6085-A attached, so it rests on side and compress valve spring with Tool 6513-EE. See figure 6C-109.

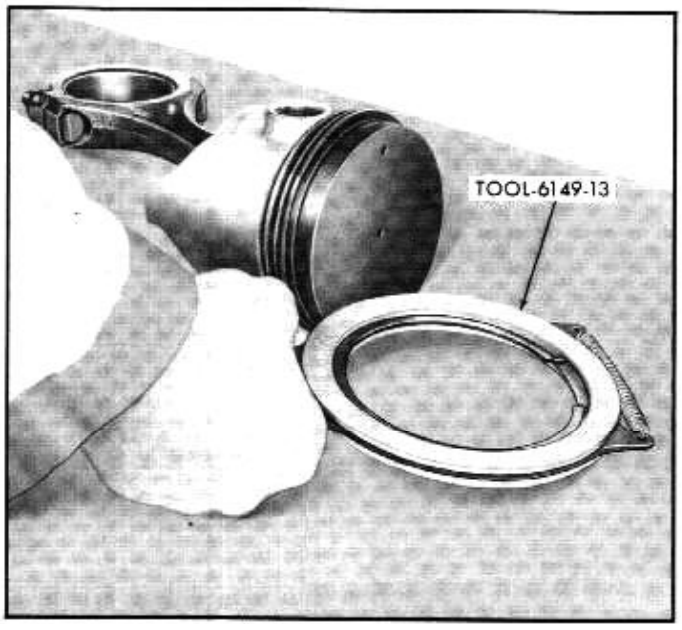


Fig. 6C-107—Piston Ring Expander Tool

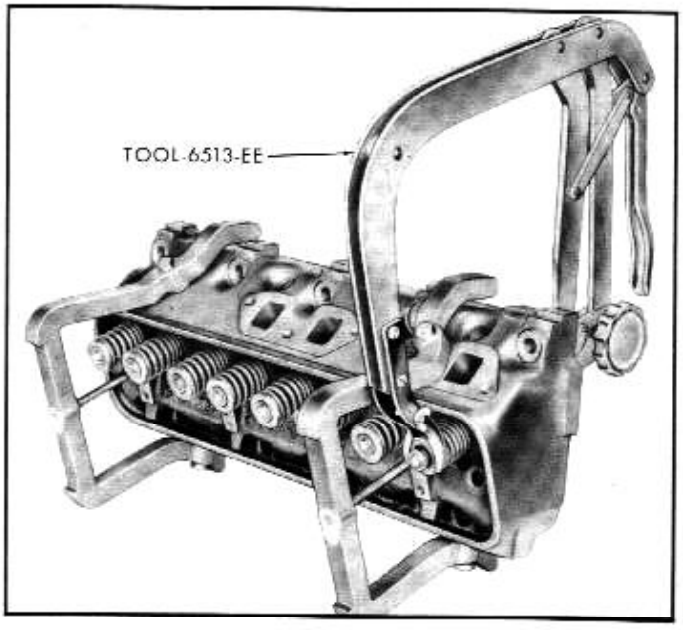


Fig. 6C-109—Compressing Valve Spring

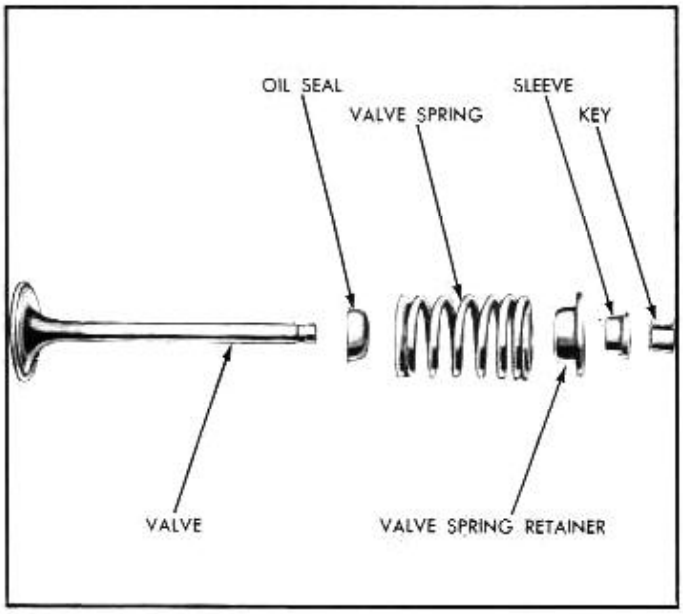


Fig. 6C-110—Valve Assembly

2. Tap retainer gently with soft hammer, then remove valve keys. See figure 6C-110.
3. Remove valve compressor Tool 6513-EE, then remove valve spring retainer, inner sleeve, valve spring, valve stem seal, and valve.
4. Repeat steps 1 to 3 for remaining valves.
   NOTE: Keep valves and their related parts together so they may be reinstalled in their respective positions.

Clean valve guide bores using Valve Stem Guide Cleaning Tool 6501-F. Check all water passages to make sure they are open.

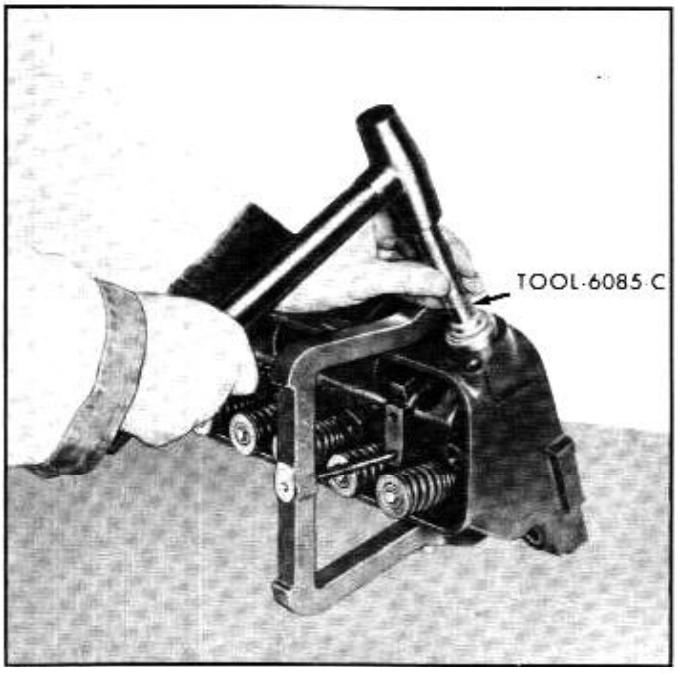


Fig. 6C-111—Installing Cylinder Head Water Jacket Plug

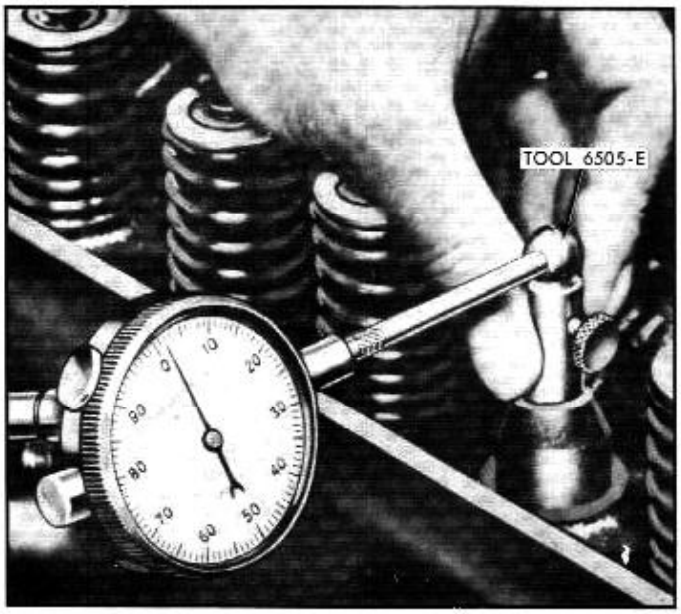


Fig. 6C-112—Checking Valve Stem Clearance

Examine the cylinder heads for water leaks or cracks in the combustion chambers, exhaust ports, or around the valve seats. Inspect the gasket surfaces for scratches or mars of any type. This is very important, as any damage to this surface may cause a leak when installed with the thin steel gasket.

The cylinder head assemblies are completely interchangeable from one cylinder bank to another providing the water outlet coincides with the water opening in the front section of the intake manifold. It may be necessary to remove the water outlet plug on one section of the cylinder head and install a new plug. Coat edges of plug with a light coat of water resistant sealer. Install plug with flange facing inward using Tool 6085-C. See figure 6C-111.

The steel cylinder head gaskets are also interchangeable and should be installed so the word "FRONT" is at the forward edge of the block. Whenever a cylinder head is removed, clean the mounting surface thoroughly.

Valve, Valve Seats and Valve Springs

Remove all carbon from valve stems and heads using a fine wire brush or buffing wheel. Inspect each valve discarding any that show evidence of burned, warped, bent or cracked condition.

Check valve stem clearance of each valve in its respective valve guide using Tools 6505-E and 4201-C (or 6565). See figure 6C-112. To properly use tools, install Tool 6505-E on valve stem until fully seated and tighten knurled set screw firmly, then permit valve to drop away from its seat until tool contacts the upper surface of the valve guide.

Position dial indicator with flat tip against the

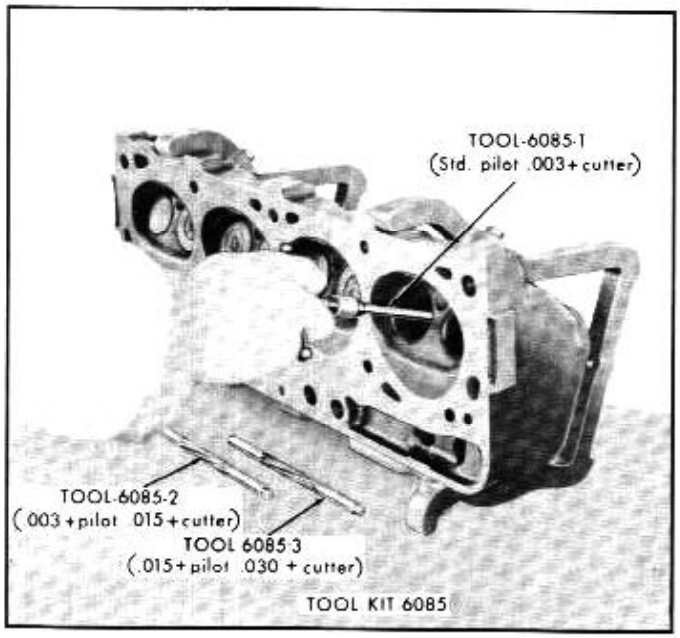


Fig. 6C-113—Reaming Valve Guide

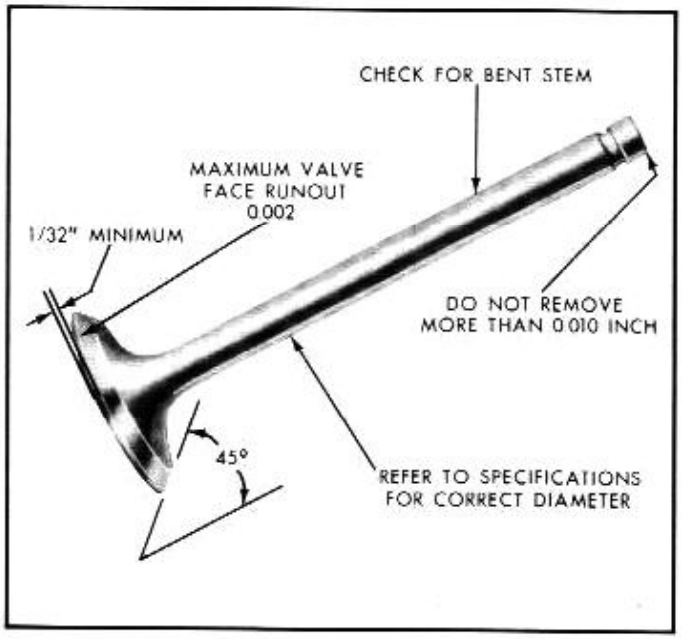


Fig. 6C-114—Valve Tolerances

center portion of tool spherical section at approximately 90° to the valve stem. In order to ascertain actual valve stem clearance, tool should be moved back and forth on an axis at a right angle to the rocker shaft. Take a reading on dial indicator without removing the tool from valve guide upper surface, then divide reading by two, the division factor of the tool.

If the clearance exceeds the service wear limits of .0045″ on the intake or .0065″ on the exhaust, it is recommended to ream the valve guides with Tool Kit 6085 to the next oversize diameter as shown in figure 6C-113. Tool Kit 6085 is made up of three reamer (cutter) pilot combinations which are as follows:

1. Tool 6085-1—Std. Diameter Pilot Plus .003″ O.S. Reamer.
2. Tool 6085-2—.003″ O.S. Pilot Plus .015″ O.S. Reamer.
3. Tool 6085-3—.015″ O.S. Pilot Plus .030″ O.S. Reamer.

IMPORTANT: Always use the reamers in sequence when reaming from standard to O.S. (oversize) diameter to accommodate oversize valve stems. Valves having oversize stems are available for service. The valve seats must be reground whenever the valve guides are reamed.

Refacing the valves and valve seats must be done with precision equipment to insure a good compression tight fit between parts. The grinding wheels of the refacers should be carefully dressed to the proper angles. The valve face should be ground at a 45° angle (both intake and exhaust) with a minimum thickness of 1/32″ on the outer edge of valve head. If thickness is less than 1/32″, replace valve. Valve face run-out must not exceed .002″. See figure 6C-114. The end of the valve stem may be ground if grooved. Do not remove more than .010″ stock.

The valve seats in the cylinder head should also be ground to a true 45° angle maintaining a seat width of between .060″-.080″ intake valve and .070″-.090″ exhaust valve. Only remove enough stock to clean up pits or grooves. If seat is wider than specified, it will be necessary to grind either the bottom of valve seat with a 30° angle grinder or the top of the seat with a 60° angle grinder until proper seat width is obtained and the seat contact with the valve is centrally located. See figure 6C-115.

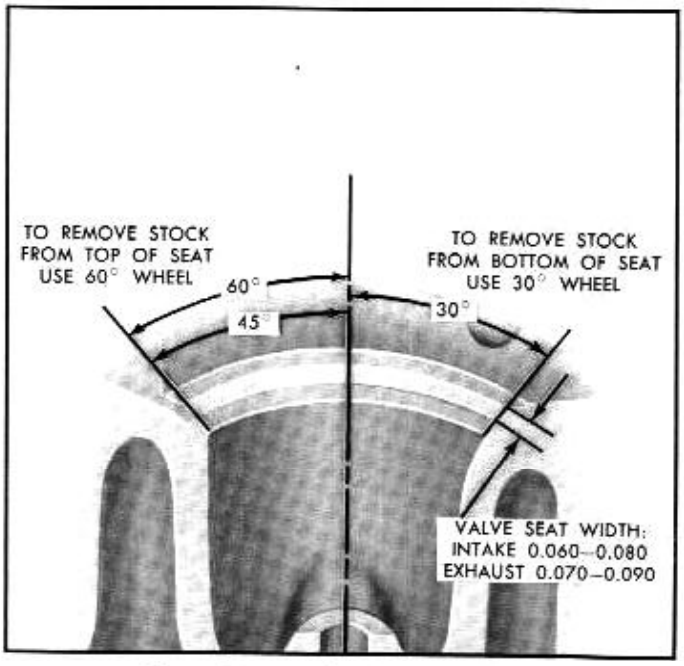


Fig. 6C-115—Valve Seat Refacing

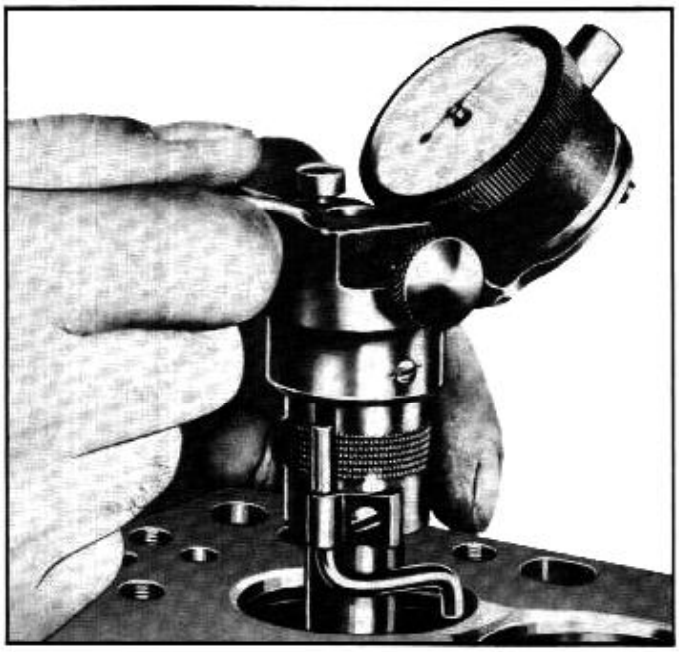


Fig. 6C-116—Checking Valve Seat Run-out — Typical

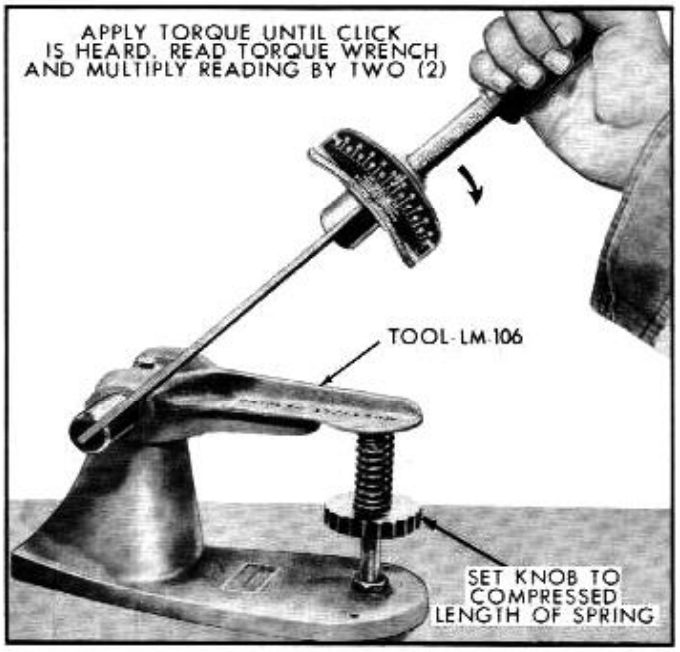


Fig. 6C-118—Testing Valve Spring Tension

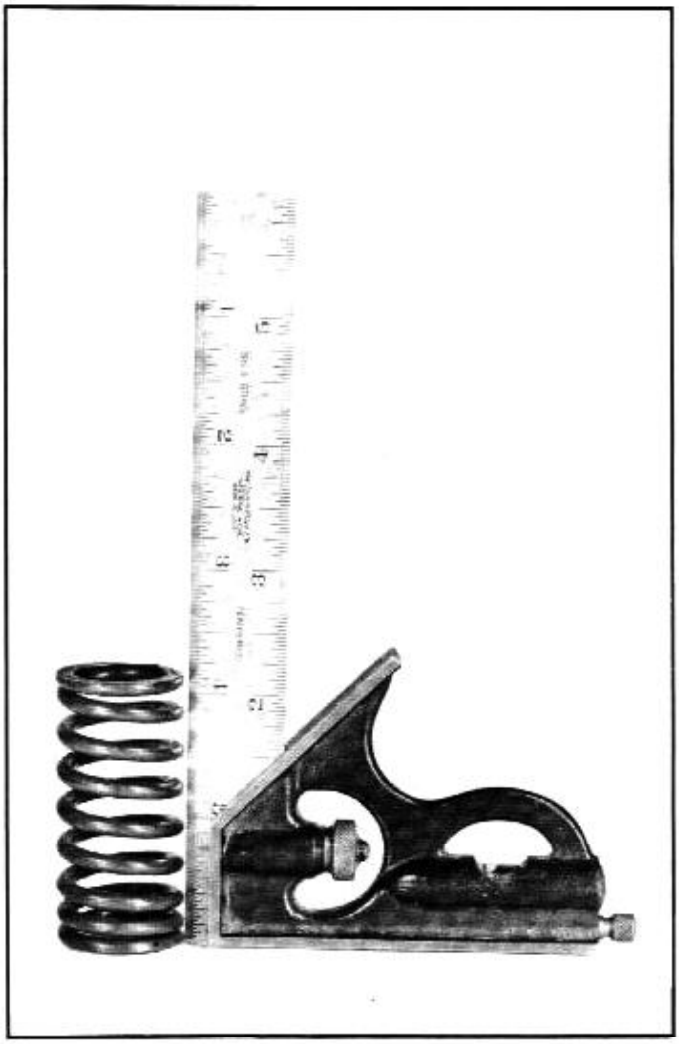


Fig. 6C-117—Testing Spring for Squareness

It is important to have the finished seat face contact the approximate center of the valve face. This can be checked by placing prussian blue on the valve seat and installing the valve. If contact is indicated near the top edge of the valve face, lower the seat by using the 60° angle grinder. If the contact is lower than the center of the valve face, raise the seat by using the 30° angle grinder. Make sure all metal particles are thoroughly cleaned from the cylinder head. A light lapping operation is recommended after refacing valves and seats, using a fine grit lapping compound.

Check the valve seat run-out with an accurate gauge. Run-out should not exceed .002" total indicator reading (wear limit .0025"). See figure 6C-116.

Examine the valve springs, discarding any that show signs of rust or pit marks. Check springs for squareness with a square and surface plate (a piece of plate glass may also be used). Discard any springs that are out of square more than 1/16". See figure 6C-117. Check pressure of each spring with Tool LM-106 as shown in figure 6C-118. The spring should exert a minimum pressure of 60 lbs. when compressed to a height of 1.800 inches or 165 lbs. when compressed to a height of 1.380 inches. If Tool LM-106 is used, set knob on calibrated screw to compressed length of valve spring and pull torque wrench until click is heard. Multiplying reading on torque wrench by two gives pressure exerted by springs. If spring is not within specified limits, it is recommended that spring be replaced.

Rocker Arm Assemblies and Push Rods

Since the rocker arm assemblies are removed from the engine as a unit, the disassembly and assembly pro-

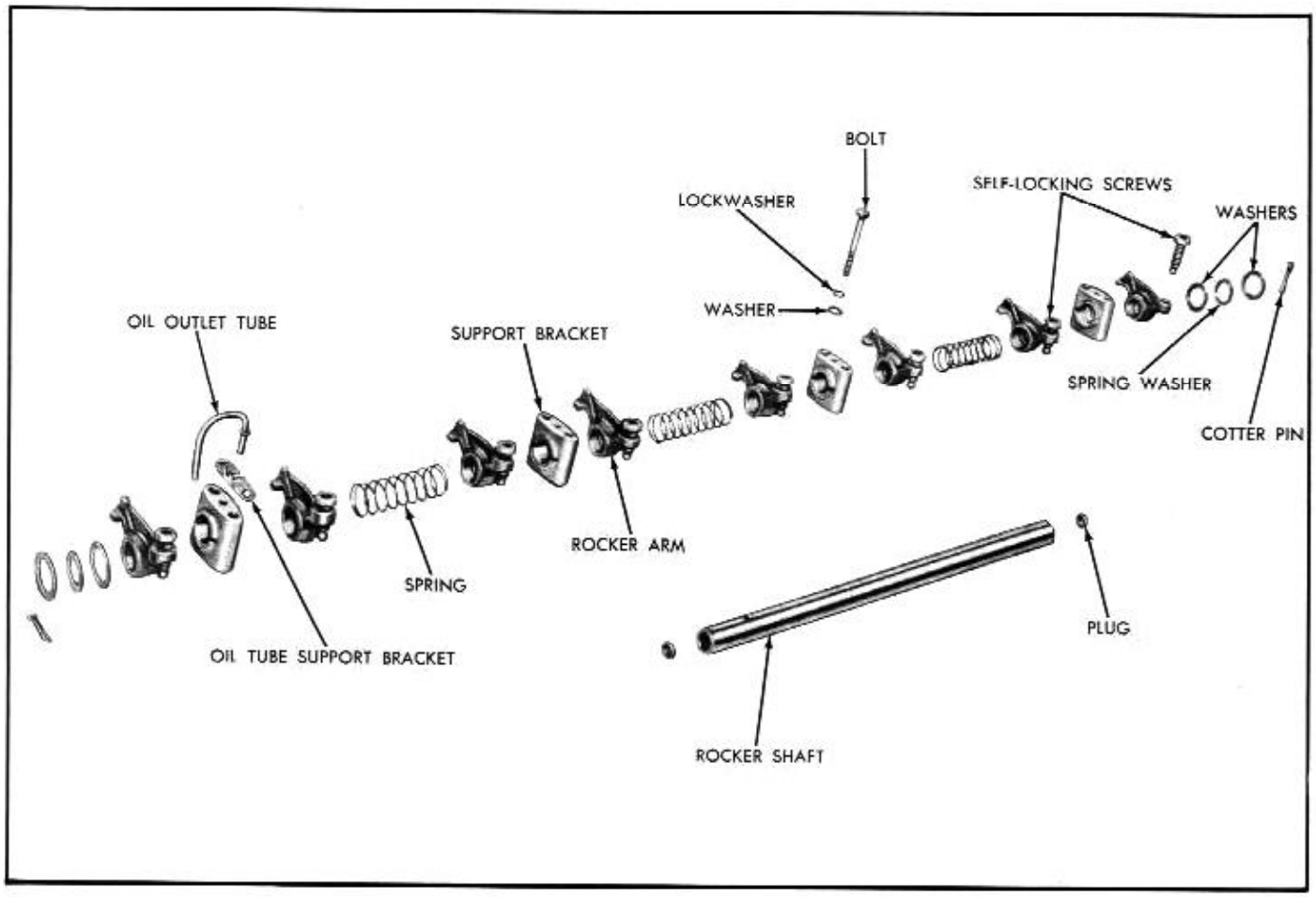


Fig. 6C-119—Rocker Arm Mechanism

cedures are presented herein. Figure 6A-119 shows a disassembled view of the complete assembly.

1. Remove cotter keys, flat and "wave" washers from ends of shaft.
2. Remove rocker arms, springs and supports from shaft. Keep parts in order so that they may be replaced in original position, if in satisfactory condition.
3. Remove plugs from end of shaft as follows:
   a. Drill a hole in plug at one end of shaft.
   b. Insert metal rod through hole and knock out plug at other end of shaft.
   c. Knock out remaining plug from end of shaft.
4. To assemble, reverse disassembly procedure.
   NOTE: Make sure rocker arms are correctly positioned to actuate valves. The oil overflow pipe hole in shaft should be seen through the center hole of front support on right bank and rear support on left bank. If hole cannot be seen, turn shaft until holes line up.

When rocker arm assemblies are completely disassembled, clean all parts thoroughly, making sure all oil passages are open.

Inspect shaft for signs of wear. Check rocker arm to shaft clearance. If clearance exceeds .006" wear limit replace rocker arm. Replace any parts showing excessive wear. If rocker arm pad radius is grooved excessively at valve end, replace rocker arm. Do not attempt to true this surface by grinding. A slight dressing of the rocker arm pad is permissible to clear up minor imperfections, however, contour of rocker arm pad must be maintained.

Check each push rod for bent or damaged condition. DO NOT ATTEMPT STRAIGHTENING PUSH ROD. Replace with new parts if bent more than .020" total indicator reading.

Crankshaft

Wash the crankshaft with suitable cleaning solvent to thoroughly clean all journals and oil passages.

Inspect the crankshaft for cracks, scored or grooved journal surfaces. Light scratches may be removed by using a smooth oilstone, otherwise the journal should be reground.

The run-out of the crankshaft should be checked with suitable equipment. Since many makes are in use it is recommended that the manufacturer's instructions

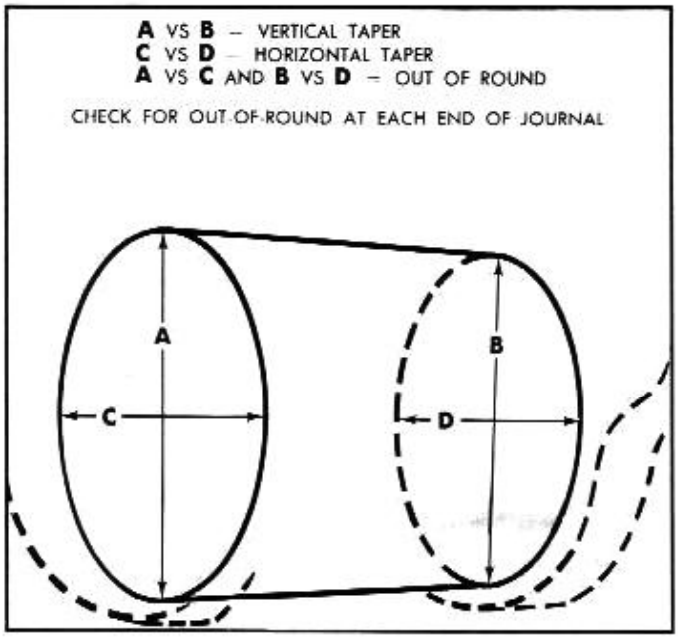


Fig. 6C-120—Crankshaft Journal Measurement

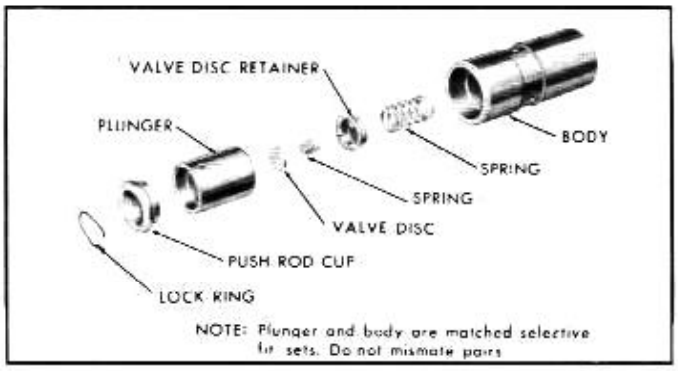


Fig. 6C-121—Disassembled Hydraulic Tappet Assembly

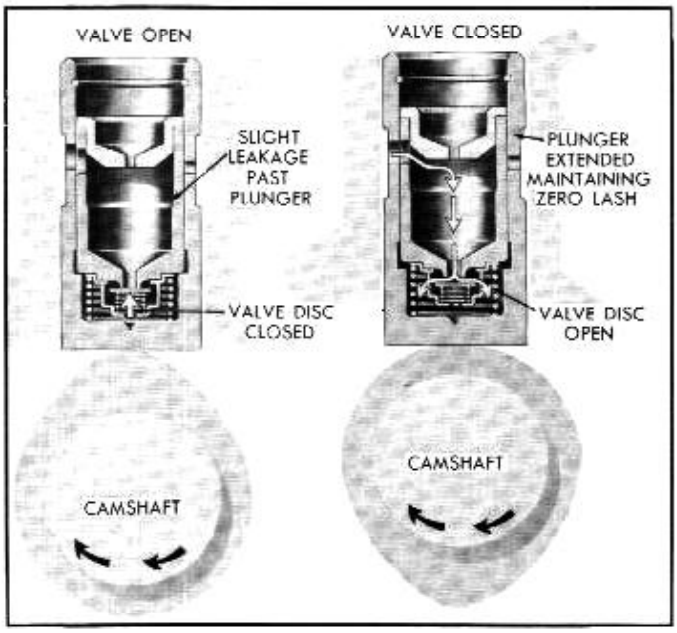


Fig. 6C-122—Operation of Hydraulic Tappet Assembly

be followed to assure that crankshaft is not bent or twisted. If main bearing journal run-out exceeds the maximum wear limit specification of .003" the crankshaft should be replaced.

Measure diameter of each main and connecting rod journal in at least four places to determine out-of-round, taper, or undersize condition. See figure 6C-120. The main bearing journal diameter specification is 2.6235"-2.6243"; out-of-round specification is .00025" (wear limit .0005"); taper specification is .0005" (wear limit .001"). The connecting rod journal diameter specification is 2.2482"-2.2490"; out-of-round specification .00025" (wear limit .0005"); taper specification .0005" (wear limit .001"). If the journals approach the taper or out-of-round wear limits they should be reground for the next undersize bearing. If the journal diameter is less than specified the journals must be reground for the next undersize bearing.

Camshaft

After cleaning the camshaft, inspect all journals and cam lobes for scores, roughness or wear.

The camshaft journal diameter specification is 2.1240"-2.1247". The bearing inside diameter specification is 2.1263"-2.1268".

Each journal should be measured and camshaft replaced if out-of-round exceeds .001". If bearing clearance wear limit exceeds .006", the bearing and/or camshaft must be replaced.

The camshaft journal run-out should be checked following procedures used to check the crankshaft run-out. If run-out exceeds .005" total indicator reading the camshaft should be replaced.

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 camshaft should not be replaced solely because this condition exists.

If camshaft lobes indicate possible wear, check lobe lift by measuring over the top of the lobe with a micrometer and subtracting the measurement of the base circle diameter. Minimum camshaft lobe lift wear limit on intake and exhaust is .256". Replace camshaft if lobes are below or approach minimum specifications.

If camshaft replacement is warranted, replace the tappets that have been operating on cam lobes worn to a degree exceeding wear specifications. Inspect the remaining tappets. Any tappets showing evidence of pitting, scoring, galling or evidence of non-rotation and/or irregular rotation, must be replaced.

Check the camshaft (distributor driving) gear for broken or chipped teeth. Replace camshaft if teeth are damaged.

NOTE: If the mating teeth on the distributor (driven)

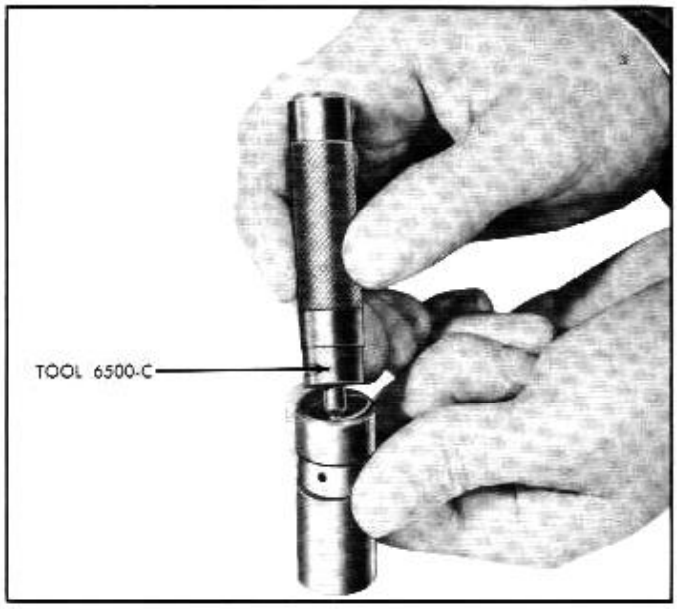


Fig. 6C-123—Installing Snap Ring

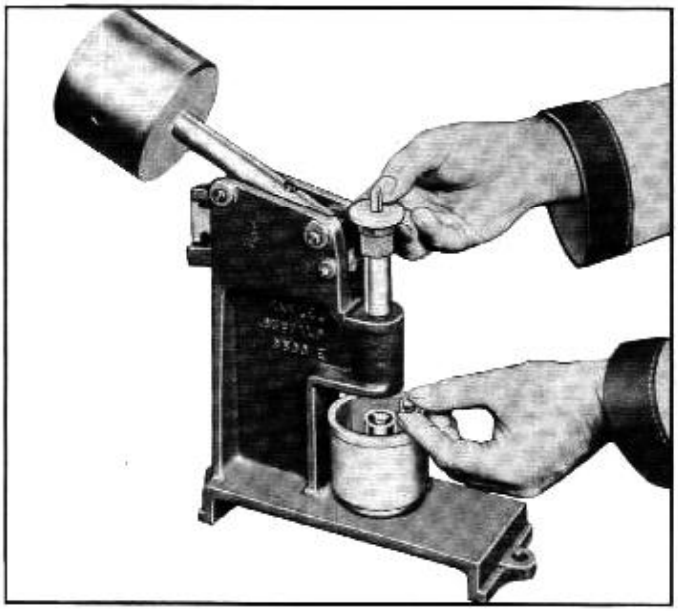


Fig. 6C-124—Placing Steel Ball in Plunger — Typical

gear are damaged, this gear will have to be replaced. Refer to "Engine Electrical" section of this manual for proper replacement procedures.

Hydraulic Tappet Assemblies

The hydraulic tappet assembly consists of a lock-ring, body, plunger, valve disc, retainer, springs, and push rod cup. A disassembled view is shown in figure 6C-121.

When the tappet assemblies were removed from the engine, it was stated, "keep the assemblies in proper sequence so they can be reinstalled in their original position, providing their condition proves to be satisfactory when inspected." It is recommended, therefore, that each unit be disassembled, inspected and tested separately so as not to mix the internal parts, as each assembly is a matched set. Mixing these parts will likely cause improper operation.

The operation of these hydraulic tappet assemblies is similar in principle to the type used in previous models. See figure 6C-122.

All tappets assemblies should be immersed in clean solvent to remove all traces of carbon or varnish. Varnish or carbon ring in the top of the body can be removed by soaking unit and wiping deposit to remove. Never cut or scrape carbon to remove. Discard tappet if body is scored.

Using needle nose pliers, remove the lock ring from top of lifter body. Remove push rod cup. Remove plunger, using Tool 6500-F. Remove valve disc, and spring, then remove remaining spring from body and soak all parts in solvent.

After cleaning each assembly, inspect all surfaces of parts for scratches or other defects. Do not lubricate the surface of the parts.

To assemble unit, place push rod cup upside down on bench. Install plunger on push rod cup. Next, place valve disc, spring, and retainer on plunger, then set large spring on valve disc retainer. Place body over assemblies and push body down over plunger. Pick assembly up (still upside down) and push plunger and push rod cup up into body. After units are positioned, turn assembly right side up and install lock-ring using Tool 6500-C. See figure 6C-123.

Assembled tappets can be tested with a tappet tester to check the leak down rate. This test will determine if the unit will operate satisfactorily in the engine.

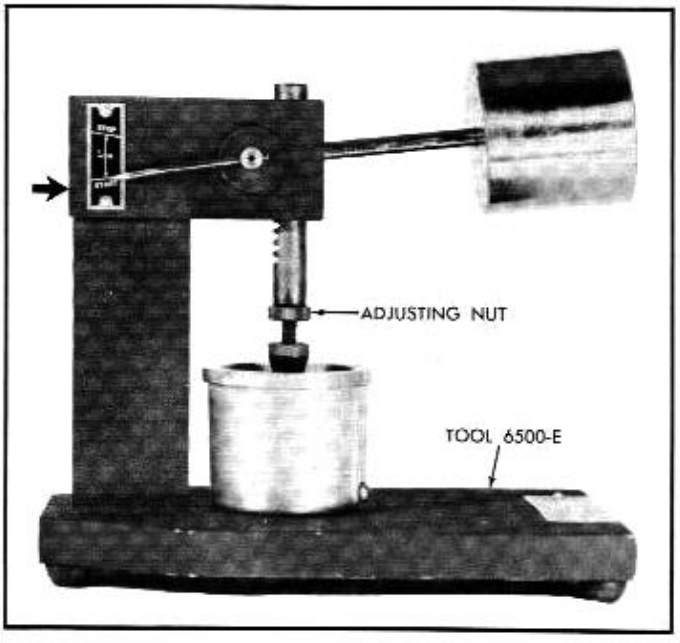


Fig. 6C-125—Adjusting Length of Ram

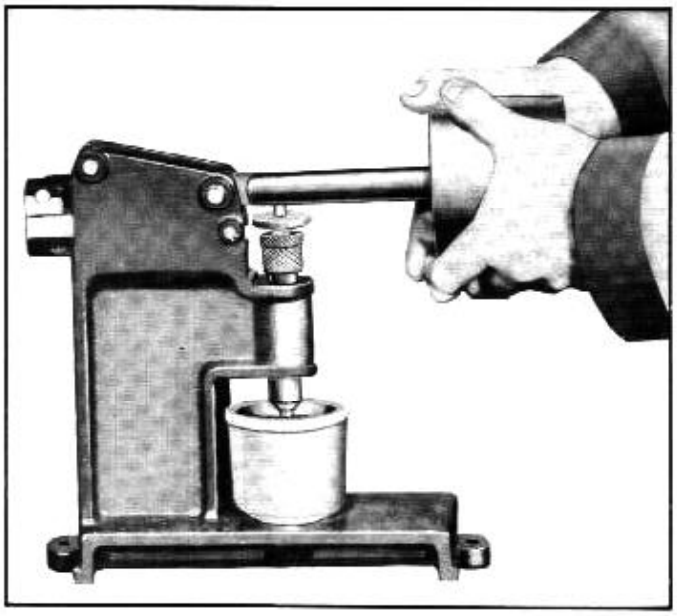


Fig. 6C-126—Working Plunger Until Air Bubbles Disappear

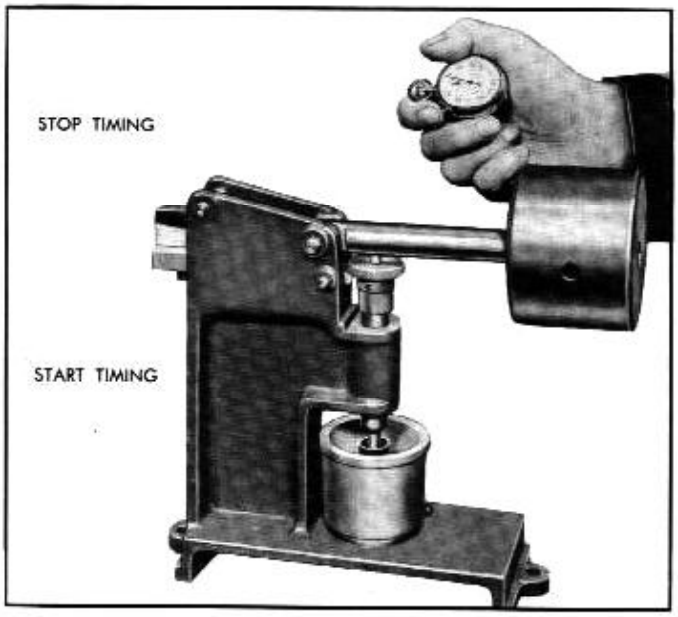


Fig. 6C-127—Checking Leak Down Rate

1. Place the tappet in the tester with plunger facing up. Special hydraulic tester fluid is then poured into the cup to a level that will cover the tappet assembly. (Fluid can be purchased from Manufacturer of Tester.) Do not use kerosene as it will not provide an accurate test.
2. Place a five-sixteenth inch steel ball in the plunger cup. See figure 6C-124.
3. Adjust the length of the ram so that the pointer is in line with the starting mark when the ram just contacts the tappet plunger. See figure 6C-125.
4. Work the tappet plunger up and down until it fills

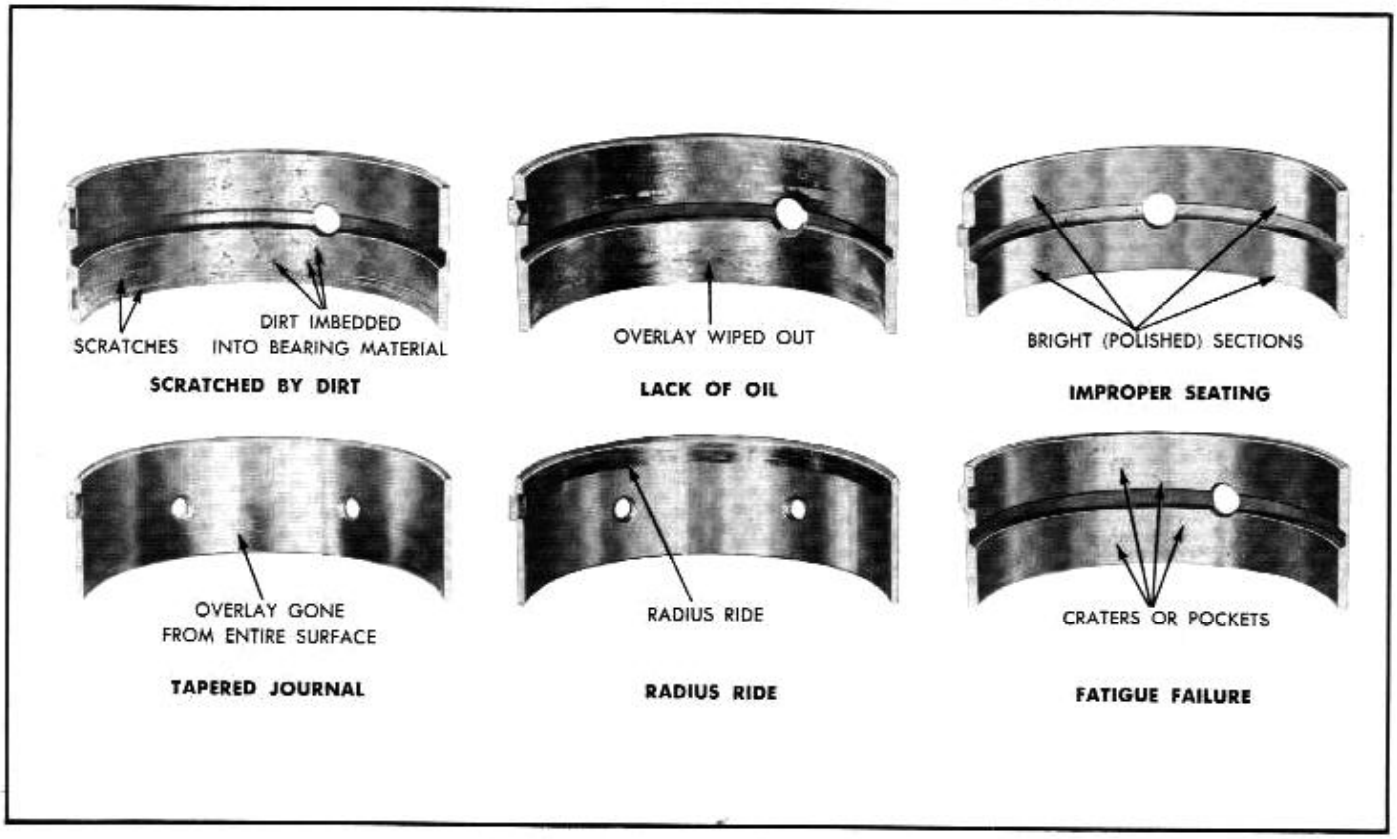


Fig. 6C-128—Bearing Failures — Typical

with fluid. Repeat this operation until all traces of air bubbles disappear. See figure 6C-126.

5. Then, let the ram and the weight force the plunger downward and measure the exact time it takes for the pointer to travel from the "START TIMING" mark to the "STOP TIMING" mark. See figure 6C-127.
6. A used tappet that is satisfactory must take at least 6 seconds to leak down but not more than 45 seconds, while a new tappet requires at least 10 seconds, but not more than 45 seconds to leak down.

There are three contributing factors to hydraulic tappet failure.

1. DIRT
2. DEPOSITS OF GUM AND VARNISH
3. AIR BUBBLES IN THE LUBRICATING OIL

Dirt can keep a check valve from seating, causing the plunger to force oil back into the tappet reservoir during the time the push rod is being lifted to force the valve from its seat. Thus the tappet would lose its hydraulic pressure and could not maintain zero tappet clearance.

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

A check for air in the oil system can be made by observing the oil flow from the rocker arm oil outlet tubes of each bank while the engine is running.

When installing assemblies into the engine, do not fill lifter body cylinder with oil. The lifters will fill with oil much quicker after the engine is started, if they are free of an oil film which may cause an oil seal between the plunger and body cylinder.

It is recommended to run the engine during the time that the hydraulic lifters are being filled, about the equivalent of an ordinary fast idle. The tappets will fill more quickly if you avoid excessive engine speeds.

Bearings (Mains and Rods)

The bearing inserts used throughout this engine are selective fit and require no line reaming on installation. The bearings are available for service in standard and undersizes for use on journals that have been reground.

If inspection reveals badly worn or scored bearings, replace bearings during reassembly of engine. See figure 6C-128. The installation of new bearings must be closely checked to maintain the proper clearance between the journal and bearing surface. A convenient and accurate method for checking this bearing clearance is with the use of Plastigage (manufactured by the Perfect Circle Corporation).

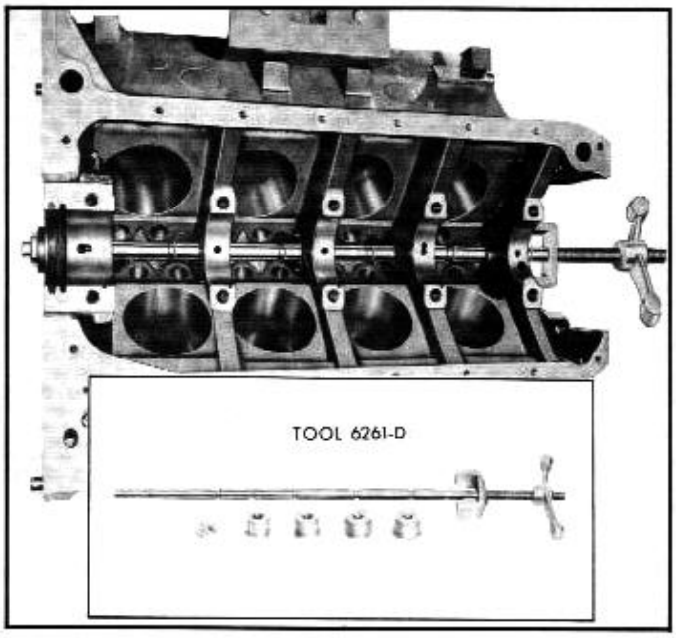


Fig. 6C-129—Removing Camshaft Bearings

Camshaft Bearings

Check the camshaft journal to camshaft bearing clearances by measuring the diameter of the journals and the inside diameter of the bearings. The recommended clearance limits are .0011"-.0028" (wear limit .006"). If the clearance approaches the wear limit, the camshaft and/or bearings should be replaced.

If camshaft bearings have to be replaced, it will be necessary to remove the camshaft bearing bore plug at rear of cylinder block. Remove plug by driving it out with a long rod.

NOTE: The bearing bore plug can also be removed by drilling a 1/2" hole in center of plug. Remove plug using Clutch Pilot Bearing Removing Tool 7600-E. Insert tool in hole and pull out plug.

Clean camshaft bearing bore to remove scale, rust and old sealing compound. Check bore for cracks or sand holes.

Remove the camshaft bearings using Tool 6261-D and adaptors. See figure 6C-129.

Manifolds

The intake manifold is cast in one piece and supplies both cylinder banks while each bank has a separate exhaust manifold. Located at the end of the right exhaust manifold where it connects to the muffler inlet pipe, is the exhaust control valve. This bi-metal spring "Counterweight" type thermostat is completely automatic in its operation, and does not need any adjustment, but should operate freely.

The manifolds should be thoroughly cleaned and examined for cracks or leaks. If cracks or leaks exist, replace manifold. The center exhaust passage of the

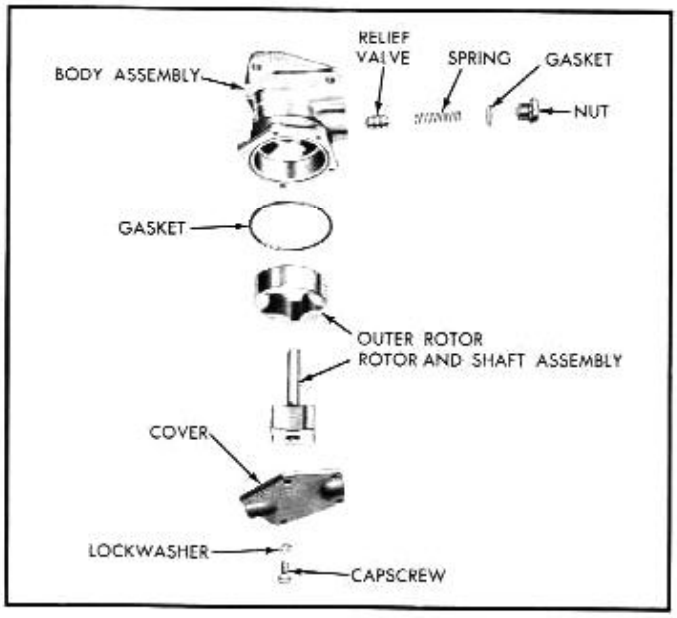


Fig. 6C-130—Disassembled Oil Pump

intake manifold below the carburetor should be cleaned of all carbon deposits. The passage of the automatic choke control heat tube should be cleaned so that it is completely open, otherwise the operation of the choke will be impaired.

If the automatic choke control heat tube in the manifold is cracked or broken, the automatic choke will not function properly.

To check for leaks, adjust a vacuum pump to three inches of mercury. Block off one end with a moistened finger, then connect the vacuum hose to the other opening. If the pump does not maintain a steady reading, there is a leak in the tube and it must be replaced as follows:

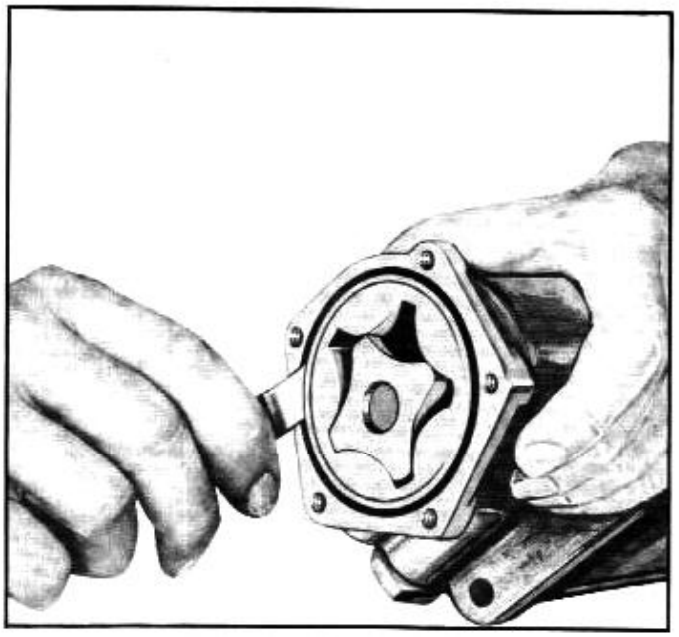


Fig. 6C-131—Checking Outer Rotor to Pump Body Clearance

REMOVAL:

1. Drive the small end of the heat tube, located on the right hand side of manifold, back into the manifold with a flat end pin punch.
   NOTE: If the large end of the tube does not come out the other side of manifold, the tube is probably bent or broken off. In this case the large end should also be driven into the manifold. Remove the tube, or pieces, out through the manifold heat riser chamber. This can usually be accomplished by shaking the manifold. If it does not fall out, make a hook out of wire and remove pieces.

INSTALLATION:

NOTE: Before installing the new heat tube, check manifold right hand bore to see if small end of the new tube fits easily. If the hole is too small, it should be reamed to provide a slip fit. A 5/16 inch expansion reamer, with the adjusting screw removed, can be used for the operation. It is important not to ream the hole too large or there will be an exhaust leak.

1. Insert the small end of the heat tube through the large bore in the left side of manifold. Line the tube up using a 1/4 inch pin punch in the small bore in the right side. Drive the tube in place. The tube ends should stick out about 1/16 inch on each side of manifold.
2. To check installation, adjust a vacuum pump to three inches of vacuum. Block off one opening of heat tube with a moistened finger, then connect the vacuum 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.

Oil Pan

The pan should be thoroughly cleaned in cleaning solvent to remove any foreign material from below the baffle plate which is spot welded in place. Examine the gasket surfaces of the pan for dents.

Disassembly, Inspection and Assembly of Oil Pump

1. Remove four cap screws securing cover to body assembly. Remove cover and gasket. See figure 6C-130.
2. Remove rotor and shaft assembly.
3. Remove relief valve nut-spring and relief valve.
4. Clean all parts in a suitable solvent.
5. Check pump housing and rotors for damage or excessive wear.
6. Check compression of the relief valve spring. Check relief valve clearance in body assembly. The specified clearance is .002 to .004 inch.

7. Measure the outer rotor race to body clearance as shown in figure 6C-131. The clearance should be .006″ to .009″.
8. With the rotor and shaft assembly installed in the housing, place a straight edge over the rotor assembly and pump body. Measure the clearance between the pump and the straight edge at the rotor. The clearance should be .0015″ to .0029″. See figure 6C-132.
9. Check the cover for wear, if it is scored or grooved replace it.
   NOTE: The outer rotor, and shaft and rotor assembly are replaced as an assembly.
10. To assemble pump, reverse disassembly procedure.
    IMPORTANT: Remove all old gasket material from cylinder block and pump body.

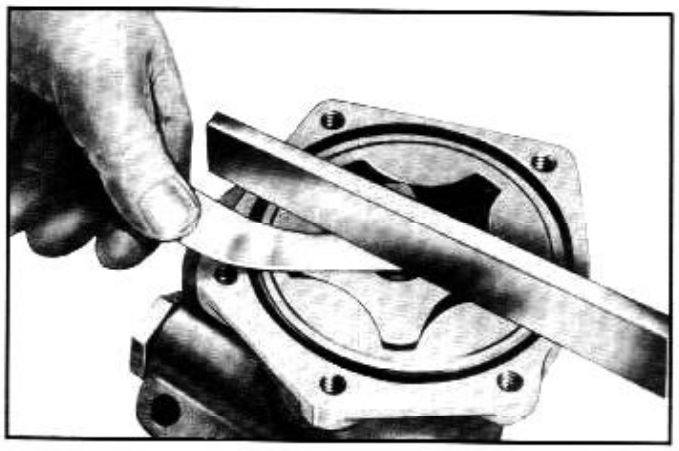


Fig. 6C-132—Checking Rotor End Play Clearance

ASSEMBLY OF ENGINE (REMOVED FROM VEHICLE)

For your reference, figures 6C-133 through and including 6C-135 are presented for reference and parts identification during assembly procedures.

1. With cylinder block attached to engine repair stand turn block on stand so bottom faces upward. Install the two drain cocks in the cylinder block outlet holes. Use sealer on threads.
2. Install new camshaft bearings, if original bearings were removed because of wear or damage. To install bearings, use Tool 6261-D and adaptors. See figure 6C-136.
   CAUTION: *Install bearings so oil holes in each bearing are in line with holes in cylinder block web. The notch on edge of bearing should face the front of the engine at the bottom of the bore.*
   NOTE: Number 1 camshaft bearing must be at least .005″ and not more than .020″ below front face of cylinder block bearing bore.
3. Coat edges of new camshaft bearing plug with a suitable oil resistant sealing compound. Install the plug, with the flange side facing in, using Tool 6266-C.
4. Install new rear crankshaft journal oil seal in the cylinder block, using Tool 6701. See figure 6C-137.
   NOTE: It is very important to the sealing efforts of the rear crankshaft seal that the packing be cut flush with the surfaces and have no rough edges that may project from the groove and lodge between the bearing cap and the cylinder block. Tool 6701 is provided with a fibre insert which allows a smooth cut of the packing.
5. Place upper main bearing inserts in position in bore with tang of bearing in slot provided. Lubricate bearings with engine oil. If main journals have been reground to a definite undersize, install correct undersize bearing inserts.
6. Install crankshaft and position lower main bearing inserts and caps over crankshaft in their original position. Torque cap screws 120 to 130

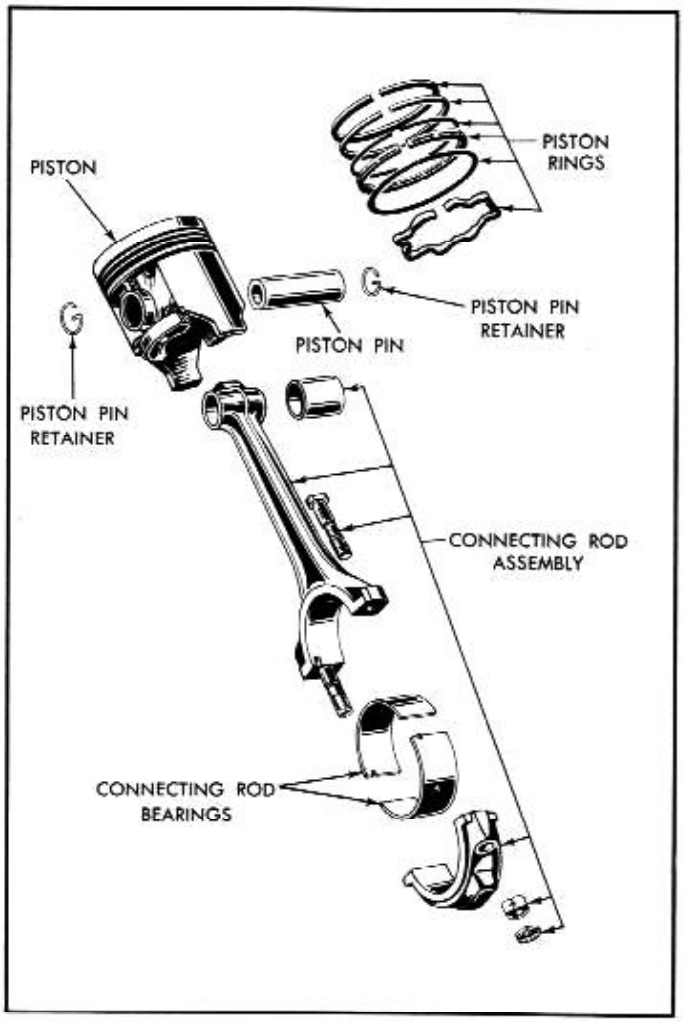


Fig. 6C-133—Piston and Connecting Rod Assembly

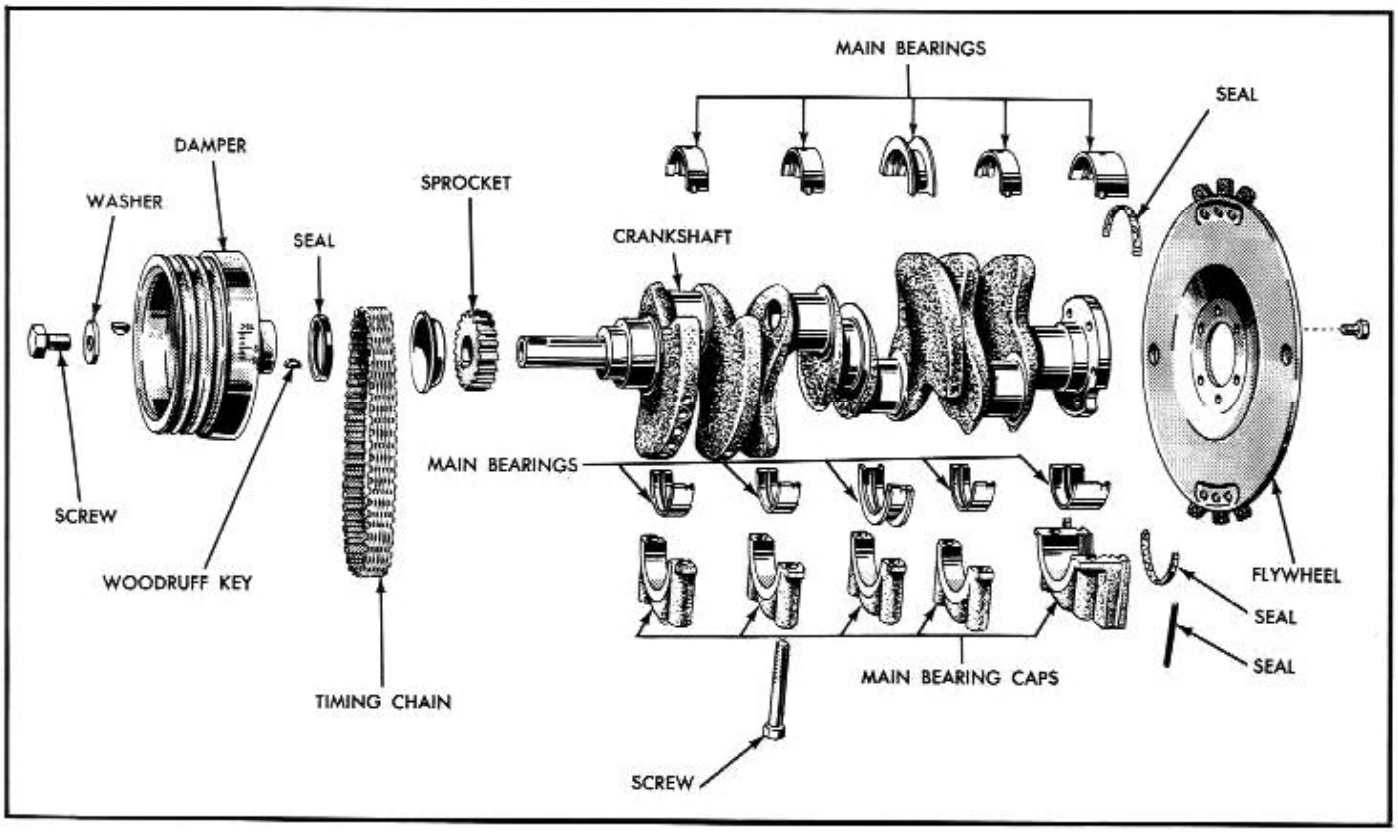


Fig. 6C-134—Crankshaft, Flywheel and Related Parts

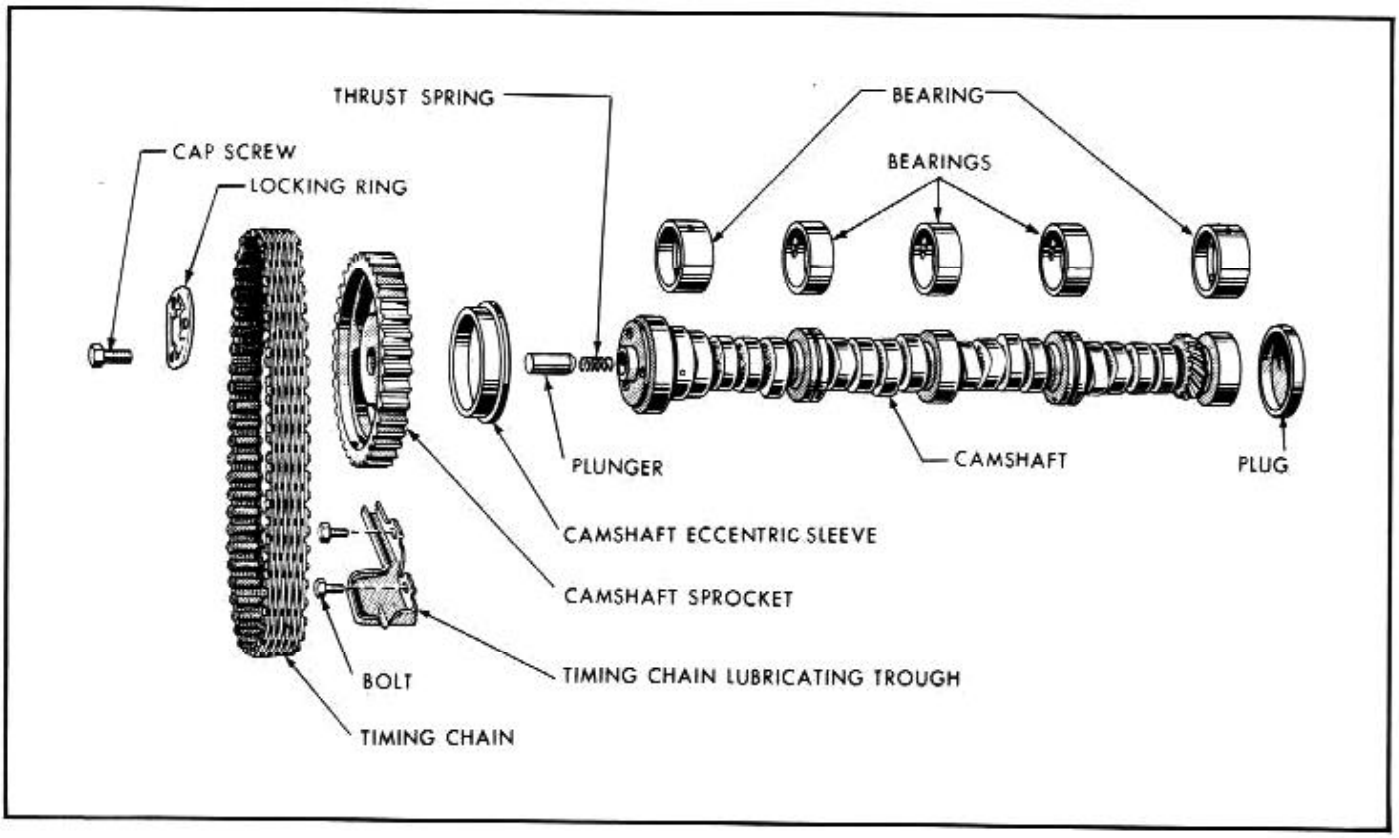


Fig. 6C-135—Camshaft and Related Parts

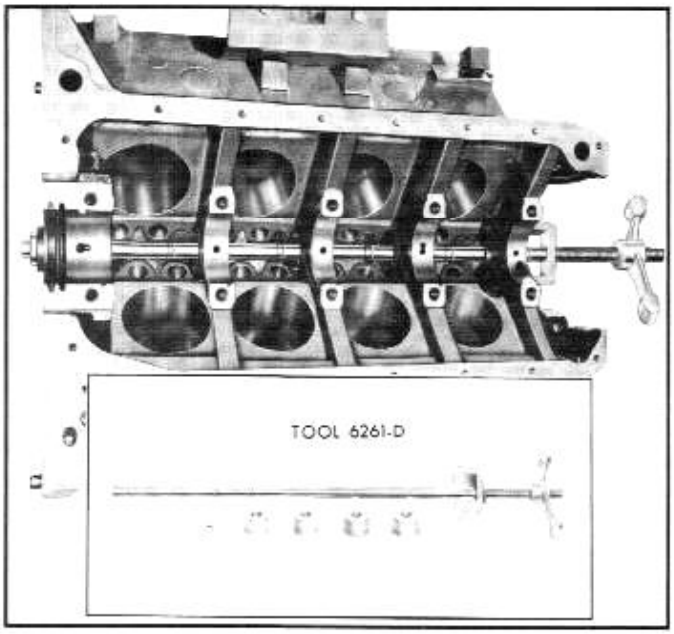


Fig. 6C-136—Installing Camshaft Bearings

lbs. ft. To determine if bearing clearance is within limits, use Plastigage method as follows:

a. Remove one bearing cap and bearing insert at a time. Remaining caps are left tight while checking the bearing clearance.

b. Place a piece of Plastigage, the full width of the bearing surface, on the crankshaft journal about 1/4" off center. Install bearing insert and cap. Tighten cap screws to 120-130 lbs. ft. torque.
CAUTION: *Do not rotate crankshaft while making checks with Plastigage.*

c. Remove bearing cap and insert, but do not disturb Plastigage.

d. Compare the width of the flattened Plastigage at its widest point with the scale printed on the Plastigage envelope. See figure 6C-138. This reading indicates the minimum bearing clearance in thousandths of an inch. Clearance should be from .0008" to .0026" (wear limit .0036").

e. If the clearance is less than .0008" or more than .0036", try another bearing insert to bring the clearance within the desired specification.
NOTE: Standard size bearing inserts are divided into two sizes carrying different suffixes to the part number. They can be identified by a daub of either red or blue color dye. Red bearing inserts will increase the clearance. Blue bearing inserts will decrease the clearance. Any combination of red and/or blue bearing inserts may be used to bring the

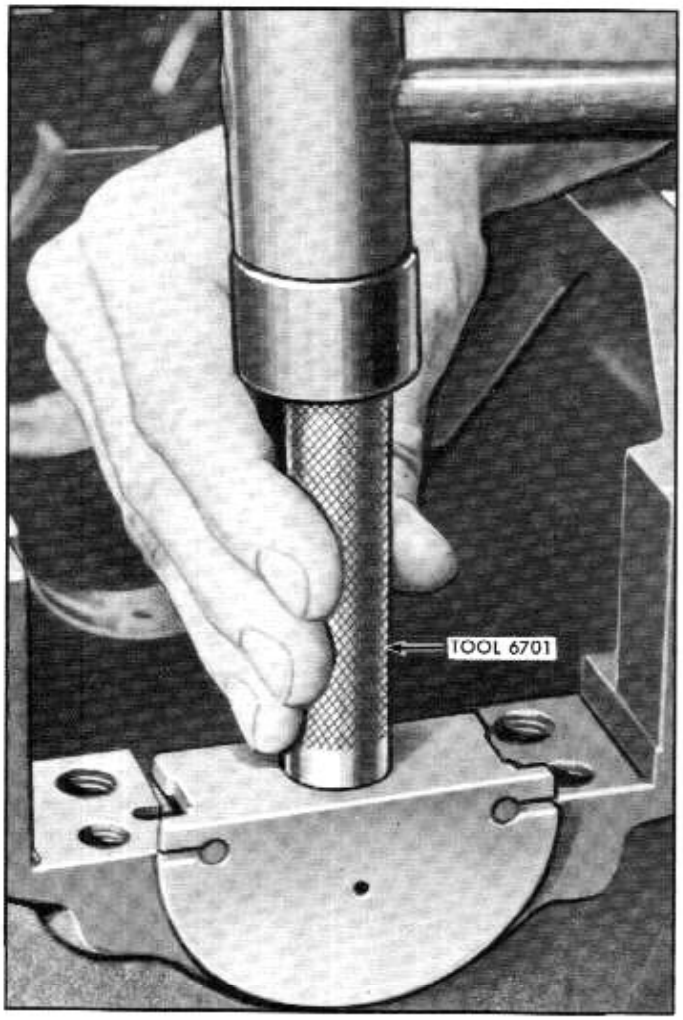


Fig. 6C-137—Installing Rear Crankshaft Oil Seal

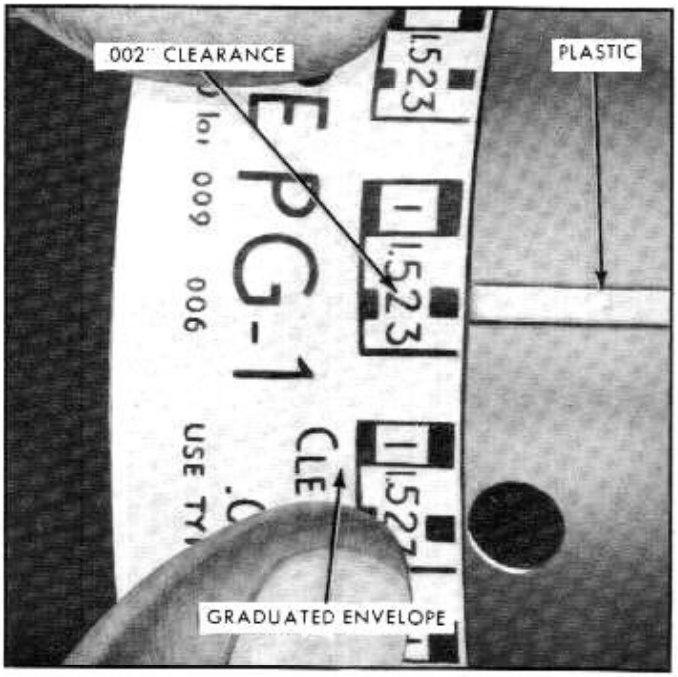


Fig. 6C-138—Checking Bearing Clearance

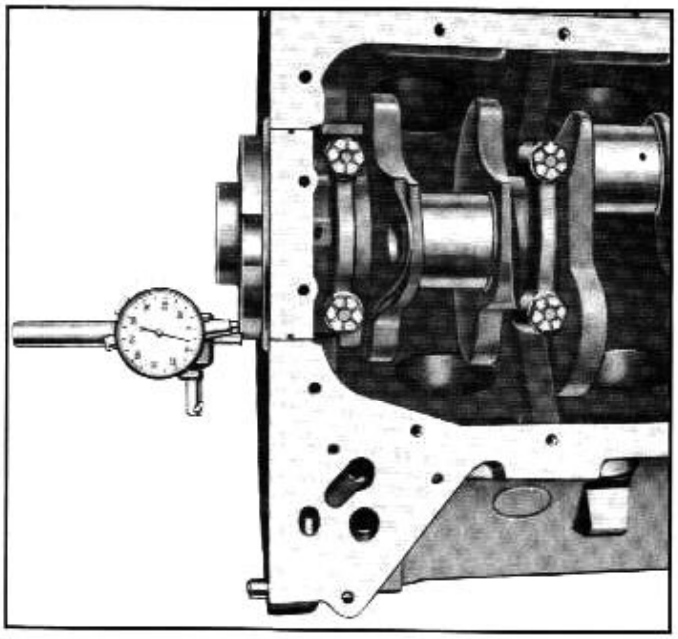


Fig. 6C-139—Checking Crankshaft End Play

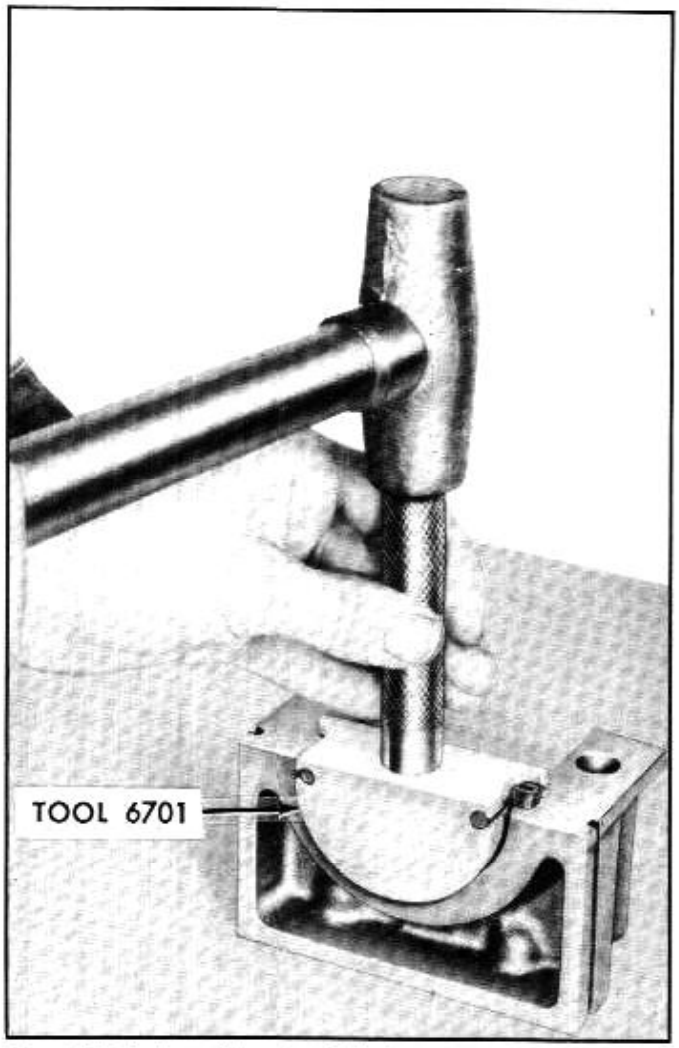


Fig. 6C-140—Installing Crankshaft Oil Seal in Rear Main Bearing Cap

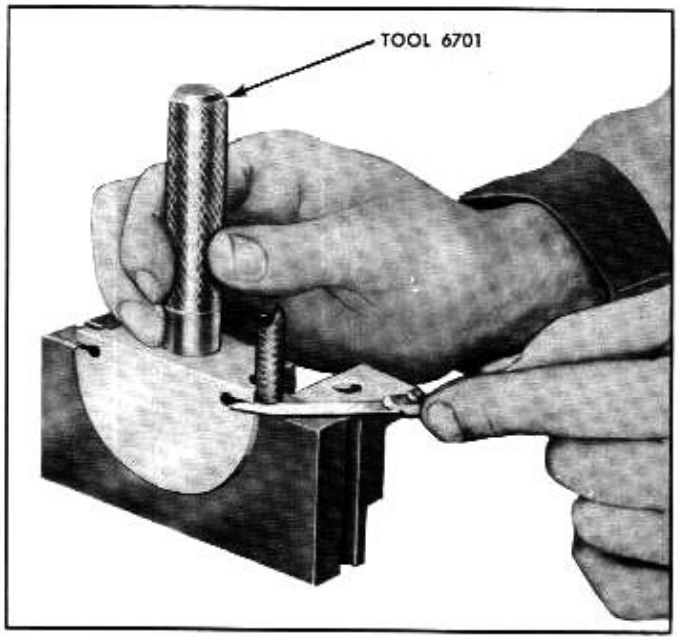


Fig. 6C-141—Cutting Oil Seal

desired results.

NOTE: If the various selective fit bearings do not bring the clearance within the desired limits it will be necessary to regrind the crankshaft journals and install undersize bearing inserts.

f. Lubricate the bearings with engine oil.

g. Install bearings. Align thrust bearing.

NOTE: When aligning thrust bearing, install the main bearing caps and inserts except the thrust bearing cap, and tighten to proper torque. Install the thrust bearing cap and

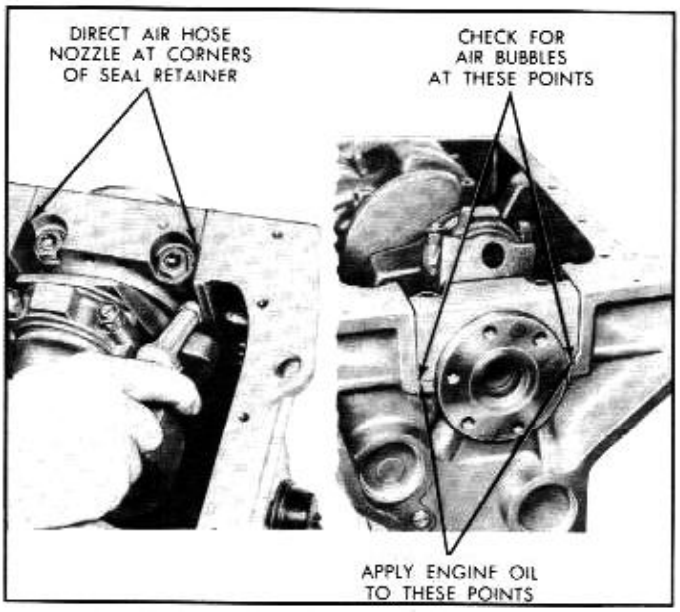


Fig. 6C-142—Checking Rear Oil Seals with Compressed Air

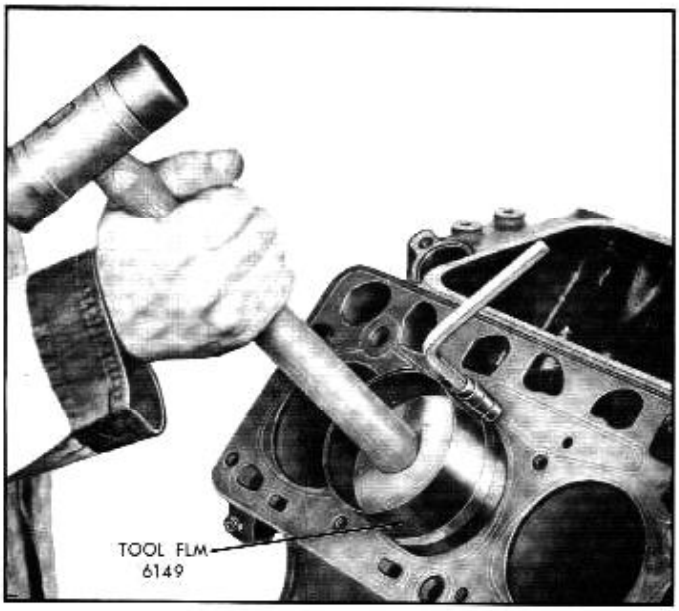


Fig. 6C-143—Installing Piston — Typical

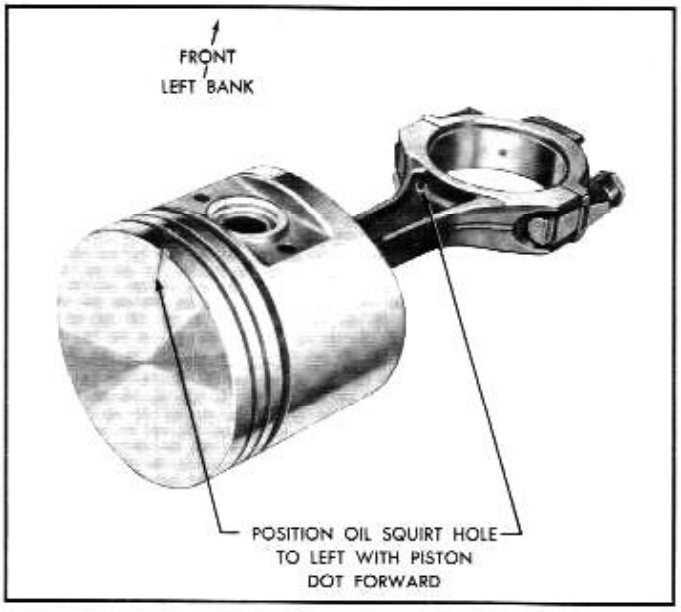


Fig. 6C-144—Position of Piston and Connecting Rod Squirt Hole — Left Bank — Typical

insert. Install the retaining screws snug tight, then pry the crankshaft towards the rear of the engine. Reverse this action by prying the crankshaft forward (towards the front of the engine). This will align the thrust surfaces of both halves of the thrust bearing. Retain this forward pressure on the crankshaft, and tighten main bearing retaining screws to 120-130 lbs. ft. torque.

7. Check crankshaft end play. See figure 6C-139. Force crankshaft forward as far as possible and release. Connect dial indicator so contact point rests against crankshaft flange. Set indicator at zero and then force crankshaft to rear and release. Note end play reading. Limits are .004" to .008".
8. Install number 5 main bearing cap and seal as follows:
   a. Remove main bearing cap and install new crankshaft packing in the seal retainer using Tool 6701. Cut packing flush without frayed edges. See figures 6C-140 and 6C-141.
   b. Install bearing cap assembly and torque bolts to 120-130 lbs. ft.
   c. Lubricate the seals with engine oil and insert into their respective side grooves. When the seals are in place, they will project below the oil pan gasket surface. DO NOT cut off the excess material.
   NOTE: The seals may be lightly tapped in place with a mallet.
   d. Test assembly with compressed air for leaks as shown in figure 6C-142.
9. Turn cylinder block to vertical position so front end faces upward.
10. Turn crankshaft so crankpin for No. 1 and No. 5 cylinders is at approximately B.D.C.
11. Coat cylinder bores, crankshaft journals, pistons, piston pins, and piston rings with engine oil. (Check ring gap spacing. Oil ring gap should be positioned to the inside of the "V" of engine and the remaining ring gaps spaced 120° apart.)
12. Insert the previously assembled piston assembly into Piston Ring Compressor Tool FLM-6149 and install piston assembly into respective cylinder bore, as shown in figure 6C-143. Refer to figures 6C-144 and 6C-145.

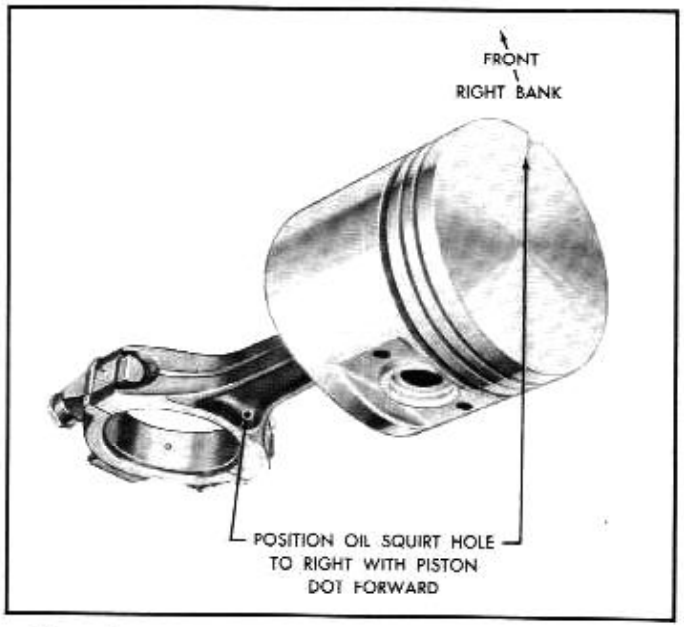


Fig. 6C-145—Position of Piston and Connecting Rod Squirt Hole — Right Bank — Typical

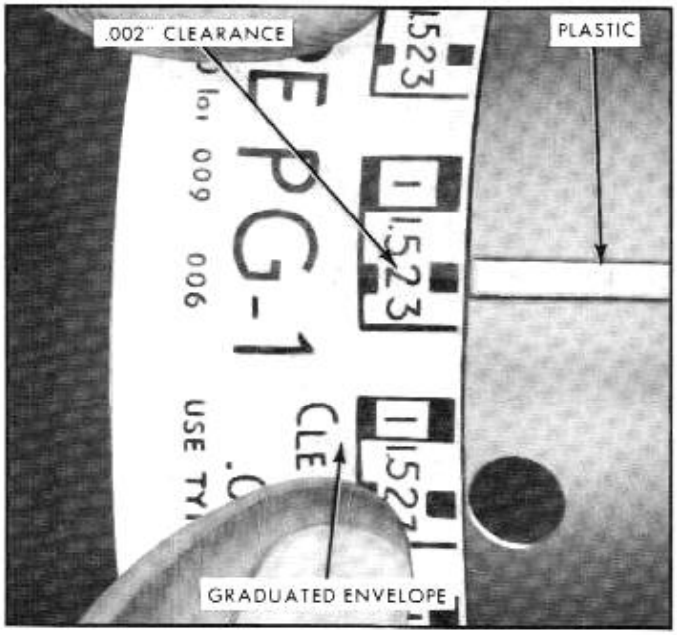


Fig. 6C-146—Checking Bearing Clearance

CAUTION: *When installing piston assemblies, be extremely careful that the connecting rod bolts do not strike the crankshaft journals. If this should happen, remove burr using fine oil stone. DO NOT HAMMER ON TOP OF PISTON when installing assembly in cylinder bore. Apply even pressure to wood hammer handle. See figure 6C-143. By applying a continuous pressure to the piston, any obstruction will be immediately indicated. The piston assembly can then be removed and rings checked and reinstalled correctly, if obstruction is present.*

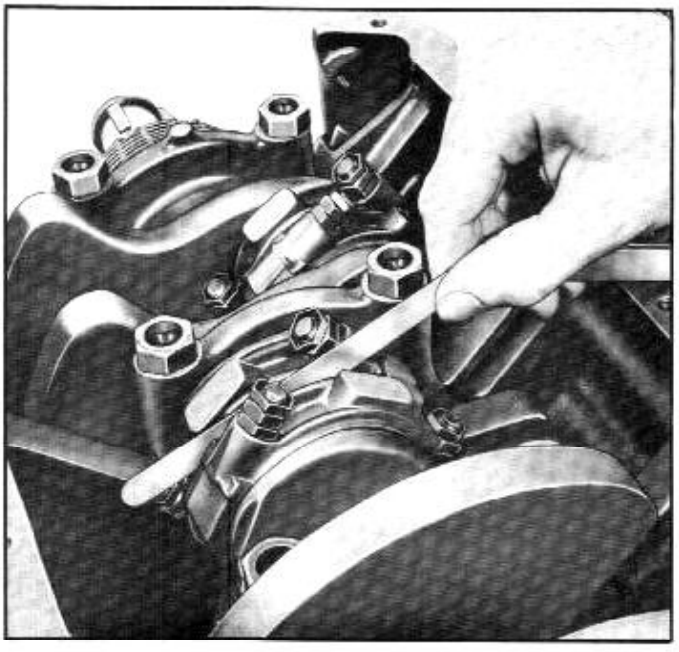


Fig. 6C-147—Checking Connecting Rod Side Clearance

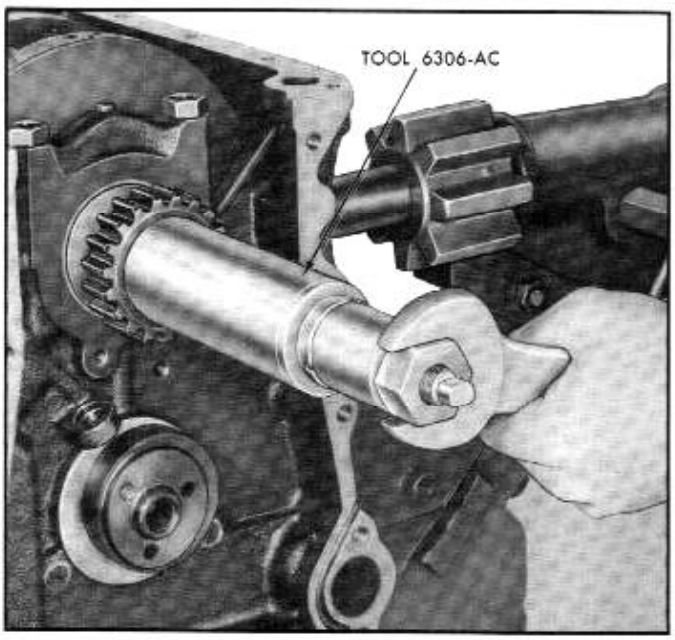


Fig. 6C-148—Installing Crankshaft Sprocket

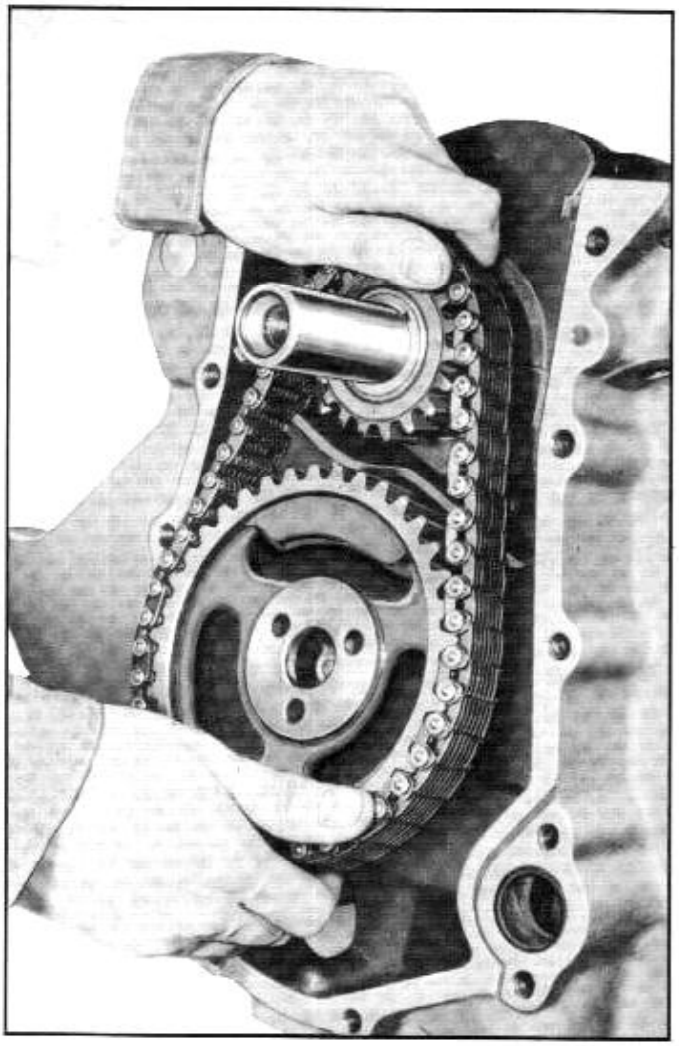


Fig. 6C-149—Installing Camshaft Sprocket and Timing Chain

13. Install connecting rod bearings and caps. The numbered side of the cap must match and be on the numbered side of the rod. Secure with hex nuts and pal nut. Torque hex nuts 45-50 lbs. ft. Install pal nuts and torque 3 to 3½ lbs. ft. or finger tight plus 1/3 turn.
14. Repeat above operation for remaining cylinders, turning crankshaft so crankshaft journal for each set of cylinders is at approximately B.D.C. for installation of remaining piston assemblies. The numbered side of the rods must face towards the outside of the block and dimple embossed or slot cut on the top of the piston, must face the front of the engine. See figures 6C-144 and 6C-145.
15. Install connecting rod bearings as follows:
    a. Clean oil from crankshaft journal, rod and cap bearing bores and bearing contact surfaces.
    b. Install upper bearing into the rod and pull rod assembly into firm contact with the crankshaft journal.
    c. Install lower bearing into rod cap. Place a piece of Plastigage on the bearing surface the full width of bearing about 1/4" off center.
    d. Install cap and tighten to 45-50 lbs. ft. torque. CAUTION: *Do not turn crankshaft while Plastigage is in place.*
    e. Remove bearing cap and compare the width of the flattened Plastigage at its widest point with the scale printed on the Plastigage envelope. See figure 6C-146. If clearance is less than .0007" or more than .0026" (.0036" wear limit) try another selective fit bearing to bring the clearance within the desired limits.
16. Check connecting rod side clearance using feeler gauge. See figure 6C-147. Limits are .004" to .008" (wear limit .012").
17. Install timing chain lubrication trough to block, bending tabs to lock the screws.
18. Install camshaft after coating all journals and bearings with a liberal amount of engine oil.
19. Insert Woodruff key in crankshaft and install crankshaft sprocket using Tool 6306-AC. See figure 6C-148. Timing marks on gear should be towards front of engine.
20. Install fuel pump push rod and snap ring retainer using Tool 9400-B.
21. Install camshaft eccentric sleeve over camshaft eccentric hub so flange is against the cylinder block.
22. Turn crankshaft so number 1 piston is on T.D.C. and timing mark is on vertical center line of crankshaft.

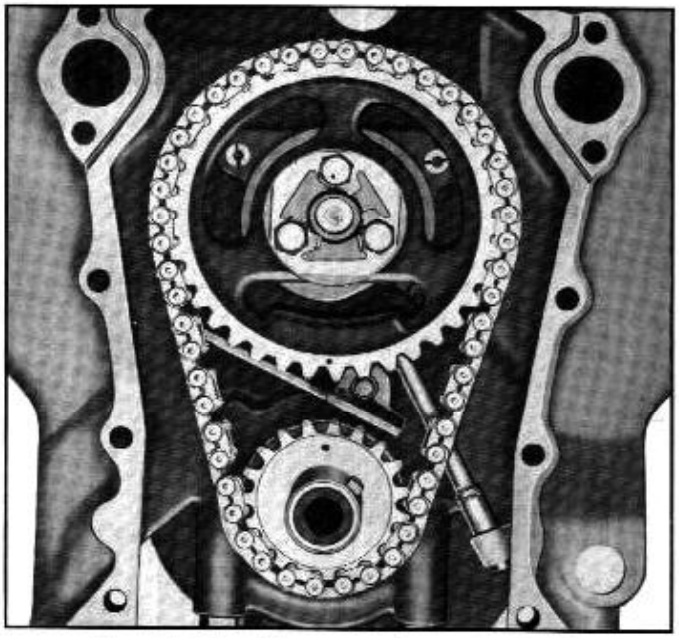


Fig. 6C-150—Alignment of Timing Marks

23. Place camshaft sprocket on camshaft to align holes in sprocket with those of camshaft. (Do not install bolts at this time). Rotate camshaft and sprocket until timing marks on sprockets are adjacent and in same vertical line. Remove camshaft sprocket and install on timing chain so timing mark remains in same position.
24. Holding the camshaft sprocket and timing chain as shown in figure 6C-149, position chain around crankshaft sprocket and install camshaft sprocket on camshaft. Install new lock plate and tighten three bolts to 15-18 lbs. ft. torque. Bend lock tabs against flat side of bolt heads.
    NOTE: Timing marks must be on crankshaft vertical center line as shown in figure 6C-150. If these marks are not positioned as shown, remove sprocket and reassemble correctly.
25. Check timing chain outward deflection. See figure 6C-151. Rotate crankshaft to take up slack on driving side of chain and establish straight position. Rotate crankshaft in opposite direction to take up slack on opposite side of chain. Pull chain outward with fingers. Measure outward deflection of chain. See figure 6C-151. There should not be more than 1/2" difference between the chain straight position and the position of chain when deflected outward.
26. Install camshaft spring and thrust plunger in front end of camshaft with radius end outward.
27. Install fuel pump assembly using new gasket. NOTE: Fuel pump assembly is installed at this time because of low position of cam eccentric.
28. Install new crankshaft front seal in front cover using Tool 6700-B. See figure 6C-152. Coat

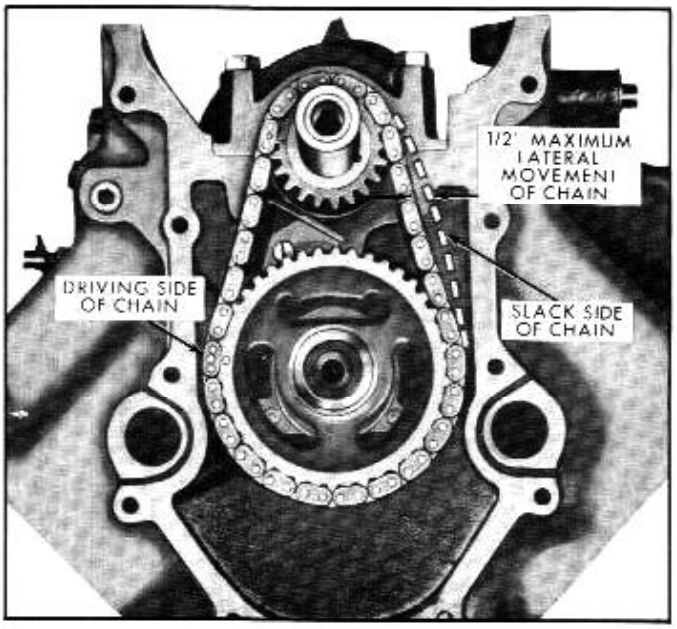


Fig. 6C-151—Timing Chain Deflection

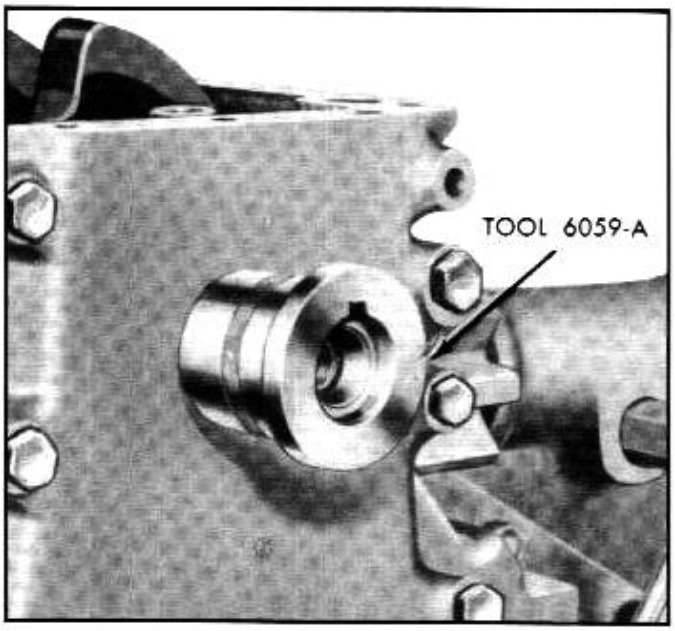


Fig. 6C-153—Aligning Front Cover

seal with engine oil to facilitate driving operation. NOTE: When installing the new seal, place seal on tool. Center seal and tool over front cover boss and drive in until seated. Make sure spring on inside of seal is properly seated.

29. Install new front cover gasket. Use sealer on gasket. Install front cover assembly, do not tighten cap screws. Position Tool 6059-A over crankshaft as shown in figure 6C-153 and align front cover to tool. Hold tool inward and tighten cap screws to 23-28 lbs. ft. torque.
30. Install engine oil pan using a new gasket. NOTE: When tightening, start from the center and work toward the front and rear alternately on both sides.
31. Invert engine so top of block faces upward. Place engine oil on hydraulic lifters. Install hydraulic lifters in their original bores.
32. See figure 6C-154. Install valves in their respective guides and install new valve stem seals, valve springs, valve spring retainers, and inner sleeves. Position Compressor Tool 6513-EE over valve spring retainer and valve head. See figure 6C-155. Compress valve spring and install keys. Release Tool 6513-EE slowly and check position of valve keys.

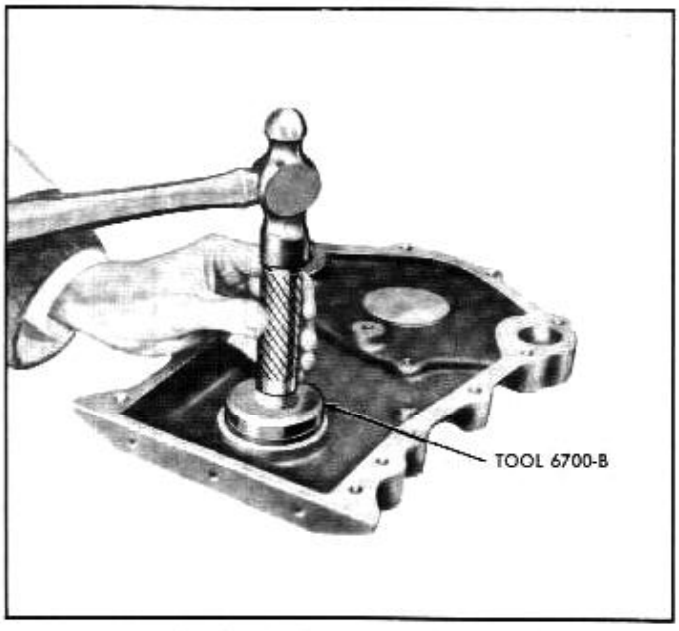


Fig. 6C-152—Installing Front Cover Seal

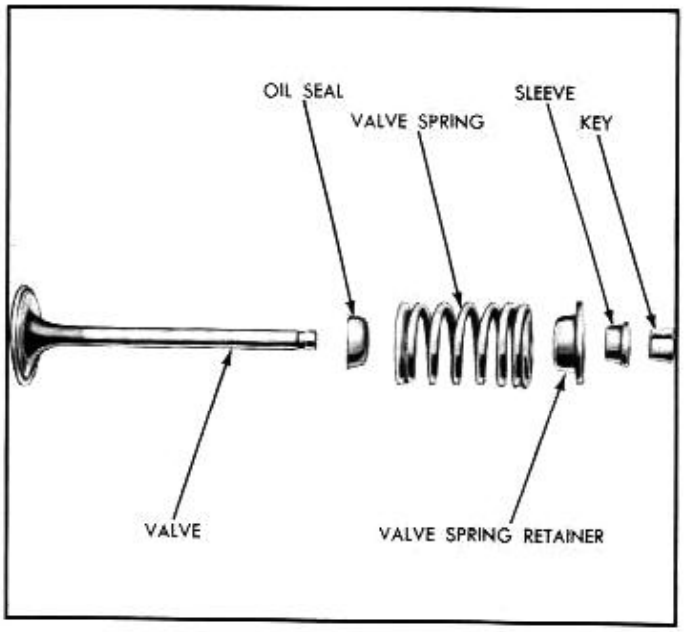


Fig. 6C-154—Valve Assembly

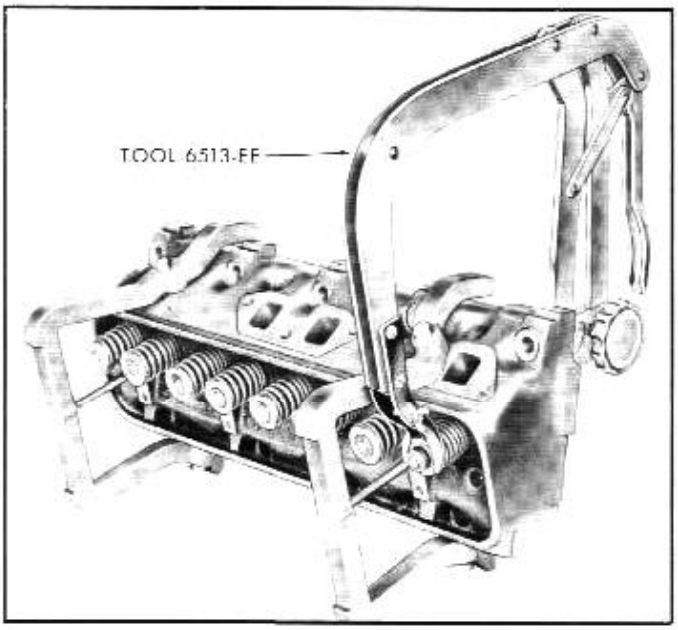


Fig. 6C-155—Compressing Valve Spring

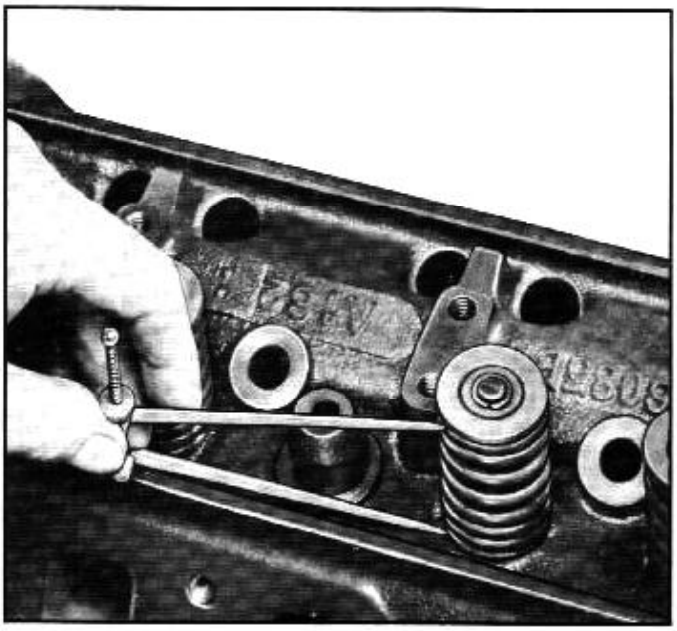


Fig. 6C-156—Measuring Valve Spring Assembled Length

33. Correct valve spring load is necessary for efficient high speed engine operation. Due to variance in the valve seats, the assembled height of the spring installed on cylinder head should be measured as follows:
    a. Use dividers to measure the assembled height from the surface of the cylinder head spring pad to underside of the spring retainer. See figure 6C-156.
    b. Check the dividers against a scale. If the valve closed assembled height is 1.800" or greater, install the necessary spacer or spacers between the cylinder head spring pad and the valve spring to bring the assembled height to the recommended dimension of 1.800 inches. See figure 6C-157.
    NOTE: The spacers available for service are .030 inch thick. Never use more than two spacers to bring the assembled height to specifications. Do not use 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.
    c. Coat valve stems with engine oil to furnish initial lubrication.
34. Install pilot studs, Tool 6051-A, in two end cylinder head cap screw holes and install new steel gasket over pilot studs and dowels after coating both sides with gasket sealer.
    NOTE: These gaskets are interchangeable for use on both banks. Make sure gaskets are installed properly by checking water passage holes and forward end for word "FRONT" stamped on gasket.
35. Install cylinder head assembly (assembly with valves only) over dowels and pilot studs so plugged water jacket hole is to the rear of the block. See figure 6C-158.
36. Remove cylinder head holding fixtures, Tool 6085-A, and install push rods, being sure they are properly seated in hydraulic lifters.
37. Install 8 cylinder head cap screws, remove pilot studs and install 2 remaining screws. Make 3 torque applications, 2 cold and 1 hot, as shown in figure 6C-159.

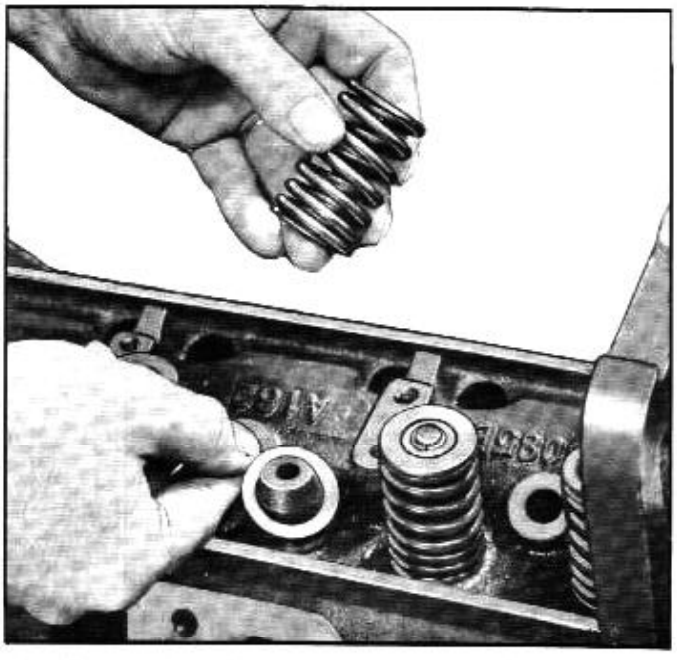


Fig. 6C-157—Adding Spacers to Correct Valve Length

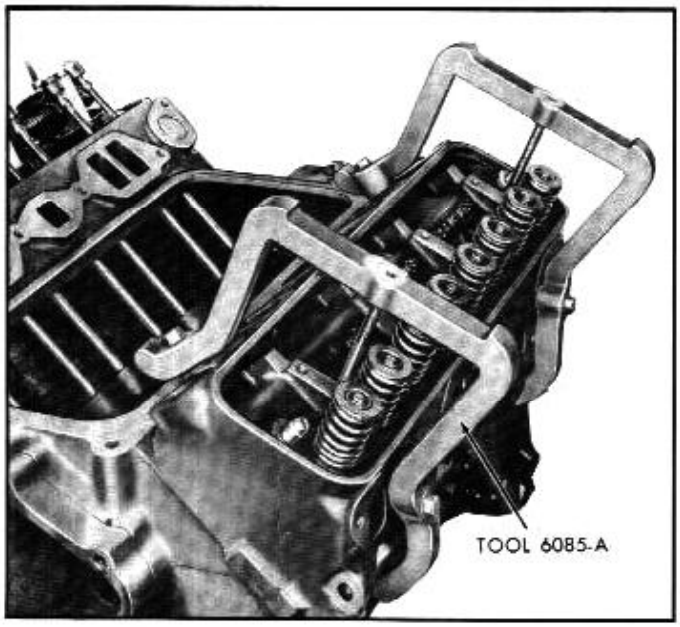
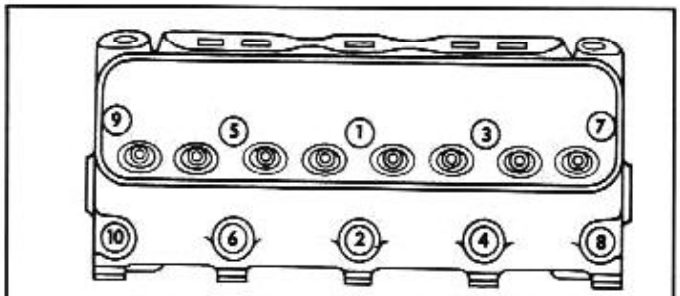


Fig. 6C-158—Installing Cylinder Head

After torquing is completed, the cylinder head bolts require no additional torquing and should not be disturbed for any reason.

NOTE: Tools are available that eliminate the necessity of removing the exhaust manifold for the final hot torquing of the cylinder head. A combination of these three tools: Cylinder head wrench, part number S-9513-C; head wrench adaptor, part number S-9526; and a thin wall hexagon socket, part number TW-241, can be used to torque all the cap screws to specifications.

38. Position 4 oil baffle plates on rocker arm mounting pads. Position rocker arm assembly over studs and push down into place engaging rocker arm adjusting screws in push rod.



TORQUING OF ALL CYLINDER HEAD BOLTS, IN THE ABOVE SEQUENCE, TO BE PROGRESSIVELY INCREASED IN THREE STEPS:

	EARLY PRODUCTION	"FT" ON BOLT HEAD
1ST STEP ENGINE COLD	60-70	65-80
2ND STEP ENGINE COLD	70-80	80-95
3RD STEP ENGINE HOT—STABILIZED AT 160°—180° F.	80-90	95-105

Fig. 6C-159—Torque Sequence and Values

39. Install oil overflow pipes on front right bank rocker arm support and rear left bank rocker arm support. Install stiffener plates and tighten cap screws and nuts to 22-23 lbs. ft. torque.
NOTE: The overflow pipes must enter holes in the rocker arm shaft and cylinder head, prior to torquing rocker shaft support cap screws and nuts.

40. The cylinders in the engine 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. Adjust valve clearance as follows:

a. Check rocker arm adjusting screw torque by turning all tappet adjusting screws until interference is noted, then check the torque required to turn the screw further.

b. If the torque required to turn the screw is less than 3 lbs. ft. (36 inch pounds) replace the rocker arm and adjusting screw.

c. Turn crankshaft until lifters, to be adjusted, are on the low side of the cam lobe. The following table shows, in sequence, which lifters are in position for adjustment with numbers 1, 4, and 3 pistons on T.D.C.
With number 1 piston on T.D.C. (compression stroke) adjust the following valves:

No. 1 – Exhaust	No. 1 – Intake
No. 4 – Exhaust	No. 2 – Intake
No. 5 – Exhaust	No. 7 – Intake

Rotate the crankshaft 180° or 1/2 turn (this puts number 4 piston on T.D.C.), then adjust the following valves:

No. 6 – Exhaust	No. 4 – Intake
No. 8 – Exhaust	No. 5 – Intake

Rotate the crankshaft 270° or 3/4 turn (this puts number 3 piston on T.D.C.), then adjust the following valves:

No. 2 – Exhaust	No. 3 – Intake
No. 3 – Exhaust	No. 6 – Intake
No. 7 – Exhaust	No. 8 – Intake

d. To adjust valve clearance, turn adjusting screw clockwise while moving push rod up and down as shown in figure 6C-160, until slack is removed.
IMPORTANT: Plunger unit of hydraulic lifter should not be forced down into lifter body during this operation. With the slack removed, turn adjusting screw clockwise an additional 2½ turns. Repeat until all lifters are adjusted.
CAUTION: *To eliminate any possibility of bending a push rod, force each tappet to*

leak down after adjustment, by pressing on the push rod end of the rocker arm.
NOTE: If lifter is noisy during engine operation, adjustment can be varied by turning adjustment screw ±1/2 turn from the original 2½ turn setting. When valve clearance adjustment operation is performed with the engine in the vehicle, remove distributor cap and turn engine until distributor rotor is at the firing position for the cylinders indicated in the preceding table.

41. Install rocker arm covers with new gaskets, place sealer on gaskets. Install seals and nuts. Torque to 2-2½ lbs. ft.
42. Install valve lifter chamber cover assembly using new gasket and bolt seals.
43. Install new intake manifold gasket and intake manifold. Torque cap screws, 23-28 lbs. ft. alternately, from center to the end. When installing manifold and gasket make up pilot studs to hold gasket in position.
44. Install exhaust manifolds to cylinder heads. No gaskets are used with this installation. Coat mating pads with graphite grease. Place spark plug wire heat shields in position at this time. Tighten screws from center toward both ends to 23-28 lbs. ft. torque.
NOTE: If car is equipped with heater, install water inlet fitting in cylinder heads prior to installing exhaust manifolds.
45. Install oil dipstick tube. Coat end of tube with sealer.
46. Install new gasket and exhaust control valve on the right hand exhaust manifold. Make sure the valve is installed correctly. The valve is marked "front". Tape control valve in position until engine is installed.
47. Install Woodruff key in crankshaft for crankshaft damper and install damper using Tool 6306-AC. See figure 6C-161. Secure with flat washer and bolt.
48. Turn crankshaft to position No. 1 piston on T.D.C. of compression stroke. Hold thumb over spark plug hole to determine the compression stroke. Set distributor rotor in position to fire No. 1 cylinder spark plug with points just breaking. Mark this location by scribing line on distributor housing. Turn rotor counterclockwise a distance equal to amount observed during the disassembly procedure (approximately 1/8 turn). Install distributor. Shaft and rotor will turn clockwise as distributor gear meshes with camshaft gear. Recheck position of rotor with scribed line on housing. Install the distributor cap. If installation is correct, install spark plug grommet then retain

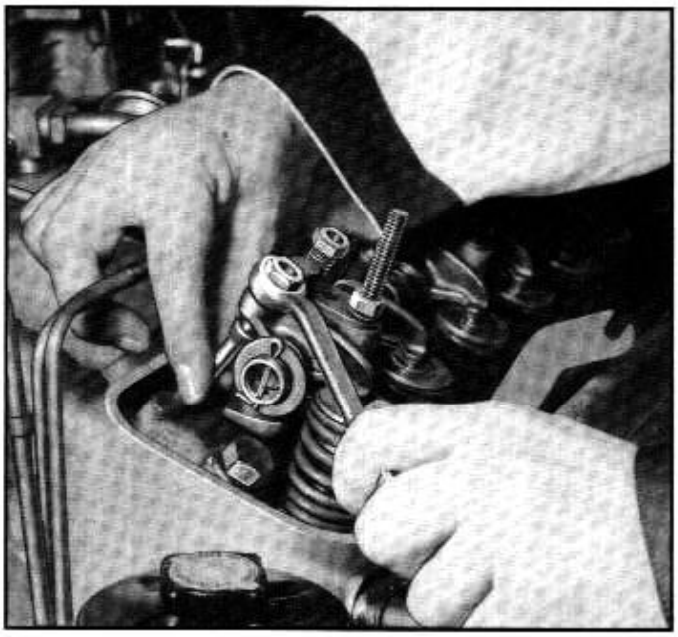


Fig. 6C-160—Valve Clearance Adjustment

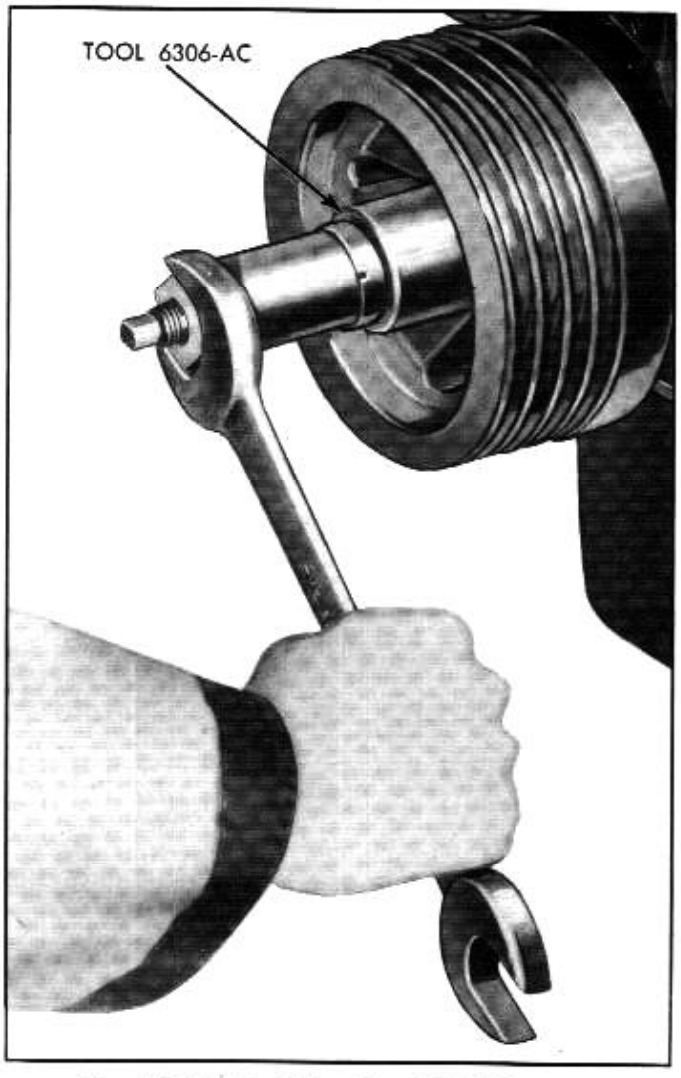


Fig. 6C-161—Installing Crankshaft Damper

the distributor with clamp, nut and lockwasher. Final timing of the distributor must be made after the engine is operating in the vehicle. See "Engine Electrical" section of this manual.

49. Install spark plugs. Torque plugs 15 to 20 lbs. ft. Install wiring harness brackets and connect wires to spark plugs.
NOTE: Only the No. 1 position is marked on the distributor cap. Since the distributor rotates counterclockwise, connect the wires in the firing sequence of 1-5-4-8-6-3-7-2 following this counterclockwise rotation.
50. Install distributor intermediate shaft in the oil pump drive gear shaft. Install new gasket on oil pump. (Use sealer on gasket surfaces.)
51. Gently install intermediate shaft into position in block. Turn oil pump assembly back and forth until engagement of intermediate shaft with the end of distributor shaft hex is felt. When this occurs, oil pump may be raised into position so it is flush with the bottom of block. Install retaining screws to secure pump. Alternately tighten screws to 12-15 lbs. ft. torque.
52. Install new "O" ring seal on oil inlet pipe. Install oil inlet pipe in oil pump. Tighten nut at oil pump 10-12 lbs. ft. Install new inlet tube gasket, using sealer. Tighten inlet tube retaining screws at oil pan to 28-32 lbs. ft.
53. Install carburetor gasket, spacer, and another gasket. Install carburetor on intake manifold by placing carburetor over heat tube so it enters the large hole in the carburetor throttle body. Retain carburetor on manifold with four lockwashers and hex nuts. Do not tighten at this time.
54. Install vacuum line from carburetor to distributor, fuel and vacuum lines to fuel pump.
55. Secure heat tube to carburetor choke housing with hex nut. Tighten four nuts at carburetor base, securing carburetor to intake manifold. Tighten each pair of nuts alternately and in a criss-cross pattern. Torque to equivalent of 12 to 15 lbs. ft.
56. Position new water pump gasket and install water pump (use sealer on gasket).
57. Install generator, support bracket, adjusting arm, and timing pointer. Install water pump-fan and generator drive belts.
58. Adjust belt tension by loosening lower bolt on generator adjusting arm and pull generator away from engine. Belts should have approximately 1/2" deflection.
59. Install thermostat and water outlet connection to intake manifold using new gaskets. Make certain thermostat is placed correctly. Connect water by-pass tube to water pump and outlet elbow (use sealer on gaskets).
60. Install oil filler and road draft tube assembly.
61. Place flywheel in position on crankshaft. Install 6 cap screws and alternately torque 75-80 lbs. ft.

INSTALLATION OF 368 CUBIC INCH ENGINE (LESS TRANSMISSION)

1. Install two locating dowels in upper cylinder block to converter housing mounting bolt holes.
2. Lower engine into the engine compartment. Align exhaust manifold and muffler inlet pipes, be sure exhaust thermostat valve and new gaskets are in position on exhaust manifold. (A piece of masking tape will secure them in position temporarily.)
3. Align locating dowels in cylinder block with the mounting holes in converter housing.
NOTE: Index the two large notches in flywheel with the converter cover drain plugs.
4. Push engine rearward until it is flush with the converter housing. Align the engine mount insulator studs with holes in the front engine support bracket. Lower engine carefully until it rests on engine support bracket.
5. Remove cylinder block locating dowels and secure engine in position with two upper converter housing to cylinder block retaining screws. Tighten screws to 40-50 lbs. ft. torque.
NOTE: It may be necessary to lift engine slightly to start the screws.
6. Remove engine hoisting sling. Raise vehicle, then install nuts that secure the right and left front engine mount insulators to the front engine support brackets. Tighten nuts 34 to 42 lbs. ft. torque.
7. Install lower converter housing to cylinder block retaining screws. Tighten screws to 40-50 lbs. ft. torque.
8. Check to be sure converter can be rotated by hand and is not binding. Secure converter cover to flywheel and tighten nuts to 25-28 lbs. ft. torque.
9. Install converter housing cover and lower access cover. Tighten screws to 10-13 lbs. ft. torque.
10. Install oil pressure sending unit and connect wire. Coat gasket face of filter assembly with engine oil and install filter on insert. Hand tighten filter until filter gasket contacts adaptor face, then, advance filter 1/2 turn. DO NOT OVERTIGHTEN.
NOTE: Be sure the word "Top", on the adaptor face, is in the uppermost position before installing filter.
11. Connect armature wire to generator.

12. Install starter assembly. Be sure that rubber seal is properly positioned to prevent binding and misalignment. Tighten the outer flange bolt first then tighten the top and bottom flange bolts. This will prevent misalignment of starter assembly.
13. Install the spark plug wire assembly grommet on cylinder block. Connect starter cable to starter.
14. Install transmission coolant line bracket on cylinder block.
15. Install transmission oil filter pipe bracket on right exhaust manifold. Install nuts and lockwashers on the right and left exhaust manifold to muffler inlet pipe studs. Tighten nuts to 34-42 lbs. ft. torque.
16. Install transmission linkage splash shield.
17. Install stabilizer bar assembly on front lower suspension arms. Secure the respective stabilizer brackets to frame crossmember with two lock washers and screws. Tighten screws to 22-28 lbs. ft. torque.
18. Install engine splash shield. Lower vehicle.
19. Coat threads of heater inlet fitting and control valve with water proof sealer. Install fitting in right hand cylinder head and connect heater control valve to fitting. Connect heater inlet hose to control valve.
20. Connect generator field and ground wires to generator.
21. Connect primary and secondary wires to distributor assembly. If vehicle is equipped with a tachometer, connect tachometer driven gear and cable to distributor.
22. Install control shaft assembly and accelerator shaft bracket on engine. Connect carburetor to control shaft rod to the control shaft assembly. Install accelerator shaft retracting springs.
23. Connect engine ground wire to rear of left cylinder head. Connect windshield wiper hose to vacuum booster line.
24. Connect wires to automatic starter cut out switch and coolant temperature sending unit. Connect oil pressure sending unit wire to connector.
25. POWER BRAKE EQUIPPED VEHICLES: Install and secure the brake vacuum booster assembly to mounting bracket with four (4) screws. Tighten screws to 10-13 lbs. ft. torque. From inside vehicle, install push rod on lever assembly and secure with bolt and locknut. Tighten nut to 12-15 lbs. ft. torque. Connect vacuum hose to intake manifold connector.
26. Install windshield washer mounting bracket on fender apron. Install container, then, connect vacuum and water hoses.
27. Connect flexible fuel line to fuel pump.
28. POWER STEERING EQUIPPED VEHICLES: Install power steering pump drive belt in position on rear crankshaft damper pulley.
29. Install fan pulley, spacer, fan blade assembly, and four (4) mounting screws and lockwashers on the pulley hub as an assembly. Tighten screws 10-13 lbs. ft. torque.
30. Install generator-fan belts. Adjust generator adjusting bracket to allow 1/2" belt deflection between generator and water pump pulleys.
31. Place a piece of fibreboard or heavy cardboard on radiator to protect radiator core from damage upon installation. Install radiator on radiator support. Tighten retaining bolts to 10-13 lbs. ft. torque.
32. Connect transmission coolant lines at lower radiator tank. Connect lower radiator hose to water pump. Connect upper radiator hose to water pump. Connect heater outlet hose to water pump.
33. POWER STEERING EQUIPPED VEHICLES: Install power steering pump on mounting bracket. Install drive belt on crankshaft and power steering pump pulleys. Adjust power steering pump bracket to allow 1/2 inch drive belt deflection.
34. Install battery and connect cables.
35. Close all drain cocks and fill cooling system with coolant, fill crankcase to required level with proper grade of lubricant.
36. Install hood assembly. Check hood alignment.
37. Start engine. Check for oil and coolant leaks. Run engine until normal operating temperature is indicated. Check the following items:
    a. Oil and coolant leaks
    b. Ignition timing
    c. Carburetor idle adjustments
    d. Transmission linkage adjustments