FORD

Service Manual

FORD
NEW HOLLAND

Wheel Loaders
A-62, A-64 and A-66

Part 1 – Engine System
Part 2 – Fuel System
Part 3 – Electrical System
Part 4 – Transmission
Part 5 – Engine-Transmission Removal
Part 6 – Axles, Brakes, Drive Shafts, Wheels and Tires

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Vol. 1

Reprinted

FOREWORD

This manual provides information for the proper servicing of the Ford A62 — A64 — A66 Wheel Loaders. The manual is grouped into parts, each containing chapter divisions. The chapters contain such information as general operating principles, detailed inspection and repair procedures, and full specifics regarding trouble shooting, specifications, and special tools. Whenever possible, the special tools are illustrated performing their specific operations. Any reference made in the manual to right, left, front, rear, top, or bottom, is as viewed facing the direction of forward travel from the driver's seat.

The material contained in this manual was correct at the time the manual was approved for printing. Ford policy is one of continuous improvement and the Ford Motor Company reserves the right to discontinue models at any time or change specifications or design without notice and without incurring obligation.

Ford Tractor Operations
Ford Motor Company

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PART 1
ENGINE SYSTEM

Chapter 1
ENGINE

1. DESCRIPTION AND OPERATION

Direct injection diesel engines installed in Ford Wheel Loaders are in-line type with integral bores cast in the block and have overhead valves. This Chapter deals with the disassembly, inspection and repair, assembly and installation of both 4- and 6-cylinder engines. Servicing procedure for both engines is basically the same except where otherwise stated.

The cylinder head assembly incorporates the valves, valve springs and spring retainers. Valve guides are an integral part of the cylinder head with replaceable valve seats which are pressed into the valve ports. The exhaust valves are fitted with positive rotators and the push rods locate inside the tappets. The combustion chamber is in the piston crown and the fuel injectors are mounted outside the rocker cover.

MANIFOLDS: The intake and exhaust manifolds are on opposing sides of the cylinder head, providing better heat distribution. The intake manifold is provided with a tapped hole for installation of a thermostart or an ether cold starting aid.

CYLINDER BLOCK ASSEMBLY: The cylinder block features full length water jackets for cooling the cylinders, which are integral with the block. The firing order is 1-3-4-2 on the 4-cylinder and 1-5-3-6-2-4 on the 6-cylinder model.

The engine timing can be checked by observing the timing punch marks on the gears.

The crankshaft is supported in the cylinder block by five main bearings in the 4-cylinder engine and seven in the 6-cylinder. The thrust bearing is the third intermediate on the 4-cylinder engine and fifth intermediate on the 6-cylinder engine.

A slinger is machined on the rear of the crankshaft to direct oil away from the rear oil seal. The rear seal is a circular lip-type rubber seal that fits into a pocket machined into the cylinder block and into the rear main bearing cap. The cap also has two composition side seals. There is also a rear plate gasket to assist in sealing off the joint between the bearing cap and the block.

The 4-cylinder engine is equipped with a dynamic balancer which consists of a housing attached to the bottom of the cylinder block containing a drive gear and a driven gear. The balancer is driven by a gear machined on the crankshaft and the balancer gears are timed from the crankshaft balancer drive gear.

The pistons are trunk type with three compression and one oil control ring, all above the piston pin.

The connecting rods are heavy I-section which are drilled centrally to lubricate the piston pin and cool the piston crown on turbo-charged engines. The piston pin is free floating and held in place by two snap-rings (circlips).

The engine lubrication system oil flow, which is similar on the 4- and 6-cylinder engine is shown in Figure 1. A rotor-type oil pump, driven from a gear on the camshaft and mounted on the bottom of the cylinder block, takes oil through a filter screen and pumps the oil into the lubrication system.

A spring-loaded relief valve in the pump body limits the maximum pressure in the system by directing excess oil back to the intake side of the pump.

Oil flows from the pump to an external filter which contains a relief valve, permitting oil to bypass a blocked filter. This ensures that an oil flow is maintained to the engine at all times.

Oil flows from the filter to the main oil gallery, which runs the length of the cylinder block and intersects the tappet chambers.

The main oil gallery also supplies oil to the turbocharger bearings and all the crankshaft main bearings. Oil flow to the connecting rod journals is by way of the crankshaft. Camshaft bearings receive oil by means of drilled passages from the main bearings.

The camshaft drive gear bushing is pressure lubricated through a drilled passage from the front main bearing. The gear has small oil passages machined on both sides which allows the oil to exhaust.

The timing gears are splash-lubricated by oil from the tappet chamber and from the pressure-lubricated camshaft drive gear.

On the 4-cylinder engine, the balancer is lubricated through a drilled passage from the block intermediate thrust bearing web to the balancer housing. Oil flows through the balancer housing to the drilled balancer shafts and onto the bushings in the balancer gears.

Cylinder walls, pistons and piston pins are splash-lubricated by the crankshaft.

NOTE: In the turbocharged engines the pistons and pins are pressure lubricated through passages in the connecting rod.

An intermittent flow of oil is fed to the valve rocker arm shaft assembly through a drilled passage in the cylinder block at the No. 1 camshaft bearing which indexes with a hole in the cylinder head.

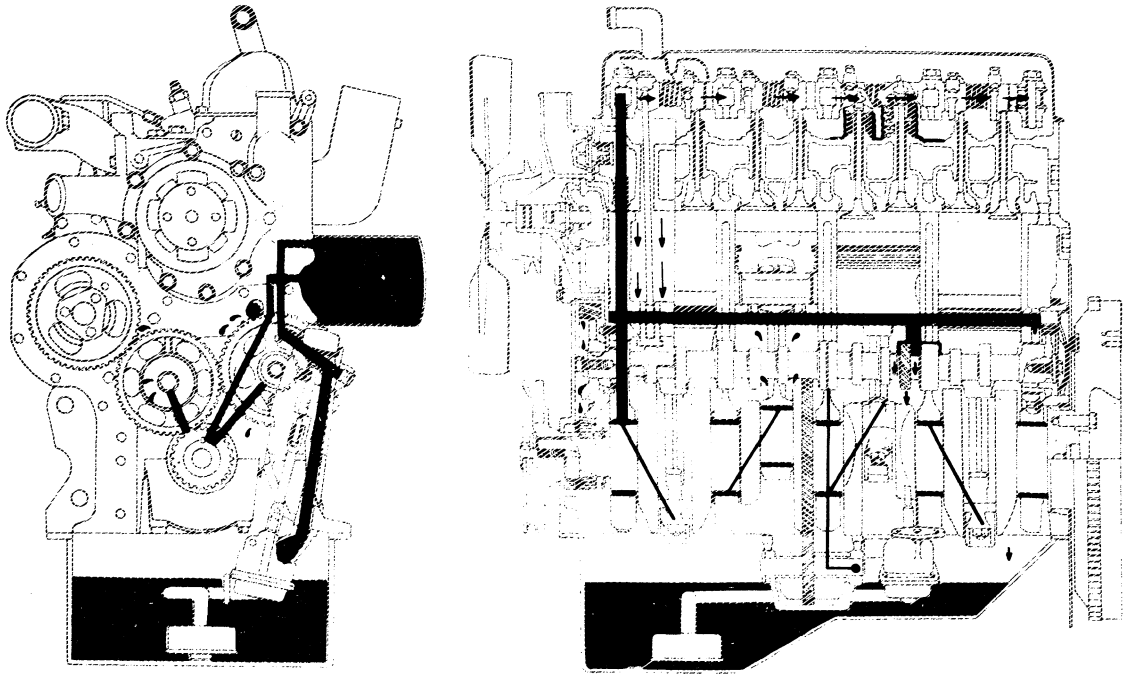

Figure 1
4-Cylinder Engine Lubrication System

From the head, the oil flows up around the No. 1 rocker arm support bolt to the rocker shaft, then from the shaft through drilled holes in each rocker arm to lubricate the valve end and adjusting screw end of the rocker arm. Oil from the ball ends of the rocker arms flows down the push rods and assists in lubricating the tappets and push rods.

Excess oil drains into the push rod chamber through the push rod holes in the cylinder head and then back to the oil pan sump through cored opening in the block.

A water-jacketed oil cooler, located in the base of the radiator, is connected into the system. The lubricating oil flows to the cooler from a tapping into the main oil gallery in the cylinder block, and returns to the oil pan sump via a pipe tapped into the skirt of the cylinder block.

OVERHAUL

The service procedures in this Chapter are written as if the engine were removed from the unit. However, some of these repairs can be effectively carried out with the engine installed in the vehicle.

Part 5 details the procedure for removal and replacement of the engine.

The engine units have been treated in four sections to make the overhaul procedure easier to understand. These sections are:

- Cylinder Head Assembly.
- Timing Gears, Camshaft and Oil Pump. Balancer, Connecting Rods and Pistons, Bearings, Flywheel and Crankshaft.
- Block Assembly.

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2. CYLINDER HEAD ASSEMBLY - OVERHAUL

REMOVAL

1. Remove the muffler components.

2. Disconnect the air intake tube and on turbocharged engines:

   (a) Disconnect and remove the air cleaner-to-turbocharger tube.

   (b) Disconnect the oil pressure and return lines at the turbocharger and the engine, remove and cap the ends.

   (c) Remove the turbocharger complete, and cover all parts to prevent entry of dirt.

3. Drain the engine coolant and disconnect the top radiator-to-engine hose.

4. Remove the exhaust manifold.

5. Remove the injector lines and cap all openings in the pump, injectors and lines.

6. Remove the fuel inlet line from the fuel lift pump.

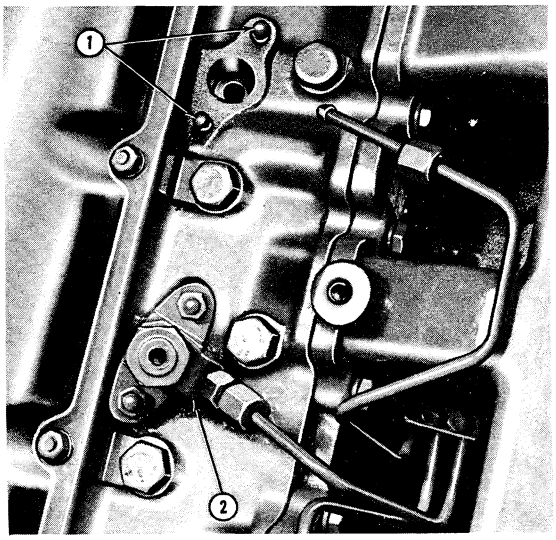

Figure 2
Injector Removal
1. Injector Mounting Studs
2. Injector

7. Remove the intake manifold.

8. Remove the ventilation tube from the rocker cover and remove the cover and gasket.

9. Disconnect the injector leak-off pipe and remove the injector and washers, Figure 2. Keep the injector area clean. Cap the openings and protect the nozzle tips.

10. Before removing the push rods, visually check for straightness by rotating each rod with the valve closed. Replace any push rod found to be defective. Loosen the rocker shaft retaining bolts in the cylinder head evenly and alternately until all tension has been relieved. Then remove the head.

    NOTE: The rocker shaft retaining bolts should be left in the rocker shaft supports during removal. The bolts hold the assembly together; only remove the bolts when it is necessary to disassemble the rocker shaft completely.

11. Remove the valve push rods and place in a rack in the order in which they were removed, so the rods may be installed in the same bores and along with the same tappets during reassembly.

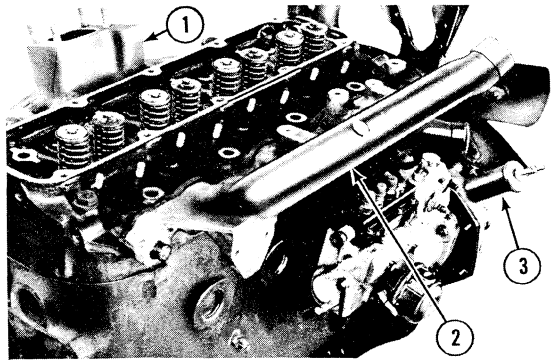

Figure 3
4-Cylinder Diesel Engine
With Valve Cover Removed
1. Intake Manifold
2. Exhaust Manifold
3. Engine Oil Filler Tube

12. Remove the cylinder head retaining bolts, working from the ends to the center of the head, and carefully lift the cylinder head from the block.

DISASSEMBLY

1. Remove the coolant outlet connection, the thermostat and gasket, Figure 4.

2. Clean the head thoroughly and then with a valve spring compressor, Figure 5, remove the retainer locks, spring retainer, spring and valve stem seal, Figure 6.

3. Lift out the valves and place in a numbered rack so they can be reinstalled in the respective guides. Keep the exhaust valve retainer (rotator) with the valve from which it was removed.

4. Remove the bolts that retain the rocker shaft supports to the rocker shaft, Figure 7.

INSPECTION AND REPAIR

1. CYLINDER HEAD: Inspect the cylinder head for damage and, if necessary, remove burrs or nicks from the gasket surface with an oil stone. If required, install a new head.

2. Check the flatness of the cylinder head with a straight edge, Figure 8. Flatness specification is 0.006 in. (0.15 mm) overall or 0.003 in. (0.08 mm) in any 6 in. (152 mm).

   NOTE: If the cylinder head is not within the flatness specification, it may be skimmed providing the depth from cylinder head face after skimming to the valve head (with valve installed) is not less than .062 in. (1.58 mm).

3. If the cylinder head is skimmed, check whether any cylinder head bolt is bottoming by mounting the cylinder head on the block without the gasket fitted and by installing all bolts finger tight. If a 0.010 in. (0.25 mm) feeler gauge cannot be inserted under the bolt head, the bolts are not bottoming. In the case of the rocker support, ensure that the specified flat washer is fitted under the bolt head when carrying out the check. If a bolt is bottoming, the cylinder block bolt thread should be increased in depth. The thread size is ½ in. 13 t.p.i. UNC-2a.

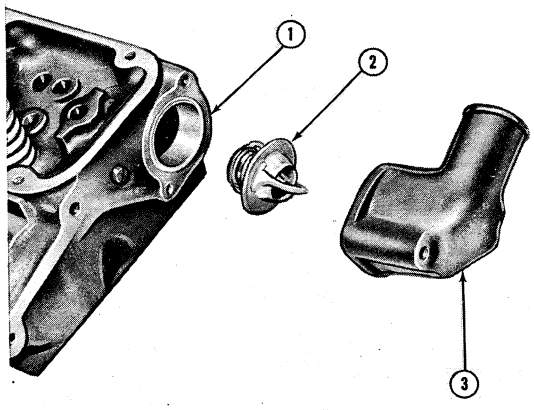

Figure 4
Engine Thermostat

1. Gasket
2. Thermostat
3. Coolant Outlet Connection

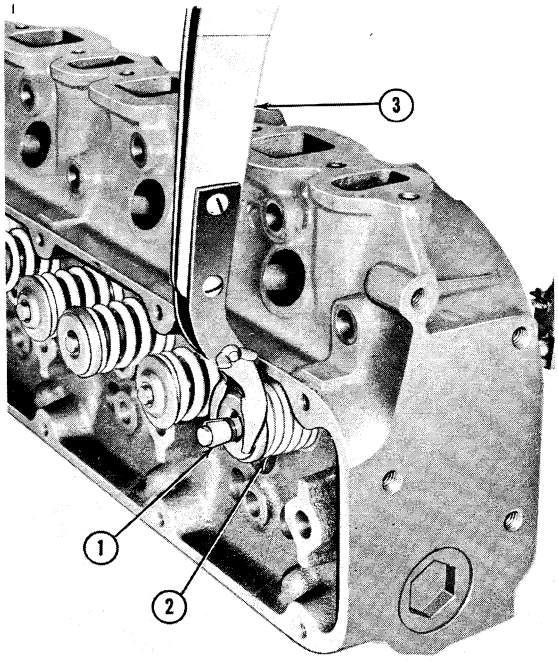

Figure 5
Removing Valves

1. Retainer Locks
2. Valve Spring
3. Valve Spring Compressor

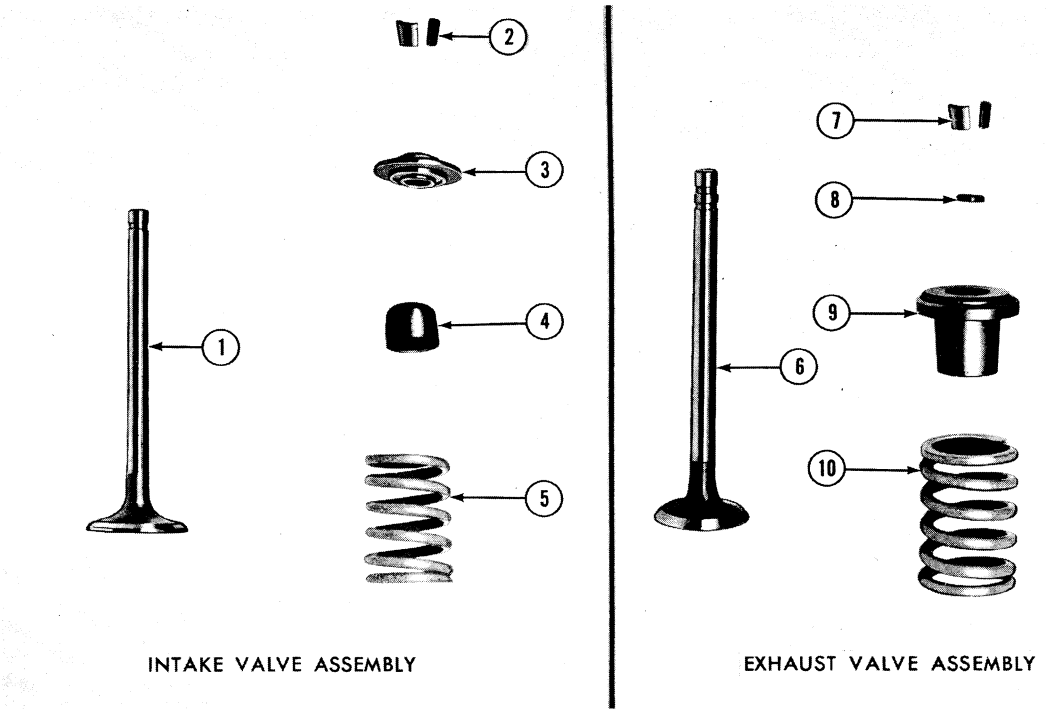

Figure 6

Valve Assembly Components

1. Intake Valve
2. Retainer Locks
3. Retainer
4. Seal
5. Spring
6. Exhaust Valve
7. Retainer Locks
8. Seal
9. Rotator
10. Spring

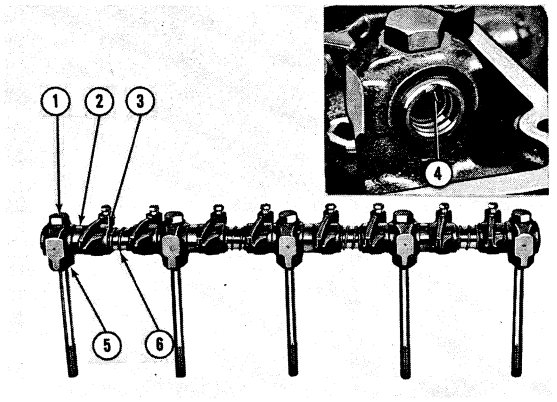

Figure 7

Rocker Arm Shafts

1. Bolt
2. Spacer
3. Rocker Arm
4. Notch
5. Rocker Arm Shaft Support
6. Spring

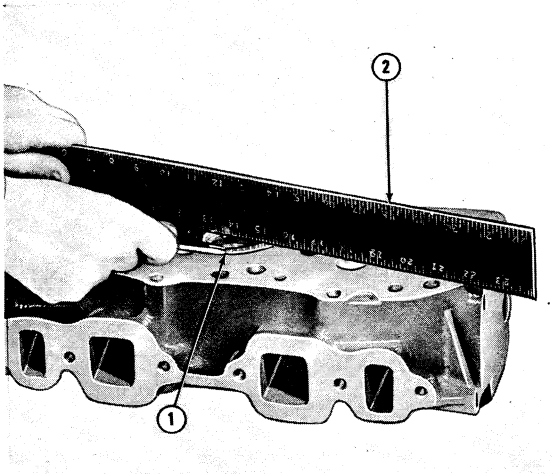

Figure 8

Measuring Cylinder Head Flatness

1. Feeler Gauge
2. Straight Edge

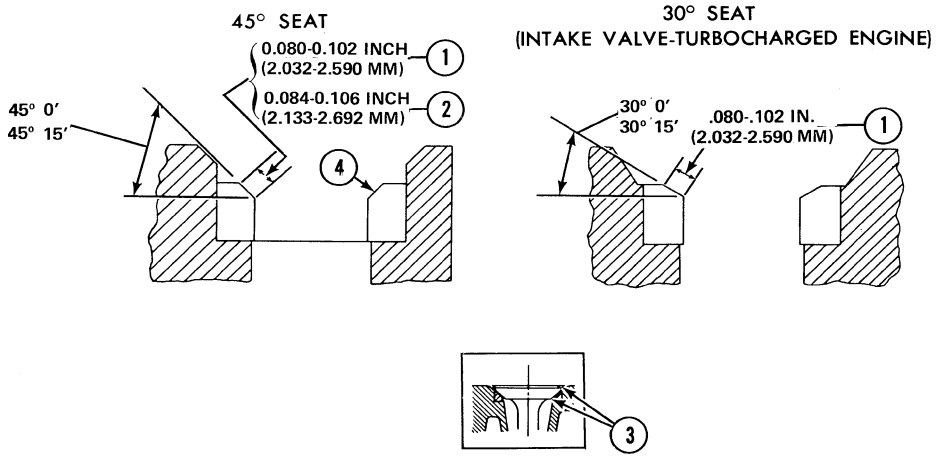

Figure 9

Valve Seats and Face

1. Intake Valve Seat
2. Exhaust Valve Seat
3. Valve Face
4. Valve Seat

4. VALVE SEAT INSERTS: Examine the intake and exhaust valve seats and re-face or regrind if badly pitted or burred. If necessary, replace with an oversize insert (see Table 1 for dimensions).

IMPORTANT: Valve seat inserts of 0.010 in. (0.25 mm) and 0.020 in. (0.5 mm) oversize diameter are fitted to some cylinder heads in production. Heads fitted with these inserts are stamped $^{S010}_{OS}$ and $^{S020}_{OS}$ on the exhaust manifold side in line with the valve seat.

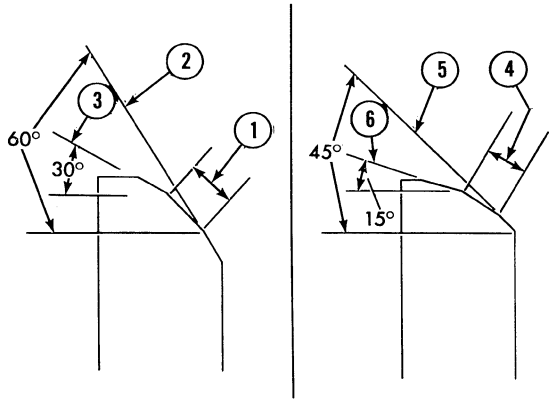

Figure 9A

Dressing Valve Seat Inserts

1. 45° Valve Seat
2. Grind Bottom of Seat at Angle of 60° to raise seat
3. Grind Top of Seat at Angle of 30° to Lower Seat
4. 30° Seat
5. Grind Bottom of Seat at Angle of 45° to Raise Seat
6. Grind Top of Seat at Angle of 15° to Lower Seat

5. The valve seat insert should be ground to give 1° interference fit with the valve. Valve seat insert angles are 45°00'–45° 15' for all valve seats with the exception of the intake valve on turbocharged engines, where it is 30°00'–30' 15'. See Figure 9.

NOTE: Grind valve seat inserts as shown in Figure 9A if required to obtain correct seat width and location.

6. VALVES: If the valve face is unduly pitted, replace or reface all valves to 44° 15'–44 30' except the intake valve on the turbo-charged engine, which is to be ground to 29° 15'–29° 30', Figure 10.

7. When new valve seat inserts or new valves are installed, the valves and seats should be ground to maintain a minimum dimensions of 0.062 in. (1.58 mm) from the cylinder head face to the top of the valve head.

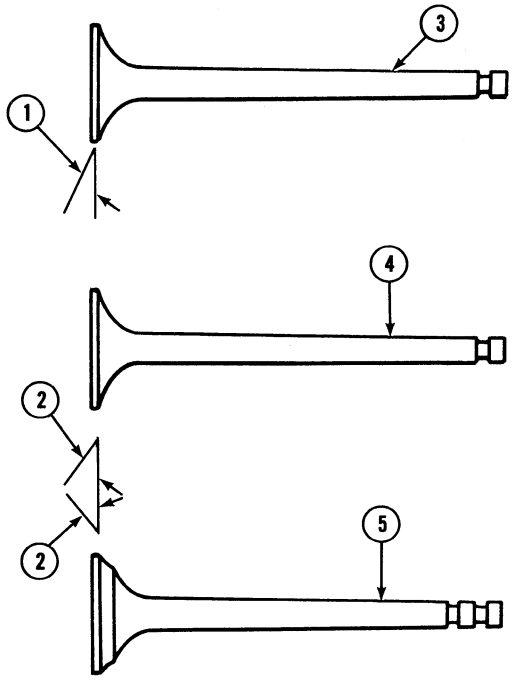

Figure 10

Exhaust and Intake Valves

1. 29° 15' – 29° 30'
2. 44° 15' – 44° 30'
3. Turbocharged Engine Intake Valve
4. Naturally Aspirated Engine Intake Valve
5. Exhaust Valve

NOTE: Before refacing ensure that the valve stem is not bent or worn. The thickness of the valve edge after re-facing must not be less than 0.062 in. (1.58 mm) for turbocharged inlet valves, and 0.031 in. (0.79 mm) for other valves. Valve seat run-out, measured at right angles to the seat, must not exceed a total of 0.0015 in. (0.038 mm) after re-facing.

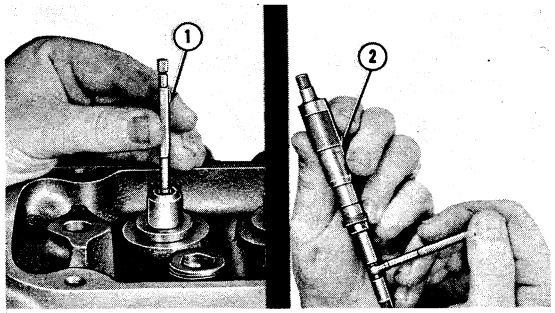

Figure 11

Measuring Valve Guide

1. Telescope Gauge
2. Micrometer

8. VALVE GUIDES: Measure the valve to guide clearance with a telescoping gauge guide clearance with a telescoping gauge and micrometer, Figure 11. If the intake clearance is not within 0.001–0.0045 in. (0.025–0.11 mm) and the exhaust within 0.002–0.0055 in. (0.05–0.14 mm), ream the valve guide to fit the next over-size valve.

IMPORTANT: Some production cylinder heads may have one or more 0.015 in. (0.38 mm) oversize valve guides and valves installed. Where this condition applies, the exhaust manifold side of the cylinder head opposite the valve will be stamped "15" or "V015" 05

TABLE 1

Insert Oversize	Exhaust Valve Seat Insert	Intake Valve Seat Insert
	Counterbore Diameter in Cylinder Head	Counterbore Diameter in Cylinder Head
0.010 in. (0.254 mm)	1.607/1.608 in. (40.82/40.84 mm)	1.907/1.908 in. (48.44/48.46 mm)
0.020 in. (0.508 mm)	1.617/1.618 in. (41.07/41.10 mm)	1.917/1.918 in. (48.69/48.72 mm)
0.030 in. (0.762 mm)	1.627/1.628 in. (41.33/41.35 mm)	1.927/1.928 in. (48.95/48.97 mm)

9. To ream out a guide to accept an oversized valve, use kit SW502. The kit contains three oversize reamers, 0.003 in. (0.076 mm), 0.015 in. (0.38 mm) and 0.030 in. (0.76 mm). Along with the appropriate guides, always use the reamers in sequence and reface the valve seat after reaming.

10. VALVE SPRINGS: Discard valve springs that shows signs of erosion, rust, or are out of square in excess of 0.060 in. (1.6 mm), Figure 12. Check the specified free length and loaded length of the valve spring and replace any below specification. Be sure the valve spring retainer locks are in good condition.

11. ROCKER ARM ASSEMBLY: Examine the rocker arm adjusting screw and push rod end of the rocker arm for stripped or worn threads and the pad end for grooves or excessive wear and replace if severly damaged.

12. Examine the locating spring and spacer for breakage or damage and replace if necessary.

13. Check the rocker to shaft clearance and replace either or both parts if not within specification, Chapter 4.

RE-ASSEMBLY

1. CYLINDER HEAD: Re-assembly of the cylinder head components follows the disassembly procedure in reverse.

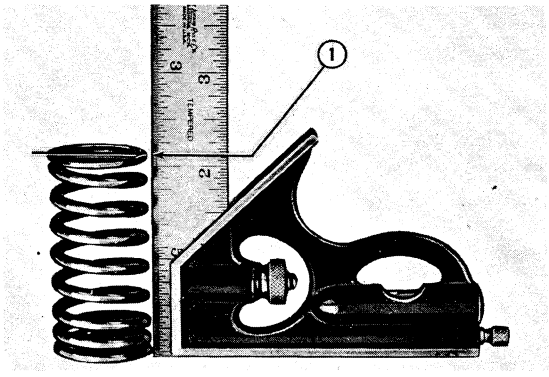

Figure 12
Checking Valve Spring Squareness
1. Maximum .060 in. (1.6 mm)

NOTE: Turbo-charged engines have no seal fitted to the intake valve.

2. ROCKER SHAFT: Coat all the components with engine oil and position the notch on the front of the rocker shaft upwards to locate the oil holes correctly, Figure 13.

3. Start the assembly from the shaft rear end and secure the rocker arm support with a long bolt, Figure 13, and proceed with the spacer, rocker arm, spring and rocker arm support. Repeat the procedure until complete.

INSTALLATION

1. Install the cylinder head assembly with a new gasket.

2. Position the rocker shaft assembly on the head, lubricate the cylinder head bolts and install finger tight. Tighten the cylinder head bolts in the proper sequence, Figure 14. Tighten progressively in three steps: first 80 lb. ft. (11.04 kgm), then to 90 lb. ft. (12.42 kgm) and finally to 110 lb. ft. (15.21 kgm).

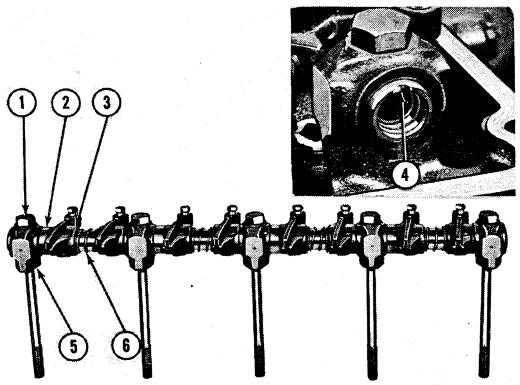

Figure 13
Rocker Arm Shafts
1. Bolt
2. Spacer
3. Rocker Arm
4. Notch
5. Rocker Arm Shaft Support
6. Spring

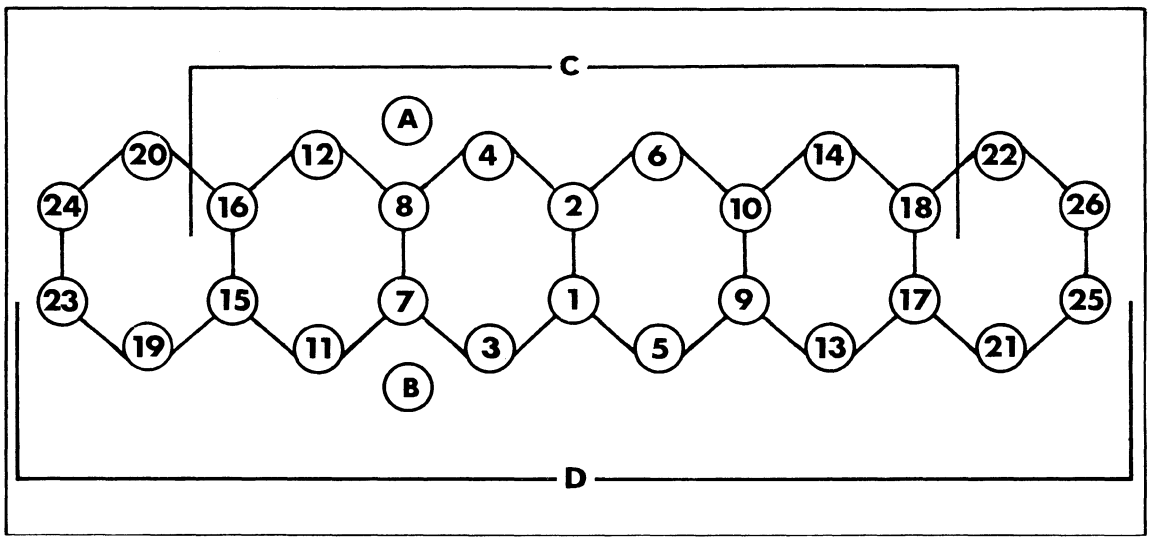

Figure 14
Cylinder Head Tightening Sequence

A. Intake Side
B. Exhaust Side
C. 4-Cylinder Head
D. 6-Cylinder Head

3. Rotate the engine and set the valve lash Figure 15. See specification, Chapter 5 for specified limits. Install injectors with new washers and cork seals. Tighten progressively to the specified torque, Chapter 4, and install the leak-off line with new washers.

4. Replace the intake manifold, fuel filters, injector lines, exhaust manifold and on turbocharged engine, oil feed and return lines and the air cleaner components. Use new gaskets throughout and tighten bolts to the specified torque, see Chapter 4.

5. Bleed the fuel system as outlined in Part 2, "Fuel System" and check for leaks.

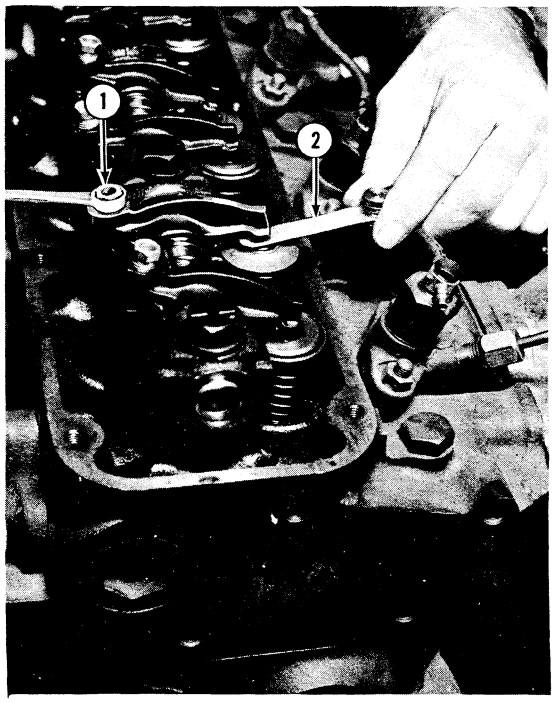

Figure 15
Adjusting Valve Lash

1. Adjusting Screw
2. Checking Gap with Feeler Gauge

3. TIMING GEARS , CAMSHAFT AND OIL PUMP - OVERHAUL

REMOVAL

1. TIMING GEARS: Remove the fan belt and crankshaft pulley, using tool No. 518 and shaft protector No. 625-1, Figure 16. Remove the alternator bracket.

2. Remove the front cover and measure the backlash between the timing gears in four equidistant places, Figure 17, prior to removal, see Chapter 4 for tolerance.

3. CAMSHAFT: Drain the engine oil and remove the cylinder head assembly, oil pan sump, tachometer drive fitting (A-62 only), oil pump drive gear and front cover.

4. Measure the clearance between the camshaft gear hub and the thrust plate, either with a dial indicator against the camshaft gear retaining bolt or with a feeler gauge. If the clearance exceeds the specified limit, Chapter 4, install a new thrust plate on re-assembly.

5. Invert the engine and remove the camshaft gear, thrust plate, key, spacer and camshaft.

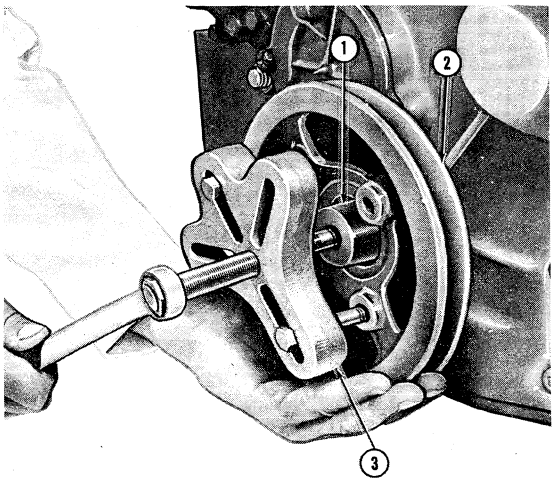

Figure 16
Removing Crankshaft Pulley

1. 625-1 Shaft Protector
2. Crankshaft Pulley
3. 518 Puller

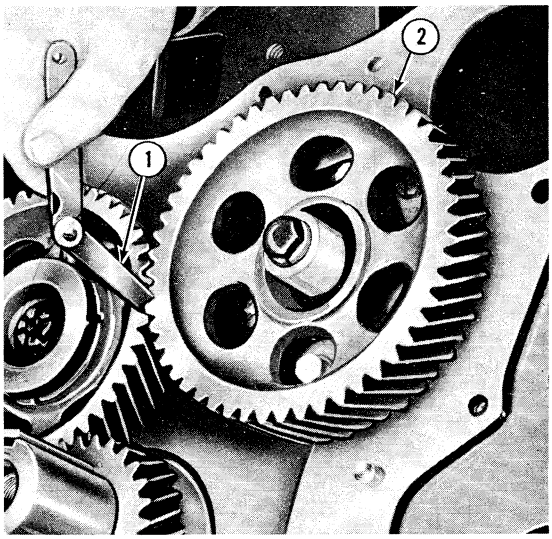

Figure 17
Checking Timing Gear Backlash

1. Feeler Gauge
2. Camshaft Gear

6. Remove tappets and number, so they can be installed in the same bore on re-assembly.

7. OIL PUMP: Remove the oil pump and intermediate shaft Figure 18.

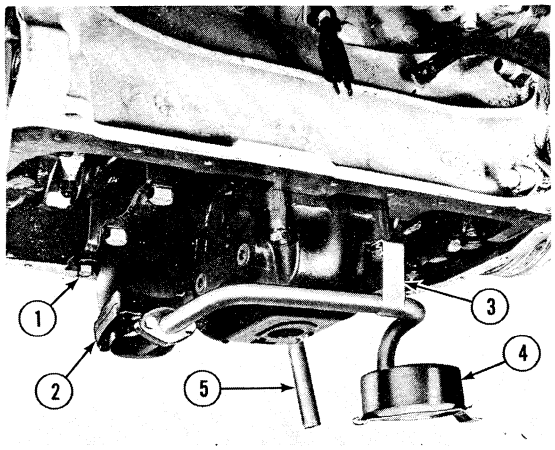

Figure 18
Oil Pump and Filter

1. Mounting Bolt
2. Oil Pump
3. Support Bracket
4. Filter
5. Dipstick Tube

DISASSEMBLY

1. OIL PUMP: Remove the cover, outer rotor, inner rotor and shaft, Figure 19.
2. Remove the relief valve and spring by removing the plug with a self-tapping screw, Figure 19.

INSPECTION AND REPAIR

1. CAMSHAFT: Inspect the camshaft oil pump gear teeth and lobes. If badly worn, replace the camshaft, Clean the angle drilling on the No. 1 journal.
2. TIMING GEAR: Clean the gears and inspect teeth for wear. Remove minor imperfections with a carborundum stone but replace worn or severely damaged gears.
3. Inspect the camshaft drive gear bushing and adapter, Figure 20. Replace if worn.
4. FRONT COVER: Examine the oil seal and replace if necessary.
5. OIL PUMP: Clean the inside of the pump housing and relief valve chamber, check the inside of the pump cover for wear or score marks.

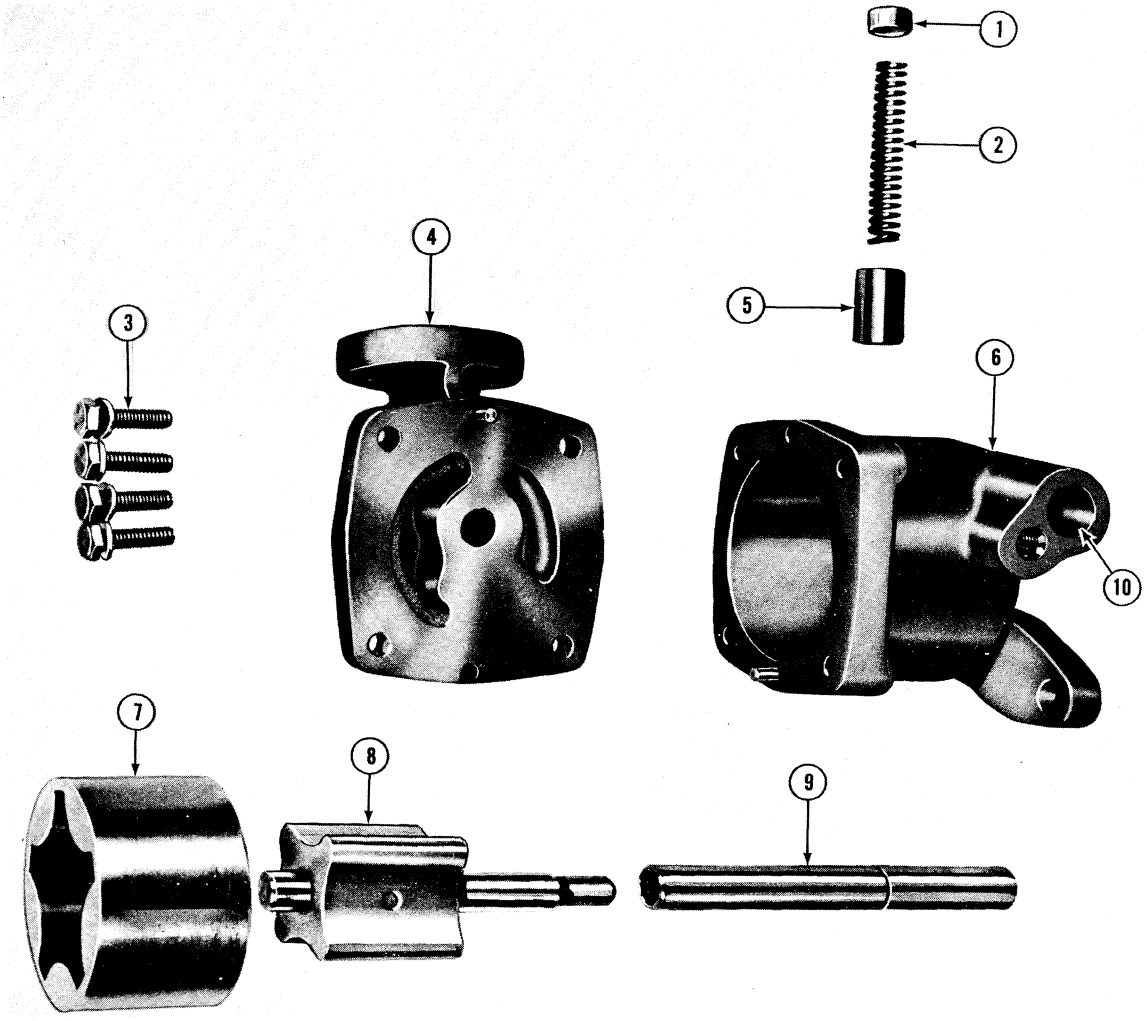

Figure 19
Oil Pump Disassembled

1. Plug
2. Spring
3. Capscrews
4. Cover
5. Relief Valve
6. Pump Body
7. Outer Rotor
8. Inner Rotor
9. Drive Shaft
10. Relief Valve Chamber

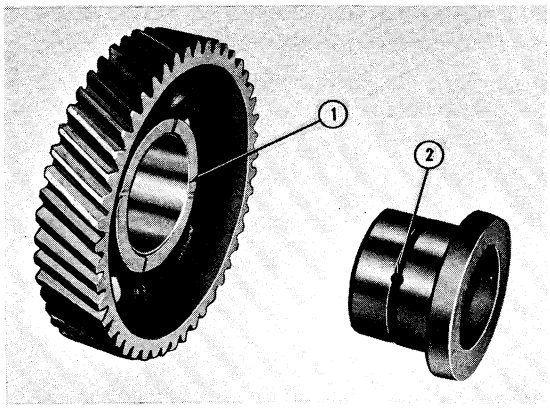

Figure 20
Camshaft Drive Gear and Adapter
1. Camshaft Drive Gear Bushing
2. Oil Passage in Adapter

Replace if severely damaged.

6. Measure the clearance between the inner and outer rotor assembly and the face of the body using a straight edge, Figure 21, and also the rotor to housing clearance. Inspect all remaining components of the pump and replace as necessary. See Chapter 4 for wear limits and tolerance.

7. CRANKSHAFT GEAR: Inspect the gear teeth and dress minor imperfections with a carborundum stone. If the gear teeth are worn or chipped, remove the gear with tool SW 501 for CPT 6040B as shown in Figure 22. After the gear has been removed, inspect the key and keyway for wear. Replace any worn or damaged part.

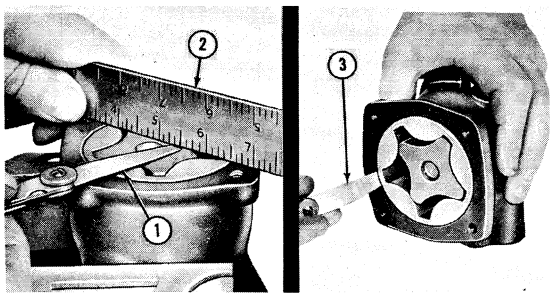

Figure 21
Checking Oil Pump Clearance
1. Measuring Clearance– Pump Cover to Rotor with Feeler Gauge
2. Straight Edge
3. Measuring Clearance–Pump Body to Rotor with Feeler Gauge

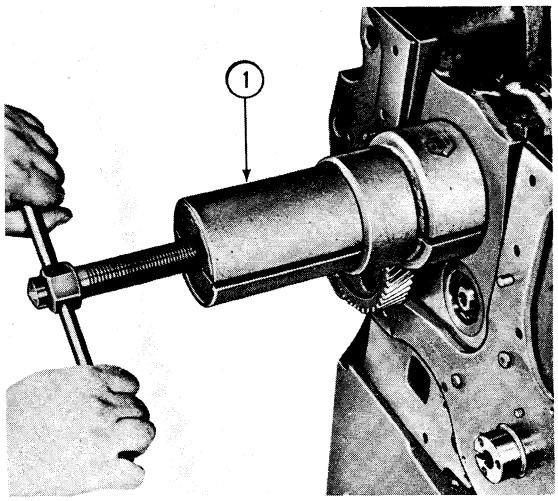

Figure 22
Removing Crankshaft Gear
1. Tool No. SW 501 w/SW 501-1 Insert

ASSEMBLY

1. OIL PUMP: Oil all parts and assemble the components, Figure 19. The rotor and shaft assembly with the outer rotor are serviced as an assembly. After assembly, prime the pump in clean engine oil.

2. FRONT COVER: Install the dust seal, lubricate the oil seal and press into position using tool No. 630-16, Figure 23.

3. Install the crankshaft gear with tool SW 501 or CT 60694.

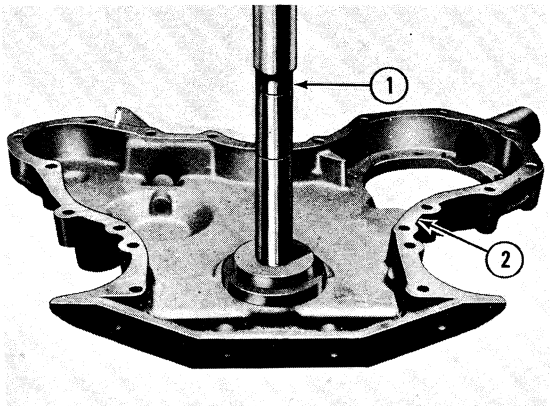

Figure 23
Installing Front Cover Seal
1. Drive and Step Plate (Tool 630-16
2. Front Cover

INSTALLATION

1. CAMSHAFT: Install the tappets. Lubricate the camshaft journal and insert in the block along with the spacer, key and thrust plate. Install the gear and tighten bolts to the specified torque, Chapter 4. Recheck the end float of the camshaft.

2. TIMING GEAR: Install the camshaft drive gear and bushing with the timing marks aligned, Figure 24. Tighten the bolt to the specified torque, Chapter 4. Recheck the backlash between the gears.

3. Install the injection pump gear with No. 1 piston at TDC on the firing stroke and align the timing mark.

4. FRONT COVER: Replace the front cover. Install a new gasket and ensure the crankshaft oil slinger is in place. Use a non-setting sealant between the oil pan and front cover to block joint.

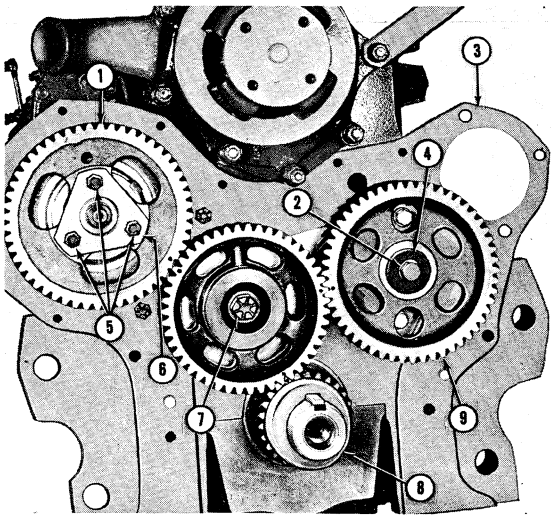

Figure 24
Timing Gears

1. Injection Pump Gear
2. Retaining Bolt
3. Engine Front Plate
4. Washer
5. Attaching Bolts
6. Adapter Plate
7. Self Locking Bolt
8. Slinger
9. Camshaft Gear

5. CRANKSHAFT PULLEY: Lubricate the crankshaft pulley spacer and slide it over the key. Replace the pulley hub and tighten to the specified torque, Chapter 4.

6. OIL PUMP: Install the oil pump drive gear assembly, tachometer drive fitting (A-62 only), stop and plug, Figure 25.

7. Replace the intermediate shaft and oil pump. Use a new gasket. Tighten the bolts to the specified torque, Chapter 4.

8. OIL PAN: Install the oil pan with a new gasket and tighten the bolt to the specified torque, Chapter 4. Fill with clean engine oil, then run the engine and check for leaks.

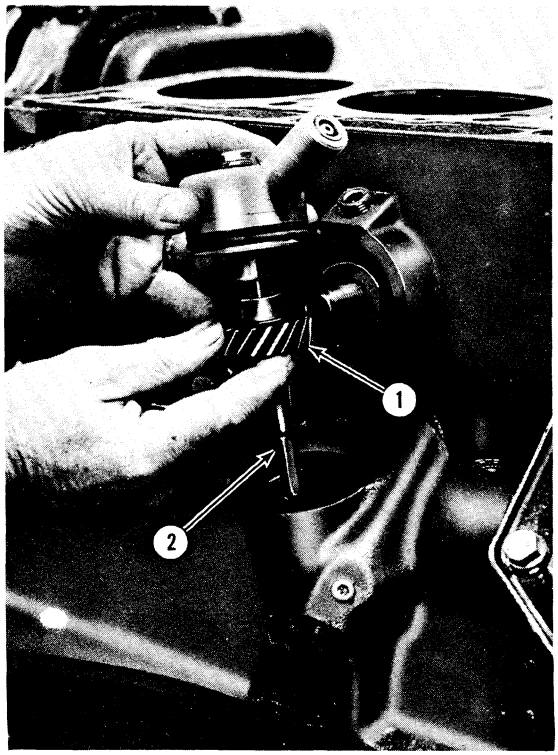

Figure 25
Installing Oil Pump Drive Gear and Tachometer Drive Ass'y.

1. Oil Pump Drive Gear and Shaft
2. Tachometer Drive Ass'y.

4. BALANCER, CONNECTING ROD AND PISTON, BEARINGS, FLYWHEEL AND CRANKSHAFT - OVERHAUL

BALANCER: Four cylinder engines are equipped with a dynamic balancer which is attached to the cylinder block and lubricated by oil from the engine pressure system.

REMOVAL

1. Remove the oil pan sump and before removing the balancer check the back lash in four places with a feeler gauge or a dial indicator, Figure 26. See Chapter 4 for backlash specification.

2. PISTON AND CONNECTING ROD ASSEMBLY: Remove the cylinder head assembly oil pan sump and oil pump.

3. Remove any ridge from the top of the cylinder with a cylinder ridge reamer or hard scraper, Figure 27. Do not cut down into the ring travel area.

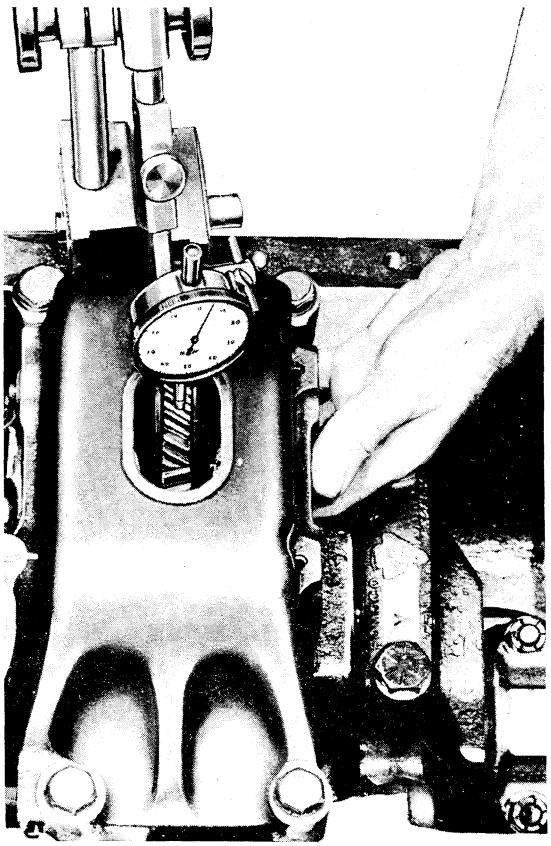

Figure 26
Checking Balancer Backlash

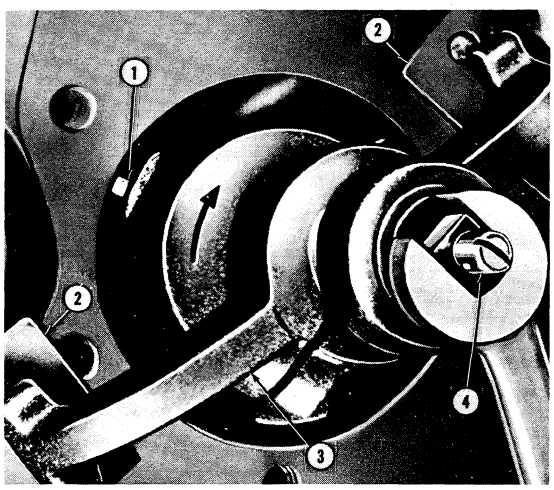

Figure 27
Removing Cylinder Ridge

1. Cutter Blade
2. Shoe
3. Cylinder Ridge Reamer
4. Pilot Adjusting Screw

4. With the connecting rod at the bottom of the stroke, remove the bearing cap and liner, Figure 28.

   Push the piston and rod assembly out of the top of the block. Turn the crankshaft to bring each rod to the bottom and repeat the procedure. Keep the bearing cap and liners with the respective connecting rod.

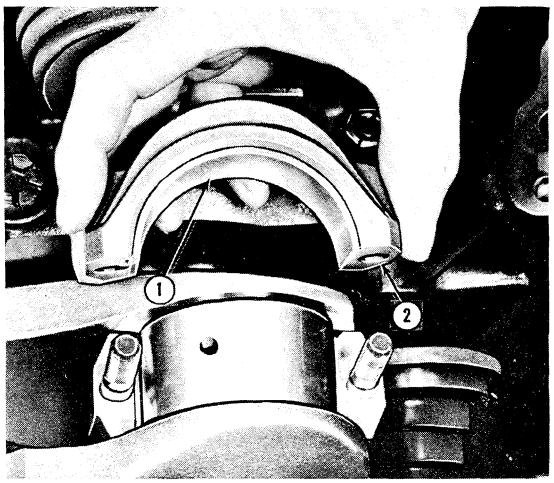

Figure 28
Removing Connecting Rod Bearing Cap

1. Bearing Liner
2. Rod Bearing Cap

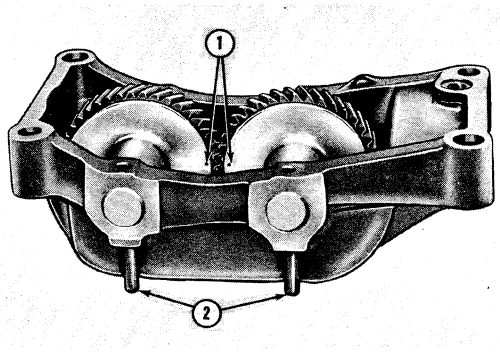

Figure 29

Balancer Timing Marks and Roll Pins

1. Timing Marks
2. Roll Pins

5. CRANKSHAFT: Remove the flywheel, engine rear cover plate, crankshaft pulley and engine front cover. Remove main bearing caps and crankshaft.

DISASSEMBLY

1. BALANCER: Drive out the roll pins securing the shafts to the housing, Figure 29, and disassemble the balancer as shown in Figure 30.

2. PISTON AND CONNECTING ROD: Remove the piston pin retainer (snap ring). Slide the piston pin out and remove the piston. Keep the piston and connecting rod together if these are to be reassembled, Figure 31.

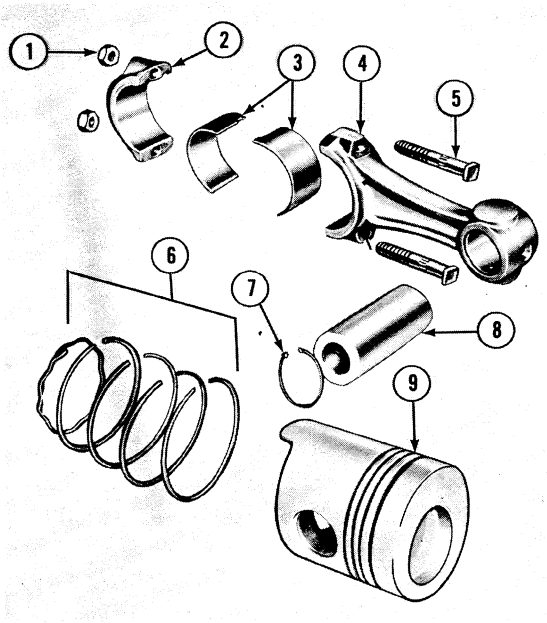

Figure 31

Piston and Connecting Rod Assembly

1. Nut
2. Cap
3. Bearings
4. Connecting Rod
5. Bolt
6. Piston Rings
7. Pin Retainer
8. Piston Pin
9. Piston

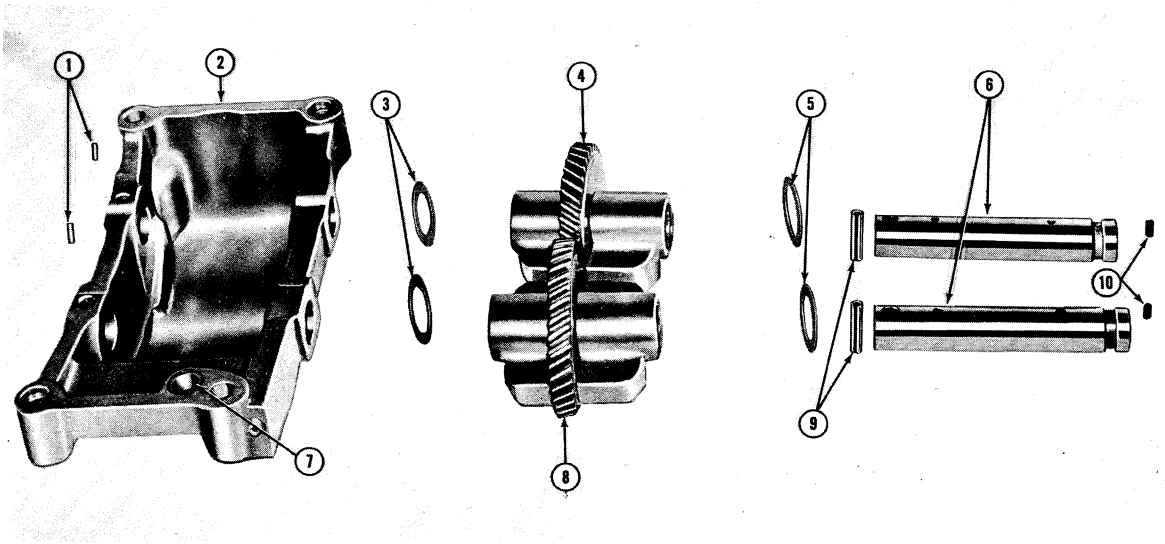

Figure 30

Balancer Disassembled

1. Roll Pins
2. Housing
3. Thrust Washers
4. Driven Gear
5. Thrust Washers
6. Shafts
7. Gasket
8. Drive Gear
9. Roll Pins
10. Allen Screws

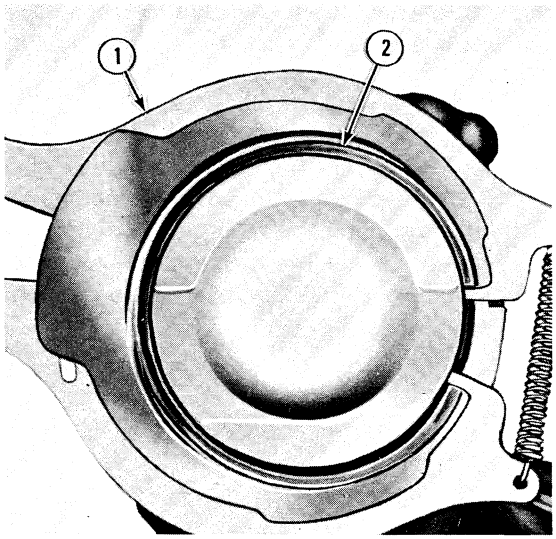

Figure 32
Removing Piston Ring
1. Expander
2. Piston Ring

3. Remove the piston rings with an expander, Figure 32.

INSPECTION AND REPAIR

1. BALANCER: Measure the outside diameter of the shafts and inside diameter of the gear bushings. Replace either or both parts if the shaft-to-bushing clearance exceeds the specification, Chapter 4. Clean the lubrication holes in the shafts and install new balancer gears if the teeth are worn.

2. PISTON: If the piston is to be reinstalled, inspect for damage to the ring lands skirts and pin bosses, use a piston ring groove cleaner to remove carbon deposits, Figure 33.

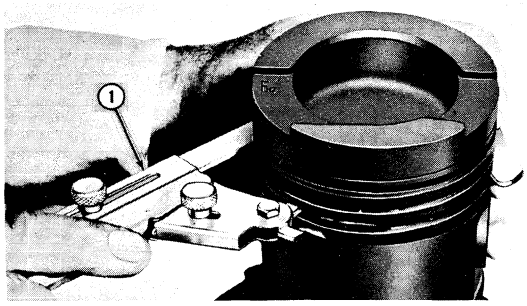

Figure 33
Cleaning Piston Ring Groove
1. Groove Cleaner

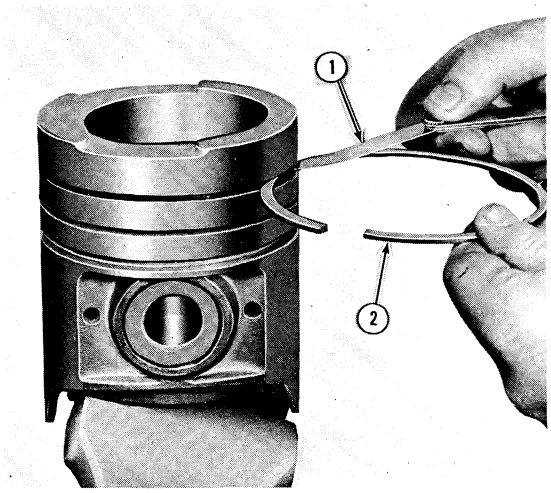

Figure 34
Checking Ring Side Clearance
1. Feeler Gauge
2. Piston Ring

3. Check the piston ring lands for wear, using a new piston ring and feeler gauge as shown in Figure 34. See Chapter 4 for clearance specifications.

4. CONNECTING ROD: Check each connecting rod for wear patterns that would indicate bent or misaligned rods and replace as required. See Specifications, Chapter 4.

5. Check the connecting rod bushing to piston pin clearance. If the clearance exceeds 0.0005–0.0007 in. (0.013–0.018 mm), remove and install a new bushing with tool No. 818 and adapter, Figure 35.

6. **Naturally aspirated engine only:** After installation of a new bushing, use the hole in the top of the connecting rod as a guide and drill a 0.25 in. (6.4 mm) diameter hole through one wall of the bushing, Figure 36.

   Turbocharged engine only: Using the hole in the top of the connecting rod as a guide, drill a 0.046 in. (1.2 mm) diameter hole completely through both walls of the bushing to connect with the oil passage in the connecting rod. Open out the upper hole in the bushing with a 0.156 in. (4 mm) diameter drill.

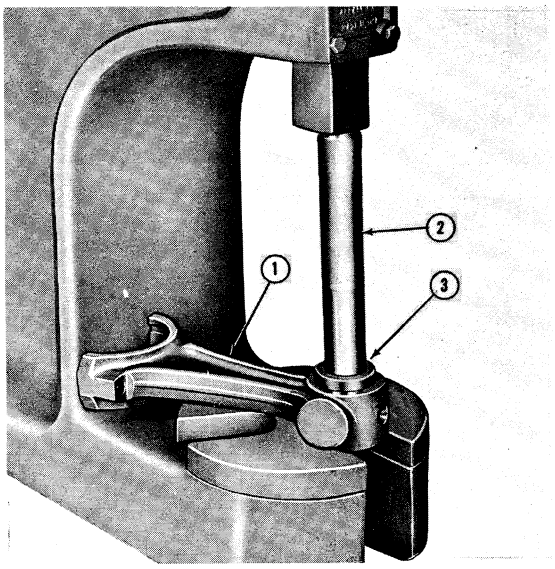

Figure 35
Removing and Installing Connecting Rod Bushing
1. Connecting Rod
2. 818 Handle
3. 818 Adapter

7. Ream the bush to obtain the specified clearance, Chapter 4.

8. FLYWHEEL: Inspect the flywheel ring gear and replace if teeth are damaged. Inspect the starter motor armature shaft and drive.

9. Clean the mating surfaces of the flywheel and the ring gear and with a temperature indicating crayon of 400° F (204° C). Mark the inner face at six equidistant points.

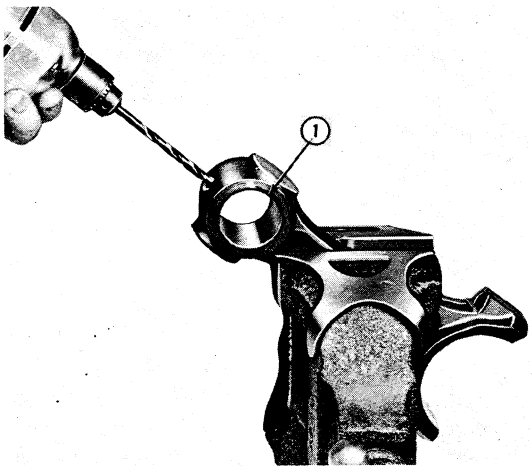

Figure 36
Drilling Connecting Rod Bushing
1. Connecting Rod Bushing

10. With an oxy-acetylene torch, tip size not larger than No. 2, apply heat from the inside of the ring gear until the 400° F (204° C) crayon just melts and quickly place the ring gear on the flywheel. Ensure the gear is flush with the shoulder of the flywheel, then quench with water.

11. CRANKSHAFT: Current production engines may have a crankshaft with main or pin journals ground 0.010 in. (0.25 mm) undersize. These crankshafts are identified with the lettering '010MUS' or '010PUS' stamped on one of the counterbalance weights of the crankshaft.

12. Clean the crankshaft and drilled passages. Dress minor imperfections with an oil stone and refinish severely marked journals to the next undersize bearing.

13. Measure the diameter of each journal in four places to determine out-of-round, taper or wear, Figure 37. If the journal exceeds the specified wear limit, Chapter 4, refinish the journal to the next undersize bearing. Always reproduce the same journal radius that originally existed and, after refinishing, chamfer the oil holes.

14. Examine the rear oil seal journal for score marks. Remove minor imperfection with fine emery cloth and if severely damaged, replace the crankshaft.

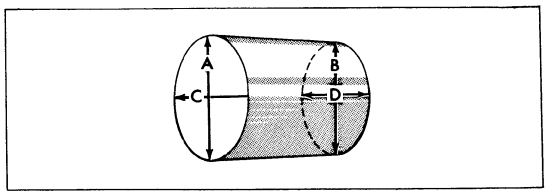

Figure 37
Crankshaft Journal Measurement
A to B = Vertical Taper
C to D = Horizontal Taper
A to C and B to D = Out-of-Round
Check for Out-of-Round at Each End of Journal

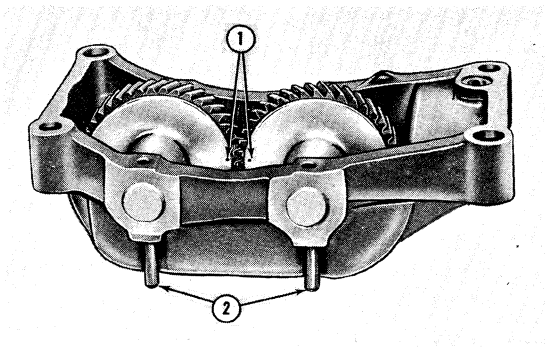

Figure 38
Balancer Timing Marks and Roll Pins
1. Timing Marks
2. Roll Pins

ASSEMBLY

1. BALANCER: Install the balancer gears, thrust washers and shafts, Figure 38. The timing marks must align and should face the roll pin side of the balancer.

2. Check the end float of the gears and the back lash between the gears in four places. If backlash is unobtainable or exceeds specification, Chapter 4, replace either or both gears and repeat the backlash check.

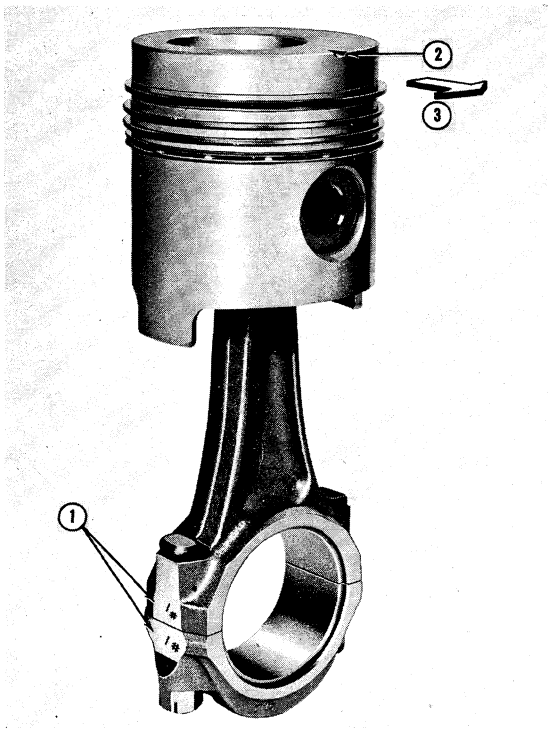

Figure 39
Piston to Connecting Rod Relationship
1. Cap Numbers
2. Notch
3. Front of Engine

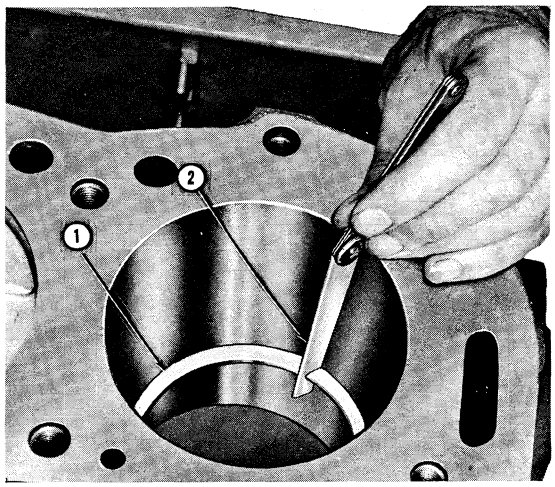

Figure 40
Checking Piston Ring Cap
1. Piston Ring
2. Feeler Gauge

3. Assemble the piston to the connecting rod with the notch on the piston crown in line with the pip on the connecting rod, Figure 39, and install the piston pin and pin retainers (snap rings).

4. PISTON RINGS: Rings should be checked for minimum gap before fitting to the cylinder bore, Figure 40. Use a piston crown to square the ring in the bore. New rings should also be checked for side clearance in the piston, Figure 34.

5. Install the piston rings with a ring expander. Begin the assembly from the oil ring groove work up, Figure 41.

The service ring set consists of:

- 3 Compression rings
- 1 Oil control ring
- 1 No. 3 Compression Ring Expander (Non slotted)
- 1 Oil Control Ring Expander (slotted)

The top compression ring is chrome finished with a chamfer on the inside diameter. Assemble with chamfer facing up.

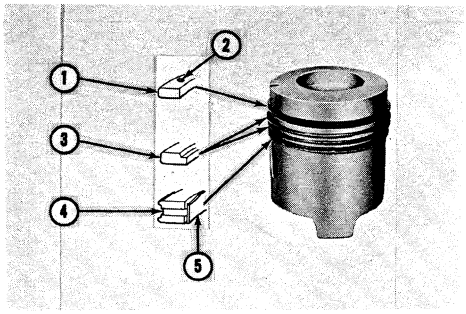

Figure 41
Fitting Piston Rings

1. Top Compression Ring
2. Top Identification Mark (Dimple or Word "Top")
3. Intermediate Compression Ring
4. Oil Control Ring
5. Hump Type Expander

The second compression ring is also chrome finished with a step on the inside diameter. Assemble with step facing up.

The third compression ring has a dull finish with a step on the outside diameter. Assemble with the step facing down and with a non-slotted expander behind the ring.

The oil control ring can be installed either way with the slotted expander behind the ring. After the rings are installed stagger the ring gaps around the circumference. Do not install assembly with rings gaps in line.

INSTALLATION

1. CRANKSHAFT AND BEARING LINERS: Because of the variation in liner to crankshaft journal clearance, liners are color coded to indicate wall thickness.

2. When fitting standard liners, using the "Plastigauge" method, it may be necessary to fit color code red, blue or a combination of both on the same journal. The engine may be assembled with liners of different material, but liners of the same material must be installed on the same journal.

3. Fitting main and connecting rod bearings. (Plastigauge method). Wipe away the oil and place a piece of the correct size plastigauge on the bearing liner surface the full width of the bearing cap and about 0.25 in. (6 mm) off center, Figure 42. Install the cap and tighten the bolts to the specified torque, Chapter 4. Do not turn the crankshaft while the gauge is in place.

4. Remove the cap and, using the Plastigauge scale, check at the widest point in order to get the minimum clearance and the narrowest point to get the maximum clearance. The difference between the two readings is the taper.

   NOTE: Normally main bearing journals wear evenly and will not be out-of-round. However, if a liner is being fitted to an out-of-round journal which is within specification, Chapter 4, fit the bearing to the maximum diameter of the journal.

5. When calculating clearances, red liners have a thinner wall section than blue liners. If the measured clearance is greater than specified when two blue liners are used, a 0.002 in. (0.05 mm) under-size liner with either a red or a blue liner should be installed.

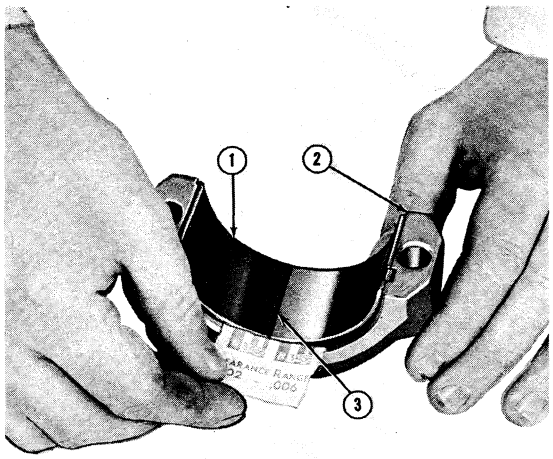

Figure 42
Checking Bearing Clearance-Plastigauge Method

1. Bearing Insert
2. Bearing Cap
3. Checking Width with Plastigauge

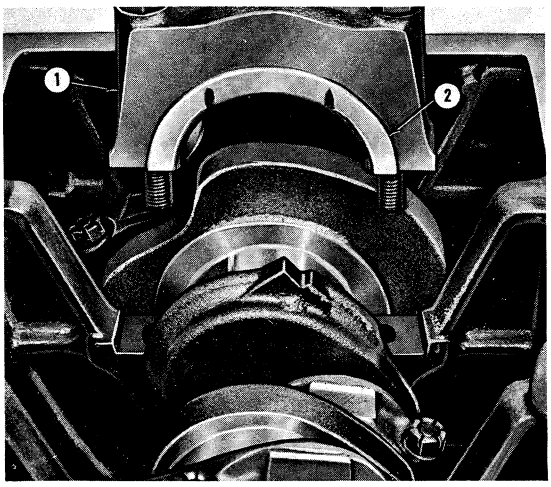

Figure 43
Thrust Bearing
1. Bearing Cap
2. Flange Type Insert

If any of the above combinations of liners does not meet the specified clearance, Chapter 4, refinish the crankshaft journal to fit undersize bearings.

6. Clean and oil the upper main bearing bores and cap prior to installing the bearing liner. Install the cap liner in the block with the bearing tang aligned with the slots in the block and cap.

7. Install the upper thrust bearing and all bearing caps except the rear. Then install the thrust bearing cap and liner with the bolts finger tight, Figure 43. Pry the crankshaft forward against the upper thrust bearing and pry the bearing cap and liner against the crankshaft to align the thrust surfaces. Hold forward pressure on the crankshaft and tighten to the specified torque, Chapter 4.

8. Check the crankshaft and with a dial indicator so that the contact point rests against the rear flange of the crankshaft, Figure 44. Move the crankshaft rearwards and set the dial indicator to zero. Pry the crankshaft forward and note the reading, If the end play exceeds the limits, Chapter 4, install a new thrust bearing liner. If the end play is less than the specified limit, inspect the thrust bearing surfaces for burns or dirt. If the thrust surfaces are not defective or dirty, re-align the thrust bearings, following the above procedure.

9. REAR MAIN BEARING CAP: Wipe the mating surfaces of the block and rear main bearing cap and apply a light coating of sealing compound to both surfaces. Install new side seals in the rear main bearing cap so that the seals project slightly beyond the block face of the cap. Assemble the cap and seals to the block, Figure 45. Tighten the rear main bearing cap bolts to ensure positive bottoming of the seals and cut the side seals to allow a projection of 0.016 in. (0.4 mm) above the pan rail, Figure 46.

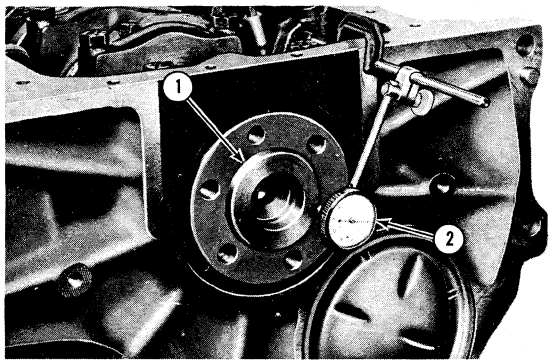

Figure 44
Checking Crankshaft End Play
1. Crankshaft
2. Dial Indicator

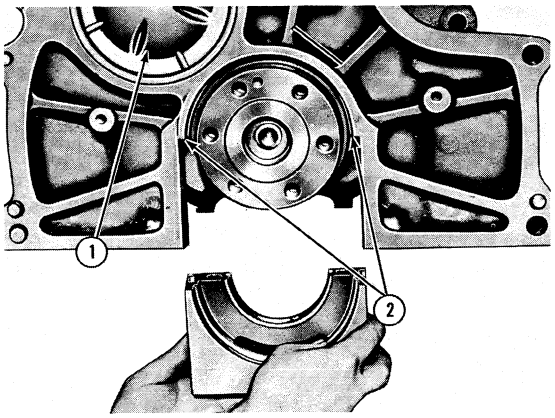

Figure 45
Assembling Rear Main Bearing Cap and Vertical Seals
1. Camshaft Rear Cover Plate
2. Sealing Compound

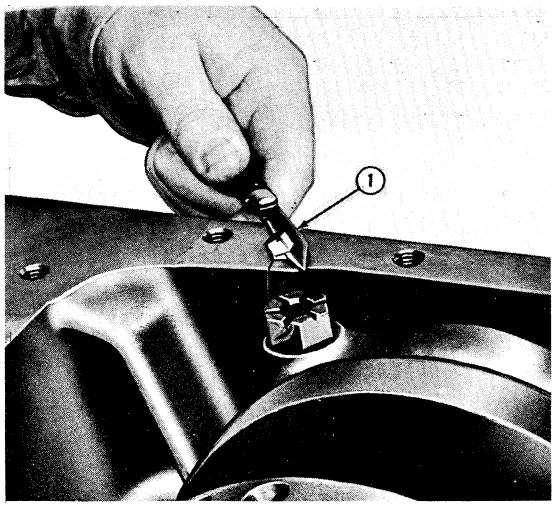

Figure 46
Trimming Vertical Side Seals
1. Cut Seal Approximately .016 in. (.4 mm)

10. REAR OIL SEAL: Apply a light coating of high temperature grease to the rear oil seal bore, seal and journal, and install the seal with tool No. SW520, Figure 47. If the tool is not available, use a 4.875 in. (124 mm) internal diameter sleeve and carefully press the seal into the block until the rear face of the seal is approximately 0.06 in. (1.5 mm) inside the rear face of the block. With a dial indicator mounted on the end of the crankshaft, check the run out of the seal which should not exceed 0.015 in. (0.38 mm).

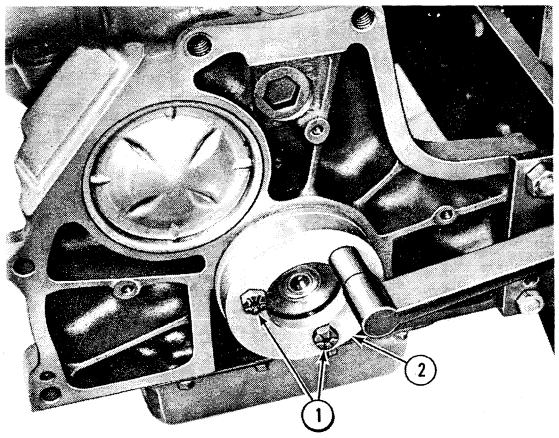

Figure 47
Installing Rear Main Bearing Crankshaft Seal
1. Crankshaft Bolts
2. Tool No. SW 520

11. Swell the side seals by applying a liberal coating of penetrating oil.

12. CONNECTING ROD: Determine the correct connecting rod bearing liners by the Plastigauge method. Install the bearing liner tang in the slots of the rod and cap. Turbocharged engine bearing liners have a groove and a hole to be aligned with the drilling in the rod.

13 Before installing a piston and new rings in a used cylinder bore, remove the high polish on the cylinder wall by passing a hone lightly through the cylinder or by making a figure eight pattern with very fine emery cloth dipped in a mixture of diesel fuel and lubricating oil.

14. With a bore gauge (or inside micrometer) measure the cylinder bore diameter across the block at a depth of 2.75 in. (69.8 mm), Figure 48. Check and record the diameter of the piston measured at right angles to the piston pin, Figure 49. Subtract the piston diameter from the bore diameter to obtain the piston to bore clearance. If the specified clearance is unobtainable, refinish the bore to the next piston oversize.

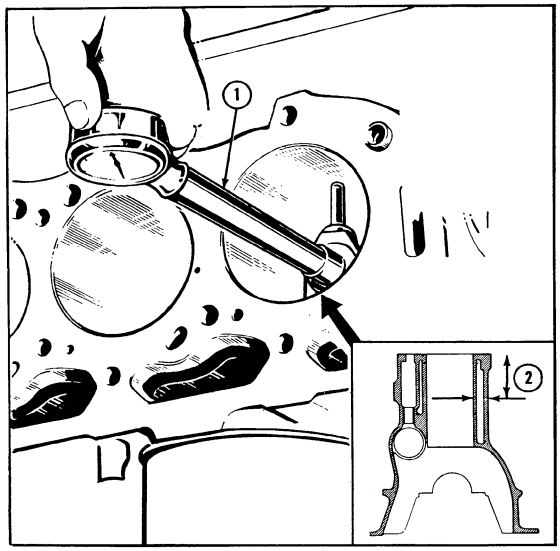

Figure 48
Cylinder Bore Grading Depth
1. Bore Gauge
2. Measure Cylinder Bore 2.75 in. (69.85 mm) from Top of Head

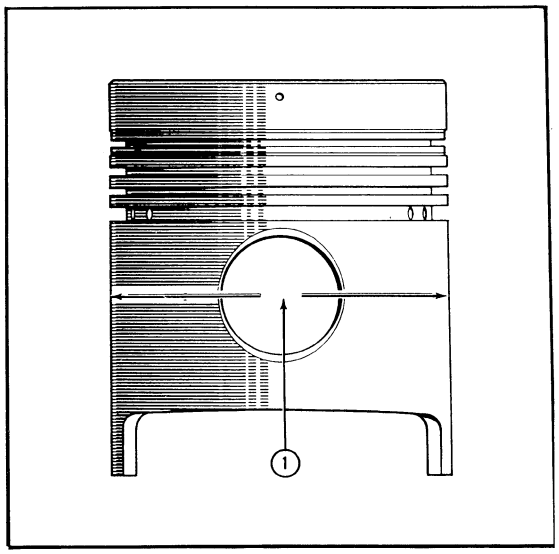

Figure 49
Piston Grading Diameter
1. Piston Diameter

NOTE: Cylinder bores must be checked for taper and out-of-round before fitting a new piston. See Section E, Cylinder Block Assembly.

15. PISTON AND CONNECTING ROD ASSEMBLY: Turn the crankshaft to position the No. 1 crankpin at the bottom of the stroke. Oil the piston and rings, cylinder bore and bearing liner and install the assembly with a ring compressor, Figure 50. Ensure that the notch on top of the piston is towards the front of the engine.

16. Push the pistons into the cylinders until the connecting rods and liners are seated on the respective crankpin. Install the connecting rod cap and tighten to the specified torque, Chapter 4. Check that the side clearance of each connecting rod is within tolerance, Chapter 4.

17. BALANCER: Wipe all mating faces clean and rotate the crankshaft so the timing mark is at the bottom. (Nos. 2 & 3 pistons will be at T.D.C.) Align the mark on the balancer drive gear with the crankshaft mark, Figure 51, and install a new gasket in the lubrication hole.

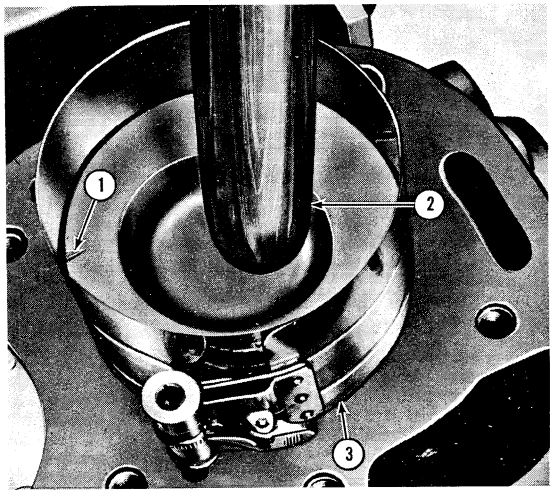

Figure 50
Installing Piston and Connecting Rod Assembly
1. Identification Notch (Assemble Piston with Notch Toward Front of Engine)
2. Hammer Handle
3. Piston Ring Compressor

IMPORTANT: Balancer gear will interfere with the connecting rod if timing marks are not correctly aligned.

Tighten the bolts to the specified torque, Chapter 4.

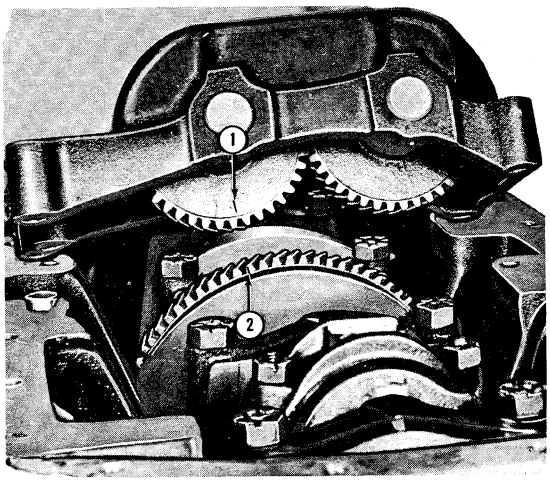

Figure 51
Timing Balancer to Crankshaft
1. Drive Gear Timing Mark
2. Crankshaft Gear Timing Mark

18. Install the oil pump and realign the timing gear marks if necessary. Replace the front cover, crankshaft, pulley, oil-pan (sump), cylinder head and equipment attached to the head.

19. Install the flywheel and check the run-out with a dial indicator, Figure 52. See Chapter 4 for tolerance. If run-out is not within specifications, check mating surfaces.

20. Fill the engine with clean engine oil, run the engine, and check for leaks.

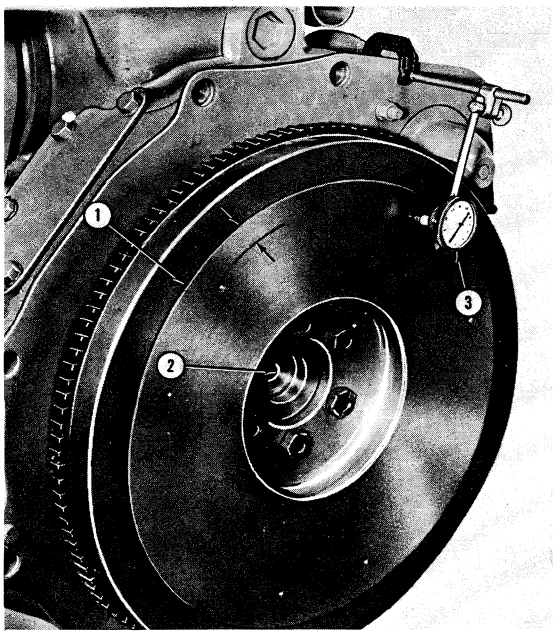

Figure 52
Checking Flywheel Runout
1. Check Runout in this Area
2. Pilot Bore
3. Dial Indicator

5. BLOCK ASSEMBLY - OVERHAUL

REMOVAL

1. Remove the engine from the unit and place on a stand or work bench. Remove the cylinder head, oil pan, oil pump, balancer (if installed), the piston and connecting rod assemblies, crankshaft and camshaft.

DISASSEMBLY

1. Drive out the camshaft rear cover plate to gain access to the camshaft rear bearing.

INSPECTION AND REPAIR

1. CYLINDER BLOCK: Thoroughly clean the block, bearing bores and oil passages. Inspect the core plugs. Rust indicates leakage and a new plug should be installed with sealer if necessary. Also examine the plugs at either end of the main oil gallery.

2. Inspect and measure the cylinder bores for waviness, scratches, scuffing, out-of-round, wear and taper. A wavy cylinder wall has a series of parallel lines or rings worn around the cylinder within the ring travel area. These irregularities, although in most cases are too small to be measured, can be felt by running a finger over the surface. A scuffed cylinder can be identified by discolored areas. Out-of-roundness, wear and taper can be detected with a cylinder bore gauge, Figure 53. Measure lengthwise and crosswise and shown at "A", "B", "C" and "D". The difference between measurements "A" and "B" compared with "C" and "D" indicates taper, while the cross wise readings compared to those taken lengthwise show if an out-of-round condition exists. See Chapter 4 for limits.

3. If cylinder taper, out-of-roundness, wear or piston-to-bore clearance do not meet specifications, the cylinders should be honed or bored to fit the next oversize piston. The finished bore size can be determined by measuring the piston diameter at right angles to the piston pin.