

REPAIR MANUAL
for
FORD 8700
& 9700
TRACTORS
40870020

Ford Tractor Operations

Ford Motor Company

Foreword

This manual provides information for the proper servicing of the Ford 8700 and 9700 Tractors. The information is essential for all mechanics and will be especially meaningful to those who have attended the Training Programs for the 8700 and 9700 Tractors. We recommend therefore, that this manual be readily available for reference at all times.

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**

Part 1

ENGINE SYSTEM

Chapter 1

ENGINE AND LUBRICATION SYSTEM

Section	Page
1. Description and Operation	1
2. Cylinder Head, Valves, and Related Parts	3
3. Engine Front Cover and Timing Gears	15
4. Oil Pan and Oil Pump	20
5. Connecting Rods, Bearings, Pistons, Rings, Cylinder Block, and Sleeves	24
6. Main Bearings, Flywheel, and Crankshaft	36
7. Camshaft	44
8. Engine Compression Test	46

Chapter 2

TURBOCHARGER

Section	Page
1. Description and Operation	47
2. Turbocharger Overhaul	48

Chapter 3 COOLING SYSTEM

Section	Page
1. Description and Operation	59
2. Radiator and Thermostat	60
3. Water Pump	62

Chapter 4 TROUBLE SHOOTING

Section	Page
1. Trouble Shooting	65

Chapter 5 SPECIFICATIONS AND SPECIAL TOOLS

Section	Page
1. Specifications	67
2. Special Tools	78

Part 1

ENGINE SYSTEM

Chapter 1

ENGINE AND LUBRICATION SYSTEM

Section	Page
1. Description and Operation	1
2. Cylinder Head, Valves, and Related Parts	3
3. Engine Front Cover and Timing Gears	15
4. Oil Pan and Oil Pump	20
5. Connecting Rods, Bearings, Pistons, Rings, and Cylinder Block.	24
6. Main Bearings, Flywheel, and Crankshaft	36
7. Camshaft	44
8. Engine Compression Test	46

1. DESCRIPTION AND OPERATION

The engine described in this manual is a six cylinder diesel "in-line" type with direct fuel injection and overhead valve design. The displacement amounts to 401 cu. in. (6580 cc), the bore to 4.4 in. (111.76 mm) and the stroke to 4.4 in. (111.76 mm). Because of the bore and stroke dimensions it is also referred to as a square engine.

This part of the manual deals with the disassembly, inspection and repair, and assembly of the engine and lubrication system, plus the cooling system.

CYLINDER HEAD ASSEMBLY – INCLUDING VALVE TRAIN COMPONENTS

The cylinder head assembly incorporates the valves, valve springs, and rotators. The valve rocker arm shaft assembly is bolted to the cylinder block, through the head. The intake and exhaust manifolds are bolted to the head. The intake manifold is on the right side of the engine, and the exhaust manifold is on the left side.

Valve guides are an integral part of the cylinder head, and valves with oversize stems are available for service. Special replaceable cast alloy valve seats are pressed into each valve port of the cylinder head. The alloyed steel exhaust valves are fitted with positive valve rotators. Intake valves use umbrella-type seals while the exhaust valves use a square section O-ring. The push rods are high tensile strength steel with oil-cushioned sockets, and locate inside the tappet. The tappets are cast cylindrical, chill-hardened iron. Valve lash is maintained by self-locking adjusting screws.

The camshaft is supported by five replaceable bearings. The camshaft is driven by the camshaft drive gear which is in mesh with the camshaft gear. Camshaft thrust is controlled by a plate secured to the block and located between the camshaft gear and the front journal of the camshaft.

The cylinder head is designed with the entire face flat and uses six evenly spaced headbolts per cylinder. The fuel injectors are mounted outside the rocker cover and the combustion chambers are in the heads of the pistons.

MANIFOLDS

The aluminum alloy intake and two part cast iron exhaust manifolds are on opposing sides of the cylinder head providing better heat distribution in the head with less heat being transferred to the intake manifold. Tractors are equipped with an exhaust expansion manifold and a vertical exhaust system. The intake manifold is connected through tubing to the air cleaner. The intake manifold is provided with a tapped hole for installation of an ether cold starting air kit. Another tapped hole is provided for the air cleaner restriction gauge.

NOTE: *On tractors where cold start equipment is not fitted, the plug assembled in the manifold should remain securely assembled at all times. Considerable damage to the cylinder bores could result from its absence. The cylinder bores can also be damaged by grit and other foreign matter passing through the air cleaner hose connections if they are not properly secured.*

CYLINDER BLOCK ASSEMBLY

The cylinder block is alloy cast iron with heavy webbing and deep cylinder skirts. The block features full length water jackets for cooling the cylinders. Cylinder arrangement is vertical in-line with the cylinders numbered from 1 to 6, starting at the front of the block. The firing order is 1-5-3-6-2-4.

The oil pan sump is heavy cast iron with deeper end flanges to enable greater bolt span required by the increased engine loading and will also incorporate the implement mounting pad.

The oil pan is attached to the bottom of the cylinder block and is the sump for the lubrication system. The engine front cover is attached to the front engine adapter plate forming a cover for the timing gears.

The crankshaft gear is keyed and press fitted on the front of the crankshaft. The crankshaft gear drives the camshaft drive gear which is attached to the front of the cylinder block. The camshaft drive gear drives the camshaft gear and the injection pump drive gear.

The camshaft gear is attached to the front of the camshaft by a bolt, lock washer, a flat washer, and a spacer. The gear is keyed to the camshaft to maintain the position of the gear and drive the shaft.

All the timing gears can be checked by observing the timing punch marks on the gears. The crankshaft is supported in the cylinder block by seven main bearings.

The fifth bearing is a flanged thrust bearing which controls crankshaft end play.

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

The engine pistons have a continuous skirt around the entire piston. Each piston has three compression rings and one oil control ring, the top compression ring is a keystone ring.

The piston is connected to the crankshaft by a heavy I-beam connecting rod. The crankshaft end of the connecting rod has an insert-type bearing. The piston end of the connecting rod has a replaceable bronze bushing. The piston pin is a free-floating steel pin held in place in the piston by two snap-rings. (circlips).

LUBRICATION SYSTEM

A rotor-type oil pump, driven from a gear on the camshaft and mounted on the bottom of the cylinder block, takes oil from the deepest part of the oil pan 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 a replaceable cartridge external filter. A relief valve in the filter permits oil to bypass a clogged filter, thereby maintaining oil flow 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 all the crankshaft main bearings and to the connecting rod journals by way of the crankshaft. Camshaft bearings receive oil by means of drilled passages from the main bearings.

On some Ford 8700 Tractors, part of the oil from the pump flows through an external bypass filter mounted on the engine. The filter uses a replaceable cartridge and incorporates a restrictor to limit oil flow through the filter. The filter takes oil from the vertical oil gallery and delivers oil back to the oil pan. This filter helps to prolong the useful life of the oil.

The camshaft drive gear bushing is pressure-lubricated through a drilled passage from the front main bearing and has spiral grooves to direct oil toward the outside of the gear. The gear has small oil passages machined on both sides which allows the oil to exhaust. The timing gears are splash-lubricated from the pressure-lubricated camshaft drive gear.

Cylinder walls and pistons are splash-lubricated by the crankshaft on the 8700. Piston pins are splash-lubricated on the 8700; pressure-lubricated on the 9700 tractor. 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. From the head, the oil flows up around the No. 1 rocker arm support bolt to the rocker shaft. The oil from the shaft flows through drilled holes in each rocker arm to lubricate the valve end and the

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 openings in the block.

A water jacketed oil cooler is attached to the top of the front steering motor behind the radiator. The lubricating oil flows to the cooler from a tapping into the main oil gallery which runs the full length of the cylinder block, and returns to the oil pan sump via a pipe tapped into the right-hand side of the cylinder block.

The fitting at the oil outlet from the oil cooler is a restrictor. This valve helps to maintain satisfactory oil pressure in the oil gallery at low engine speed.

2. CYLINDER HEAD, VALVES AND RELATED PARTS

The cylinder head can be removed from the engine for service with the engine installed in the tractor.

A. REMOVAL

1. Remove the pre-cleaner from the fresh air intake pipe and the fuel tank cap.
2. Remove two side panels, three radiator grille panels and the top hood panel, Figure 1.

3. FORD 8700:

Muffler — Unbolt the muffler pipe from the exhaust manifold. Remove the muffler, muffler support bracket and muffler pipe from the tractor, Figure 2.

Air Cleaner — Remove the air intake pipe at the intake manifold and at the radiator bracket flange and remove from the tractor, Figure 3.

FORD 9700:

Muffler — Unbolt the muffler pipe from the turbocharger bracket. Remove the two heat shield clamps. Remove the muffler, support bracket and muffler pipe from the tractor, Figure 3.

Air Cleaner — Remove the air intake pipe from turbocharger to the radiator support (four clamps), Figure 4. Remove the intake manifold hose, Figure 5.

Turbocharger — Remove the turbocharger oil lines. Remove the four bolts attaching the turbocharger to the exhaust manifold. Remove the turbocharger, Figure 4. Plug all turbocharger parts to prevent the entry of dirt.

4. Shut off the fuel at the main fuel tank, Figure 5.
5. Disconnect the wiring harness at the alternator and air intake sensor. Remove the harness from the fuel tank bracket, Figure 5.
6. Remove eight bolts that attach the main fuel tank support brackets to the tractor, Figure 3.
7. Using a sling, remove the fuel tank and brackets from the tractor, Figure 6.
8. Remove the fan brace. Straighten the lock tabs and remove the twelve exhaust manifold bolts, and the exhaust manifold and gasket from the tractor.
9. Remove the cold start (ether) unit and the fuel delivery lines. Plug the fuel line, injector and fuel pump openings to prevent the entry of dirt.
10. Remove fourteen intake manifold bolts and the intake manifold and gasket from the tractor, Figure 5.
11. Remove the breather tube from rocker cover.

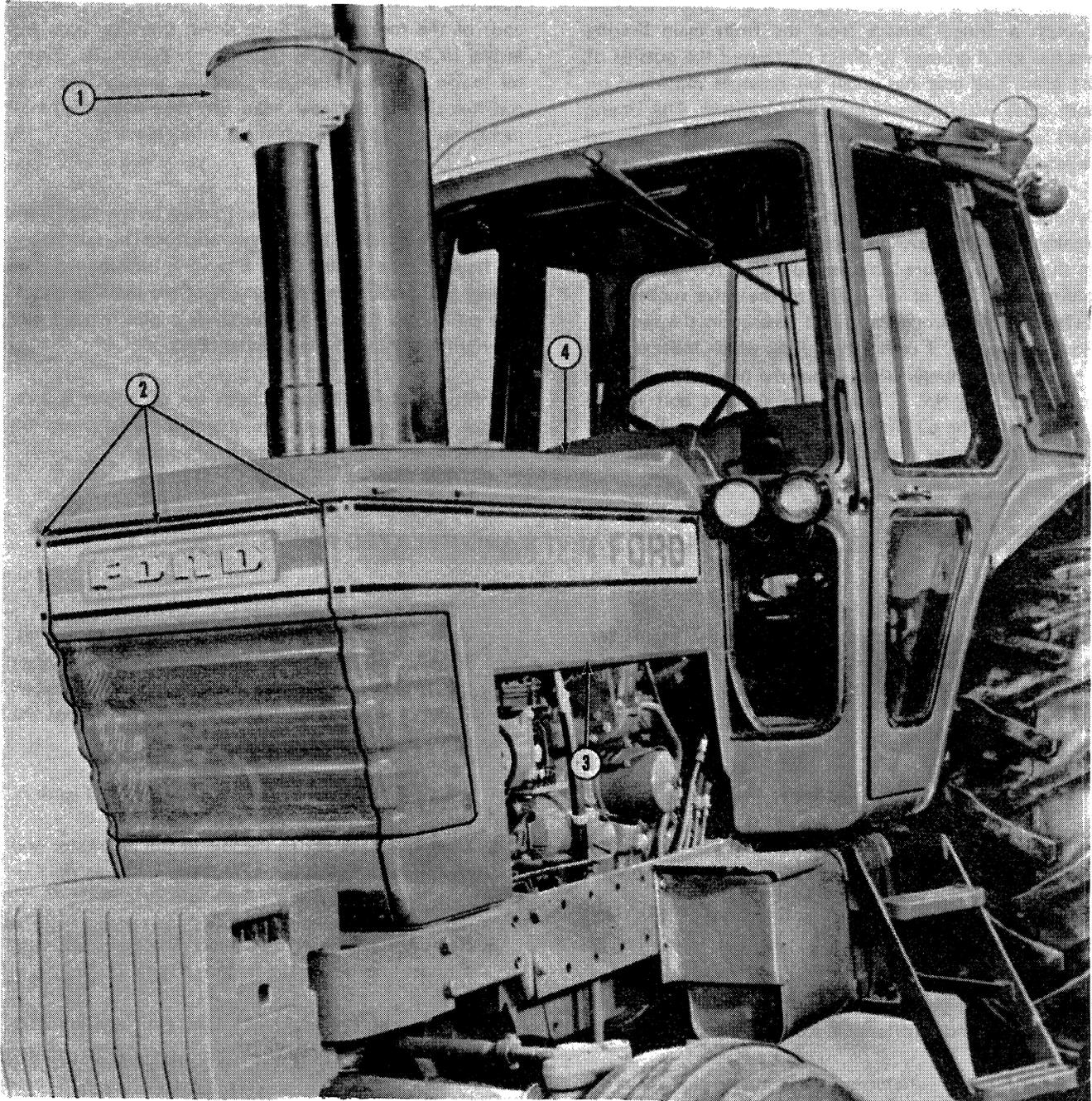


Figure 1
Tractor Sheet Metal

- 1. Pre-Cleaner
- 2. Radiator Grille And Panels

- 3. Side Panel(s)
- 4. Hood Panel

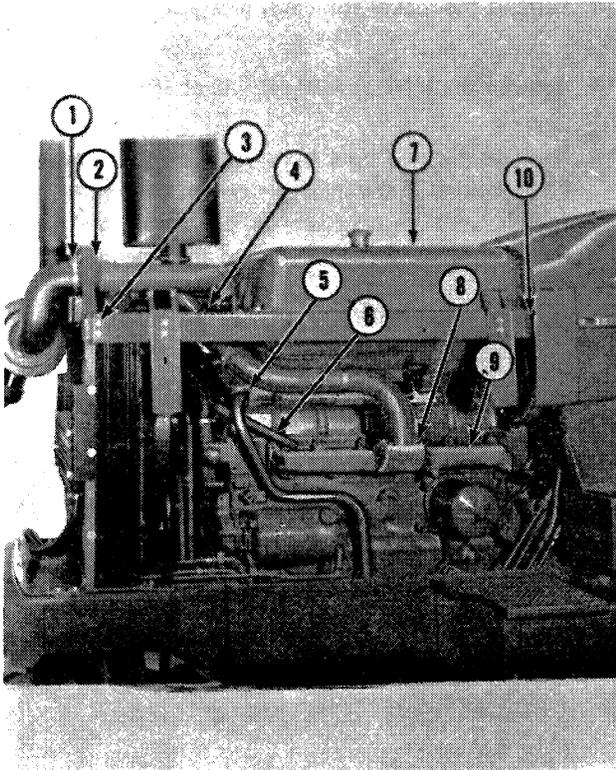


Figure 2
Access To Cylinder Head (8700)

1. Air Cleaner Clamp
2. Flange Bolts (Not Visible)
3. Fuel Tank Bracket Bolts
4. Muffler Support Bracket
5. Breather Tube
6. Fan Hub Brace
7. Fuel Tank (Main)
8. Muffler Pipe To Manifold Bolts
9. Exhaust Manifold
10. Fuel Tank Bracket Bolts (Not Visible)

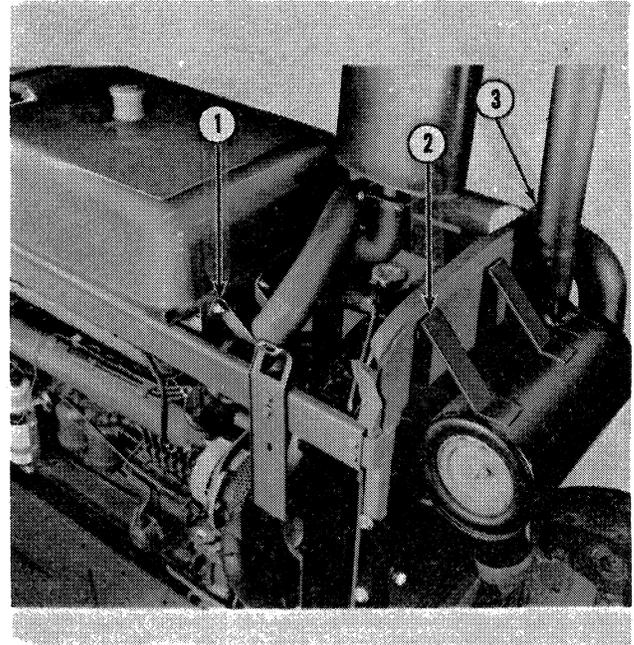


Figure 3
Access To Cylinder Head

1. Air Intake Pipe Bracket
2. Air Intake Bracket
3. Flange (Not Visible)

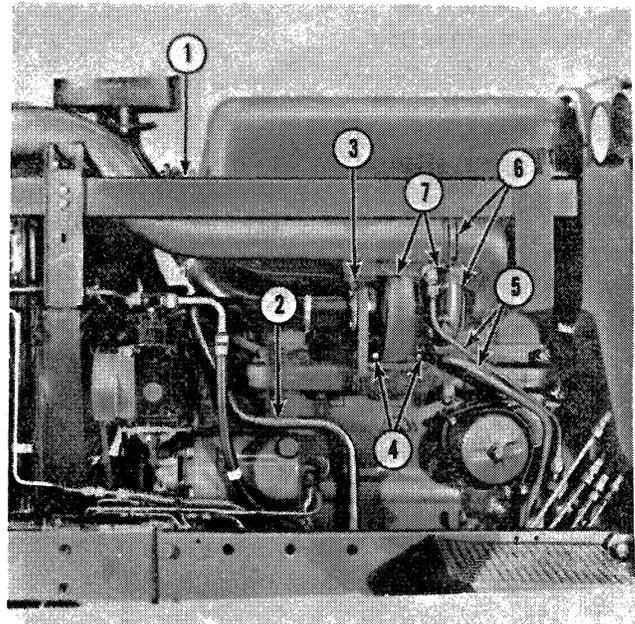


Figure 4
Access To Cylinder Head (9700)

- | | |
|----------------------------------|--------------------------------|
| 1. Muffler Bracket (Not Visible) | 4. Turbo Mounting Bolts |
| 2. Breather Tube | 5. Turbo Lube Tubes |
| 3. Muffler - To - Turbo | 6. Air Intake Hose Clamps |
| | 7. Turbocharger Assembly Bolts |

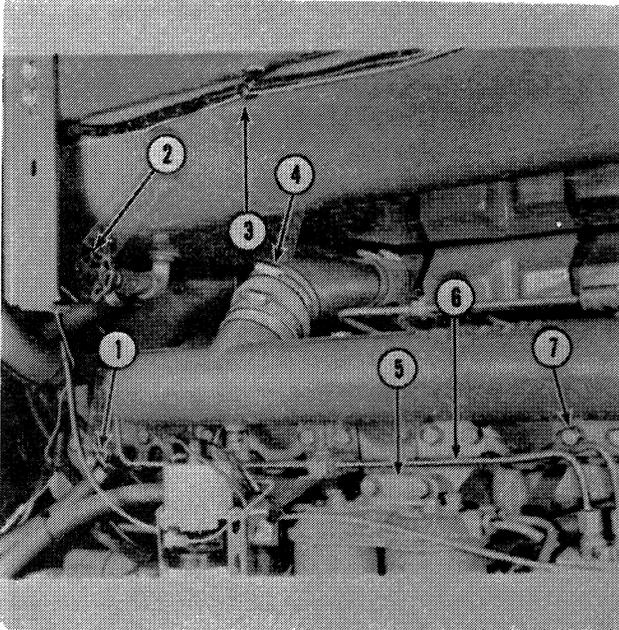


Figure 5
Engine (9700)

1. Heater Hose Valve
2. Fuel Shut-Off Valve
3. Wiring Harness
4. Intake Manifold To Turbo Hose
5. Fuel Filter Bracket
6. Fuel Injector Line
7. Intake Manifold Bolt

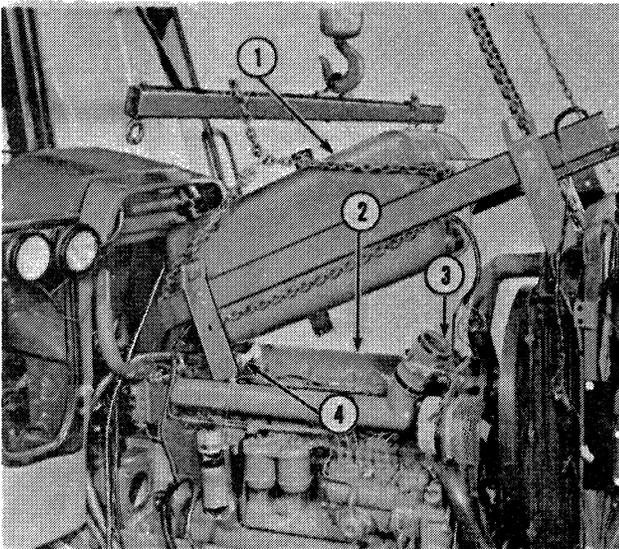


Figure 6
Access To Cylinder Head

1. Main Fuel Tank
2. Valve Cover
3. Intake Manifold Air Inlet
4. Fuel Shut-Off Valve

12. Drain the engine coolant. Remove the heater hose from the head fitting, Figure 5.
13. Remove the fuel filters and lines from the engine. Plug all openings to prevent the entry of dirt.
14. Remove the rocker arm cover and gasket.
15. Remove the injector leak-off line at No. 6 cylinder.
16. Remove the two nuts from each injector. Remove the injectors. If the injectors cannot be removed by hand it may be necessary to pry them out. Keep the area clean to avoid fouling the injectors with dirt.

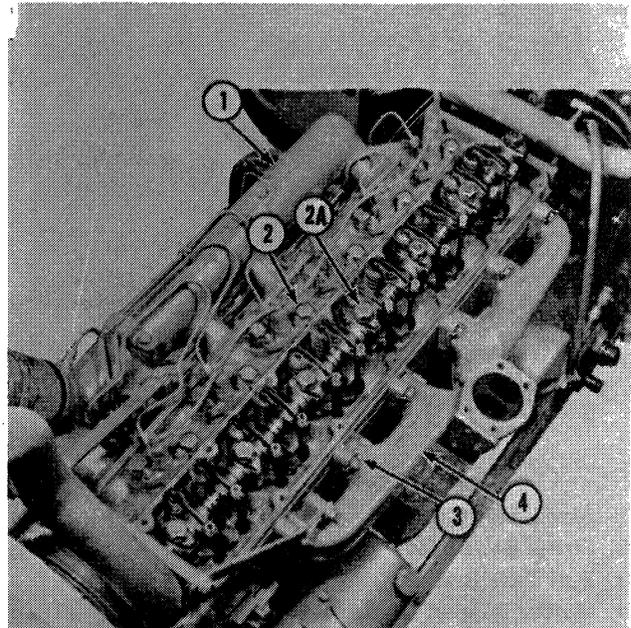


Figure 7
Top View Of Engine

1. Intake Manifold
2. Head Bolt
- 2A. Head/Rocker Arm Bolt
3. Lock Tab
4. Exhaust Manifold

17. Visually check the push rods for straightness by rotating them with the valve closed. Loosen the rocker arm shaft bolts evenly and remove the assembly from the tractor, Figure 7.

NOTE: Do not remove the rocker arm shaft retaining bolts unless it is necessary to disassemble the rocker arm shaft.

18. Remove the valve push rods from their holes in the cylinder head and arrange them in a rack in the order in which they were removed. It is important that the rods are installed in the same bores during reassembly.
19. Loosen and remove the cylinder head retaining bolts evenly, working from the ends to the center of the head, and carefully lift the cylinder head from the block.

B. DISASSEMBLY

1. Before removing the valves from the cylinder head, clean all carbon deposits from the valve heads.

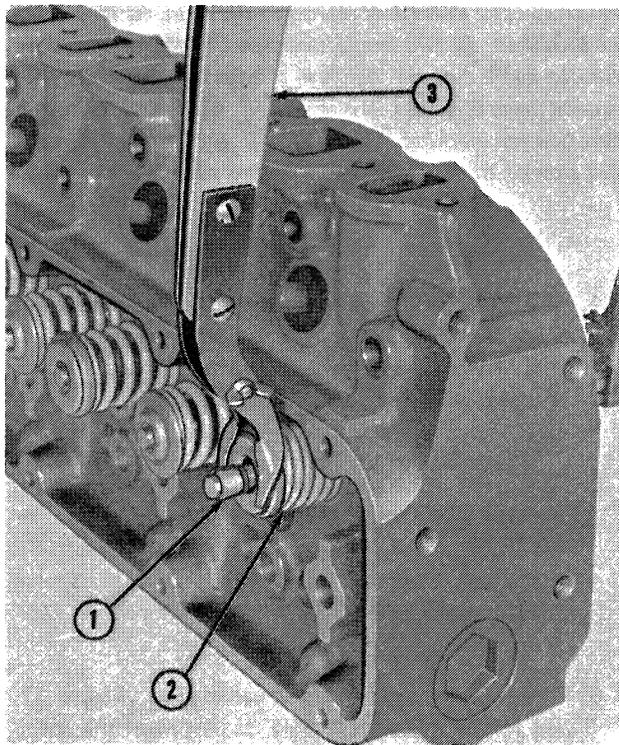


Figure 8
Removing Valves

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

2. Position the valve spring compressor over the valve and spring, as shown in Figure 8, and compress the spring.

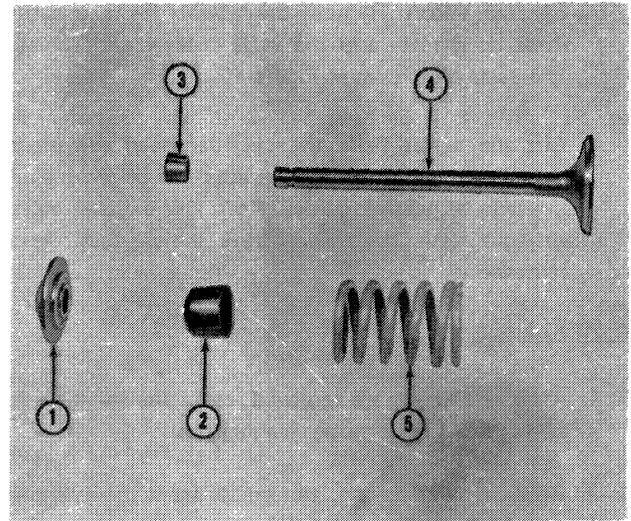


Figure 9
Intake Valve Assembly

1. Retainer
2. Seal
3. Retainer Locks
4. Intake Valve
5. Spring

Intake Valves: Remove the retainer locks, spring retainer, spring, and valve stem seal. The parts are shown in Figure 9.

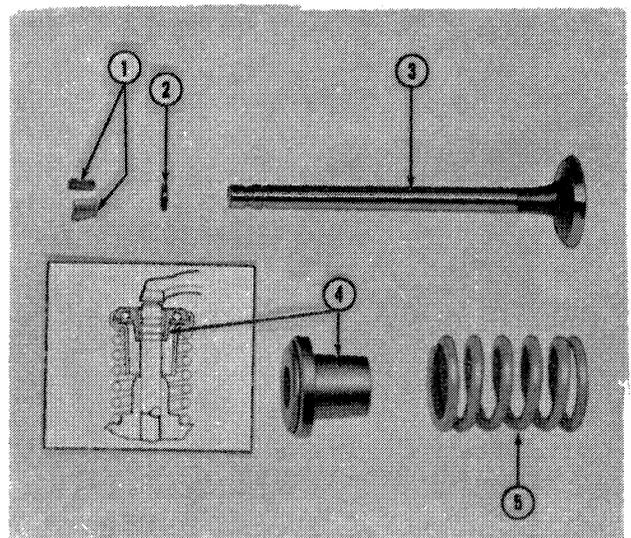


Figure 10
Exhaust Valve Assembly

1. Retainer Locks
2. Seal
3. Exhaust Valve
4. Rotator
5. Valve Spring

Exhaust Valves: Remove the retainer locks, the seal from its groove, and the valve rotator and spring. The parts are shown in Figure 10.

3. Lift the valves from the cylinder head and place them in a numbered rack so they can be reinstalled in their respective guides. Keep the exhaust valve rotators with the valves from which they were removed.

C. CLEANING

1. After the valves are removed, clean the valve guide bores with a valve guide cleaning tool.
2. Remove all dirt, grit, and grease from the cylinder head with cleaning solvent.

NOTE: Be sure to remove any injector washers that may have remained in the bores.

D. INSPECTION AND REPAIR

1. Inspect the cylinder head for cracks, nicks, or burrs. Install a new head if necessary. Remove all burrs or nicks from the gasket surface.

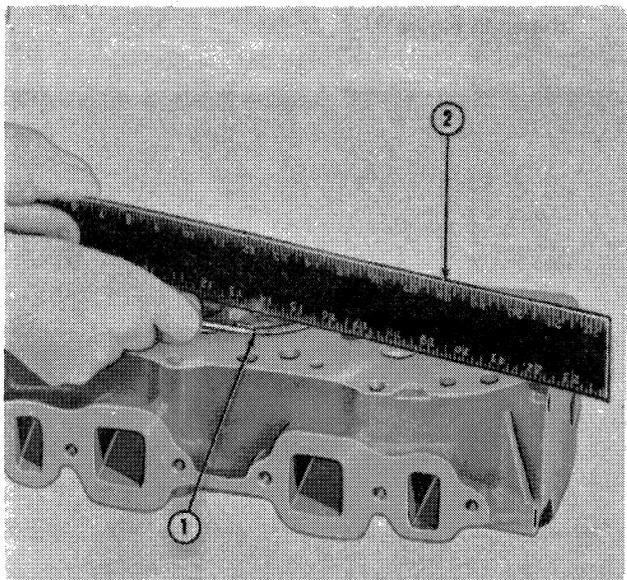


Figure 11
Measuring Cylinder Head Flatness

1. Feeler Gauge
 2. Straight Edge
2. With a straight edge and feeler gauge, check the flatness of the cylinder head, as shown in Figure 11. Specifications for flatness are 0.006 in. (0.15 mm.) maximum overall, or 0.003 in. (0.76 mm.) in any six inches (152.40 mm.).

NOTE: If the cylinder head face is not within the flatness specification, it may be skimmed providing the depth from the lower face of the valve seat insert to the cylinder head face after skimming is not less than 0.117 in. (2.97 mm.).

3. If the head has been skimmed, determine that all the head bolts will bottom. Place the cylinder head, less gasket, on the block and install and finger tighten all the head bolts (rocker arm shaft supports and washers should be used under the long bolts). Using a feeler gauge, check the clearance between the underside of the head bolts and the cylinder head rocker arm support. If the clearance is 0.010 in. (0.254 mm) or greater for any bolt, use a 1/2" X 13 UNC-2A thread tap and increase the tap depth. The head bolts should be marked so they are re-installed in the hole in which they were checked.

IMPORTANT: Valve seat inserts of 0.010 in. (0.254 mm.) and 0.020 in. (0.508 mm.) oversize diameter have been fitted to some cylinder heads in production. Heads having oversize inserts fitted are stamped with the following identification marking $\frac{SO10}{OS}$ and $\frac{SO20}{OS}$ on the exhaust manifold side of the cylinder head in line with the valve seat.

4. The intake and exhaust valve ports in the cylinder head are equipped with removable valve seat inserts. Remove and replace inserts that are cracked or loose, or that show excessive wear.
5. To install a larger insert than originally fitted, machine the counter bore for the seat in the cylinder head to the dimensions in Table 1, page 11. The insert must be thoroughly chilled in dry-ice before installation.
6. Measure the width of the valve seats, Figure 12, and reface the seats if they do not meet the specifications shown in Figure 14.
7. Measure the concentricity of the valve seat with a suitable gauge, as shown in Figure 13, or with Prussian Blue. If the valve seat runout exceeds 0.002 in. (0.0508 mm) reface the seat.

NOTE: Reface the valve seat and face at the same time so the finished measurements correspond to Figure 14.

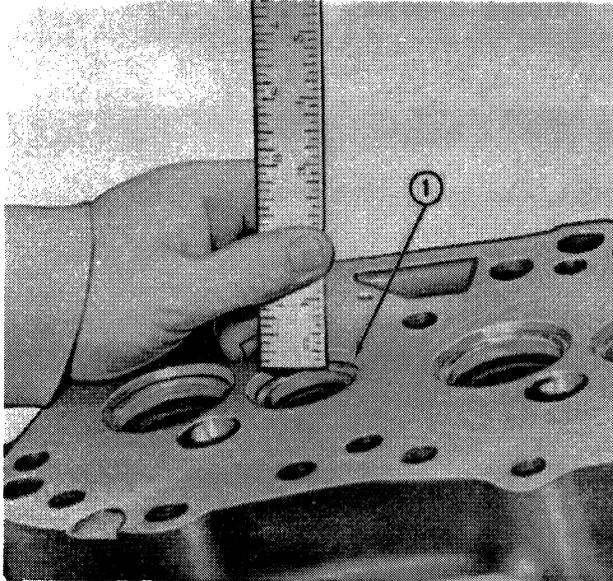


Figure 12
Measuring Valve Seat Width

1. Valve Seat

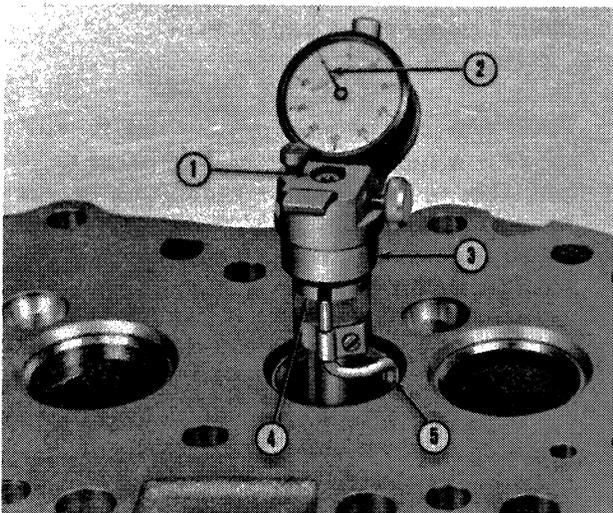
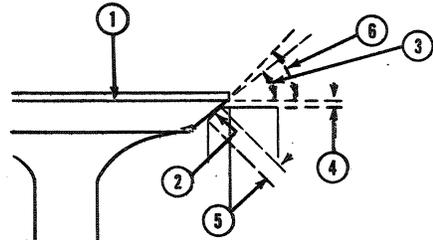


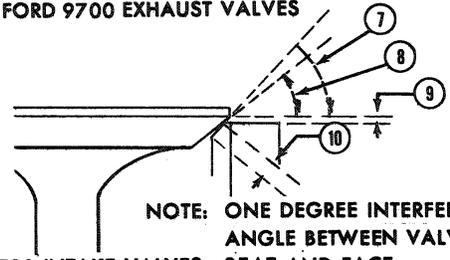
Figure 13
Checking Valve Seat Concentricity

1. Tighten Pilot
2. Set Dial At "0"
3. Valve Seat Concentricity Gauge
4. Rotate Sleeve Clockwise & Read Dial
5. Set Point To Ride On Valve Seat Face



NOTE: ONE DEGREE INTERFERENCE ANGLE BETWEEN VALVE SEAT AND FACE

FORD 8700 INTAKE AND EXHAUST VALVES
FORD 9700 EXHAUST VALVES



NOTE: ONE DEGREE INTERFERENCE ANGLE BETWEEN VALVE SEAT AND FACE

FORD 9700 INTAKE VALVES

Figure 14
Valve Face And Seat Angles

1. Valve Face
2. Valve Seat
3. Valve Face Angle - 44°
4. $1/16$ In. (1.59 MM)
5. Seat Width $3/32$ In. (2.38 mm)
6. Valve Seat Angle - 45°
7. Valve Seat Angle - 30°
8. Valve Face Angle - 29°
9. $1/16$ In. (1.59 mm)
10. Seat Width - $3/32$ In. $\pm 1/64$ In. ($2.38 \pm .40$ mm)

Remove only enough stock from the seat to clean up the pits and grooves, or to correct the seat run-out. After refacing, the seat should measure $3/32$ in. (2.38 mm) $\pm 1/64$ in. (0.40 mm). If the refaced seat exceeds this width, narrow the seat by removing stock from the top or bottom of the seat. See Step 8. If the seat measures less than this width, widen the seat.

8. Rotate a new or refaced valve lightly in the seat, using Prussian Blue. If the blue is transferred to the valve face $1/16$ in. (1.59 mm) below the upper edge of the valve face, the contact is satisfactory. If the blue is transferred to the valve face above or below this point, raise or lower the seat as follows.

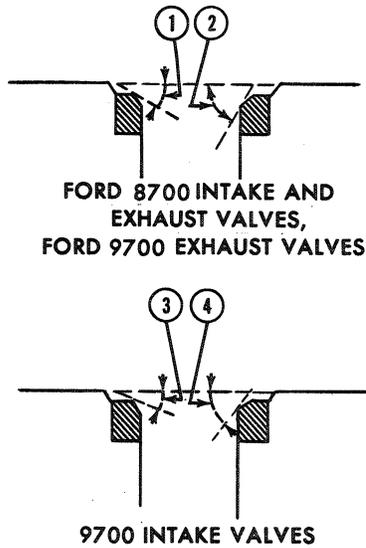


Figure 15
Dressing Valve Seats

1. 30°
2. 60°
3. 15°
4. 30°

FORD 8700 INTAKE; FORD 8700 AND 9700 EXHAUST VALVES

Lower the valve seat by removing stock from the top of the seat with a 30° grinding wheel. Raise the seat by removing stock from the bottom of the seat with a 60° grinding wheel. See Figure 15.

FORD 9700 INTAKE VALVES

Lower the valve seat by removing stock from the top of the seat with a 15° grinding wheel. Raise the seat by removing stock from the bottom of the seat with a 45° grinding wheel. See Figure 15.

IMPORTANT. Some production cylinder heads may have one or more 0.003 in. (.0762 mm) or .015 in. (0.381 mm.) oversize valve guides and valves installed. The exhaust manifold side of the cylinder head opposite these valves will be stamped "03" or "Y003 OS"; "15" or "Y015 OS" as appropriate.

IMPORTANT: Some cylinder heads may have one or more 0.003 in. (.0762 mm) or 0.015 in. (0.381 mm) oversize valves and guides installed. The exhaust manifold side of the cylinder head opposite these valves will be stamped "03" or Y003 OS; "15" or Y015 OS as appropriate.

9. Valve stem-to-guide clearance tolerances are as follows. Intake valves, 0.0010 - 0.0045 in. (0.0245 - 0.114 mm); exhaust valves, 0.0020 - 0.0055 in. (0.0508 - 0.139 mm).

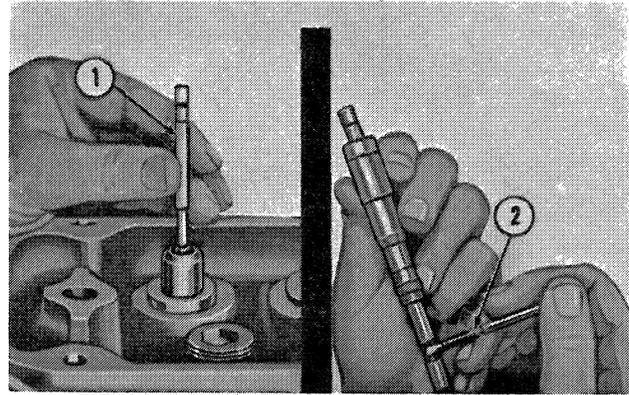


Figure 16
Measuring Valve Guide

1. Telescope Gauge
2. Micrometer

Measure stem-to-guide clearance with a telescoping gauge and micrometer, Figure 16. If not within tolerances, or if excessive oil consumption is indicated, replace the affected guides.

Valves with oversize stems are available for service. If it is necessary to ream valve guides to install valves with oversize stems, use Valve Reamer Kit, SW502, and ream guides in steps, first using the small reamer and standard diameter pilot. The kit contains the following reamer and pilot combinations.

Reamer Diameter	Pilot Diameter
0.003 in. (0.0762 mm) oversize	Standard Diameter
0.015 in. (0.3810 mm) oversize	0.003 in. (0.0762 mm) oversize
0.030 in. (0.7620 mm) oversize	0.015 in. (0.3810 mm) oversize

NOTE: Always reface the valve seat after reaming the valve guide.

TABLE 1

Insert Oversize	Exhaust Valve 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 (43.44/43.46 mm)
0.020 in. (0.508 mm)	1.617/1.618 in. (41.07/41.10 mm)	1.917/1.918 (43.69/43.72 mm)
0.030 in. (0.762 mm)	1.627/1.628 in. (41.33/41.36 mm)	1.927/1.928 (43.95/43.97 mm)

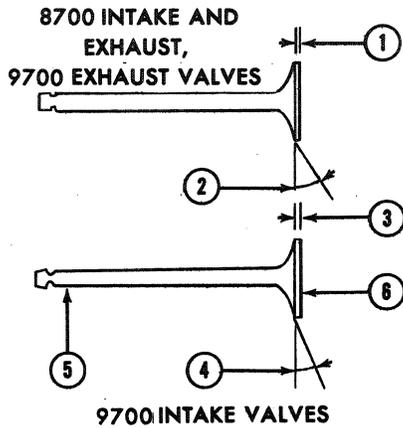


Figure 17
Critical Valve Measurements
And Inspection Checks

1. 1/32 In. (.79 mm) Minimum
2. 44°
3. 1/16 In. (1.58 mm)
4. 29°
5. Check For Bent Stems And Correct Diameter
6. Check Maximum Valve Face Run-Out

VALVES AND PUSH RODS

A. INSPECTION

The critical inspection points of the valves are shown in Figure 17. Inspect the valve face and the edge of the valve head for pits, grooves, scores, or other defects. Inspect the stem for a bent condition and the end of the stem for grooves or scores. Check the valve head for cracks, erosion, warpage, or burn. Minor defects such as small pits or grooves, can be removed. Check

the valve tip for pits or grooves and replace the valve if such a condition exists. Discard valves that are severely damaged.

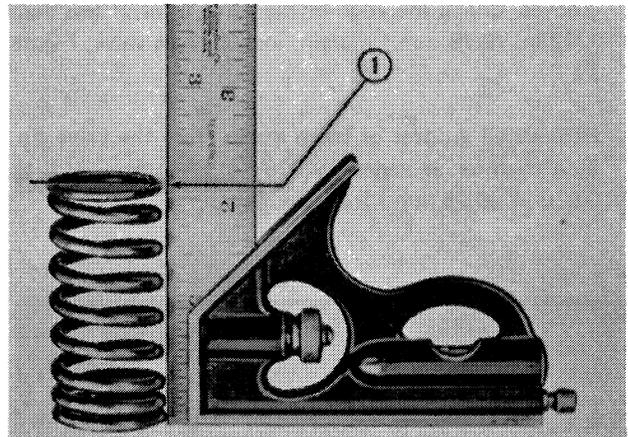


Figure 18

Checking Valve Spring Squareness

1. Not More Than 1/16 In. (1.59 mm)

Discard any valve springs that show signs of erosion or rust. Check each valve spring for squareness, as shown in Figure 18. Discard valve springs that are out of square in excess of 1/16 in. (1.59 mm.).

Check specified free length and loaded height of the valve springs. Weak valve springs cause poor engine performance. If the free length is less than 2-5/32 in. (54.8 mm), add one 0.030 in. (0.76 mm) spacer between the cylinder head spring pad and the valve spring to bring the assembled height to the recommended dimensions of 2-1/8 in. - 2-3/16 in. (53.9 - 55.6 mm).

Check the valve spring retainer locks to be sure they are in good condition. Rotate the exhaust valve positive rotator to be sure it is not binding or excessively worn. Install new rotators if necessary.

Check the ends of the push rods for nicks, grooves, roughness, or excessive wear. If the push rods were not straight when checked in Step 19 of "Removal," or if any of the above wear conditions exist, install new rods. Do not attempt to straighten push rods.

B. REFACING VALVES

The valve refacing operation should be closely coordinated with the valve seat refacing operation so the finished angle of the valve is 1° less than the valve seat to provide an interference angle for better seating, Figure 18. Adjust the refacing tool to obtain a face angle of 44° or 29° as shown in Figure 15.

Remove only enough stock to clean up the pits and grooves. Check the edge of the valve head; if less than $1/32$ in. (0.79 mm.) margin, install a new valve, Figure 17.

Remove all grooves or score marks from the valve tip, then chamfer as necessary. Do not remove more than 0.010 in. (0.25 mm.) from the tip.

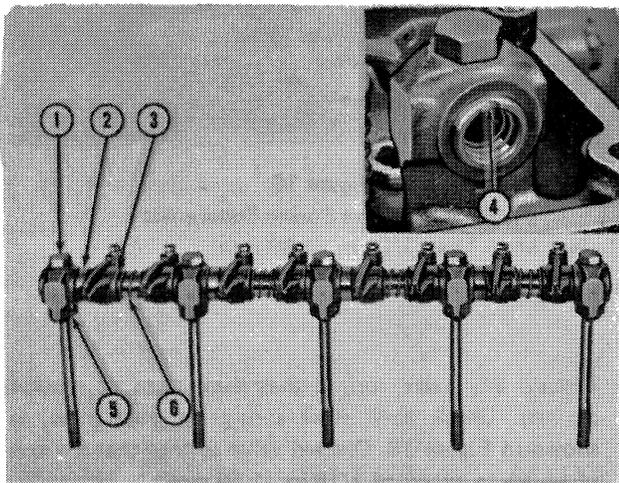


Figure 19
Rocker Arm Shaft

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

ROCKER ARMS AND SHAFT

A. DISASSEMBLY

To disassemble the rocker shaft assembly, remove the bolts that attach the rocker shaft to the cylinder head from the rocker shaft supports, Figure 19.

B. INSPECTION

1. Inspect the rocker arm adjusting screws and the push rod ends of the rocker arms for stripped or worn threads.
2. Check the ball end of the screws for nicks, scratches, or excessive wear.
3. Check the rocker arm locating springs and spacers for breaks or other damage.
4. Inspect the pad end of the rocker arm for roughness or grooves, or excessive wear. If any of the above conditions exist, install new parts.
5. Check the rocker arm and rocker shaft diameters. If the diameter exceeds the specifications, page 70, install a new part. If the shaft meets specifications, clean it thoroughly in solvent. Make sure the oil passages are clean of obstructions.

C. INSTALLATION

1. Reassemble the rocker arm and shaft assembly as shown in Figure 19.
2. Coat the rocker arm shaft with engine oil prior to assembly. Lubricate the valve pads on all rocker arms.
3. The rocker shaft has an identification groove at one end of the shaft. Position the mark upward and use this end as the front of the shaft. This puts the oil holes and grooves in the shaft facing down.
4. Start reassembly from the rear of the shaft by first positioning a rocker arm support with the notch on the support to the right of the shaft facing forward.
5. Be sure the springs and spacers are in their correct position, as shown in Figure 19, then proceed with the assembly.

CYLINDER HEAD

A. ASSEMBLY

1. Insert each valve in the guide bore from which it was removed and lap it in position to give an even seat around the valve. On completion of this operation remove the valve and carefully clean the lapping compound from the valve seat and seat insert.
2. Lubricate all moving parts with engine oil prior to installation. Refer to Figures 9 and 10 for reference to parts of the intake and exhaust valves.
3. Insert each valve in the guide bore from which it was removed or to which it was fitted. Position a new valve seal over each intake valve and guide.
4. Install the valve springs over the valve guides.
5. On intake valves, compress the springs and spring retainer as shown in Figure 8, and install the retainer locks. On exhaust valves, compress the spring and the valve rotator. Be sure to install the rotator onto the valve from which it was removed.
6. On exhaust valves install the new sealing ring into the second groove from the top of the valve stem and install the retainer locks.

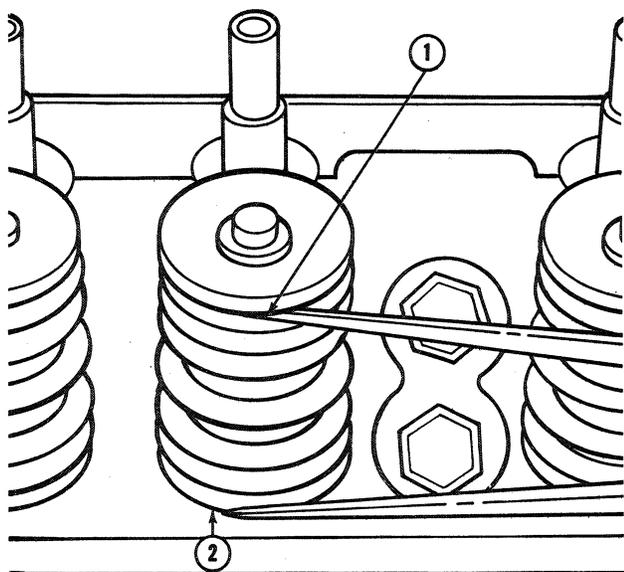


Figure 19A

Checking Valve Spring Assembled Height

1. Underside Of Spring Retainer
2. Surface Of Spring Pad

CHECKING VALVE SPRING ASSEMBLED HEIGHT

Measure the assembled height of the valve spring from the surface of the cylinder head spring pad to the underside of the spring retainer. Use dividers, Figure 19A.

If the assembled height is greater than the specified limit, install .030 in. (0.76 mm) spacers between the cylinder head spring pad and the valve spring to bring the assembled height to the recommended dimension, listed below.

NOTE: Do not install spacers unless necessary. Use of spacers in excess of recommendations will result in overstressing the valve springs and overloading the camshaft lobes.

VALVE SPRING ASSEMBLED HEIGHT –

1-23/32 - 1-25/32 in.
(43.6 - 45.2 mm)

B. INSTALLATION

1. Place a new head gasket on the cylinder block, then carefully position the cylinder head on the gasket. Two dowels are on the top of the cylinder block at opposite corners to aid in positioning the cylinder head and gasket.
2. Lubricate the cylinder head bolts and install them finger tight.
3. Install the valve push rod with the cupped end up in the holes in the cylinder head from which they were removed. Be sure the ball ends of the push rods are seated in the tappet sockets.
4. Position the rocker shaft assembly on the cylinder head, the long cylinder head bolts and washers in the respective holes. Refer to Figure 7. Make sure that the ball ends of the rocker arm adjusting screws are seated in the cupped end of the push rods.

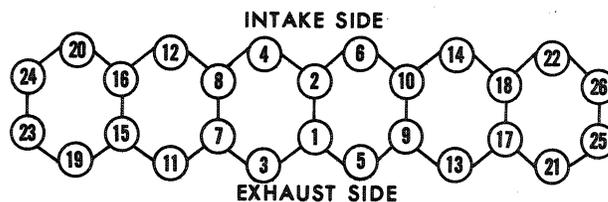


Figure 20

Cylinder Head Tightening Sequence

5. Tighten 1/2 in. cylinder head bolts in the sequence shown in Figure 20. Tighten in three steps:
 - (a) 90 lbs. ft. (122 Nm)
 - (b) 100 lbs. ft. (135 Nm)
 - (c) 110 lbs. ft. (149 Nm)
 Tighten 9/16 in. cylinder head bolts (new) in the sequence shown in Figure 20. Tighten in two steps:
 - (a) 140 lbs. ft. (190 Nm)
 - (b) 160 lbs. ft. (217 Nm)

NOTE: *The cylinder head bolts should be torqued only when the engine is cold.*

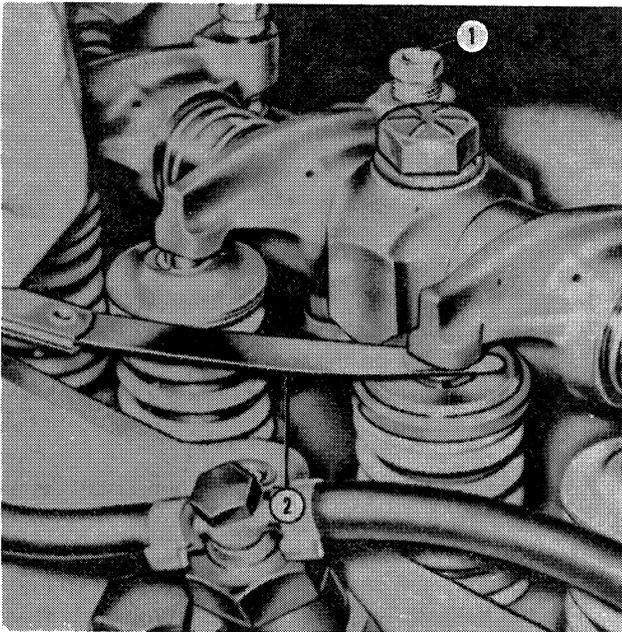


Figure 21
Checking Valve Lash

1. Adjusting Screw
 2. Check Gap With Feeler Gauge
6. Rotate the engine and set the preliminary valve lash, Figure 21, to the specified limits, page 69.
 7. Install a new seat washer in each injector bore in the cylinder head. Position new cork seals over the injectors.
 8. Install each injector into the cylinder head and over the two studs, as shown in Figure 7. Install the nut on each stud and tighten progressively to the specified torque, page 76 .
 9. Using new copper washers, install the injector leak-off line.

10. Install a new gasket and the intake manifold onto the cylinder head. Secure the manifold with the bolts and lock washers and tighten the bolts to the specified torque, page 76.
11. Attach the fuel filters to the manifold with two bolts and flat washers, and connect the fuel lines.
12. Connect the injector lines to the injection pump and to the injectors. Position the clamps on the injector lines in the same position from which they were removed.
13. Connect cold start equipment where fitted.
14. Position a new metal exhaust manifold gasket on the cylinder head and install the exhaust manifold, as shown in Figure 2. Use new lock tabs and tighten the bolts to the specified torque, page 76. Bend the lock tabs to retain the bolts.
15. **Ford 8700:** Bolt the muffler, with a new gasket installed, to the exhaust manifold.

Ford 9700: Bolt the turbocharger, with a new gasket installed, to the exhaust manifold. Install the oil pressure and return lines to the turbocharger and engine.
16. Connect the upper radiator hose to the cylinder head.
17. Fill the radiator with coolant.
18. Install the rocker cover, installing a new gasket, and tighten the bolts to the specified torque, page 76. Connect the ventilating tube.
19. Lift the air cleaner and support assembly into place and attach with the hardware previously removed.
20. **Ford 8700:** Attach the muffler to the air cleaner support assembly and connect the air intake tube to the intake manifold.

Ford 9700: Connect the exhaust extension to the turbocharger exhaust outlet and attach it to the air cleaner support assembly. Connect the air intake tube to the inlet side of the turbocharger and the air cleaner.
21. Install the fuel tank assembly, Figure 6.
22. Turn on the fuel.

23. Position the wiring harness in the clips on the support brace and connect the harness at the alternator and air intake restrictor valve.
24. Install the top hood panel and the pre-cleaner.
25. Install both hood side panels and the three radiator grille panels.

26. Bleed the fuel system as described in Part 2, "FUEL SYSTEM". Start the engine and make a final valve lash adjustment.

NOTE: Do not make valve lash adjustments when the engine is operating at above normal operating temperature.

3. ENGINE FRONT COVER AND TIMING GEARS

Engine front cover and timing gear service operations can be performed after separating the front axle assembly from the engine, transmission, and rear axle assembly, as outlined in Part 9, "COMPONENT REMOVAL".

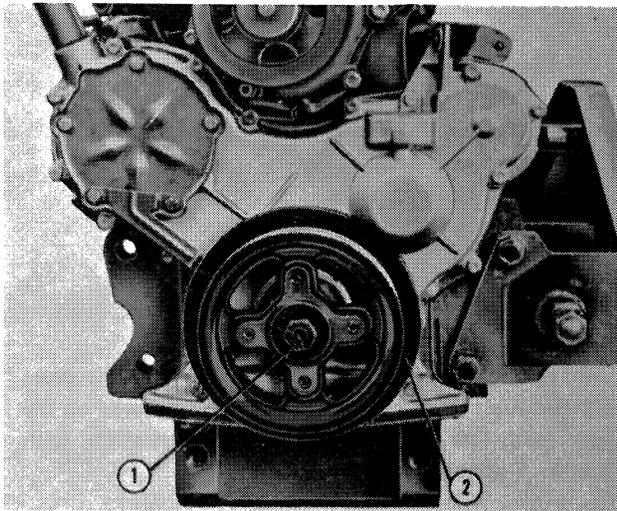


Figure 22
Crankshaft Pulley

1. Pulley Bolt
2. Crankshaft Pulley

CRANKSHAFT PULLEY REMOVAL

1. Remove the fan and water pump belts. Remove the bolt and washer from the crankshaft pulley, Figure 22, using Puller No. 518 and Shaft Protector No. 625-1, as shown in Figure 23. To use the puller for this purpose, 7/16" x 14 UNC bolts have to be used and the slots in the puller enlarged.
2. Check the pulley belt grooves to be sure the surfaces are smooth and the flanges are not cracked or broken.

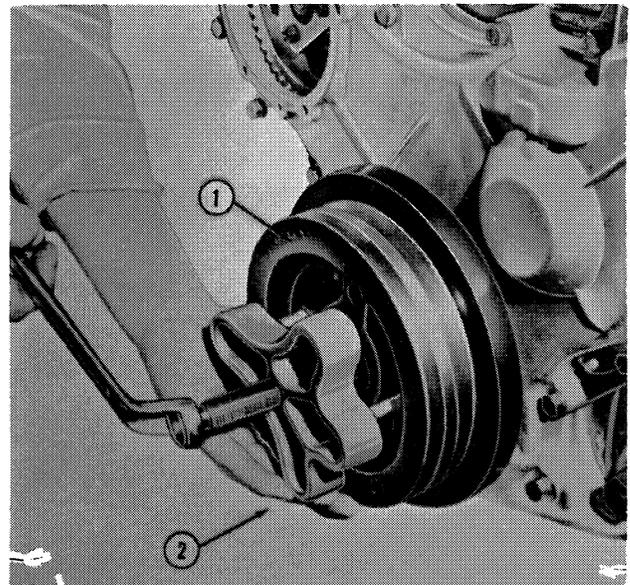


Figure 23
Removing Crankshaft Pulley

1. Crankshaft Pulley
2. 518 Puller

3. Check the shaft spacer in the area that contacts the front oil seal to be sure it is free of scratches or grooves that may cause oil leakage past the seal. Clean the seal contact surface with solvent and polish with crocus cloth prior to installation.

FRONT COVER REMOVAL

1. Drain the engine oil, and remove the oil pan.
2. Remove the front cover-to-front engine plate bolts and note the position of the fan mounting.
3. Remove the alternator front mounting bracket bolt.

4. Carefully pry the front cover off the dowel pins and remove it.
5. Remove the oil slinger.
6. Clean all the gasket material from the front cover and from the front engine plate.

FRONT COVER CRANKSHAFT SEAL REMOVAL

The front cover oil seal should be removed and a new seal installed every time the front cover is removed.

1. Drive out the old oil seal and dust seal with a punch. Be careful not to damage the cover.
2. Thoroughly clean the seal bore in the cover.

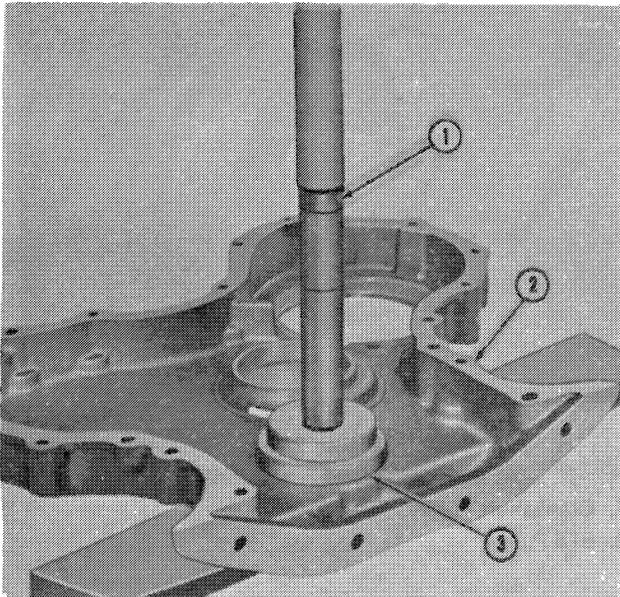


Figure 24
Installing Front Cover Seal

1. Driver
 2. Engine Front Cover
 3. 630 — 16 Step Plate
3. Insert the dust seal in the seal bore before installing the oil seal. Coat the new oil seal with petroleum jelly and install the seal as shown in Figure 24. To install the seal, use Step Plate No. 630-16 and a driver handle. Drive the seal in until it is fully seated in the seal bore. Check after installation to be sure the spring is properly positioned in the seal.

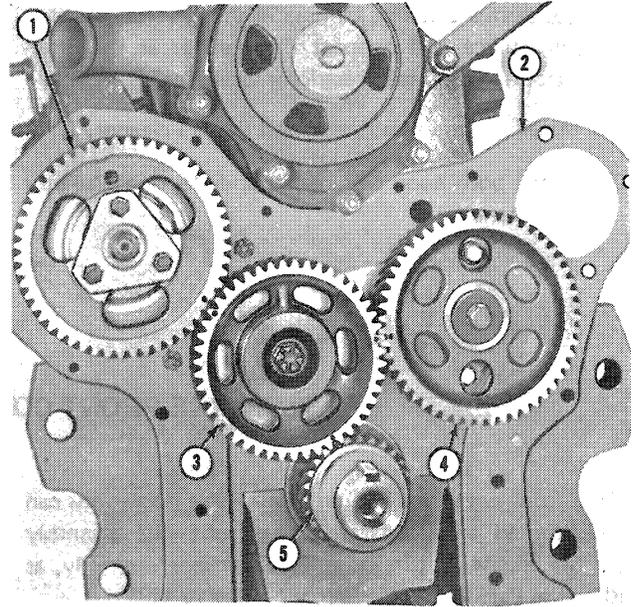


Figure 25
Timing Gears

1. Injection Pump Gear
2. Front Cover Plate
3. Camshaft Drive Gear
4. Camshaft Gear
5. Crankshaft Gear

CHECKING TIMING GEAR BACKLASH

1. The timing gears are shown in Figure 25. The gears are correctly assembled when the timing marks on the gear teeth line up, as shown in the illustration, with the No. 1 piston on TDC.
2. Check the backlash of the gears with a dial indicator or a feeler gauge, as shown in Figure 26.
3. Check between the camshaft drive gear and camshaft gear as shown, and also between the injection pump gear and camshaft drive gear. Also check between the crankshaft gear and camshaft drive gear.
4. Check the backlash at four equidistant points on the gears.
5. If the backlash is within specifications, page 70, the gears are suitable for reinstallation. If not, install new gears.

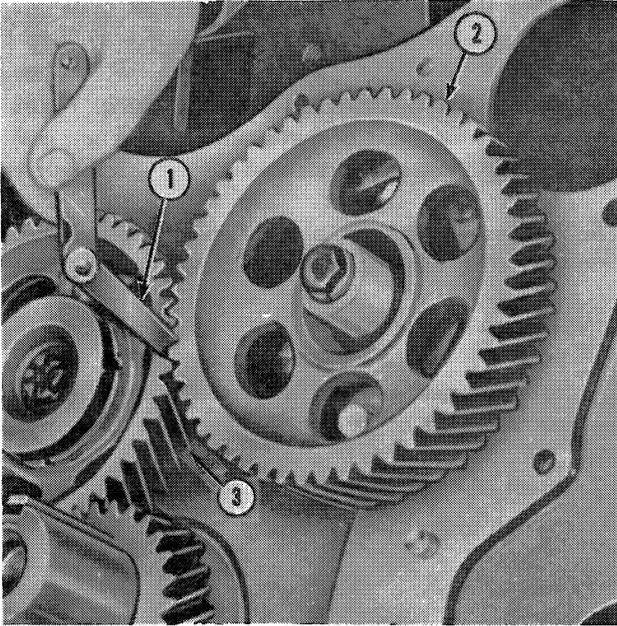


Figure 26

Checking Timing Gear Backlash

1. Feeler Gauge
2. Camshaft Gear
3. Camshaft Drive Gear

INJECTION PUMP GEAR

A. REMOVAL

1. Turn the crankshaft until the camshaft gear is in the approximate timed position, Figure 27.
2. Remove the three attaching bolts that retain the injection pump gear, Figure 27, to the pump adapter plate and remove the gear.

B. CLEANING AND INSPECTION

1. Clean the gear in solvent.
2. Inspect gear teeth for scores and nicks and the condition of the teeth contact pattern.
3. Use a carborundum stone to remove minor gear teeth imperfection. If gear teeth wear or damage is severe install a new gear.

C. INSTALLATION

1. Time the engine before installing the injection pump gear. To do this remove the camshaft drive gear, place No. 1 piston at top dead center, and

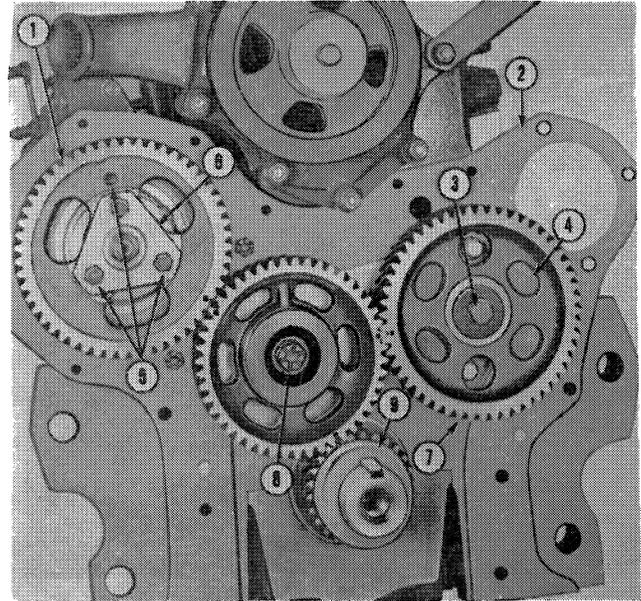


Figure 27

Engine Front Cover Removed

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

reinstall the camshaft drive gear in mesh and the timing marks aligned to the other gears as shown in Figure 27. Tighten the camshaft drive gear adapter bolt to the specified torque, page 76.

2. Install the new injection pump gear on the pump adapter plate, with the timing mark aligned.
3. Install the three bolts and the adapter plate and tighten to the specified torque, page 76.

CAMSHAFT DRIVE GEAR AND ADAPTER

A. REMOVAL

1. Remove the self-locking bolt that retains the camshaft drive gear and adapter to the cylinder block.
2. Remove the adapter and camshaft drive gear. Refer to Figure 28.

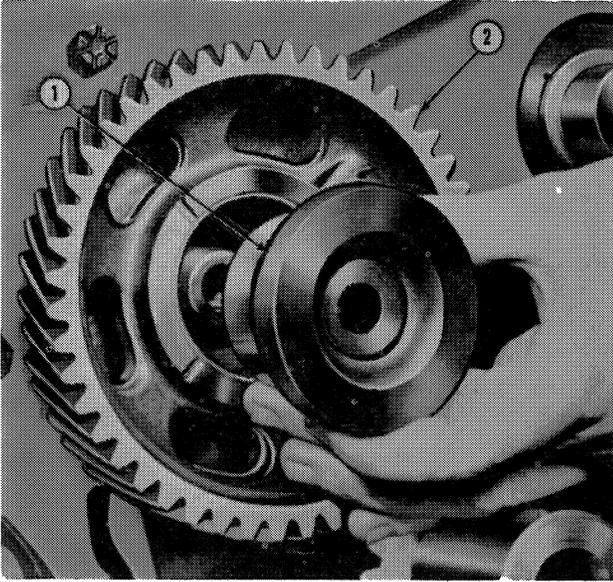


Figure 28

Removing Camshaft Drive Gear Adapter

1. Adapter
2. Camshaft Drive Gear

B. CLEANING AND INSPECTION

1. Clean the gear and adapter in solvent.
2. Inspect gear teeth for scores and nicks and the condition of the teeth contact pattern. Use a carborundum stone to remove minor gear teeth imperfections. If tooth wear or damage is severe install a new gear.

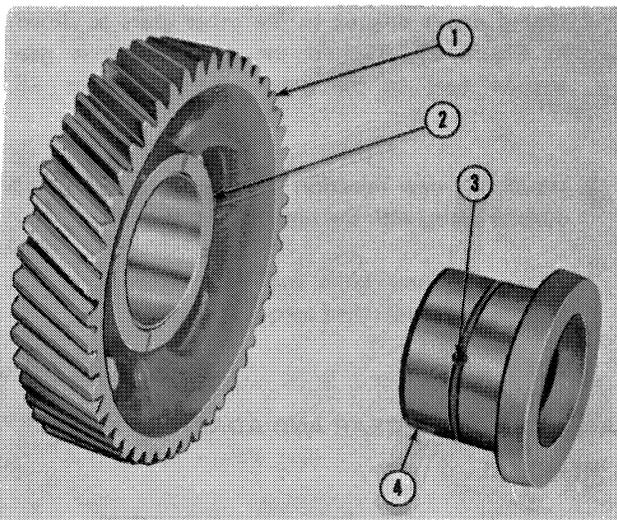


Figure 29

Camshaft Drive Gear And Adapter

- | | |
|------------------------|----------------|
| 1. Camshaft Drive Gear | 3. Oil Passage |
| 2. Bushing | 4. Adapter |

3. Check the adapter oil passage, Figure 29, to be sure that it is clear.
4. Inspect the camshaft drive gear bushing, Figure 29, for wear, nicks or burns, and install a new gear if any of these conditions exist.
5. If excessive backlash, page 17, existed in the gears when checked, install a new gear.

C. INSTALLATION

1. Install the gear and adapter in mesh with the timing marks aligned.
2. Install the adapter self-locking bolt and tighten the bolt to the specified torque, page 76.

CRANKSHAFT GEAR

The crankshaft gear should only be removed if it shows signs of wear or chipping.

A. REMOVAL

Remove the crankshaft gear with Crankshaft Gear Remover-Replacer, No. SW 501 with Insert SW 501-1, or Remover No. CPT 6040, as shown in Figure 30.

B. CLEANING AND INSPECTION

1. Clean the gear in cleaning solvent.
2. Inspect the gear teeth for scores and nicks, and the condition of the teeth wear pattern.
3. Check the crankshaft keyway to be sure it is in good condition.
4. Check the key. If there is any evidence of distortion or chipping, use a new key when installing the gear. Install a new gear if wear or damage is evident.

C. INSTALLATION

1. Drive the key into the keyway until it is seated.
2. Install the crankshaft gear with Crankshaft Gear Remover-Replacer No. SW 501 with Insert SW 501-1, or Replacer No. CT 6069, as shown in Figure 30.

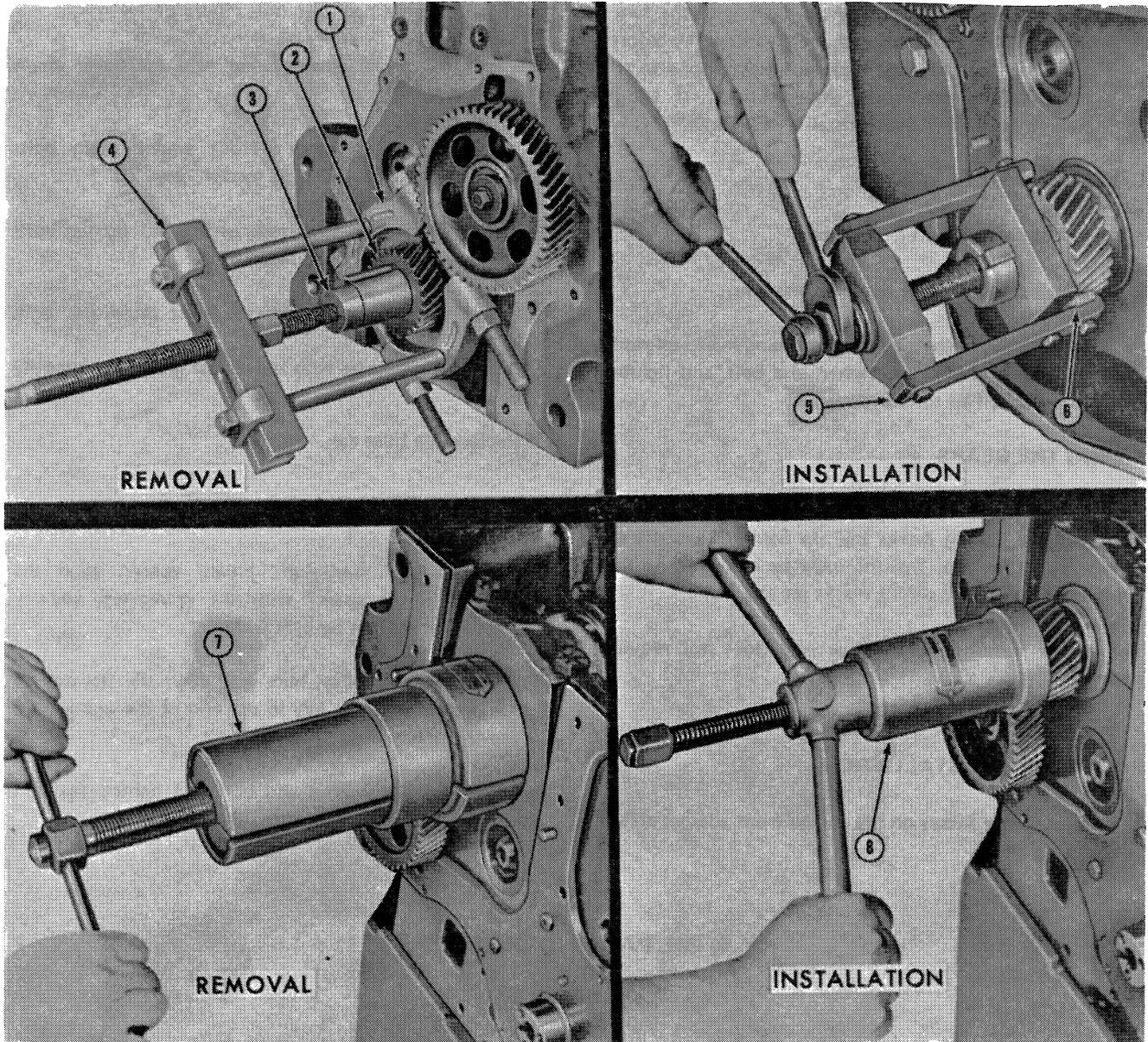


Figure 30
Removing And Installing Crankshaft Gear

1. Tool No. 951
2. Crankshaft Gear
3. Tool No. 625-1
4. Tool No. 927

5. Remover - Replacer SW 501
6. Insert SW 501-1
7. Remover CPT 6040
8. Replacer CT 6069

CAMSHAFT GEAR

A. REMOVAL

1. Remove the retaining bolt and washer, Figure 27.
2. Remove the camshaft gear from the end of the shaft.

B. CLEANING AND INSPECTION

1. Clean the gear in solvent.
2. Inspect gear teeth for scores and nicks, and the condition of the teeth wear pattern.

3. Check the keyway and key on the end of the camshaft. If the key is damaged, install a new key before installing the gear. Use a carborundum stone to remove minor gear teeth imperfections. If tooth wear or damage is severe install a new gear.

C. INSTALLATION

1. Install the camshaft gear spacer.
2. Install the key in the camshaft keyway.
3. Install the camshaft gear, with timing marks aligned, the flat washer, lock washer, and bolt, and tighten to the specified torque, page 76.

TIMING THE GEARS

When removing or installing any of the timing gears, be sure that the timing marks line up correctly, as shown in Figure 27. The No. 1 piston must be at T.D.C. on the firing stroke when the timing marks are aligned.

The power steering pump drive gear does not require timing.

FRONT COVER INSTALLATION

1. Position a new gasket on the engine front adapter plate.

2. Install the oil slinger dish out, Figure 27.
3. Install the front cover, being sure the cover aligns with the dowel pins.
4. Install the front cover-to-front engine plate bolts and tighten to the specified torque, page 76.
5. Install the oil pan with new gasket and tighten bolts to the specified torque, page 76.
6. Install the alternator support front mounting bolt.
7. Refill the crankcase with the proper grade and quantity of oil.
8. Replace the filler cap.

CRANKSHAFT PULLEY INSTALLATION

1. Lubricate the crankshaft pulley spacer, align the keyway in the spacer with the crankshaft keyway and slide it back as far as it will go.
2. Lubricate the pulley hub and align the keyway in the pulley with the key in the end of the crankshaft. Tap the pulley onto the crankshaft.
3. Install the flat washer and bolt and tighten the bolt to the specified torque, page 76.

4. OIL PAN AND OIL PUMP

OIL PAN

A. REMOVAL

IMPORTANT: *Take due care when removing the oil pan because of its weight. Use a jack or sling to support the pan.*

The oil pan on the Ford 8700 and 9700 Tractors can be removed by replacing the cylinder block-to-front support bolts one at a time with 8-inch long bolts. The purpose of installing these bolts is to safely allow the front support and radiator assembly to be eased forward approximately 1-1/2 inches (38.1 mm) to facilitate removal of the two sump front bolts.

1. Drain the engine oil and remove the engine oil level dipstick.

2. Support the tractor with a jack under the transmission and a hoist or crane at the front support and radiator assembly.
3. Remove both hood side panels.
4. Remove the pre-cleaner from the air intake tube.
5. Remove the top hood panel and the radiator grille panels.
6. Drain the engine coolant.
7. Remove all lines and hoses between the radiator/coolers/condenser and the engine. This includes (1) air intake tube, (2) coolant hoses, (3) oil cooler lines, (4) air conditioner lines, (5) hydraulic oil hoses, and (6) power steering oil lines.

8. Remove the main fuel tank front support bolts.
9. Remove the two bolts that attach each side frame member to the front support.
10. Move the front support assembly forward sufficient to remove the front oil pan bolts and oil pan.
11. Remove the two bottom transmission-to-engine attaching bolts.

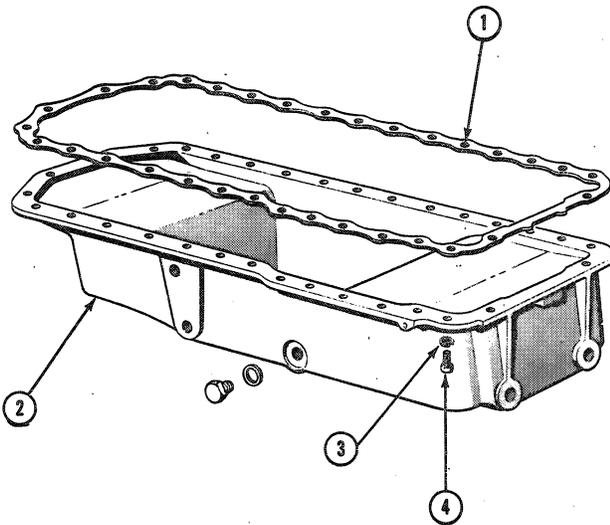


Figure 31
Oil Pan

- | | |
|------------|-------------------|
| 1. Gasket | 3. Lockwasher |
| 2. Oil Pan | 4. Attaching Bolt |

12. Support the oil pan. Remove the 31 attaching bolts and lock washers holding the pan to the engine. Refer to Figure 31.

B. CLEANING AND INSPECTION

1. Scrape all dirt and metal particles from the inside of the pan.
2. Scrape all gasket material from the gasket surface.
3. Wash the oil pan in a solvent and dry thoroughly.
4. Check the pan for cracks, holes, damaged drain plug threads, or a nicked or warped gasket surface.
5. Repair any damage, or install a new pan if repairs cannot be made.

C. INSTALLATION

To install the oil pan to an engine installed in a tractor, reverse the procedure on page 22, paying attention to the following points.

1. Be sure that the gasket surfaces on the oil pan and block are clean.
2. Position the gasket on the cylinder block and apply a thin film of gasket sealer on the gasket, front cover, and the oil pan.
3. Hold the pan against the block and install a bolt in each corner of the oil pan. Tighten the bolts by hand so they are finger tight.
4. Install the remaining bolts and tighten the rear bolts first. Then, tighten from the middle outward in each direction to the specified torque, page 76.
5. Assemble the front of the tractor to the engine. Install the two bottom engine-to-transmission bolts and spacers, if equipped.
6. Install the oil level dipstick, tighten the drain plug, and fill the crankcase with the proper grade and quality engine oil.
7. Operate the engine and check for oil leaks.

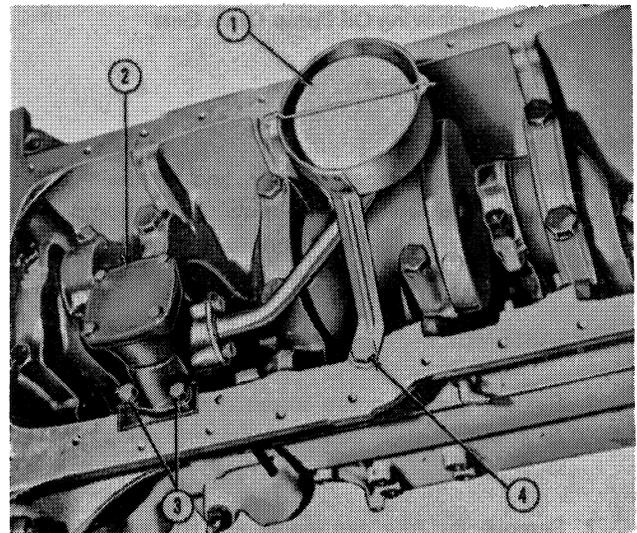


Figure 32
Oil Pump And Filter Screen

1. Filter Screen
2. Oil Pump
3. Pump Retaining Bolts
4. Support Bracket Bolt

OIL PUMP

A. REMOVAL

1. Remove the oil pan, as outlined under "A. Oil Pan Removal", page 20. Refer to Figure 31.
2. Remove the oil pump retaining bolts, and the filter screen support bracket bolt, Figure 32, and remove the oil pump and gasket. When the oil pump is removed, the intermediate shaft is loose and should be removed.

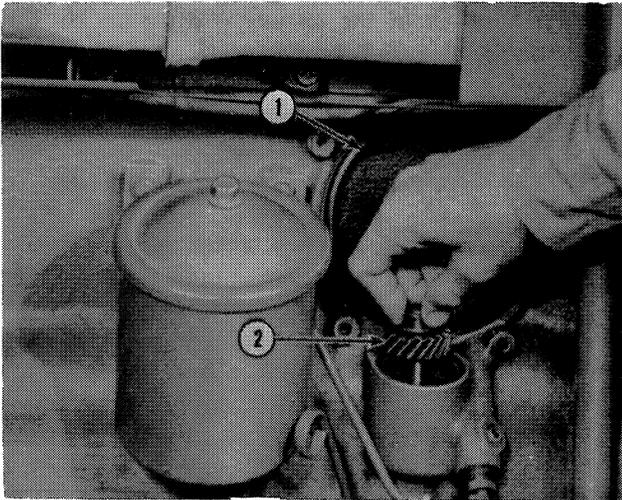


Figure 33
Removing Oil Pump Drive Gear

1. Filter Location
2. Drive Gear And Shaft

3. Remove the engine oil filter, and oil drain shield, when fitted, to gain access to the oil pump drive gear and shaft cover. Remove the cover and the drive gear and shaft, Figure 33.

B. DISASSEMBLY

1. Remove the oil pump screen, inlet tube and cover assembly, Figure 32, by removing the two bolts securing it.
2. Remove the four cap screws and remove the pump cover, Figure 34. Remove the rotor and shaft assembly and the outer rotor.
3. Insert a self-tapping screw of the proper diameter into the hole in the relief valve plug and pull the plug out of the chamber. Remove the spring and relief valve, Figure 34.

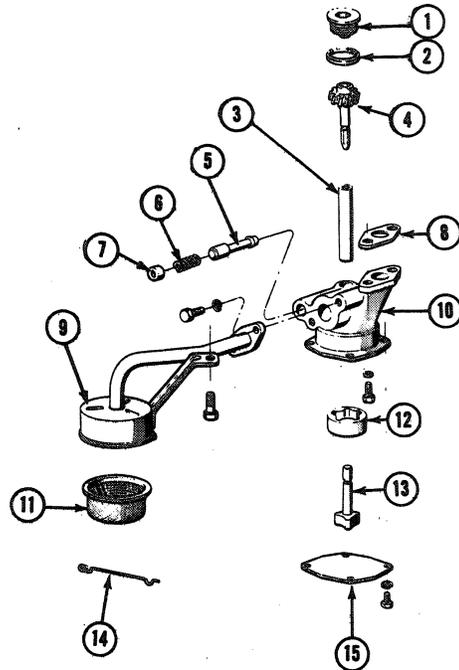


Figure 34
Oil Pump Disassembled

1. Stop
2. Gasket
3. Intermediate Shaft
4. Drive Gear
5. Relief Valve
6. Spring
7. Plug
8. Gasket
9. Inlet Tube & Cover Assembly
10. Pump
11. Oil Pump Screen
12. Outer Rotor
13. Rotor & Shaft Assembly
14. Screen Spring
15. Pump Cover

C. CLEANING AND INSPECTION

1. Wash all parts in solvent and dry thoroughly. Use a brush to clean the inside of the pump housing and the pressure relief valve chamber. Be sure all dirt and metal chips are removed.
2. Check the inside of the pump housing and the rotor and shaft assembly for excessive wear.
3. Check the inside face of the pump cover for wear or score marks. If these conditions exist, install a new cover.

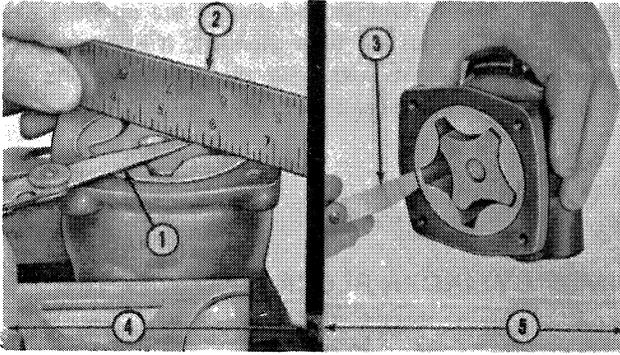


Figure 35
Checking Oil Pump Clearance

1. Feeler Gauge
2. Straight Edge
3. Feeler Gauge
4. Pump Cover To Rotor
5. Pump Body To Rotor

4. With the rotor and shaft assembly installed in the pump body, place a straight edge over the rotor and shaft assembly and the pump body. Measure the clearance between the straight edge and the inner rotor and shaft assembly and between the straight edge and the outer rotor, Figure 35. If the measurement is not within specifications, page 75, install a new rotor assembly.

NOTE: *The shaft and rotor are serviced only as an assembly.*

5. Measure the rotor-to-housing clearance by inserting feeler blades between the rotor and the housing. Take the measurements at four places, 90° apart. If the measurements are not within specifications, page 75, install a new rotor assembly. Remeasure clearances with the new rotor assembly in the pump body. If the measurements are still not within specifications install a new pump body.
6. Check the relief valve spring tension. If the spring tension is not within specifications, page 75, install a new spring.
7. Check the relief valve for score marks and be sure it is free to move within the bore.
8. Check the oil pump drive gear for worn or broken teeth. If any of these conditions exist, install a new drive gear and shaft assembly.

9. Check the intermediate drive shaft to be sure the hexagon socket ends are not excessively worn.

D. ASSEMBLY

The oil pump assembly is shown in Figure 34.

1. Oil all the parts thoroughly.
2. Install the oil pressure relief valve and spring, and drive in a new plug.
3. Install the rotor and shaft and outer rotor into the pump body. The rotor and shaft assembly and outer race are serviced as an assembly. One part should not be replaced without replacing the other.
4. Install the pump cover and screen cover together and tighten the four cap screws to the specified torque, page 75.
5. Install the screen assembly and secure it with the screen spring.

E. INSTALLATION

1. Prime the pump by filling the inlet port with clean engine oil. Rotate the pump shaft to distribute oil within the pump body.
2. Place the intermediate shaft on the rotor shaft and, using a new gasket, install the oil pump assembly on the cylinder block, Figure 32. Install the two mounting bolts and lock washers and tighten to the specified torque, page 76.
3. Install the filter support bolt. Tighten to the specified torque, page 76.
4. Install the pump drive gear and shaft, Figure 33. Install a new gear stop gasket and install the gear stop.
5. Install a new oil filter adapter if the adapter threads are damaged, a new oil filter cover gasket, and the oil filter assembly.
6. Install the oil pan.

The engine oil filter should be serviced every 300 hours on a Ford 8700 Tractor, and every 100 hours on a Ford 9700 Tractor. Operate the engine until it reaches normal operating temperature, then drain

the engine oil. Remove and discard the oil filter element and bypass oil filter element, if equipped. Install new elements and refill the crankcase with oil of the correct grade and specification.

5. CONNECTING RODS, BEARINGS, PISTONS, RINGS, CYLINDER BLOCK, AND SLEEVES

PISTON AND CONNECTING ROD ASSEMBLY

A. REMOVAL

1. Remove the cylinder head assembly as outlined on page 3.
2. Remove the oil pan .
3. Remove the oil pump assembly as outlined on page 22.

not to be used. However, it may be necessary to remove a ridge in order to remove an old piston.) When removing the cylinder ridge do not cut down into the ring travel more than 1/32 inch (0.793 mm). It is possible to cut so deeply into the cylinder wall and so far down into the ring travel that reboring, or the installation of a new engine block is necessary. Do not attempt to remove and reuse a piston from a cylinder with an excessive ridge. Forcing the piston past the ridge may break the lands on the piston or the ridge.

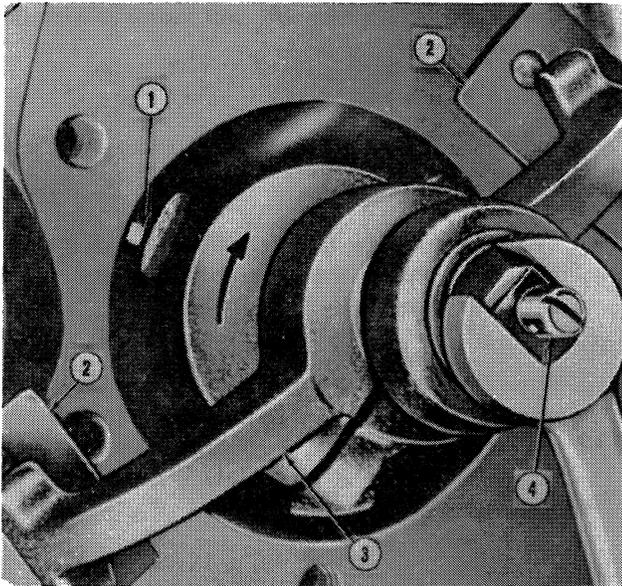


Figure 36
Removing Cylinder Ridge

1. Cutter Blade
2. Shoe
3. Reamer
4. Adjusting Screw

4. If necessary, remove the ridge from the top of each cylinder with a cylinder ridge reamer or a hand scraper, Figure 36. (Ridge removal is not necessary when reboring or if the old pistons are

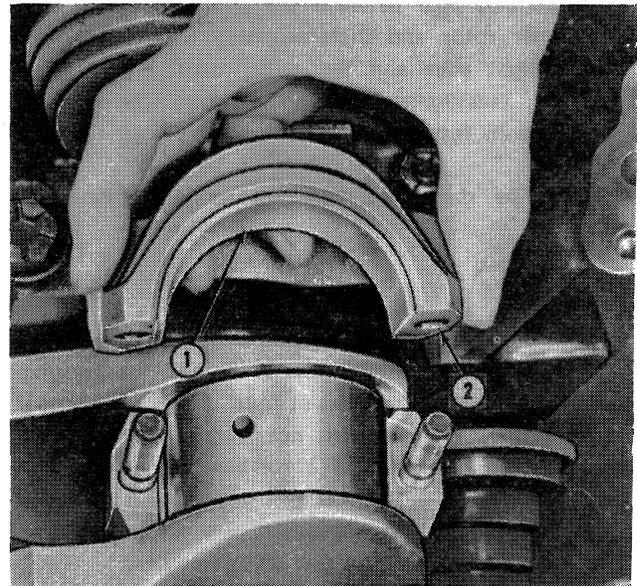


Figure 37
Removing Connecting Rod Bearing Cap

1. Bearing Liner
2. Rod Bearing Cap

5. Remove the nuts from the connecting rod bearing cap bolts of the piston that is at the bottom of its stroke. Remove the rod bearing cap and liner, Figure 37, from the rod. Push the piston and rod assembly away from the crank pin and remove the bearing liner from the rod. Push the rod and piston

assembly out of the top of the cylinder with the handle end of a hammer. Be careful not to scratch the crank pin or the cylinder. Turn the crankshaft to bring each piston to the bottom of its stroke and repeat this procedure. Keep the bearing caps and liners with their respective connecting rods.

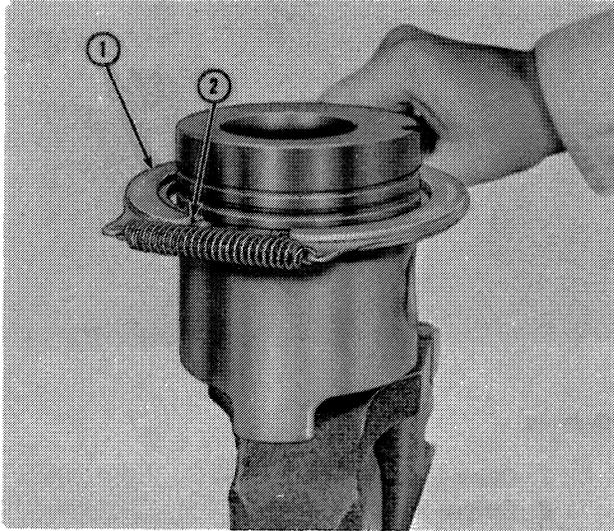


Figure 38
Removing Piston Ring

1. Piston Ring Expander
2. Piston Ring

6. Remove the piston rings from the pistons with a piston ring expander or other suitable means. See Figure 38.

B. DISASSEMBLY

1. Remove the piston pin snap ring (circlip) from each side of the piston and remove the pin.
2. Identify each piston to be sure it will be assembled to the rod from which it was removed.

C. CLEANING

Clean the piston ring grooves with a piston ring groove cleaner, Figure 39. Be careful not to scratch or remove metal from the groove sides. Place the piston assembly in liquid cleaner, if available, to soften carbon and lead deposits. Clean the rod bore and the back of the connecting rod bearing liners thoroughly. Dry the parts with compressed air. Do not use a wire brush.

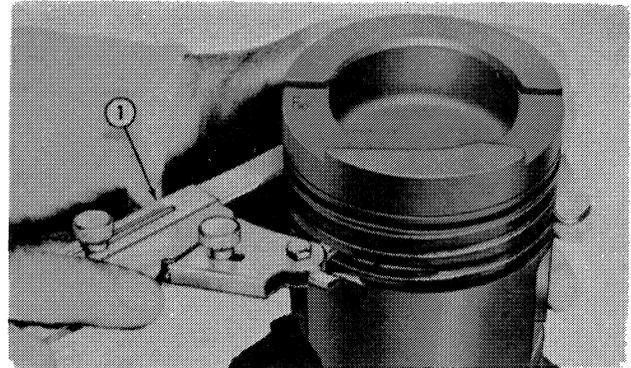


Figure 39
Cleaning Piston Ring Grooves

1. Piston Ring Groove Cleaner

D. INSPECTION

CONNECTING RODS

1. Inspect the connecting rods for signs of damage and the bearing bores for out-of-round and taper. If the bore exceeds the recommended limits or is damaged, install a new connecting rod.
2. Check the connecting rod nuts and bolts. Replace any part that shows signs of wear or damage. Always use new connecting rod bearing cap nuts.
3. Check piston pin bushings for wear or damage. Measure outside diameter of piston pin and inside diameter of piston pin bushing. If bushing is damaged, or if the measurements indicate that a clearance between the bushing and the pin is not between 0.0005-0.0007 in. (0.0127-0.01778 mm.), the bushings must be removed.

NOTE: *If a new piston pin bushing is installed, it must be reamed to provide the clearance above.*

4. A shiny surface on the pin boss side of the piston will usually indicate that a connecting rod is bent. Abnormal connecting rod bearing wear is also an indication of bent connecting rods. Twisted connecting rods will not create an easily identifiable wear pattern, but badly twisted rods will disturb the action of the entire piston assembly. Refer to page 27 under "Connecting Rod Alignment."

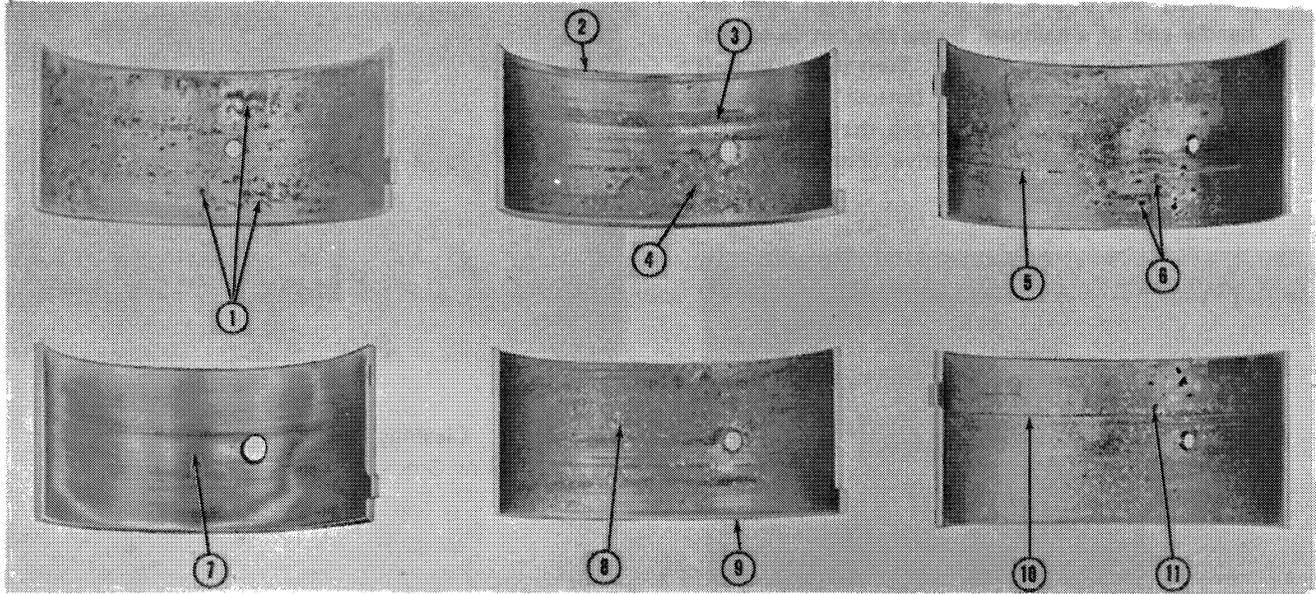


Figure 40
Typical Defective Bearings

- | | |
|-----------------------|---------------------|
| 1. Craters Or Pockets | 7. Overlay Worn Out |
| 2. Radii Ride | 8. Fatigue Failure |
| 3. Scratches | 9. Radii Ride |
| 4. Dirt | 10. Scratches |
| 5. Scratches | 11. Imbedded Dirt |
| 6. Imbedded Dirt | |

CONNECTING ROD BEARINGS

1. If the bearing liners are scored, have the flash overlay wiped out, show fatigue failure, or are badly scratched, as shown in Figure 40, install new bearing liners.
2. If the bearing liners appear to be serviceable, keep them with their respective rods for reassembly in the engine. If the clearance exceeds the specified limits, page 72, new bearings must be installed. Undersize connecting rod bearings are available in 0.002 in. (0.0508 mm.), 0.010 in. (0.254 mm.), 0.030 in. (0.762 mm.), and 0.040 in. (1.016 mm.) for service. If new bearings are required, follow the procedure covered on page 43 for fitting.

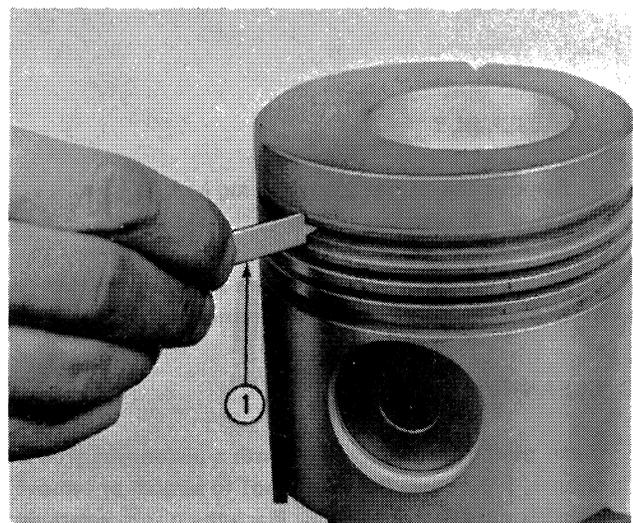


Figure 41
Checking Top Ring Groove

1. Keystone Gauge

PISTONS

1. Inspect pistons for damage and wear at the ring grooves, piston skirt and piston pin bosses.