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# FORD



## Service Manual

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Tractors

TW-10, TW-20, TW-30

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**REPAIR MANUAL**  
**for**  
**TW-10, TW-20**  
**and TW-30**  
**TRACTORS**

**Ford Tractor Operations**

**Ford Motor Company**

SE 3734

Printed in U.S.A.

# FOREWORD

This manual provides information for the proper servicing of the Ford TW-10, TW-20 and TW-30 Tractors. The information is essential for all mechanics and will be especially meaningful to those who have attended the Training Programs for the TW-10, TW-20 and TW-30 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



## SAFETY PRECAUTIONS

*Appropriate service methods and proper repair procedures are essential for the safe, reliable operation of all motor vehicles as well as the personal safety of the individual doing the work. This Shop Manual provides general directions for accomplishing service and repair work with tested, effective techniques. Following them will help assure reliability.*

*There are numerous variations in procedures, techniques, tools, and parts for servicing vehicles, as well as in the skill of the individual doing the work. This Manual cannot possibly anticipate all such variations and provide advice or cautions as to each. Accordingly, anyone who departs from the instructions provided in this Manual must first establish that he compromises neither his personal safety nor the vehicle integrity by his choice of methods, tools or parts.*

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# PART 1

## ENGINE SYSTEM

### Chapter 1

#### ENGINE AND LUBRICATION SYSTEM

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#### 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 referred to as a square engine.

This part of the manual deals with the disassembly, inspection, repair, and assembly of the engine, lubrication system and 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 chamber is in the head of the piston.

## 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. The oil filler tube and the dipstick are both located on the right side of the engine.

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 gear rotor-type oil pump, driven from the crankshaft through an idler gear, is mounted on the front cover plate. It takes oil from the deepest part of the oil pan through an 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.

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 and the fuel injection pump overflow.

Cylinder walls and pistons are splash-lubricated by the crankshaft on the TW10. Piston pins are splash-lubricated on the TW10; pressure-lubricated on the TW20 and 30 tractors. 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 heat exchange manifold is mounted on the left side of the engine block. The engine oil is cooled by water as it is pumped through the exchange manifold. Two screw-on oil filters attached to the manifold filter the engine oil.

## 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 and the fuel tank cap.
2. **TW10 and 20:**  
Remove the two side panels, three radiator grille panels and the hood panel, Figure 1.
3. **TW10:**  
**Muffler** — Unbolt the muffler pipe from the exhaust manifold and remove the muffler, muffler support bracket and muffler pipe from the tractor.

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

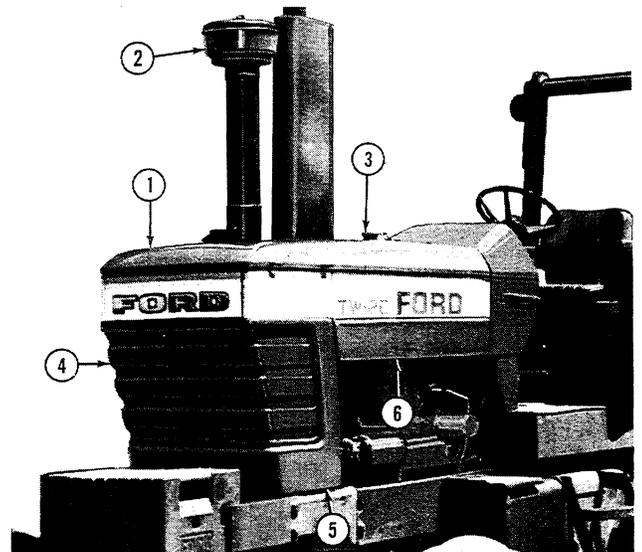
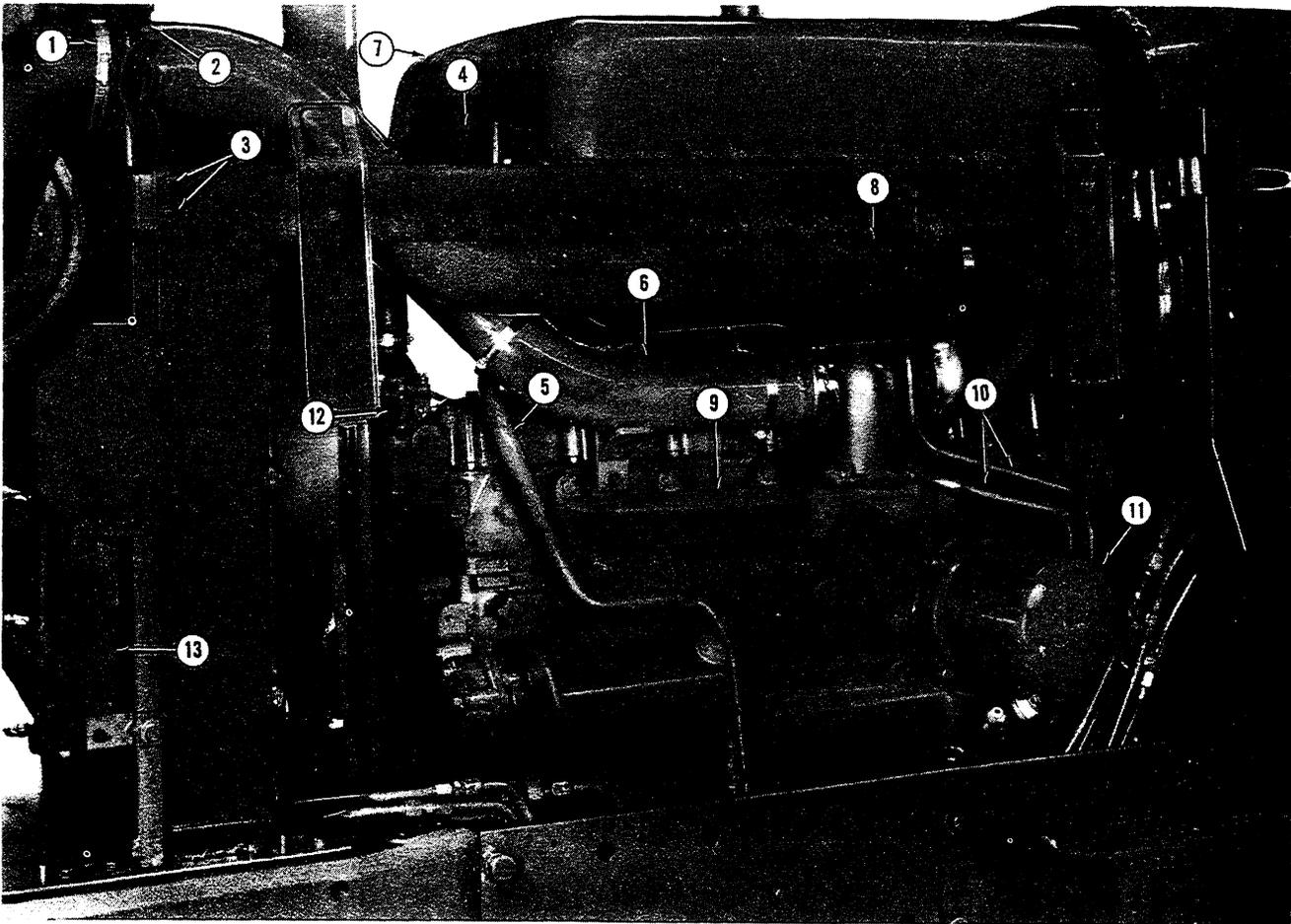


Figure 1  
Sheet Metal

- |                |                 |
|----------------|-----------------|
| 1. Hood Panel  | 4. Front Grille |
| 2. Pre-Cleaner | 5. Side Grille  |
| 3. Fuel Cap    | 6. Side Panel   |



**Figure 2**  
**Access to Engine**

- |                            |                                 |
|----------------------------|---------------------------------|
| 1. Air Cleaner Clamp       | 8. Air Intake Tube              |
| 2. Flange Bolts            | 9. Exhaust Manifold             |
| 3. Fuel Tank Bracket Bolts | 10. Turbo Lube Tubes            |
| 4. Muffler Support Bracket | 11. Engine Oil Filter (Spin-On) |
| 5. Breather Tube           | 12. Thermostat Housing          |
| 6. Turbo-to-Muffler Tube   | 13. Hydraulic Oil Cooler        |
| 7. Main Fuel Tank          |                                 |

**TW20:**

**Muffler** — Remove the muffler. Remove the heat shield from the muffler-to-turbocharger tube. Remove the tube, Figure 2.

**Air Cleaner** — Remove the air intake pipe from the turbocharger to the radiator support. Remove the intake manifold hose, Figure 3.

**Turbocharger** — Remove the turbocharger oil lines. Remove the 4 bolts attaching the turbocharger to the exhaust manifold. Remove two turbocharger oil cooler bracket bolts. Remove the turbocharger. Plug all turbocharger openings to prevent the entry of dirt. See Figure 2.

**4. TW 10 and 20:**

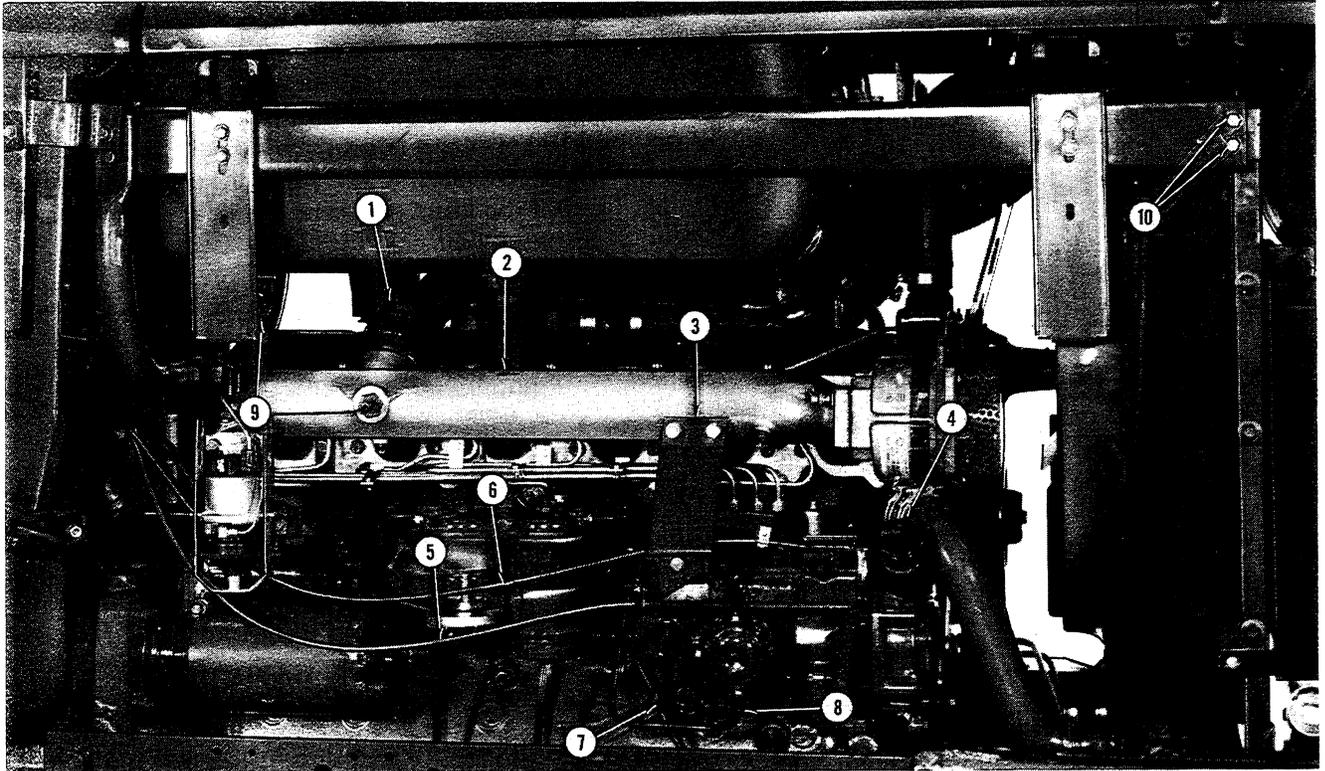
Shut off the fuel at the main fuel tank, Figure 3.

5. Disconnect the wiring harness at the alternator and air intake sensor. Remove the harness from the fuel tank bracket.

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 4.

8. Remove the fan brace.



**Figure 3**  
**Engine Access (TW20)**

- |                         |                             |
|-------------------------|-----------------------------|
| 1. Intake Manifold Hose | 6. Throttle Cable           |
| 2. Intake Manifold      | 7. Engine Oil Dipstick      |
| 3. Support Bracket      | 8. Fuel Line                |
| 4. Oil Filler Cap       | 9. Fuel Shut-Off Valve      |
| 5. Fuel Shut-Off Cable  | 10. Fuel Tank Support Bolts |

**TW30:**

1. Remove the two side panels, grille and hood panel, Figure 5.

**Air Cleaner** — Remove 4 mounting bolts, aspirator hose and air cleaner to turbocharger tube. Remove the air cleaner, Figure 6.

**Intercooler** — Remove the grille support (11), Figure 6. Remove the air cleaner-to-turbo tube and hose. Disconnect the intercooler-to-turbo tube. Disconnect the aspirator hose. Remove the intercooler assembly (8 bolts).

**Turbocharger** — Remove the exhaust hose clamp. Remove the air intake clamp. Remove two oil tubes. Remove the turbocharger assembly (6 bolts). See Figure 7.

2. Remove the intercooler support bracket at the rear of the engine, Figure 8.

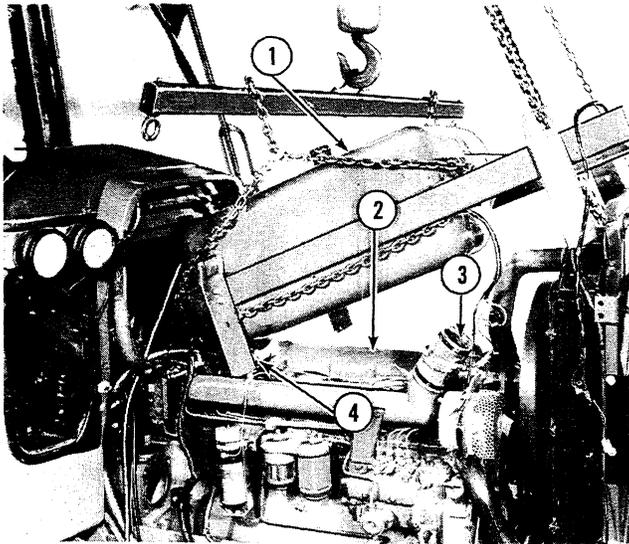
3. Remove the support bracket, fan and alternator bracket and water pump as required, Figure 9. Remove the water hoses.

**ALL TRACTORS**

4. Remove the 12 exhaust manifold bolts, the exhaust manifold and gasket.
5. 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.
6. Remove 14 intake manifold bolts, the intake manifold and gasket, Figure 3.
7. Remove the breather tube from the rocker cover.
8. Drain the engine coolant.

the order in which they were removed. It is important that the rods are installed in the same bores during reassembly.

15. 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.

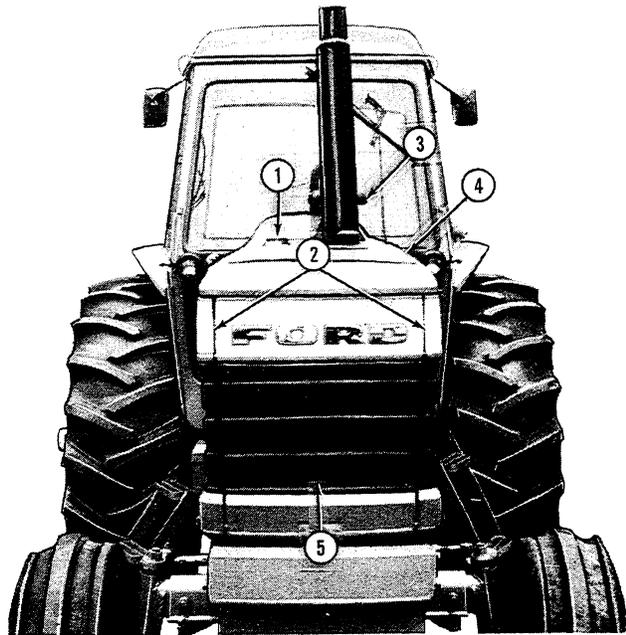


**Figure 4**  
**Access to Cylinder Head**

1. Main Fuel Tank
  2. Valve Cover
  3. Intake Manifold Air Inlet
  4. Fuel Shut-Off Valve
9. Remove the fuel filters and lines from the engine. Plug all openings to prevent the entry of dirt.
  10. Remove the rocker arm cover and gasket.
  11. Remove the injector leak-off line at No. 6 cylinder.
  12. 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.
  13. 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 10.

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

14. Remove the valve push rods from their holes in the cylinder head and arrange them in a rack in



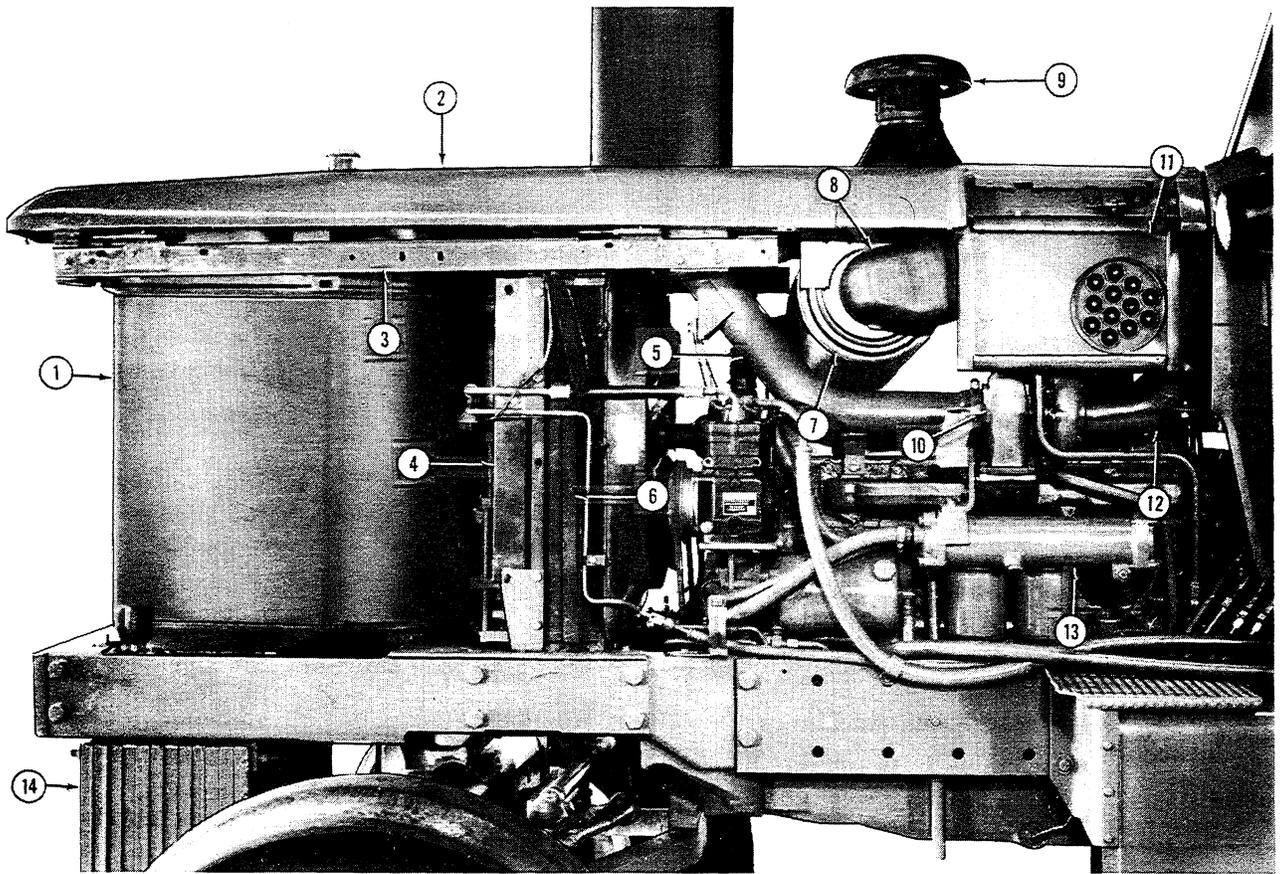
**Figure 5**  
**Sheet Metal (TW30)**

1. Fuel Tank Cap
2. Side Panels
3. Pre-Cleaner
4. Hood Panel
5. Grille

## B. DISASSEMBLY

1. Before removing the valves from the cylinder head, clean all carbon deposits from the valve heads.
2. Position the valve spring compressor over the valve and spring, as shown in Figure 11, and compress the spring.

**Intake Valves:** Remove the retainer locks, spring retainer, spring, and valve stem seal. The parts are shown in Figure 11.



**Figure 6**  
**Engine Access (TW30)**

- |                       |                                    |
|-----------------------|------------------------------------|
| 1. Fuel Tank          | 8. Air Cleaner-to-Intercooler Tube |
| 2. Hood Panel         | 9. Pre-Cleaner                     |
| 3. Side Panel Rail    | 10. Turbocharger                   |
| 4. Oil Cooler         | 11. Grille Support (Intercooler)   |
| 5. Turbo Exhaust Tube | 12. Intercooler-to-Turbo Tube      |
| 6. Radiator           | 13. Engine Oil Filter              |
| 7. Air Cleaner        | 14. Front Weights                  |

**Exhaust Valves:** Remove the retainer locks, the seal from its groove, and the valve rotator and spring. The parts are shown in Figure 13.

- 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

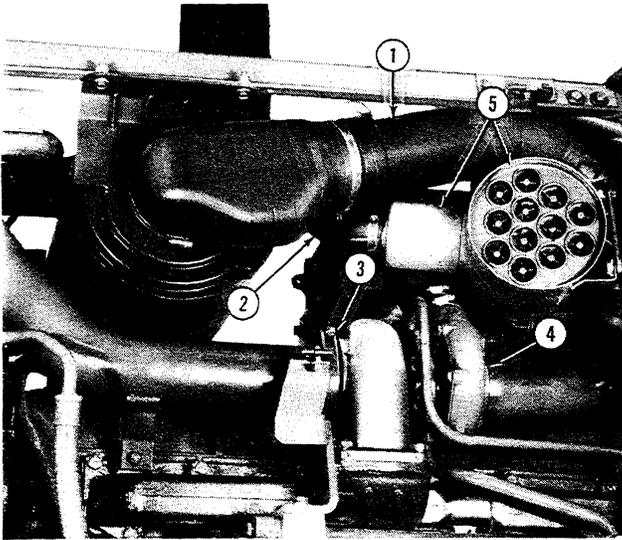
- After the valves are removed, clean the valve guide bores with a valve guide cleaning tool.

- 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.*

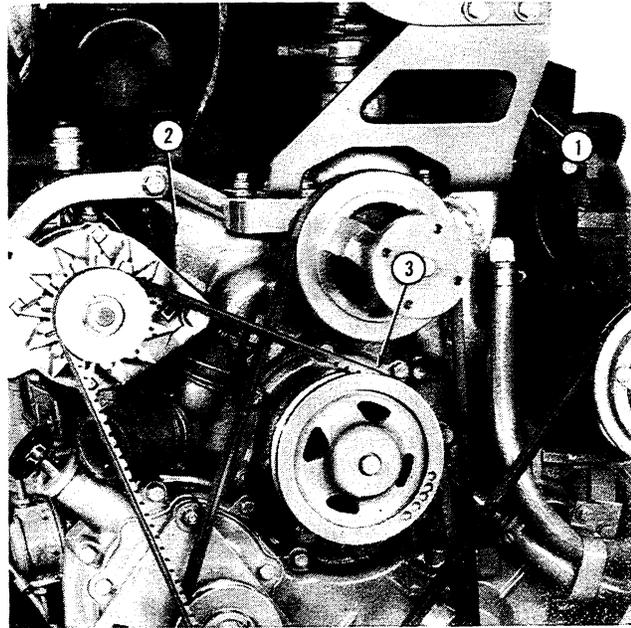
### D. INSPECTION AND REPAIR

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



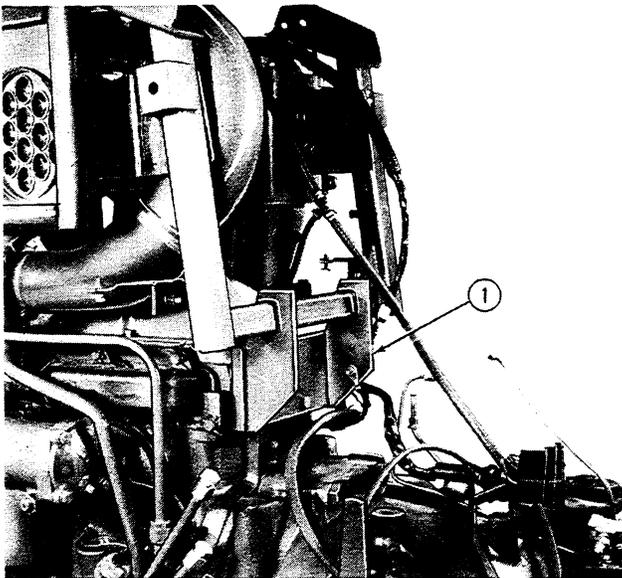
**Figure 7**  
**Turbocharger and Intercooler**

1. Air Cleaner-to-Turbo Tube
2. Aspirator Tube
3. Exhaust Clamp and Tube
4. Air Cleaner-to-Turbo Tubes and Clamps
5. Intercooler



**Figure 9**  
**Engine Access**

1. Bracket
2. Fan and Alternator Bracket
3. Water Pump



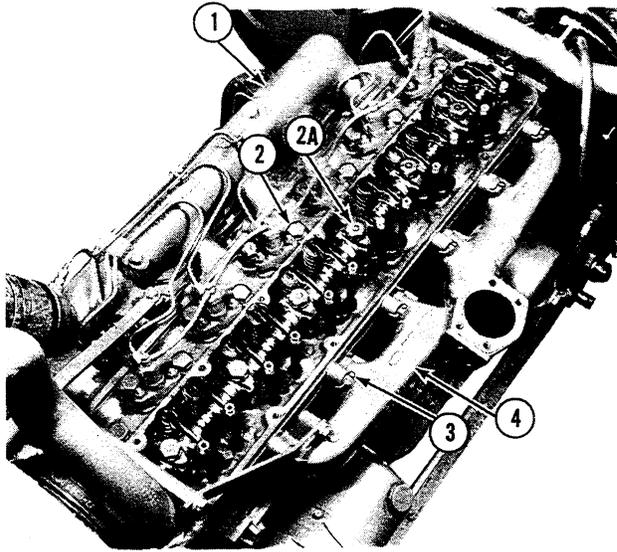
**Figure 8**  
**Engine Access**

1. Intercooler Support Bracket
2. With a straight edge and feeler gauge, check the flatness of the cylinder head, as shown in Figure 14. 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).

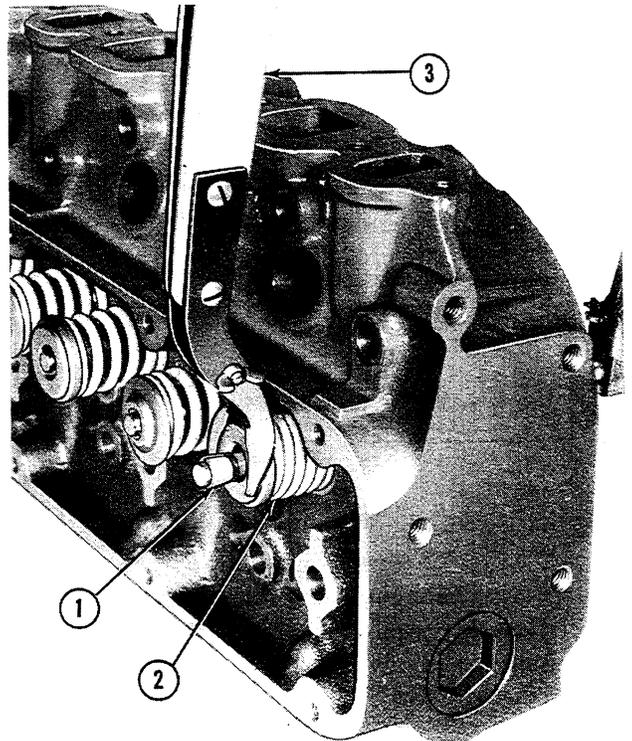
3. If the head has been skimmed, determine that all the head bolts will bottom. Place the cylinder head, less gasket, on the block and install and finger tighten all the head bolts (rocker arm shaft supports and washers should be used under the long bolts). Using a feeler gauge, check the clearance between 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 reinstalled in the hole 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 S010 OS and S020 OS on the exhaust manifold side of the cylinder head in line with the valve seat.



**Figure 10**  
**Top View of Engine**

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

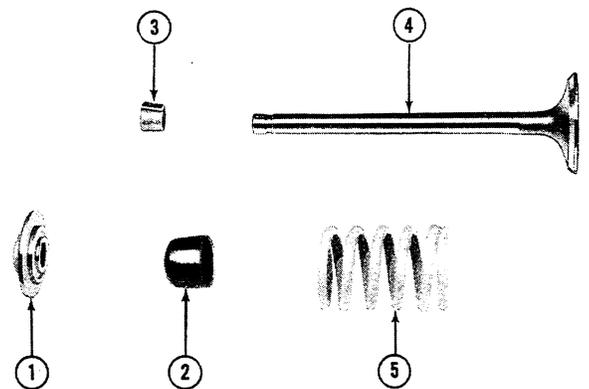


**Figure 11**  
**Removing Valves**

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

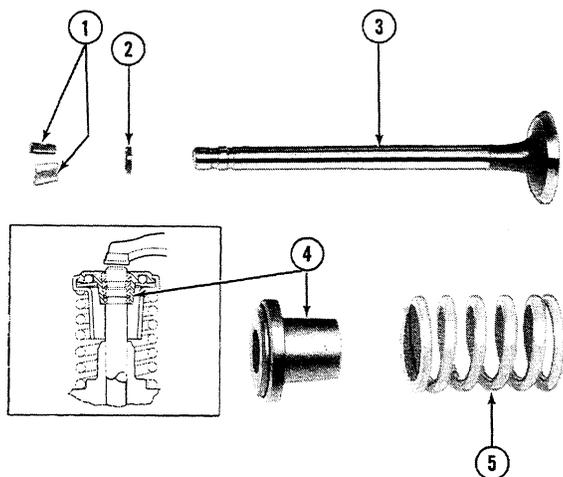
4. The intake and exhaust valve ports in the cylinder head are equipped with removable valve seat inserts. Remove and replace inserts that are cracked or loose, or that show excessive wear.
5. To install a larger insert than originally fitted, machine the counter bore for the seat in the cylinder head to the dimensions in Table 1, page 12. The insert must be thoroughly chilled in dry-ice before installation.
6. Measure the width of the valve seats, Figure 15, and reface the seats if they do not meet the specifications shown in Figure 17.
7. Measure the concentricity of the valve seat with a suitable gauge, as shown in Figure 16, or with Prussian Blue. If the valve seat runout exceeds .0015 in. (.0381 mm) reface the seat.

**NOTE:** Reface the valve seat and face at the same time so the finished measurements correspond to Figure 17.



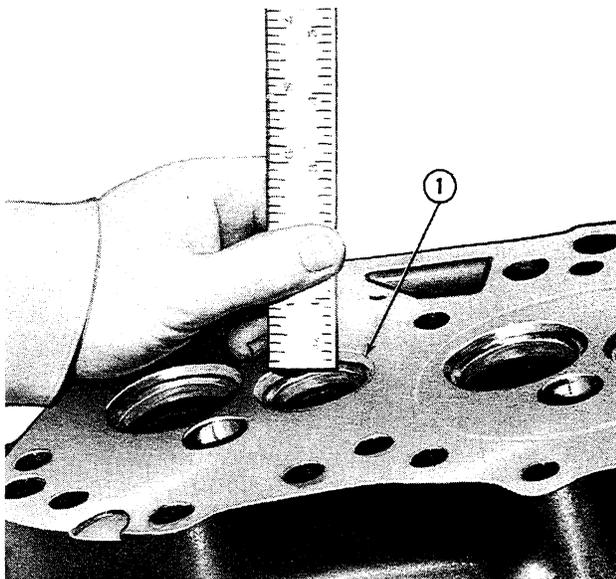
**Figure 12**  
**Intake Valve Assembly**

1. Retainer
2. Seal (TW10 Only)
3. Retainer Locks
4. Intake Valve
5. Spring



**Figure 13**  
**Exhaust Valve Assembly**

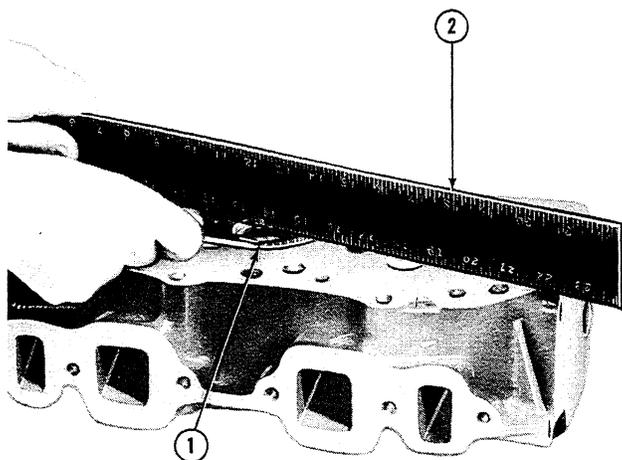
1. Retainer Locks
2. Seal
3. Exhaust Valve
4. Rotator
5. Valve Spring



**Figure 15**  
**Measuring Valve Seat Width**

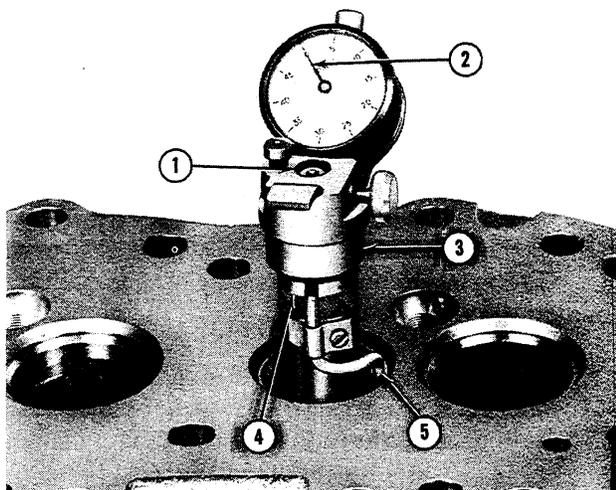
1. Valve Seat

Remove only enough stock from the seat to clean up the pits and grooves, or to correct the seat runout. 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.



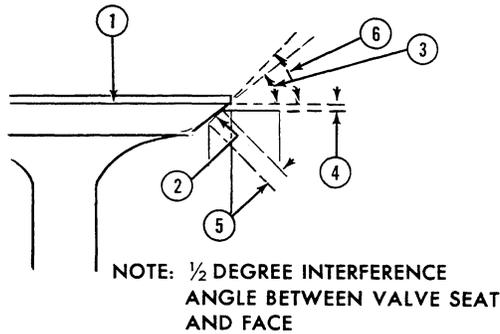
**Figure 14**  
**Measuring Cylinder Head Flatness**

1. Feeler Gauge
2. Straight Edge

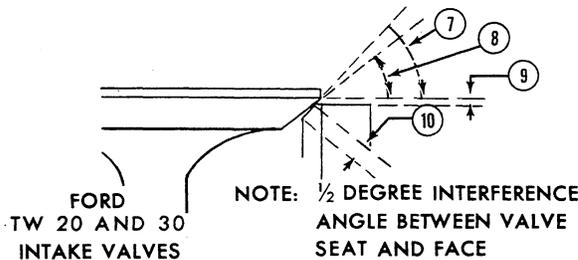


**Figure 16**  
**Checking Valve Seat Concentricity**

1. Tighten Pilot
2. Set Dial at "0"
3. Valve Seat Concentricity Gauge
4. Rotate Sleeve Clockwise and Read Dial
5. Set Point to Ride on Valve Seat Face



FORD TW 10 INTAKE AND EXHAUST VALVES  
FORD TW 20 AND 30 EXHAUST VALVES



FORD TW 20 AND 30 INTAKE VALVES

Figure 17  
Valve Face and Seat Angles

1. Valve Face
2. Valve Seat
3. Valve Face Angle — 44-1/2°
4. 1/32" (.79 mm)
5. Seat Width 3/32" (2.38 mm)
6. Valve Seat Angle — 45°
7. Valve Seat Angle — 30°
8. Valve Face Angle — 29-1/2°
9. 1/16" (1.59 mm)
10. Seat Width—3/32" ± 1/64" (2.38 ± .40 mm)

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.

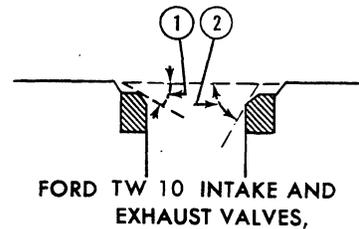
FORD TW10 INTAKE, FORD TW20 AND TW30 EXHAUST VALVES

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 18.

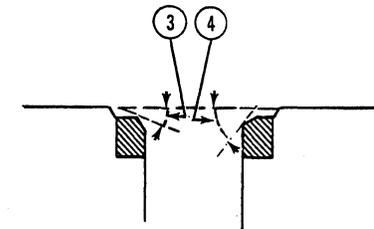
FORD TW20 AND 30 INTAKE VALVES

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 18.

**IMPORTANT:** Some 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 V015 OS as appropriate.



FORD TW 10 INTAKE AND EXHAUST VALVES,  
FORD TW 20 AND 30 EXHAUST VALVES



TW 20 AND 30 INTAKE VALVES

Figure 18  
Dressing Valve Seats

1. 30°
2. 60°
3. 15°
4. 30°
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. (0.0508-0.0139 mm).

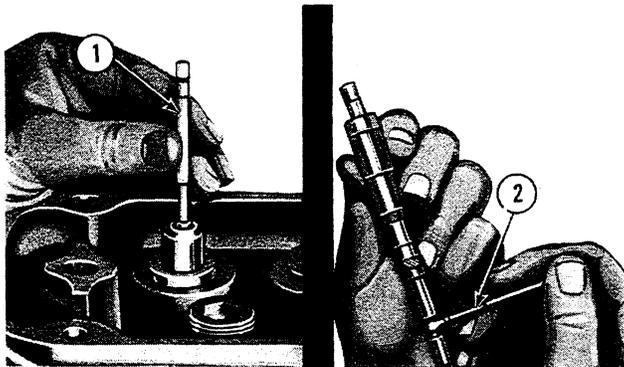
Measure stem-to-guide clearance with a telescoping gauge and micrometer, Figure 20. If not within tolerances, or if excessive oil consumption is indicated, replace the affected guides.

Valves with oversize stems are available for service. If it is necessary to ream valve guides to in-

stall 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.

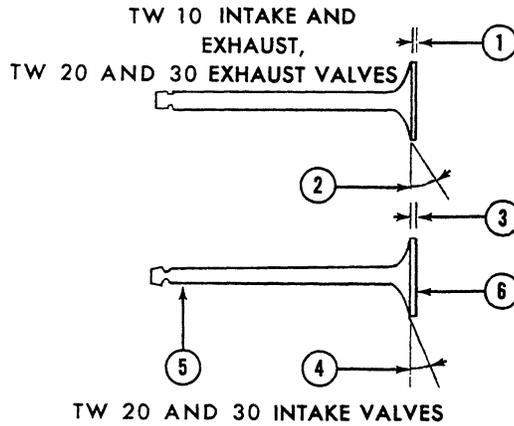
Reamer Diameter	Pilot Diameter
0.003 in. (0.0762 mm) oversize	Standard Diameter
0.015 in. (0.3810 mm) oversize	0.003 in. (0.0762 mm) oversize
0.030 in. (0.7620 mm) oversize	0.015 in. (0.3810 mm) oversize

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



**Figure 19**  
Measuring Valve Guide

1. Telescope Gauge
2. Micrometer



**Figure 20**  
Critical Valve Measurements and Inspection Checks

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

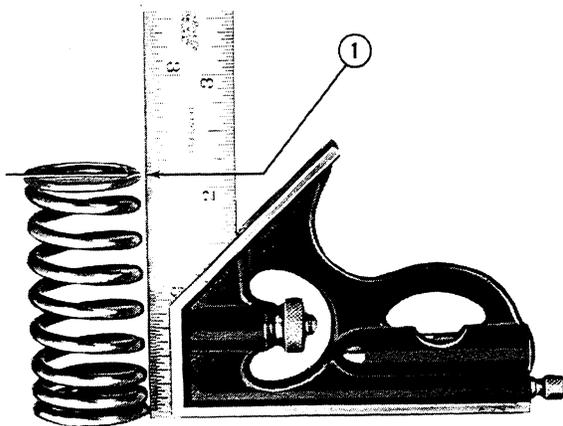
**TABLE 1**

Insert Oversize	Exhaust Valve Insert	Intake Valve Seat Insert
	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)

**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 21**

**Checking Valve Spring Squareness**

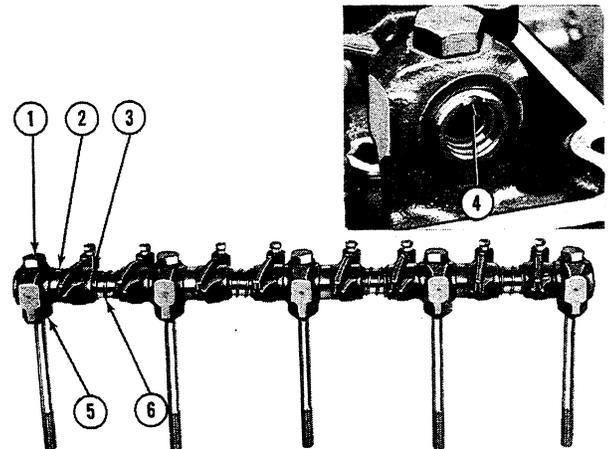
- 1. Not More Than 1/16" (1.59 mm)

Discard any valve springs that show signs of erosion or rust. Check each valve spring for squareness, such as shown in Figure 21. 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.



**Figure 22**  
**Rocker Arm Shaft**

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

**B. REFACING VALVES**

The valve refacing operation should be closely coordinated with the valve seat refacing operating so the finished angle of the valve is 1/2° less than the valve seat to provide an interference angle for better seating, Figure 17. Adjust the refacing tool to obtain a face angle of 44-1/2° or 29-1/2° as shown in Figure 18.

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 22.

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.

## 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 22.

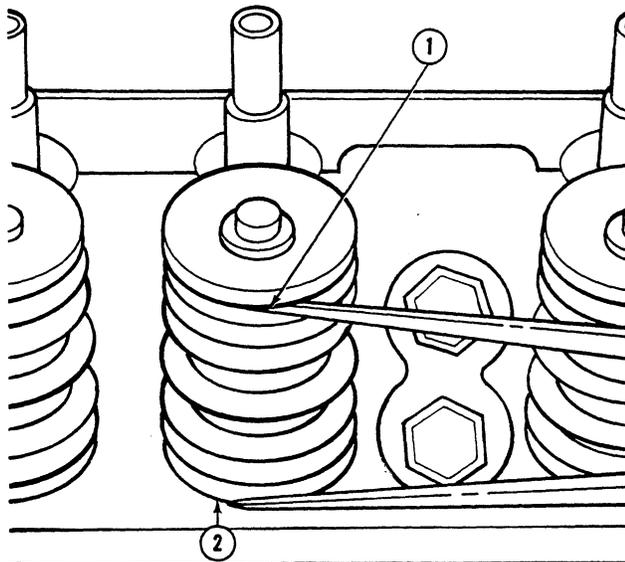
### B. INSPECTION

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 and insert 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 86, 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 22.
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 23, then proceed with the assembly.



**Figure 23**  
**Checking Valve Spring Assembled Height**

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

## 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 12 and 13 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 (on the TW10 only) 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 12, 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.

**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 23.

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.

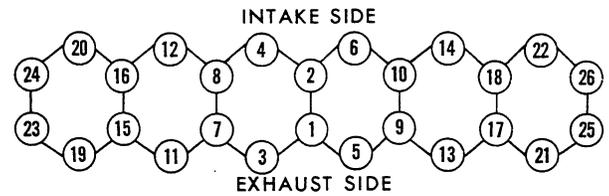
**NOTE:** Do not install spacers unless necessary. Use of spacers in excess of recommendations will result in overstressing the valve springs and overloading the camshaft lobes.

*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.

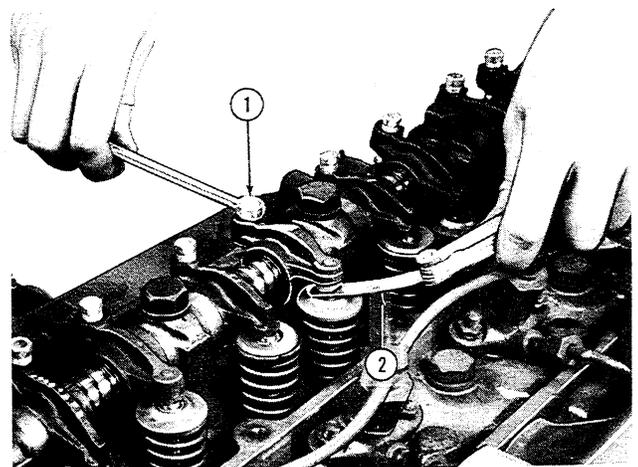
4. Position the rocker shaft assembly on the cylinder head, the long cylinder head bolts and washers in the respective holes. Refer to Figure 10. Make sure that the ball ends of the rocker arm adjusting screws are seated in the cupped end of the push rods.
5. Tighten 9/16 in. cylinder head bolts in the sequence shown in Figure 24. Tighten in two steps:
  - (a) 140 lbs. ft. (190 Nm)
  - (b) 160 lbs. ft. (217 Nm)



**Figure 24**  
**Cylinder Head Tightening Sequence**

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

6. Rotate the engine and set the valve lash, Figure 25, to the specified limits, page 85.



**Figure 25**  
**Adjusting Valve Lash**

1. Adjusting Screw
2. Feeler Gauge

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 11. Install the nut on each stud and tighten progressively to the specified torque, page 92.
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 92.
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 exhaust manifold gasket on the cylinder head and install the exhaust manifold, as shown in Figure 6. Use new lock tabs and tighten the bolts to the specified torque, page 92. Bend the lock tabs to retain the bolts.
19. Lift the air cleaner and support assembly into place and attach with the hardware previously removed.
20. **Ford TW10:** Attach the muffler to the air cleaner support assembly and connect the air intake tube to the intake manifold.  
**Ford TW20:** 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 10.
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 radiator grille panel(s).
26. Bleed the fuel system as described in Part 2, "FUEL SYSTEM". Start the engine.

**TW10 and TW20:**

15. **Ford TW10:** Bolt the muffler, with a new gasket installed, to the exhaust manifold.

**Ford TW20:** 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 92. Connect the ventilating tube.

**TW30**

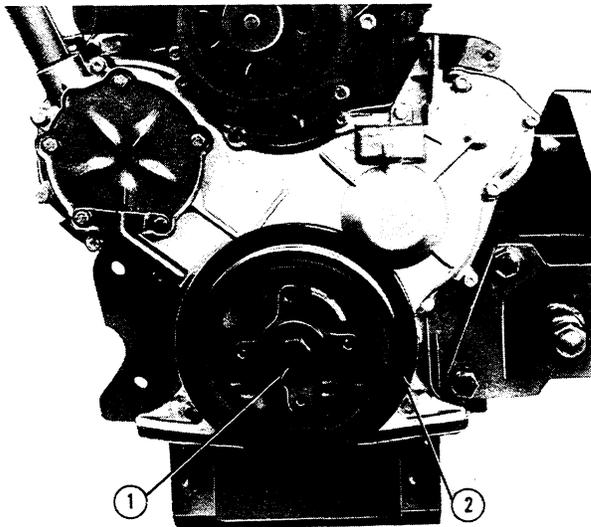
27. Bolt the turbocharger and new gasket to the exhaust manifold. Install the oil lines between the turbocharger and the engine. Install the water pump if removed. Use a new gasket.
28. Install the thermostat — fan hub housing. Attach the radiator hose and heater hose, Figure 9.
29. Install the intercooler support bracket at the rear of the engine, Figure 8.
30. Install the intercooler, Figure 7.
31. Connect the intercooler-to-turbo tube. Connect the aspirator hoses.
32. Install the air cleaner. Connect the air cleaner-to-turbo tube.
33. Attach the grille support, Figure 6.
34. Install the hood panel, grille and side panels, Figure 1.

### 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".

#### CRANKSHAFT PULLEY REMOVAL

1. Remove the fan and water pump belts. Remove the bolt and washer from the crankshaft pulley, Figure 26, using puller No. 518 and Shaft Protector No. 625-1, as shown in Figure 22. To use the puller for this purpose, 7/16" x 14 UNC bolts have to be used and the slots in the puller enlarged.



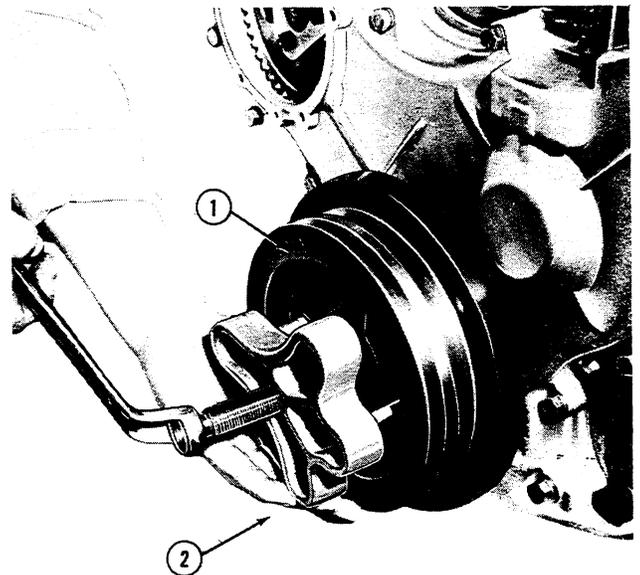
**Figure 26**  
**Crankshaft Pulley**

1. Pulley Bolt
2. Crankshaft Pulley

2. Check the pulley belt grooves to be sure the surfaces are smooth and the flanges are not cracked or broken.
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.



**Figure 27**  
**Removing Crankshaft Pulley**

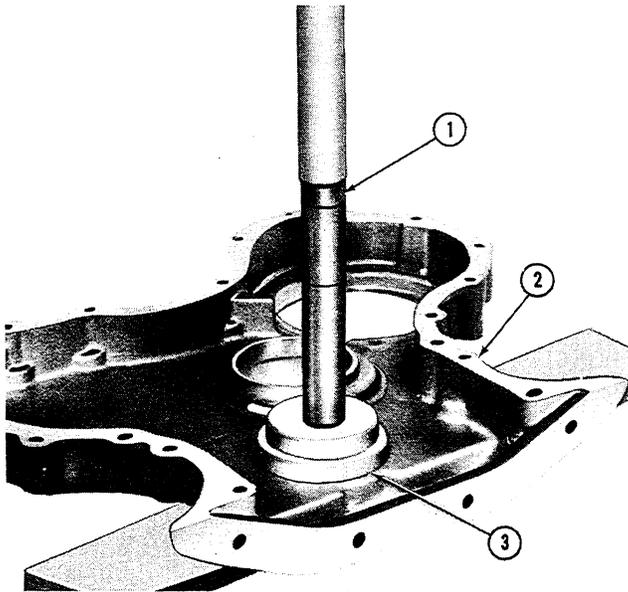
1. Crankshaft Pulley
2. 518 Pulley

#### 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.
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 28. 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.

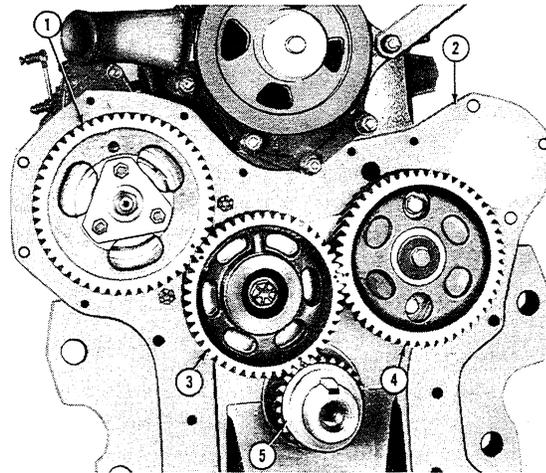


**Figure 28**  
Installing Front Cover Seal

1. Driver
2. Engine Front Cover
3. 7536 Seal Installer

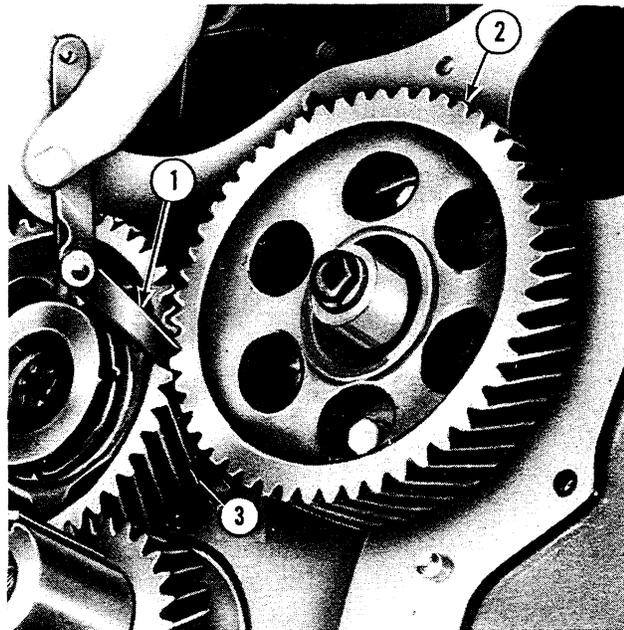
#### CHECK TIMING GEAR BACKLASH

1. The timing gears are shown in Figure 29. 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 30.
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.



**Figure 29**  
Timing Gears

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



**Figure 30**  
Checking Timing Gear Backlash

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

4. Check the backlash at four equidistant points on the gears.
5. If the backlash is within specifications, page 86, the gears are suitable for reinstallation. If not, install new gears.

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.

## INJECTION PUMP GEAR

### A. REMOVAL

1. Turn the crankshaft until the camshaft gear is in the approximate timed position, Figure 31.
2. Remove the three attaching bolts that retain the injection pump gear, Figure 31, to the pump adapter plate and remove the gear.

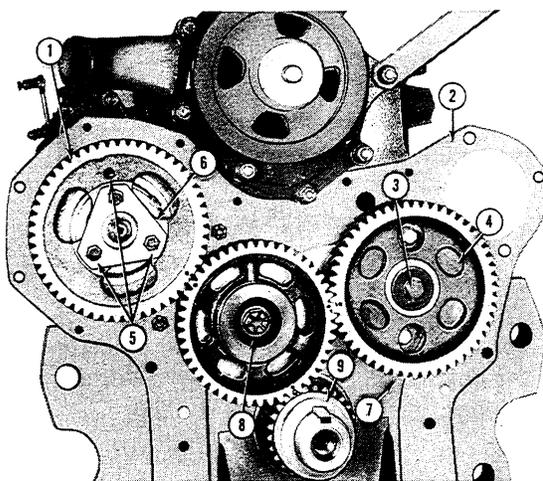


Figure 31  
Engine Front Cover Removed

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

### B. CLEANING AND INSPECTION

1. Clean the gear in solvent.

### 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 reinstall the camshaft drive gear in mesh and the timing marks aligned to the other gears as shown in Figure 31. Tighten the camshaft drive gear adapter bolt to the specified torque, page 92.
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 92.

## CAMSHAFT DRIVE GEAR AND ADAPTER

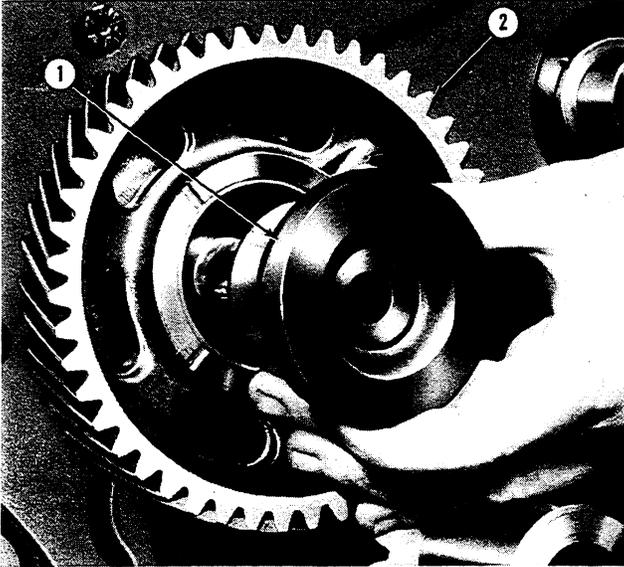
### A. REMOVAL

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 32.

### B. CLEANING AND INSPECTION

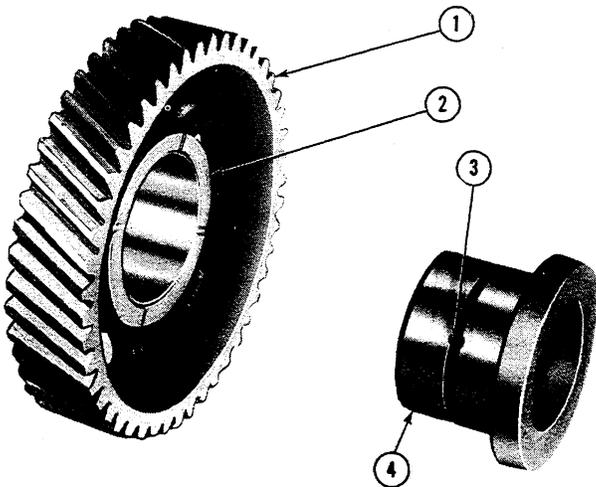
1. Clean the gear and adapter in solvent.
2. Inspect gear teeth for scores and nicks and the condition of the teeth contact pattern. Use a carborundum stone to remove minor gear teeth imperfections. If tooth wear or damage is severe install a new gear.
3. Check the adapter oil passage, Figure 33, to be sure that it is clear.
4. Inspect the camshaft drive gear bushing, Figure 33, for wear, nicks or burns, and install a new gear if any of these conditions exist.

- If excessive backlash, page 86, existed in the gears when checked, install a new gear.



**Figure 32**  
Removing Camshaft Drive Gear Adapter

- Adapter
- Camshaft Drive Gear



**Figure 33**  
Camshaft Drive Gear and Adapter

- Camshaft Drive Gear
- Bushing
- Oil Passage
- Adapter

### C. INSTALLATION

- Install the gear and adapter in mesh with the timing marks aligned.
- Install the adapter self-locking bolt and tighten the bolt to the specified torque, page 92.

### 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 34.

#### B. CLEANING AND INSPECTION

- Clean the gear in cleaning solvent.
- Inspect the gear teeth for scores and nicks, and the condition of the teeth wear pattern.
- Check the crankshaft keyway to be sure it is in good condition.
- 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.

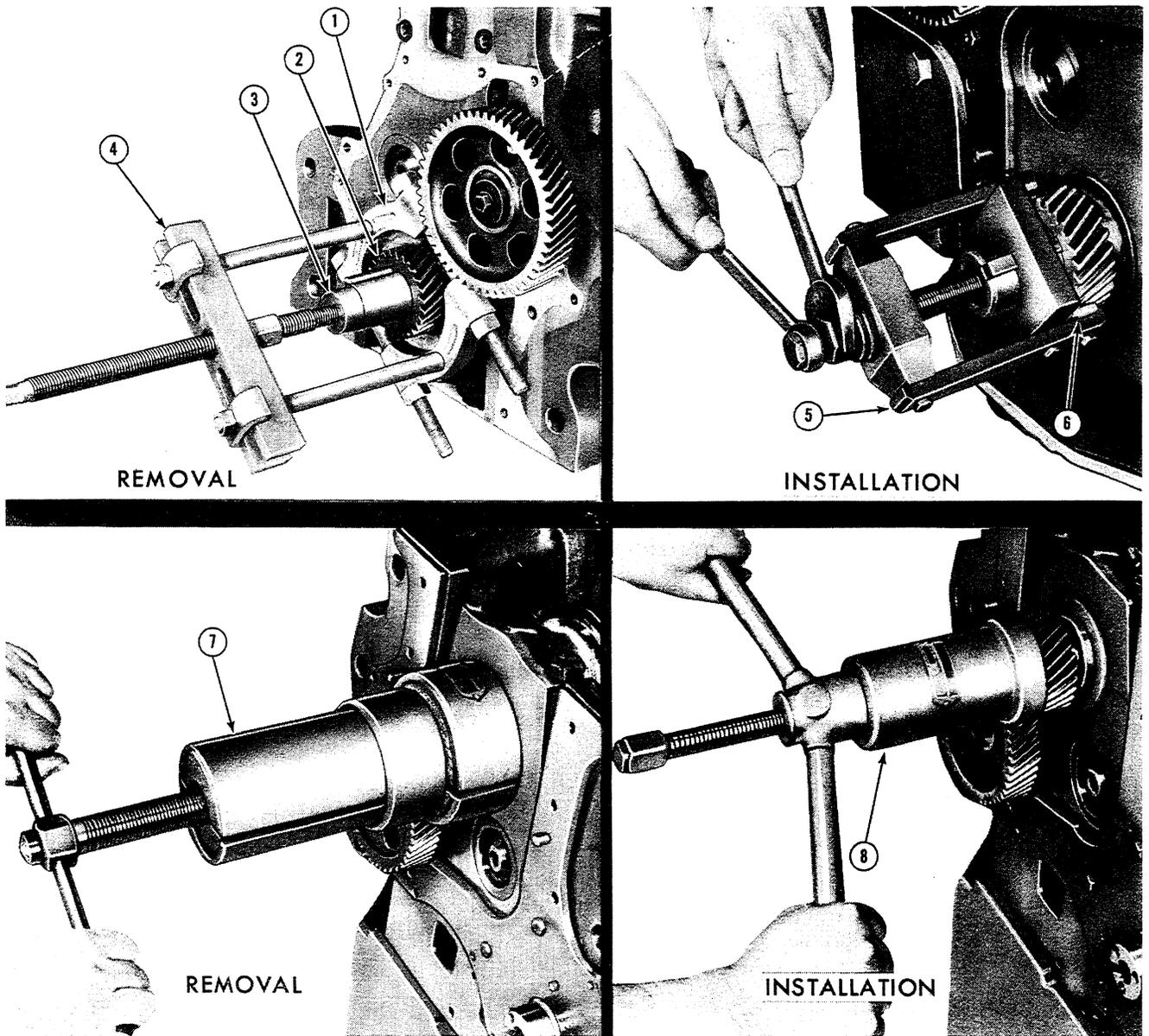
### C. INSTALLATION

- Drive the key into the keyway until it is seated.
- 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 34.

### CAMSHAFT GEAR

#### A. REMOVAL

- Remove the retaining bolt and washer, Figure 31.
- Remove the camshaft gear from the end of the shaft.



**Figure 34**  
**Removing and Installing Crankshaft Gear**

- |                    |                              |
|--------------------|------------------------------|
| 1. Tool No. 951    | 5. Remover - Replacer SW 501 |
| 2. Crankshaft Gear | 6. Insert SW 501-1           |
| 3. Tool No. 625-1  | 7. Remover CPT 6040          |
| 4. Tool No. 927    | 8. Replacer CT 6069          |

**B. CLEANING AND INSPECTION**

1. Clean the gear in solvent.
2. Inspect gear teeth for scores and nicks, and the condition of 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 92.
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 92.
5. Install the oil pan with new gasket and tighten bolts to the specified torque, page 92.

### 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 31. 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 31.

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 92.

## 4. OIL PAN AND OIL PUMP

### OIL PAN

#### A. REMOVAL

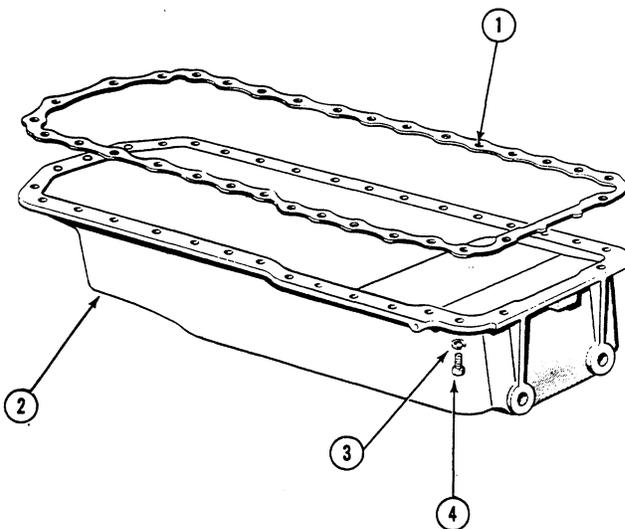
**IMPORTANT:** *Take care when removing the oil pan because of its weight. Use a jack or sling to support the pan.*

The oil pan on the Ford TW10, 20 and 30 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 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 panel(s).
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.
12. Support the oil pan. Remove the 31 attaching bolts and lock washers holding the pan to the engine. Refer to Figure 35.



**Figure 35**  
**Oil Pan**

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

**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 92.
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. Start the engine and check for oil leaks.

**OIL PUMP**

**A. REMOVAL**

1. Remove the oil pan.
2. Remove the two front pump mounting bolts, two rear delivery tube mounting bolts and one pickup tube support bolt, Figure 36. Remove pump assembly with dowels and pickup tubes.

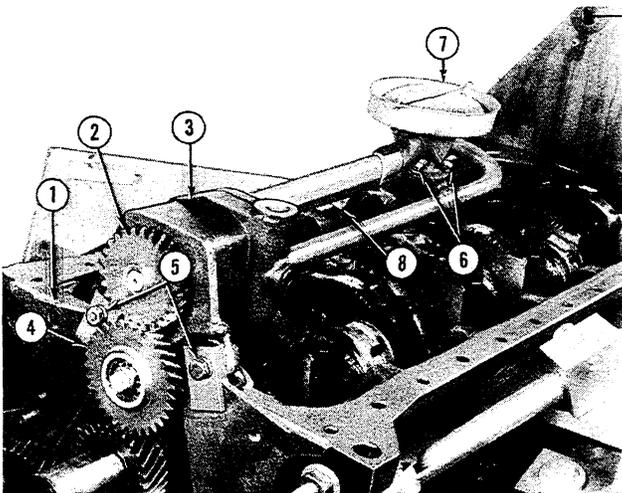
**B. DISASSEMBLY**

1. Remove 4 bolts from backplate of pump assembly.
2. Remove both tubes, screen and backplate.

3. Remove idler gear.
4. Remove outer rotor.
5. Remove drive gear by hand or with a hydraulic press.
6. Remove relief valve spring and cap, Figure 37.

**C. CLEANING AND INSPECTION**

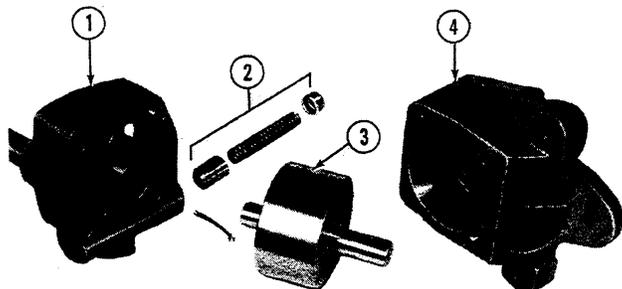
1. Wash all parts in solvent and dry thoroughly. Use a brush to clean the inside of the pump housing and the pressure relief valve chamber. Be sure all dirt and metal chips are removed.
2. Check the inside of the pump cover for wear and score marks. Inspect both rotors for wear or score marks. Replace as required. Check idler gear bearing for binding. Inspect both gears for wear and pitting.
3. 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, Figures 38 and 39. If the measurement is not within specifications, page 92, install a new rotor assembly.



**Figure 36**  
**Oil Pump**

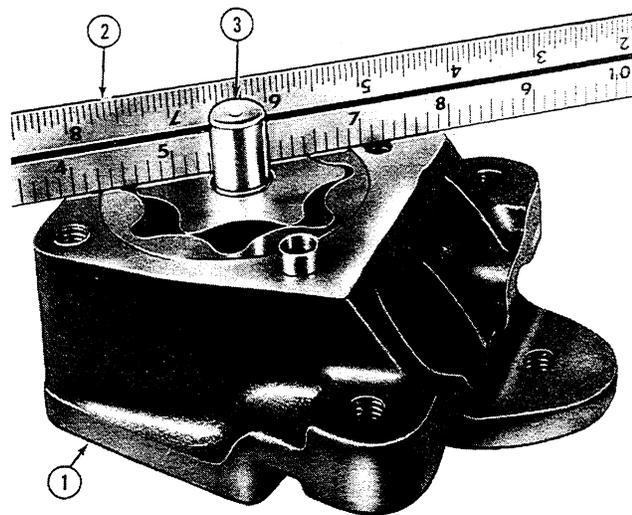
1. Oil Pump Support Plate
2. Oil Pump Drive Gear
3. Oil Pump Housing
4. Idler Gear
5. Front Support Bolts
6. Rear Support Bolts
7. Oil Pump and Screen
8. Support Bolt

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



**Figure 37**  
**Oil Pump**

1. Pump Cover
2. Relief Valve
3. Rotor and Shaft



**Figure 38**  
**Checking Oil Pump Clearance**

1. Pump Body
2. Straight Edge
4. 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 92, install a new rotor