

# FOREWORD

Appropriate service methods and proper repair procedures are essential for the safe, reliable operation of all equipment as well as the personal safety of the individual doing the work. This Repair 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 equipment, 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 does not compromise his own personal safety nor the safety of others by his choice of methods or tools.

As you read through this manual, you will come across **NOTES** and **WARNINGS**. Each one is there for a specific purpose. **NOTES** are given to prevent you from making an error that could damage the vehicle. **WARNINGS** remind you to be especially careful in those areas where carelessness can cause personal injury.

The Manual is divided into eleven Parts each sub-divided in turn into Chapters. Each Chapter contains information on general operating principles, detailed inspection and overhaul and, where applicable, specific trouble shooting, special tools and specifications. Any reference in this Manual to right, left, rear, front, top or bottom is as viewed from the operator's seat looking forward towards the loader.

The material contained in this Manual was correct at the time of going to print but Ford New Holland policy is one of continuous improvement and the right to change prices, specifications, equipment or design at any time without notice is reserved. All data in this Manual is subject to production variations, so overall dimensions and weights should be considered as approximate only and the illustrations do not necessarily depict the unit to standard built specification.

Measurement details in this Manual are tabled with the British standard first, with the metric equivalent following in brackets.

## PRODUCTION DATE CODES AND UNIT SERIAL NUMBERS

**Figure 1**  
Vehicle Identification Plate

**Figure 2**  
Four Wheel Drive Front Axle Identification Plate

IR-INTRO

**Figure 3**  
Cab Identification Plate

**Figure 4**  
Backhoe Identification Plate

The vehicle identification plate, Figure 1, is located on the left hand side of the steering console and is stamped with the following information:

Unit Serial Number, Model Code, Production Date Code of the complete Unit, of the Engine, the Transmission, and the Rear Axle assembly:

The identification plate for the Four Wheel Drive front axle (where fitted), Figure 2, is located on the rear right-hand side of the front axle casing.

The Cab/ROPS identification plate, Figure 3 is located on the right-hand 'B' pillar of the cab/ROPS frame.

The identification plate for the backhoe assembly (where fitted), Figure 4, is attached to the rear left hand side of the mainframe on the sideshift models, or attached to the side frame under the left hand rear fender on centre pivot models.

Whenever effecting a repair or overhaul of the Unit, the relevant information should be noted and used when referring to Service Bulletins or ordering parts.

# SAFETY PRECAUTIONS

Practically all Service work involves the need to drive the tractor. The Operators Manual, supplied with each tractor, contains detailed safety precautions relating to Driving, Operating and Servicing that tractor. These precautions are as applicable to the service technician as they are to the operator, and should be read, understood and practised by all personnel.

Prior to undertaking any maintenance, repair, overhaul, dismantling or re-assembly operations, whether within a workshop facility or out 'in the field', consideration should be given to factors that may have an effect upon Safety. Not only upon the mechanic carrying out the work, but also upon bystanders.

## PERSONAL CONSIDERATIONS

- The wrong clothes or carelessness in dress can cause accidents. Check to see that you are suitably clothed.  
Some jobs require special protective equipment.
- **Eye Protection**  
The smallest eye injury may cause loss of vision. Injury can be avoided by wearing eye protection when engaged in chiselling, grinding, discing, welding, painting, etc.
- **Breathing Protection**  
Fumes, dust and paint spray are unpleasant and harmful. These can be avoided by wearing respiratory protection.
- **Hearing Protection**  
Loud noise may damage your hearing and the greater the exposure the worse the damage. If you feel the noise excessive wear ear protection.
- **Hand Protection**  
It is advisable to use a protective cream before work to prevent irritation and skin contamination. After work clean your hands with soap and water. Solvents such as white spirit, paraffin, etc., may harm the skin.
- **Foot Protection**  
Substantial or protective footwear with reinforced toe-caps will protect your feet from falling objects. Additionally oil-resistant soles will help to avoid slipping.
- **Special Clothing**  
For certain work it may be necessary to wear flame- or acid- resistant clothing.
- Avoid injury through incorrect handling of components. Make sure you are capable of lifting the object. If in doubt get help.

## EQUIPMENT CONSIDERATIONS

- **Machine Guards**  
Before using any machine, check to ensure that the machine guards are in position and serviceable. These guards not only prevent parts of the body or clothing coming in contact with the moving parts of the machine, but also ward off objects that might fly off the machine and cause injury.
- **Lifting Appliances**  
Always ensure that lifting equipment, such as chains, slings, lifting brackets, hooks and eyes are thoroughly checked before use. If in doubt, select stronger equipment than is necessary. Never stand under a suspended load or raised implement.
- **Compressed Air**  
The pressure from a compressed air line is often as high as 100 lbf/in<sup>2</sup> (6.9 bar) (7 kgf/cm<sup>2</sup>). It is perfectly safe if used correctly. Any misuse may cause injury.  
Never use compressed air to blow dust, swarf, dirt, etc., away from your work area unless the correct type of nozzle is fitted.  
Compressed air is not a cleaning agent, it will only remove dust, etc., from one place to another. Look around before using an air hose as bystanders may get grit in their eyes, ears or skin.

- **Hand Tools**

Many cuts, abrasions and injuries are caused by defective or improvised tools. Never use the wrong tool for the job, as this generally leads to some injury, or to a poor job.

Never use

- A hammer with a loose head or split handle.
- Spanners or wrenches with splayed or worn jaws.
- Spanners or files as hammers; or drills, clevis pins or bolts as punches.

For removing or replacing hardened pins use a copper or brass drift rather than a hammer.

For dismantling, overhaul and re-assembly of major and sub components, always use the Special Service Tools recommended. These will reduce the work effort, labour time and the repair cost.

Always keep tools clean and in good working order.

- **Electricity**

Electricity has become so familiar in day to day usage, that its potentially dangerous properties are often overlooked. Misuse of electrical equipment can endanger life.

Before using any electrical equipment – particularly portable appliances – make a visual check to ensure that the cable is not worn or frayed and that the plugs, sockets, etc., are intact. Make sure you know where the nearest isolating switch for your equipment is located.

## **GENERAL CONSIDERATIONS**

- **Solvents**

Use only cleaning fluids and solvents that are known to be safe. Certain types of fluid can cause damage to components such as seals, etc., and can cause skin irritation. Solvents should be checked that they are suitable not only for the cleaning of components and individual parts, but also that they do not affect the personal safety of the user.

- **Housekeeping**

Many injuries result from tripping or slipping over, or on, objects or material left lying around by a careless worker. Prevent these accidents from occurring. If you notice a hazard, don't ignore it – remove it.

A clean hazard-free place of work improves the surroundings and daily environment for everybody.

- **Fire**

Fire has no respect for persons or property. The destruction that a fire can cause is not always fully realised. Everyone must be constantly on guard.

- Extinguish matches/cigars/cigarettes, etc., before throwing them away.
- Work cleanly, disposing of waste material into proper containers.
- Locate the fire extinguishers and find out how to operate them.
- Do not panic – warn those near and raise the alarm.
- Do not allow or use an open flame near the tractor fuel tank, battery or component parts.

- **First Aid**

In the type of work that mechanics are engaged in, dirt, grease, fine dusts, etc., all settle upon the skin and clothing. If a cut, abrasion or burn is disregarded it may be found that a septic condition has formed within a short time. What appears at first to be trivial could become painful and injurious. It only takes a few minutes to have a fresh cut dressed, but it will take longer if you neglect it. Make sure you know where the First Aid box is located.

- **Cleanliness**

Cleanliness of the tractor hydraulic system is essential for optimum performance. When carrying out service and repairs plug all hose ends and component connections to prevent dirt entry.

Clean the exterior of all components before carrying out any form of repair. Dirt and abrasive dust can reduce the efficiency and working life of a component and lead to costly replacement. Use of a high pressure washer or steam cleaner is recommended.



## **OPERATIONAL CONSIDERATIONS**

- Stop the engine, if at all possible, before performing any service.
- Place a warning sign on units which, due to service or overhaul, would be dangerous to start. Disconnect the battery leads if leaving such a unit unattended.
- Do not attempt to start the engine while standing beside the unit or attempt to by-pass the safety start switch.
- Avoid prolonged running of the engine in a closed building or in an area with inadequate ventilation as exhaust fumes are highly toxic.
- Always turn the radiator cap to the first stop, to allow pressure in the system to dissipate when the coolant is hot.
- Never work beneath a tractor which is on soft ground. Always take the unit to an area which has a hard working surface – concrete for preference.
- If it is found necessary to raise the tractor for ease of servicing or repair, ensure that safe and stable supports are installed, beneath axle housings, casings, etc., before commencing work.
- Use footsteps or working platforms when servicing those areas of a tractor that are not within easy reach.
- Prior to pressure testing, ensure all hoses and connectors, not only of the tractor, but also those of the test equipment, are in good condition and tightly secured. Pressure readings must be taken with the gauges specified. The correct procedure should be rigidly observed to prevent damage to the system or the equipment, and to eliminate the possibility of personal injury.
- Always lower the loader and backhoe buckets to the ground before leaving the vehicle.
- If high lift attachments are fitted to a unit beware of overhead power, electric or telephone cables when travelling. Drop attachment near to ground level to increase stability and minimise risks.
- Do not park or attempt to service a unit on an incline. If unavoidable, take extra care and block all wheels.
- Prior to removing wheels and tyres from a unit, check to determine whether additional ballast (liquid or weights) has been added. Seek assistance and use suitable equipment to support the weight of the wheel assembly.
- When inflating tyres beware of over inflation – constantly check the pressure. Over inflation can cause tyre burst and result in personal injury.

Safety precautions are very seldom the figment of someone's imagination. They are the result of sad experience, where most likely someone has paid dearly through personal injury.

Observe these precautions and you will protect yourself accordingly. Disregard them and you may duplicate the sad experience of others.

**Safety is everybody's responsibility.**

## LOADER ARM SUPPORT

The Ford 455C, 555C and 655C are equipped with a loader arm support. The loader arm support (2) is stored on the left hand loader arm (3), and retained in position by a single spring loaded pin (1), Figure 1.



**WARNING:** *To avoid personal injury never work beneath or around an unsupported loader. Always install the loader arm support.*

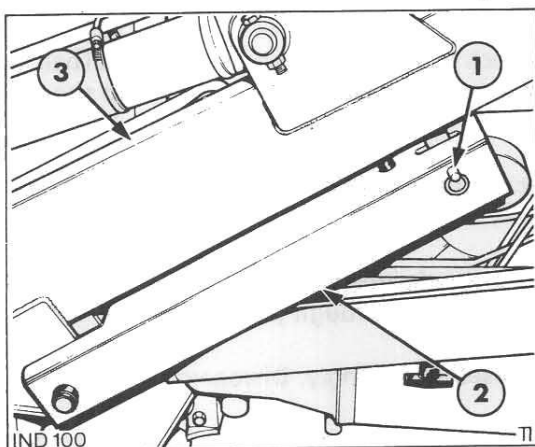
**NOTE:** *To prevent damage to the loader lift cylinder rod never release the support before raising the loader.*

To remove the support, raise the loader to full height then lift and position the support onto the loader arm. Retain the support to the loader arm with the retaining pin then lower the loader to the ground.

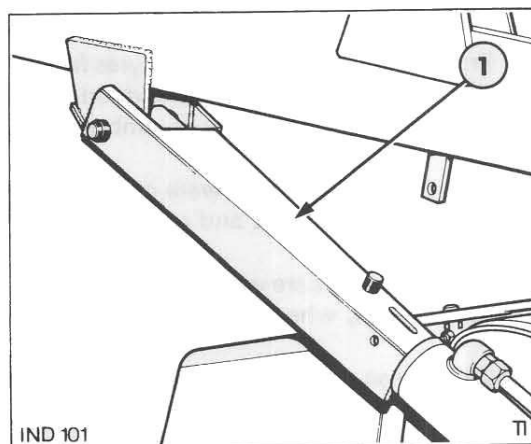
To install the support, raise the loader to full height then withdraw the retaining pin and position the support onto the load lift cylinder. Slowly lower the loader until the support (1) takes the weight of the loader, Figure 2. Do not apply down pressure on the loader lift cylinders.



**WARNING:** *To avoid serious injury whilst servicing the unit always ensure the loader bucket is on the ground in the dumped position or in the raised position with the loader arm support installed. Never work under or around a raised loader without the loader arm support installed.*



1. Loader Arm Support Stored



2. Loader Arm Support Installed

# **PART 1**

## **ENGINE SYSTEMS**

### **Chapter 1**

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# PART 1

## ENGINE SYSTEMS

### Chapter 1

#### 3-CYLINDER DIESEL ENGINE

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#### A. 3-CYLINDER DIESEL ENGINE – DESCRIPTION AND OPERATION

This Chapter describes the overhaul and repair of the 3-cylinder direct injection diesel engine.

The following chart shows the 3-cylinder diesel engine options available.

The engine Figure 1, features a cross flow cylinder head with the inlet and exhaust manifolds on opposite sides of the head. The combustion chamber is formed in the crown of the piston which has three compression and one oil control ring all located above the piston pin.

The cylinder head assembly incorporates the valves, valve springs and the spring retainers. Valve guides are an integral part of the cylinder head with replaceable valve seats pressed into the valve ports.

Model	Ford 455C
No. of Cylinders	3
Bore	4.4 in. (111.8 mm)
Stroke	4.4 in. (111.8 mm)
Displacement	201 in <sup>3</sup> (3294 cm <sup>3</sup> )

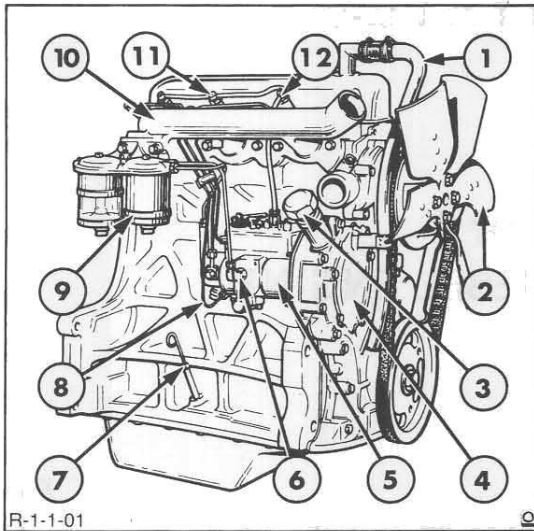


Figure 1

3-Cylinder Diesel Engine with DPA Distributor Type Fuel Injection Pump

- |                            |                            |
|----------------------------|----------------------------|
| 1. Ventilation Tube        | 7. Oil Level Indicator     |
| 2. Fan                     | 8. High Pressure Fuel Pipe |
| 3. Oil Filler Cap          | 9. Fuel Filters            |
| 4. Timing Cover            | 10. Inlet Manifold         |
| 5. Injection Pump          | 11. Rocker Cover           |
| 6. Low Pressure Fuel Inlet | 12. Injector               |

### Cylinder Head Assembly

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 on the right hand side, and the exhaust on the left. The water outlet connection and thermostat are attached to the front of the cylinder head.

Valve guides are integral with the cylinder head, and valves with oversize stems are available for service. Special replaceable cast alloy valve seats are pressed into each valve port, and exhaust valves are fitted with positive valve rotators. Intake valves use umbrella-type seals while the exhaust valves use a square section O-ring.

Valve lash is maintained by self-locking adjusting screws. The camshaft runs in four replaceable bearings, and is driven by the camshaft drive gear in mesh with the camshaft and crankshaft gears. Camshaft thrust is controlled by a plate secured to the block and located between the camshaft gear and the front journal of the camshaft. A helical gear mounted on the rear of the camshaft drives the tractor hydraulic system pump, optional on some tractor models.

The cylinder head bolts are evenly spaced in a six-point pattern around each cylinder. Diesel engine injectors are mounted outside the rocker cover.

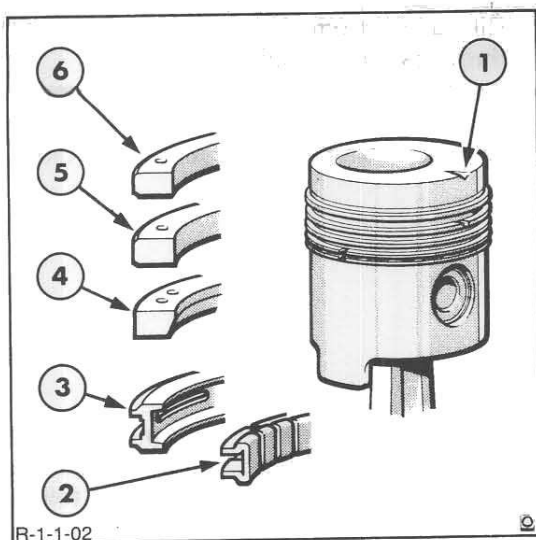
The engine cylinder head is designed with the entire face of the cylinder head flat. The combustion chambers are recessed into the piston crowns.

### Crankshaft Assembly

The crankshaft is supported in the cylinder block by four main bearings and the crankshaft end thrust is suppressed by a thrust bearing located on the second main bearing.

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 copper lead or aluminum tin alloy 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.

Front and rear crankshaft oil sealing is effected by one piece, single lip type seals.



**Figure 2**  
Conventional Piston and Rings

1. Notch to Front of Engine
2. Expander for Oil Control Ring
3. Oil Control Ring
4. 1st Compression Ring
5. 2nd Compression Ring
6. Top Compression Ring

### Pistons

Pistons are an aluminium alloy with combustion chambers recessed into the piston crowns. Each piston, Figure 2, has three compression rings and one oil control ring, all of which are located above the piston pin.

### Connecting Rods

The piston connecting rods are of 'I' section, with replaceable bronze piston pin bushings. Full-floating piston pins are retained by two snap rings in each piston.

### Manifolds

The cast iron intake and exhaust manifolds are on opposite sides of the cylinder head for better heat distribution in the head, and less heat transfer to the intake manifold. All tractors are fitted with vertical exhaust systems.

The intake manifolds are connected through tubing to the air cleaner. The diesel engine intake manifold is provided with a tapped hole for installation of a thermostart or an ether cold starting aid kit.

**NOTE:** On tractors where cold start equipment is not installed, the plug in the manifold should remain securely installed at all times, since 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, which are bored integral with the block. Cylinders are in-line and vertical, and numbered from 1 to 3, front to rear.

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 idler gear, which is attached to the front of the cylinder block. The idler gear drives the camshaft gear and the injection pump drive gear.

Oil passes from the pump to an external, throw-away, spin-on type filter incorporating a relief valve which permits oil to be by-passed, if filter blockage occurs, and so ensures engine lubrication at all times.

The camshaft gear, attached to the front of the camshaft by a bolt, lock washer, flat washer and a spacer, is keyed to maintain the position of the gear and the drive shaft. All the timing gears can be checked by observing the timing punch marks on the gears.

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

The main gallery also supplies oil to the crankshaft main bearings and to the connecting rod journals via drillings in the crankshaft. Drilled passages from each main bearing direct oil to the camshaft bearings.

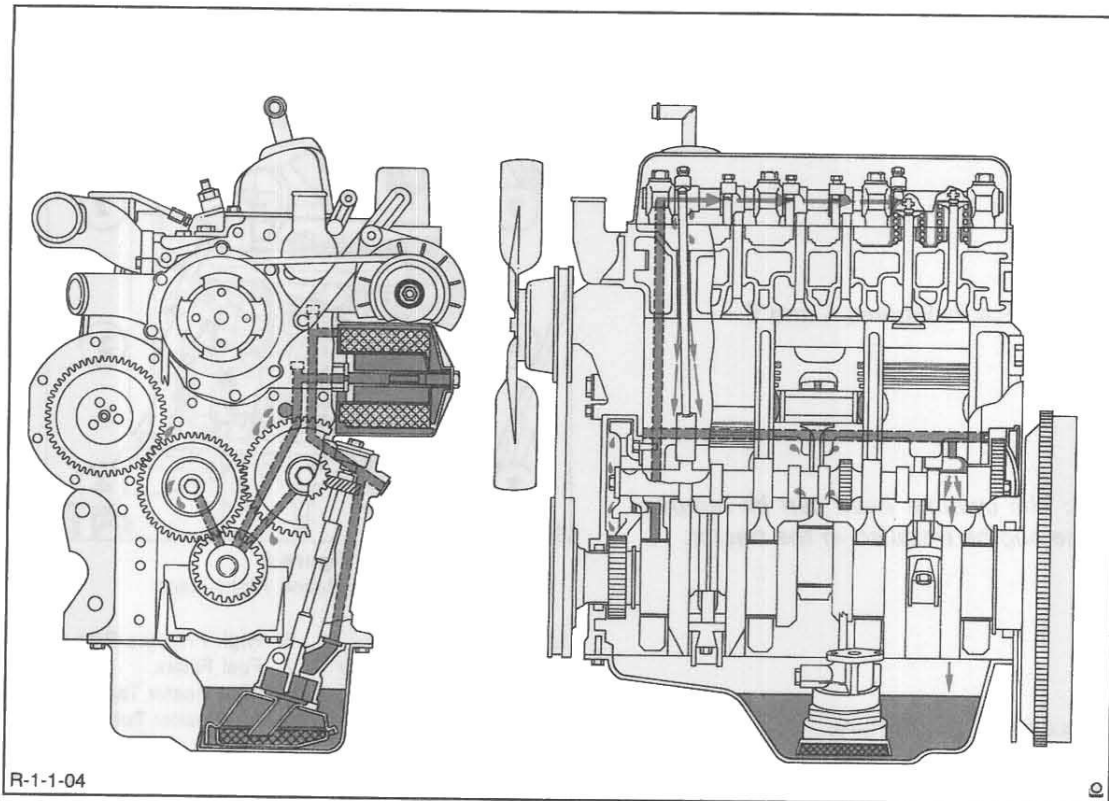
### LUBRICATION SYSTEM

Lubrication of the engine is maintained by a rotor type oil pump mounted at the base of the engine block. The oil pump is driven from the camshaft and draws oil from the engine sump through a wire mesh screen.

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

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

The timing gears are lubricated by oil from the cam follower chamber and the pressure lubricated camshaft drive gear bushing.



**Figure 3**  
3-Cylinder Engine Lubrication System

 Lubrication Oil

Cylinder walls, piston and piston pins are splash lubricated by the connecting rods and rotating crankshaft.

As the camshaft turns, holes in the camshaft and camshaft bearing align and a regulated stream of oil is directed to the cylinder head and on up the rocker arm shaft support bolt to the rocker shaft.

An intermittent flow of oil is directed to the valve rocker arm shaft assembly via a drilled passage in the cylinder block located vertically above No. 1 camshaft bearing. This drilling aligns with a corresponding hole in the cylinder head.

The oil flows from the shaft through drilled holes in each rocker arm bushing to lubricate both ends of the arms. Excess oil flows down the push rods and assists in lubricating the cam followers before draining back into the sump through cored openings in the block.

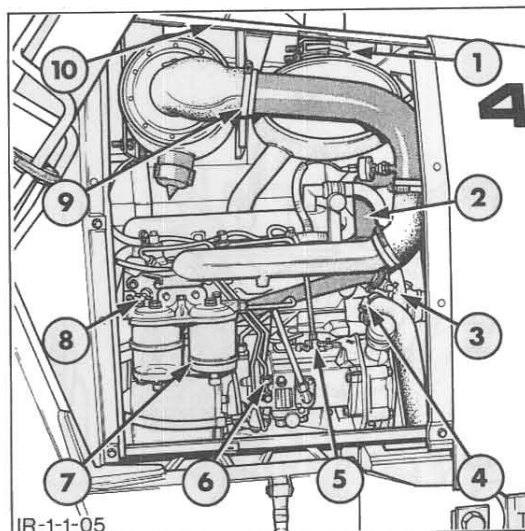
## B. 3-CYLINDER DIESEL ENGINE – OVERHAUL

### CYLINDER HEAD, VALVES AND RELATED PARTS

#### REMOVAL

With reference to Figures 4 and 5

**NOTE:** The cylinder head can be removed with the engine installed in the tractor.



**Figure 4**  
Engine Installation Right-Hand

1. Disconnect the battery:

2. Ford 455C remove the engine side panels.

3. Drain the coolant from the radiator and engine cylinder block:

4. Shut-off the heater hose taps then disconnect and plug the heater hoses (where fitted).

5. Remove the radiator top hose.

- |                         |                              |
|-------------------------|------------------------------|
| 1. Muffler Pipe         | 6. High Pressure Pipe        |
| 2. Top Radiator Hose    | 7. Fuel Filters              |
| 3. Front Heater Tap     | 8. Rear Heater Tap           |
| 4. Bottom Radiator Hose | 9. Air Cleaner Tube and Pipe |
| 5. Fuel Return Pipe     | 10. Top Hood Panel           |

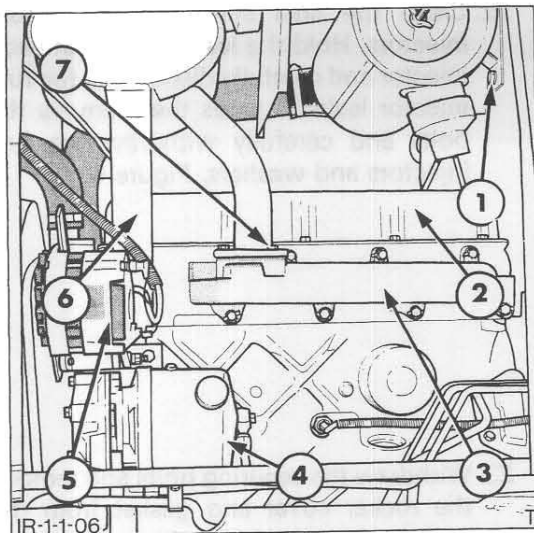
6. Remove the exhaust muffler extension pipe.

7. Remove the air cleaner pre-cleaner.

8. Remove the air cleaner to intake manifold tube and hoses.

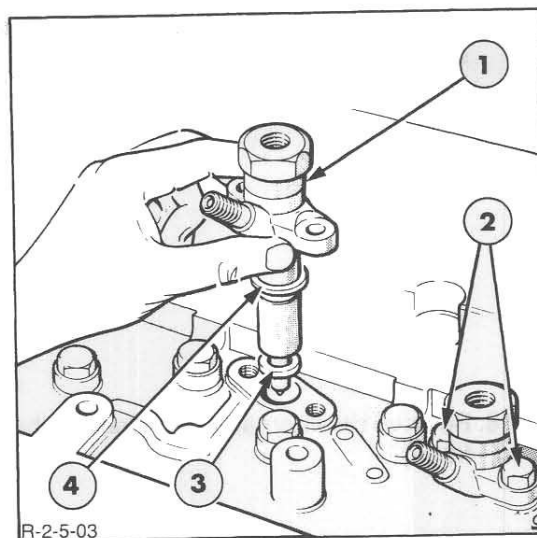
9. Remove the top hood panel.

10. Remove the exhaust muffler.



**Figure 5**  
Engine Installation Left-Hand

- |                     |                         |
|---------------------|-------------------------|
| 1. Air Cleaner      | 5. Alternator           |
| Retaining Bolts     | 6. Exhaust Muffler      |
| 2. Rocker Cover     | Bracket                 |
| 3. Exhaust Manifold | 7. Exhaust Muffler Pipe |
| 4. Steering Pump    |                         |



**Figure 6**  
Fuel Injector Removal

- |                                 |
|---------------------------------|
| 1. Fuel Injector Assembly       |
| 2. Fuel Injector Mounting Bolts |
| 3. Copper Washer                |
| 4. Cork Washer                  |

11. Shut-off the fuel tank tap then disconnect the low pressure fuel lines and remove the fuel filters from the inlet manifold and cap the exposed openings.

12. Disconnect and remove the injector fuel pipes from the fuel injection pump and the injectors. Cap the exposed openings in the pump, injectors and tubes.

13. Disconnect the thermostart fuel pipe at the intake manifold and plug the exposed openings.

4. Disconnect and remove the rocker cover ventilation tube.

5. Disconnect the cold start equipment and plug the exposed openings (where fitted).

6. Disconnect the alternator, oil pressure, coolant temperature sender, air cleaner restriction indicator, fuel injection pump solenoid, horn and cold start wiring harness connections (where fitted).

17. Remove the front engine harness and secure with tape clear of the engine.

22. Clean the area surrounding the fuel injectors. Hold the leak-off pipe at each injector and carefully disconnect the fuel injector leak-off pipes then remove the bolts and carefully withdraw the fuel injectors and washers, Figure 6.

18. Remove the alternator and guard (where fitted).

23. Withdraw the securing bolts and remove the rocker cover and gasket from the cylinder head.

19. Bend back the lock tabs, withdraw the attaching bolts and remove the exhaust manifold and gasket.

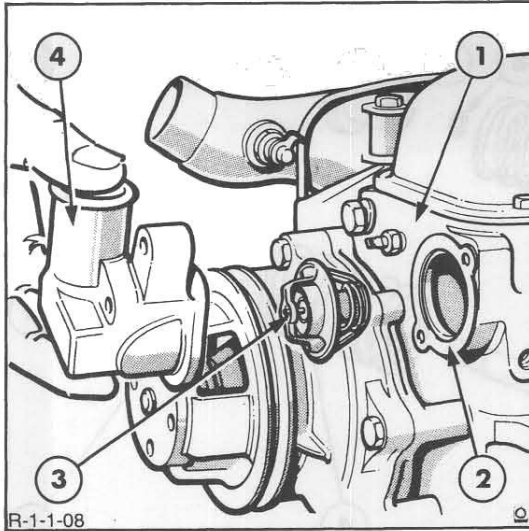
24. Check the push rods for straightness by rotating the rods with the valve closed and identify any bent rods.

20. Remove the air cleaner assembly.

25. Loosen the rocker shaft retaining bolts, which also serve as cylinder head bolts, evenly and alternately. Remove the rocker shaft assembly.

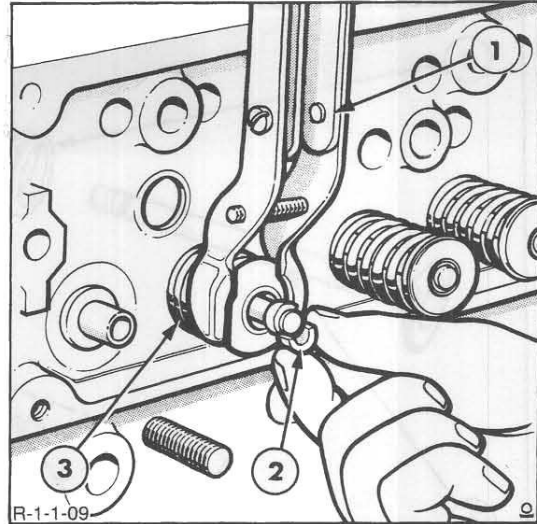
21. Withdraw the retaining bolts and lockwashers and remove the inlet manifold and gasket.

**NOTE:** Leave the bolts in the rocker shaft supports during removal as they retain the support on the shaft.



**Figure 7**  
Coolant Outlet and Thermostat Removal

1. Cylinder Head
2. Gasket
3. Thermostat
4. Coolant Outlet Connection



**Figure 8**  
Valve Removal

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

26. Remove each push rod in turn and place in a numbered rack so that it can be replaced in the same position when assembling the engine.

## DISASSEMBLY

### Thermostat

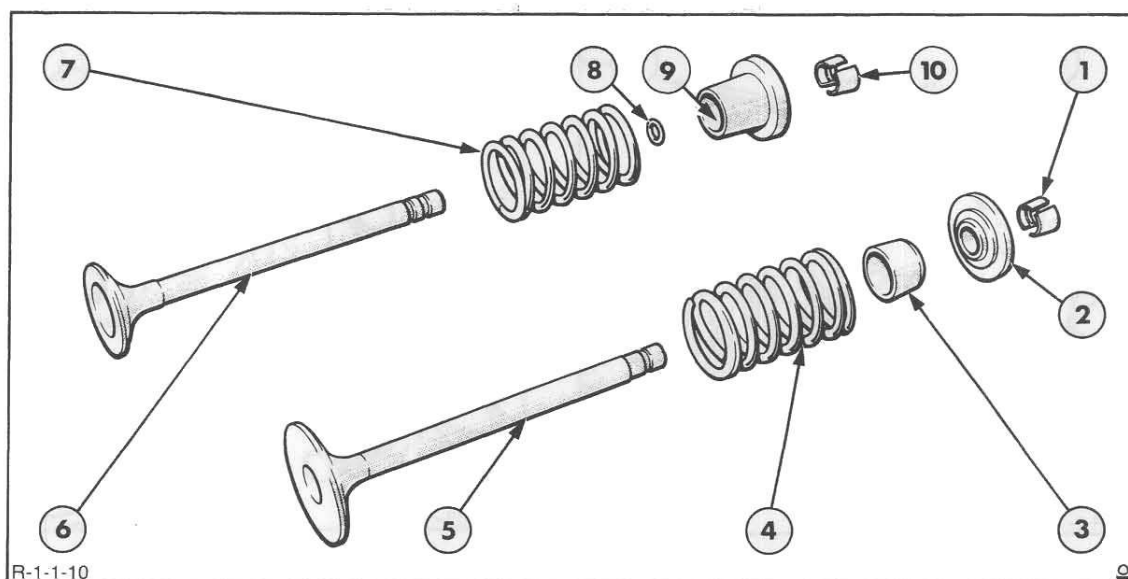
1. Remove the coolant outlet connection and the thermostat and gasket, Figure 7.

27. Remove the remaining cylinder head bolts and washers working inwards from the ends to the centre of the head.

### Cylinder Head

28. Lift the cylinder head from the block. If necessary lever the head off on the pads provided, taking care not to damage the cylinder head or block faces.

1. Clean the head and remove carbon deposits from around the valve heads.
2. Using a valve spring compressor, Figure 8 remove the retainer locks, spring retainers/rotators, springs and seals from each valve, Figure 9.
3. Withdraw the valves and place in a numbered rack.



**Figure 9**  
Valve Assembly Components

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

### Rocker Shaft Assembly

1. Remove the cylinder head bolts which pass through the rocker shaft supports and slide the rocker shaft components from the shaft, Figure 10.

2. Inspect the cylinder head for damage and, if necessary, remove nicks and burrs from the gasket faces using a suitable abrasive. Ensure all traces of abrasive material are removed after repair.

## INSPECTION AND REPAIR

### Cylinder head

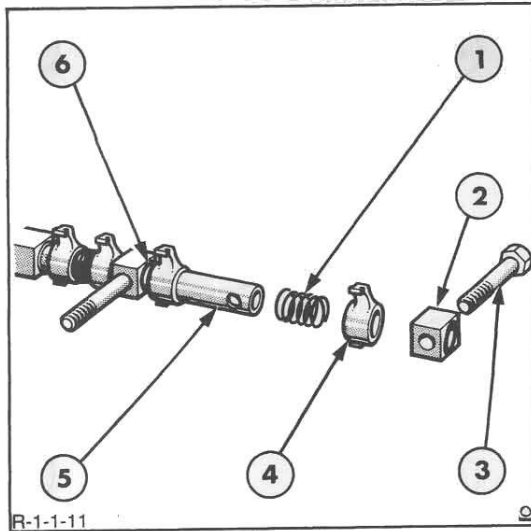
1. Scrape all gasket surfaces clean then wash the cylinder head in a suitable solvent and thoroughly dry with a lint free cloth or compressed air. Clean the valve guide bores with a valve guide cleaning tool.

**NOTE:** Ensure the injector washers have been removed from the injector bores prior to cleaning.

3. Use a straight edge and feeler gauges to check the flatness of the cylinder head in all directions, Figure 11. For flatness requirement see "Specifications" – Chapter 4.

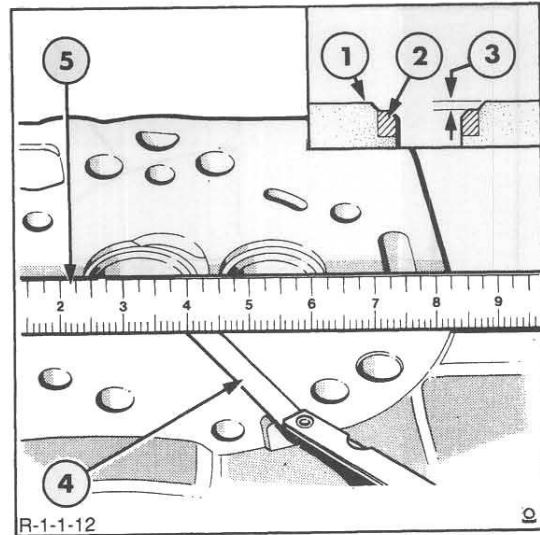
**NOTE:** If the cylinder head exceeds the flatness specification it may be skimmed providing the depth from the lower face of the valve insert to the cylinder head face is not less than 0.064 in. (1.63 mm), see the inset of Figure 11.





**Figure 10**  
Rocker Shaft Disassembled

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



**Figure 11**  
Measuring Cylinder Head Flatness

- |                       |                  |
|-----------------------|------------------|
| 1. Cylinder Head Face | 4. Feeler Gauge  |
| 2. Valve Seat Insert  | 5. Straight Edge |
| 3. Minimum Depth      |                  |

4. If the head has been skimmed, determine that all the cylinder head bolt faces will bottom. Place the cylinder head, less gasket, on the block and install all the head bolts.

5. Install all the bolts finger tight and ensure the rocker shaft supports are fitted with long bolts. Using a feeler gauge, check the clearance between the underside of the bolt heads and the cylinder head or rocker shaft support.

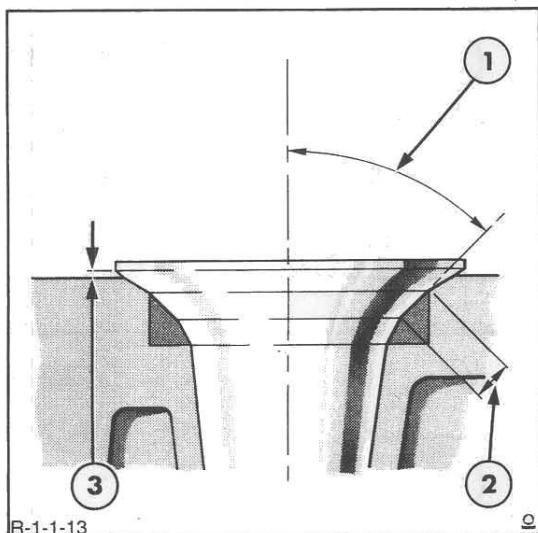
6. If a 0.010 in. (0.25 mm) feeler gauge can be inserted under the bolt head then the bolts are bottoming and the cylinder block thread must be increased in depth. Use a  $\frac{9}{16} \times 13$  UNC-2A thread tap. The head bolts should be marked so they are reinstalled in the holes in which they were checked.

## Valve Seats

1. Examine the valve seat inserts and reface if pitted but renew if loose or damaged. If necessary, install an oversize insert by machining the seat counterbore in the cylinder head, see "Specifications" – Chapter 4. The insert must be chilled in dry-ice prior to installation.

**NOTE:** Valve seat inserts of 0.010 in. (0.25 mm) and 0.020 in. (0.5 mm) oversize on diameter are sometimes installed in cylinder heads in production. Heads fitted with oversize inserts are stamped <sup>SO10</sup>OS or <sup>SO20</sup>OS on the exhaust manifold side in line with the valve seat concerned.

2. When replacing exhaust valve seat inserts ensure the replacement inserts are of the correct type as the size and material specification varies for the different engine types.



**Figure 12**  
Valve Seat Dimensions

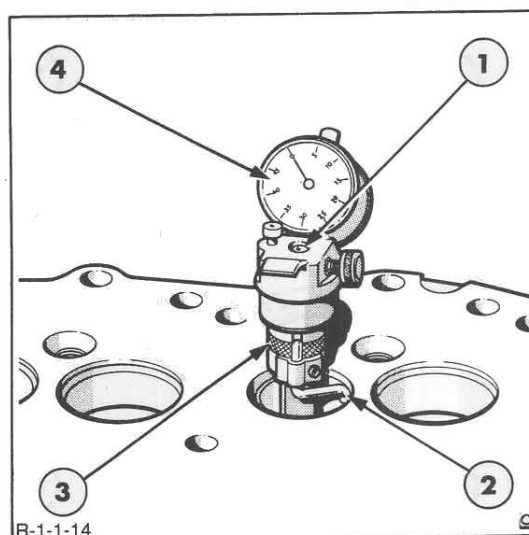
1. Valve Seat Angle:  
45°00' – 45°30' Exhaust and Intake Valves
2. Valve Seat Width:  
Intake 0.080 – 0.102 in. (2.032 – 2.590 mm)  
Exhaust 0.084 – 0.106 in. (2.133 – 2.692 mm)
3. Valve Head Protrusion

3. Check the width of the valve seat inserts and, if necessary, reface by grinding to the dimensions shown in Figure 12.

4. Measure the concentricity of the valve seat with a suitable gauge, as shown in Figure 13. If the valve seat runout exceeds the specified figure, see "Specifications" – Chapter 4, reface the seat.

5. Using a seat cutter with the correct angle (refer to Figure 11 and "Specifications," Chapter 4) remove only enough stock from the seat to clean up the pits and grooves, or to correct the seat eccentricity. After refacing, the seat width must be within the specified limit.

6. If the refaced seat exceeds this width, narrow the seat by removing stock from the top or bottom of the seat. If the seat measures less than this width, widen the seat.



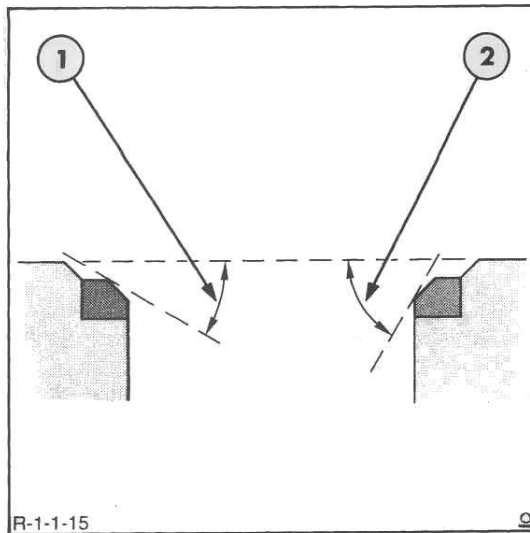
**Figure 13**  
Checking Valve Seat Concentricity

1. Gauge Pilot
2. Pointer to Ride on Valve Seat Face
3. Sleeve for Rotating Pointer
4. Dial Gauge

**NOTE:** Refacing of the valve seat should always be co-ordinated with refacing of the valve to ensure a compression tight fit.

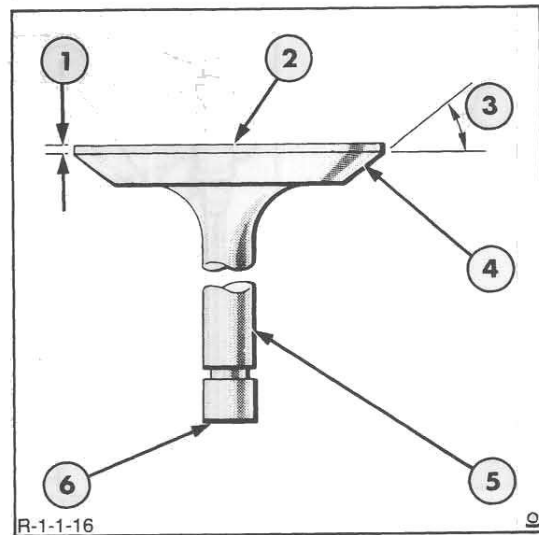
7. Rotate a new or refaced valve lightly in the seat, using Prussian Blue. If the blue is transferred to the valve face the specified distance (valve head protrusion) below the upper edge of the valve face, Figure 12, the contact is satisfactory. If the blue is transferred to the valve face above or below this point, raise or lower the seat as follows:-

8. Lower the valve seat by removing stock from the top of the seat with a 30° grinding wheel, Figure 14. Raise the seat by removing stock from the bottom of the seat with a 60° grinding wheel.



**Figure 14**  
Raising/Lowering Valve Seats

1. Use 30° grinding wheel for lowering the seat
2. Use 60° grinding wheel for raising the seat

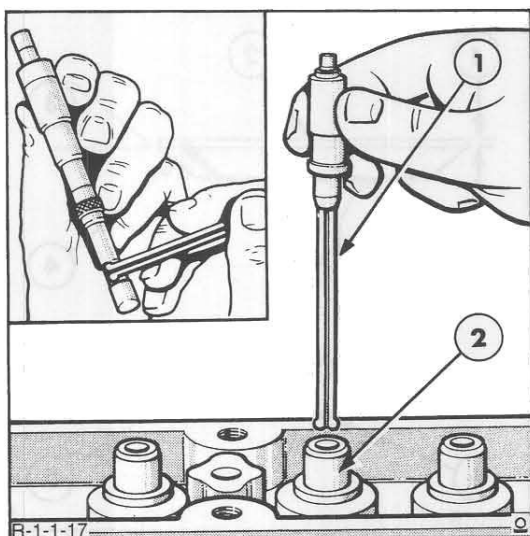


**Figure 15**  
Critical Valve Measurements and Inspection Checks

- |                             |               |
|-----------------------------|---------------|
| 1. Valve Head Edge          | 4. Valve Face |
| 2. Valve Head               | 5. Valve Stem |
| 3. Valve Face Angle (45,5°) | 6. Valve Tip  |

## Valves

1. The critical inspection points of the valves are shown in Figure 16. 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.
2. Check for bent stems and correct diameter.
3. Check maximum valve face eccentricity.
4. Any valve refacing operation should be closely coordinated with the valve seat refacing operation so that the finished angle of the valve is 0,5° less than the valve seat to provide an interference angle for better seating. Adjust the valve refacing tool to obtain a face angle of 45,5°, Figure 15.
5. Remove only enough stock to clean up the pits and grooves. Check the edge of the valve head; if less than the specified figure, see "Specifications" – Chapter 4, install a new valve.
6. Remove all grooves or score marks from the valve stem tip, then chamfer as necessary. Do not remove more than 0,010 in. (0,25 mm) from the tip.



**Figure 16**  
Measuring Valve Guide

1. Telescopic Gauge
2. Valve Guide

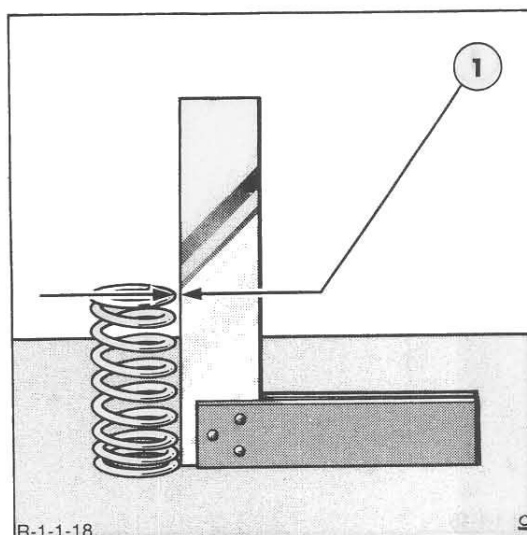
### Valve Guides

1. Using a telescopic gauge and micrometer, measure the valve to guide clearance, Figure 16. If the clearance exceeds the specified limits, see "Specifications" – Chapter 4, ream the valve guide to fit the next oversize valve.

**NOTE:** Production cylinder heads may have one or more 0.015 in. (0.38 mm) oversize valve guides and valves installed. Such cylinder heads have 15 or <sup>VO15</sup><sub>OS</sub> stamped on the exhaust manifold side of the head opposite the valve(s) concerned.

2. Use Kit No. FT 6202 or 2136 to ream out the valve guide to accept an oversize valve. The kit contains three reamers and pilot combinations as follows:

- 0.003 in. (0.076 mm) Oversize Reamer and Standard Diameter Pilot.



**Figure 17**  
Checking Valve Spring Squareness

1. Maximum Out-of-Squareness 0.06 in. (1.52 mm)

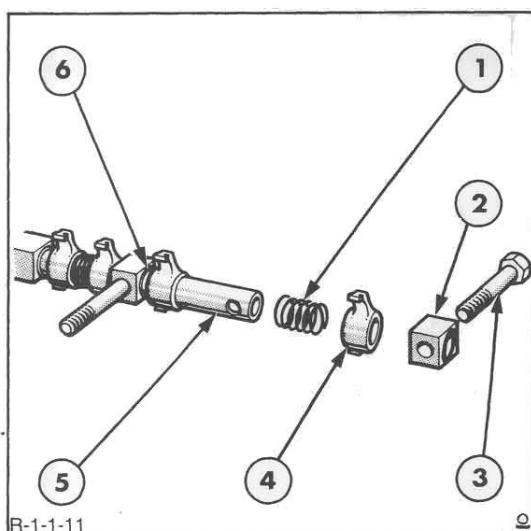
- 0.015 in. (0.38 mm) Oversize Reamer and 0.003 in. (0.076 mm) Oversize Pilot.

- 0.030 in. (0.76 mm) Oversize Reamer and 0.015 in. (0.38 mm) Oversize Pilot.

3. When going from a standard valve stem to an oversize always use the reamers in sequence. After reaming a valve guide, always check the valve seating and reface if necessary.

### Valve Springs

1. Renew worn or damaged valve springs. Check for squareness and reject if out-of-squareness exceeds 0.06 in. (1.52 mm), Figure 17. Check the free length and loaded length of each valve spring, see "Specifications" – Chapter 4. Ensure the valve spring retainer locks are in good condition.



**Figure 18**  
Rocker Shaft Components

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

### Rocker Shaft Assembly

1. Inspect the rocker arm adjusting screws and the push rod ends of the rocker arms for stripped or worn threads. Check the ball end of the screws for nicks, scratches, or excessive wear.

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.

2. Check the rocker arm locating springs and spacers for breaks or other damage.
3. Check the rocker arms and rocker shaft internal and external diameters respectively. If these are not within specified limits, install a new part. If the shaft meets specifications, clean it thoroughly in a suitable solvent and thoroughly dry with compressed air ensuring the oil passages are clear of obstructions.

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

### Thermostat

1. For inspection and repair of the coolant outlet or thermostat, see 'Cooling System' – Chapter 3.

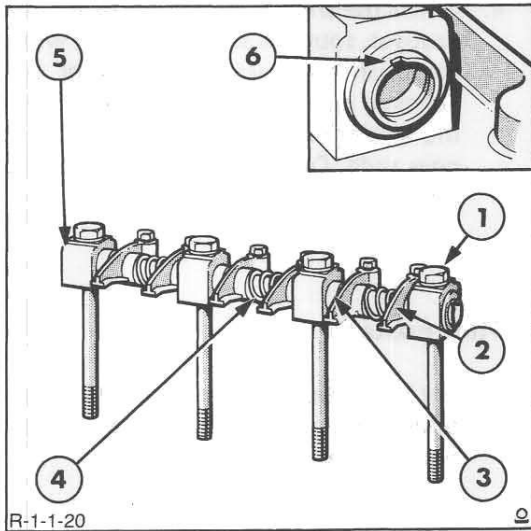
## RE-ASSEMBLY

### Cylinder Head

1. Insert each valve in the guide bore from which it was removed and lap in position to ensure an even seat around the valve. Withdraw the valve and ensure removal of all traces of lapping compound.
2. Lubricate all components with clean engine oil prior to installation.
3. Use a valve spring compressor to reassemble the valves, valve springs, retainers and retainer locks. For the exhaust valves install a new sealing ring in the second groove from the top of the valve stem.

### Thermostat

1. Install the thermostat (spring end towards the head), coolant outlet and a new gasket.



**Figure 19**  
Rocker Arm Shaft Assembly

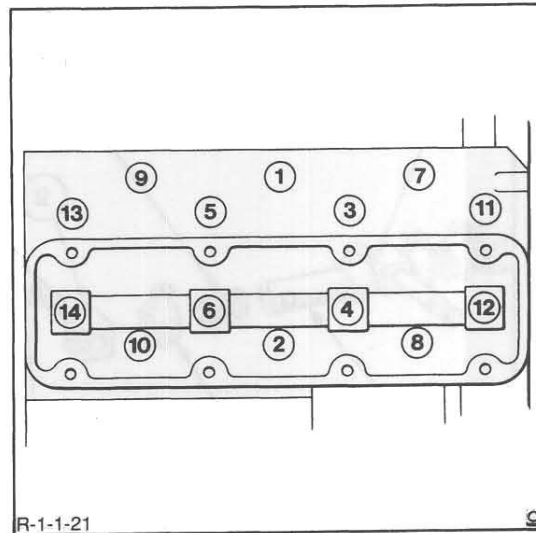
1. Bolt
2. Rocker Arm
3. Spacer
4. Spring
5. Rocker Arm Shaft Support
6. Groove at Front of Shaft

### Rocker Shaft Assembly

1. Lubricate each end of the pushrods with clean engine oil and insert each rod in its original position. Ensure that the ball end of each rod is seated in its tappet socket.
2. Coat all rocker shaft components with clean engine oil.

The rocker shaft has an identification groove at one end of the shaft. Position the mark upwards, Figure 19, and use this end as the front of the shaft, thereby ensuring the oil holes and grooves in the shaft face downwards.

3. Start assembling by securing a rocker shaft support with a long cylinder head retaining bolt.



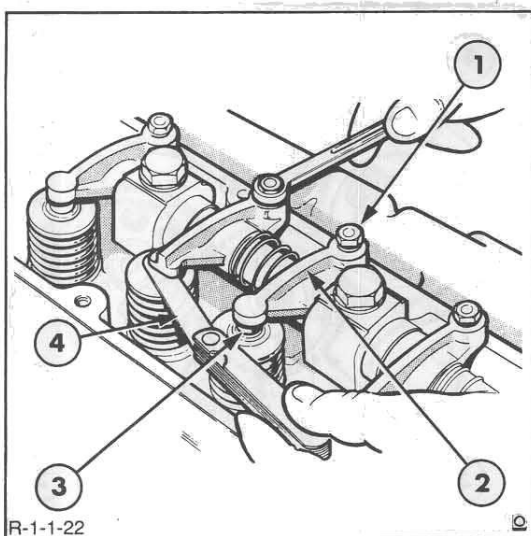
**Figure 20**  
Cylinder Head Bolt Tightening Sequence

4. Ensure the springs and spacers are in their correct position, as shown in Figure 19, then proceed with the assembly. Place a long cylinder head retaining bolt in the last (front) support to keep the complete assembly together.

### INSTALLATION

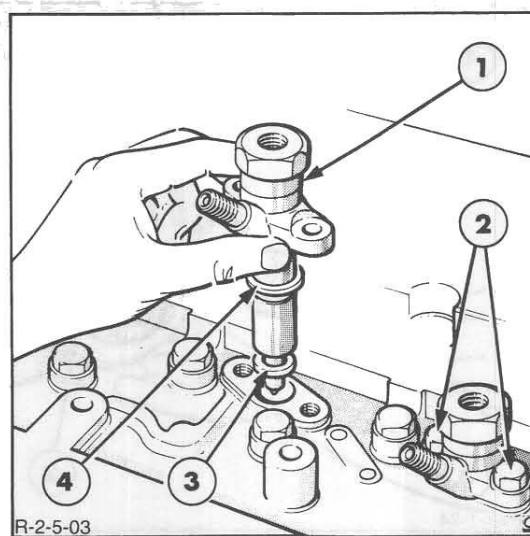
Installation of the cylinder head and related components follows the removal procedure in reverse. On installation observe the following requirements:

- Install new cylinder head, intake and exhaust manifold gaskets.



**Figure 21**  
Setting Valve Lash

1. Adjuster Screw
2. Rocker Arm
3. Valve Stem
4. Feeler Gauge



**Figure 22**  
Fuel Injector Installation

1. Fuel Injector Assembly
2. Fuel Injector Mounting Bolts
3. Copper Washer
4. Cork Washer

- Tighten the cylinder head retaining bolts in the sequence shown in Figure 20 and progressively in three steps as follows:

- (i) Torque to 115 lbf.ft. (156 Nm)
- (ii) Torque to 140 lbf.ft. (190 Nm)
- (iii) Torque to 160 lbf.ft. (217 Nm)

Do **NOT** oil the bolts before installation.

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

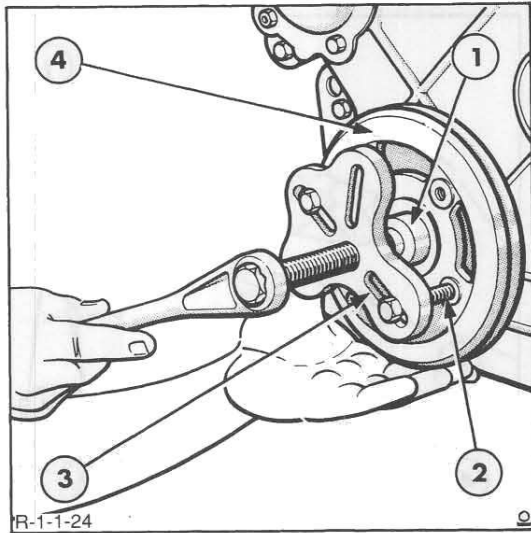
- Rotate the engine and set the valve lash, Figure 21. See "Specifications" – Chapter 4.

- Install the injectors with new seat washers and cork seals, Figure 22.
- Install the injector lines and leak-off pipe with new washers.

**NOTE:** Hold the leak-off plastic tube securely to prevent pivoting when tightening the banjo fitting bolts to the specified torque. See "Specifications" – Chapter 4.

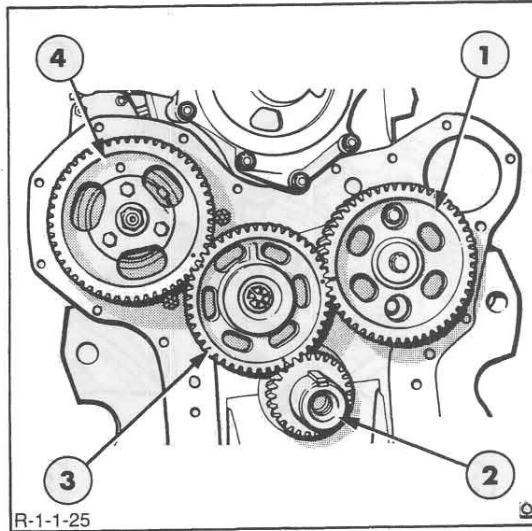
- Use new lock tabs for the exhaust manifold retaining bolts and bend the tabs to effect retention.
- Tighten all nuts and bolts to the specified torques. See "Specifications" – Chapter 4.
- Operate the engine and check for fluid leaks.





**Figure 23**  
Crankshaft Pulley Removal

1. Shaft Protector No. 625-A or 9212
2. 7/16 in. x 14 UNC Bolt
3. Puller No. 518 or 9539
4. Crankshaft Pulley



**Figure 24**  
Timing Gears

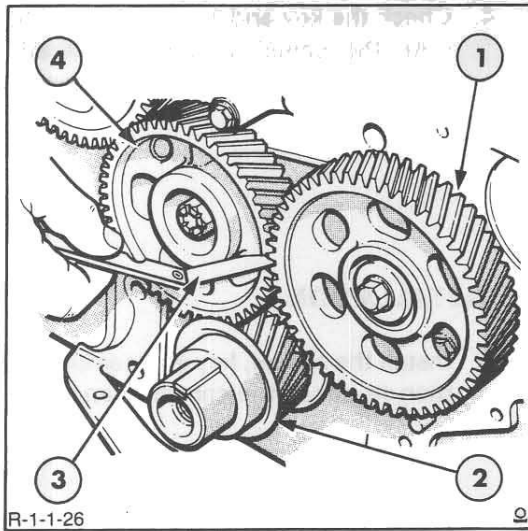
1. Camshaft Gear
2. Crankshaft Gear
3. Camshaft Drive Gear
4. Injection Pump Drive Gear

## ENGINE FRONT COVER AND TIMING GEARS

### REMOVAL

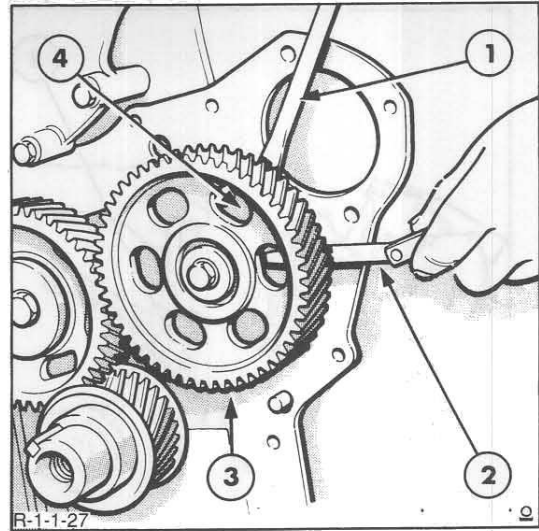
**NOTE:** The engine front cover and timing gears can only be serviced after removing the radiator and front axle. See PART 10, "SEPARATING THE UNIT".

1. Drain the engine oil and remove the oil pan.
2. Remove the fan drive belt and withdraw the bolt and washer from the centre of the crankshaft pulley.
3. Using Puller No. 518 or 9539 and Shaft Protector No. 625-A or 9212, remove the crankshaft pulley, Figure 23.
4. Support a suitable container under the power steering pump and reservoir assembly.
5. Disconnect the pump pressure and return tubes and allow the oil to drain. Plug the disconnected tubes and ports to prevent the entry of dirt.
6. Extract the two bolts retaining the pump in the timing gear casing then remove the pump from the engine and drain the remaining oil from the reservoir.
7. Withdraw the retaining bolts then remove the front cover and gasket. Remove the oil slinger.
8. Before removing the timing gears, Figure 24, use a dial indicator or feeler gauges, to measure the backlash between each set of mating gears, Figure 25. Rotate the gears and check the backlash at four equidistant points on the gears. Renew the gears if the backlash exceeds the specified limits, see "Specifications" - Chapter 4.



**Figure 25**  
Measuring Timing Gear Backlash

1. Camshaft Gear
2. Oil Slinger (Reference Only)
3. Feeler Gauge
4. Camshaft Drive Gear



**Figure 26**  
Measuring Camshaft End Play

1. Pry Bar
2. Feeler Gauge
3. Camshaft Gear
4. Thrust Plate

9. Pry the camshaft gear away from the thrust plate and using a dial indicator or feeler gauges, measure the clearance, Figure 26. Install a new camshaft thrust plate if the camshaft end play exceeds the specified limits, see "Specifications" – Chapter 4.

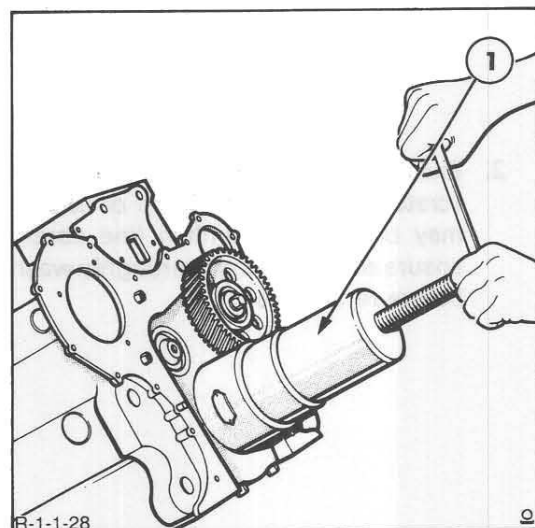
13. Remove the crankshaft gear using Tool No. CPT 6040B or 2134, Figure 27.

**NOTE:** The crankshaft gear should only be removed if it shows signs of wear.

10. Remove the self-locking bolt that retains the camshaft drive gear and adapter to the cylinder block then remove gear and adaptor, Figure 24.

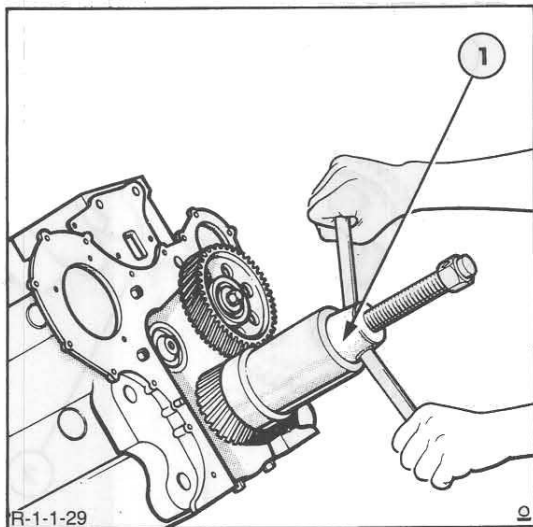
11. Remove the retaining bolt and washer, then remove the camshaft gear from the end of the camshaft, Figure 24.

12. Remove the three bolts and then remove the drive gear from the injection pump hub, Figure 24.



**Figure 27**  
Crankshaft Gear Removal

1. Puller Tool No. CPT 6040-B or 2134



**Figure 28**  
Crankshaft Gear Installation

4. Check the key and keyway in the end of both the camshaft and crankshaft for damage. Renew the keys if necessary.

### INSTALLATION

1. Install the spacer, key and camshaft gear then re-check the camshaft end play.

1. Replacer Tool No. CT6069-A or 2134 and Tool No. CT6069-1 or 1237.

2. Locate the key then use Tool No. CT6069-A or 2134 and CT6069-1 or 1237 to install the crankshaft gear, Figure 28.

### INSPECTION AND REPAIR

1. Wash the gears and adapter in a suitable solvent and dry with a clean lint free cloth or compressed air.

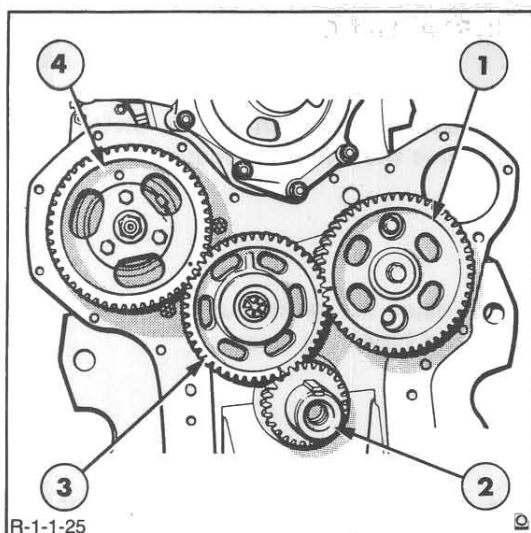
3. Position No. 1 piston at Top Dead Centre and install the camshaft drive gear and adapter with the timing marks aligned with those of the other gears.

2. Examine the gear teeth for wear, burrs or scratches. Any minor burrs or scratches may be removed with a fine abrasive; ensure such parts are thoroughly washed before re-assembly.

Tighten the bolt to the specified torque and re-check the backlash between the gears, see "Specifications" – Chapter 4.

3. Ensure the camshaft drive gear adapter oil passage is free from obstruction and the drive gear bushing is not damaged.

4. Assemble the fuel injection pump to the engine front plate. Check No. 1 piston is at T.D.C. and install the injection pump drive gear with the timing mark aligned with that of the camshaft drive gear, Figure 29.

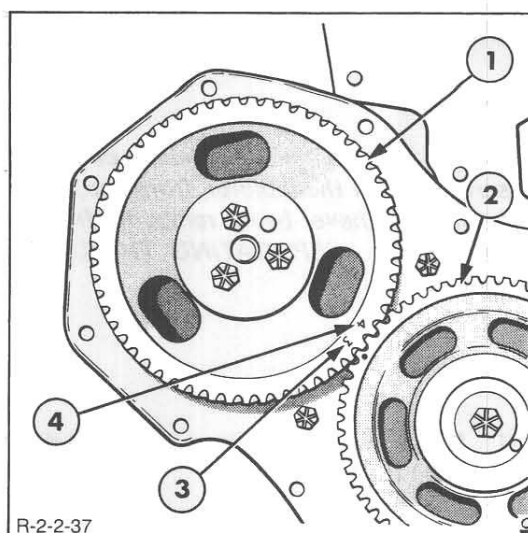


**Figure 29**  
Aligning the Timing Gears

1. Camshaft Gear
2. Crankshaft Gear
3. Camshaft Drive Gear
4. Injection Pump Drive Gear

**NOTE:** Engines with a DPA distributor type fuel injection pump have a common fuel injection pump drive gear. This gear features timing marks identified by numerals. When installing the pump drive gear, ensure that timing mark 3 aligns with the camshaft drive gear timing mark, Figure 30.

5. Install a new dust seal in the front cover. Lubricate the oil seal with petroleum jelly and use a 530-S or 9210 adaptor to press the seal into the front cover. Check after installation to ensure the spring is correctly positioned in the seal.
6. Locate the oil slinger onto the crankshaft with the dished face outwards.
7. Position a new gasket on the engine front plate and install the front cover ensuring the cover aligns with the dowel pins. Tighten the bolts to the specified torque, see "Specifications" – Chapter 4.



**Figure 30**  
DPA Distributor Type Fuel Injection Pump Drive Gear to Camshaft Drive Gear Timing

1. Pump Drive Gear
2. Camshaft Drive Gear
3. 3-Cylinder Timing Mark

8. Lubricate the crankshaft pulley spacer and slide over the key. Replace the pulley hub and tap onto the crankshaft. Tighten the securing bolt to the specified torque, see "Specifications" – Chapter 4.
9. Install the oil pan with a new gasket and tighten the bolts to the specified torque, see "Specifications" – Chapter 4.
10. Install the power steering pump and reservoir assembly and tighten the bolts to the specified torque, see "Specifications" – Chapter 4. Reconnect the pressure and return tubes and tighten the unions to the specified torque, see "Specifications" – Chapter 4.
11. Refill the engine and power steering reservoir with the correct grade and quantity of oil, see "Specifications" – Chapter 4.
12. Install the radiator and front axle – see PART 10, "SEPARATING THE UNIT", then operate the engine and check for fluid leaks.

## **OIL PAN SUMP**

### **REMOVAL**

**NOTE:** *The engine oil pan sump can only be serviced after the radiator, front support and front axle have been removed from the tractor, see "SEPARATING THE UNIT" – Part 10.*

1. Drain the engine oil and remove the oil level indicator.
2. Remove the oil pan sump retaining bolts and the two oil pan sump to transmission case attaching bolts then lower the sump.



**WARNING:** *Due to the weight of the cast iron sump, exercise great care on removal. If necessary use an hydraulic jack to lower the oil pan sump to the floor.*

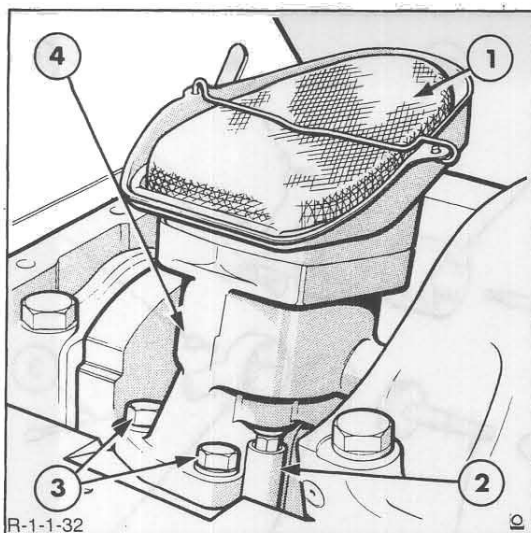
### **INSPECTION AND REPAIR**

1. Scrape all gasket material from the gasket surface then wash the oil pan sump in a suitable solvent and dry with a clean lint free cloth or compressed air.
2. Inspect the sump for cracks, damaged drain plug threads or distorted gasket surface.

### **INSTALLATION**

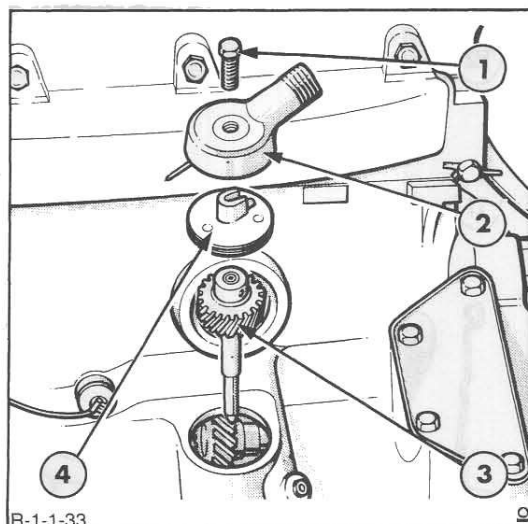
Installation of the oil pan sump follows the removal procedure in reverse. On installation observe the following requirements:

- Ensure the gasket surfaces on the oil pan and block are clean.
- Install a new gasket and apply a thin film of sealer to the gasket, front cover and oil pan, see "Specifications" – Chapter 4.
- Position the oil pan and install a bolt finger tight at each corner.
- Install a new gasket to the oil drain plug and install the plug, then tighten to the specified torque, see "Specifications" – Chapter 4.
- Fill the radiator with the correct strength and quantity of coolant see "Specifications" – Chapter 4.
- Fill the engine with the correct grade and quantity of oil, see "Specifications" – Chapter 4.
- Operate the engine and check for oil and coolant leaks.



**Figure 31**  
Oil Pump and Filter Screen

1. Filter Screen
2. Intermediate Shaft
3. Oil Pump Retaining Bolts
4. Oil Pump



**Figure 32**  
Oil Pump Drive Gear Removal

1. Retaining Bolt
2. Proofmeter Driveshaft Adapter
3. Oil Pump Driveshaft and Gear Assembly
4. Driveshaft Adapter Mounting Base

## OIL PUMP

### REMOVAL

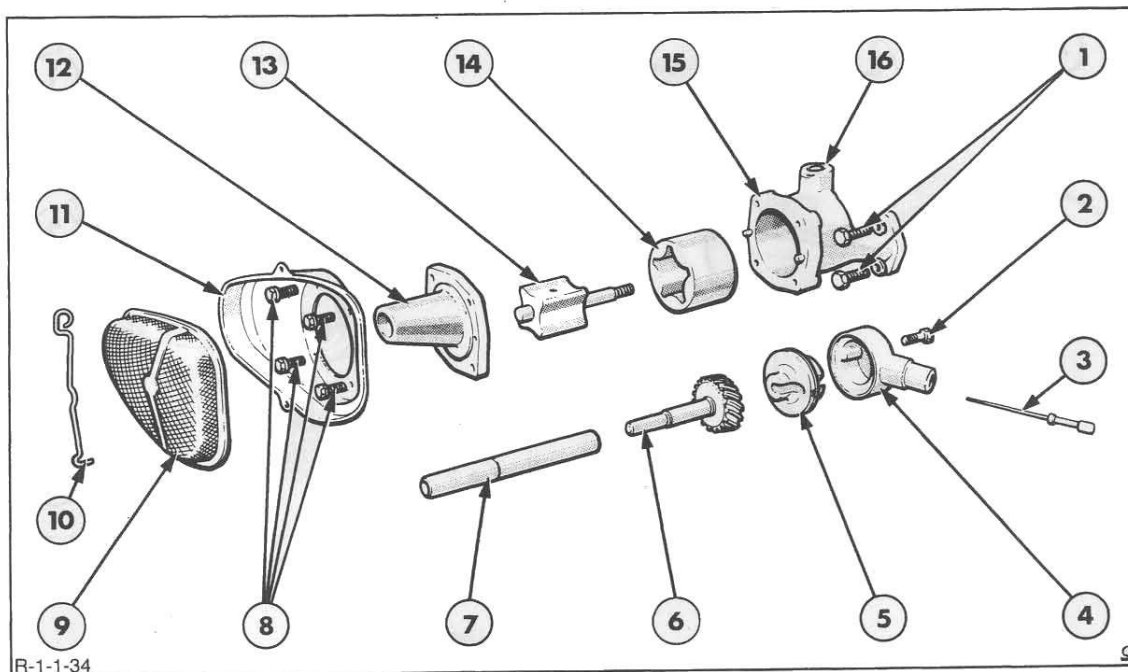
1. Remove the oil pan sump as previously described in this Chapter.
2. Remove the oil pump with the filter screen, Figure 31. Withdraw the intermediate shaft.
3. Disconnect the proofmeter drive cable from the driveshaft adapter, where fitted, and remove the engine oil filter.

4. Slacken the retaining bolt then withdraw the driveshaft adapter assembly where fitted or remove the welch plug from engine block and the oil pump drive gear, Figure 32.

### DISASSEMBLY

With reference to Figure 33.

1. Remove the spring clip and detach the pump screen.
2. Withdraw the retaining screw and washer assemblies then separate the inner and outer covers from the body and extract the rotor and shaft assembly.



**Figure 33**  
Oil Pump Assembly

- |   |                                    |
|---|------------------------------------|
| 1. Oil Pump Retaining Bolts                 | 9. Screen                          |
| 2. Adapter Retaining Bolt                   | 10. Spring                         |
| 3. Proofmeter Driveshaft and Cable Assembly | 11. Outer Cover                    |
| 4. Proofmeter Driveshaft Adapter            | 12. Inner Cover                    |
| 5. Driveshaft Adapter Mounting Base         | 13. Inner Rotor and Shaft Assembly |
| 6. Oil Pump Driveshaft and Gear Assembly    | 14. Outer Rotor                    |
| 7. Intermediate Shaft                       | 15. Body                           |
| 8. Screw and Washer Assemblies              | 16. Pressure Relief Valve Assembly |

3. Insert a self-tapping screw into the relief valve plug and pull the plug out of the body. Withdraw the relief valve and spring.

3. Use a straight edge and feeler gauges to measure the end play between the inner rotor and the pump body and measure the clearance between the outer rotor and the pump body, Figure 34.

### INSPECTION AND REPAIR

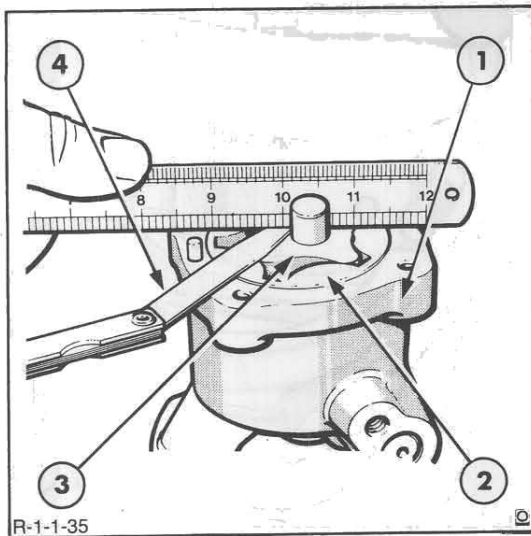
1. Wash all parts in a suitable solvent and dry with a clean lint free cloth or compressed air.

4. Use feeler gauges to measure the clearance between the periphery of the outer rotor and the pump body, Figure 35.

2. Inspect the inside of the pump cover and body for excessive wear.

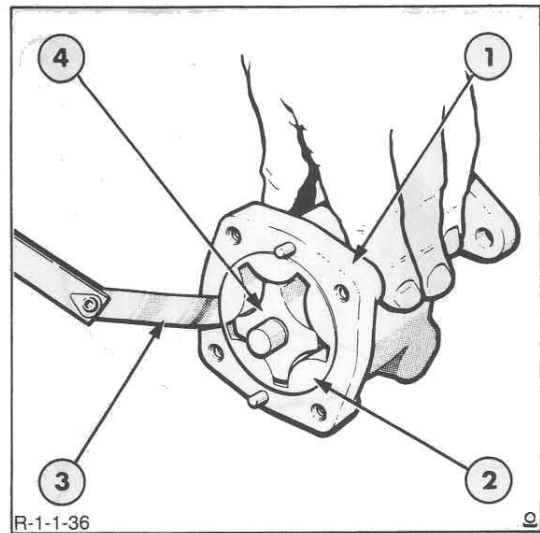
5. Check the relief valve spring tension, see "Specifications" – Chapter 4.





**Figure 34**  
Measuring Oil Pump Clearance

- |                |                 |
|----------------|-----------------|
| 1. Pump Body   | 3. Inner Rotor  |
| 2. Outer Rotor | 4. Feeler Gauge |



**Figure 35**  
Measuring Outer Rotor to Pump Body Clearance

- |                |                 |
|----------------|-----------------|
| 1. Pump Body   | 3. Feeler Gauge |
| 2. Outer Rotor | 4. Inner Rotor  |

**NOTE:** If the rotor end float or rotor-to-body clearance are greater than the limits stated in "Specifications" – Chapter 4, the inner and outer rotors must be renewed as an assembly.

6. Inspect the relief valve for wear and check for freedom of movement within the bore.
7. Check the oil pump drive gear for worn or damaged teeth.
8. Examine the intermediate drive shaft socket ends for wear.

1. Insert the relief valve and spring into the pump body and press the plug into position.

2. Install the outer rotor into the pump body, then insert the inner rotor and shaft assembly.

3. Replace the inner and outer covers on the pump body and secure with the four screws and washers.

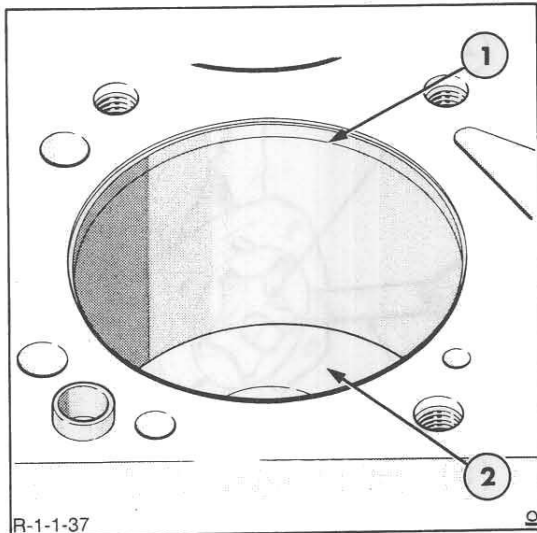
4. Replace the screen and secure in position with the spring clip.

## RE-ASSEMBLY

Coat all parts with clean engine oil when assembling.

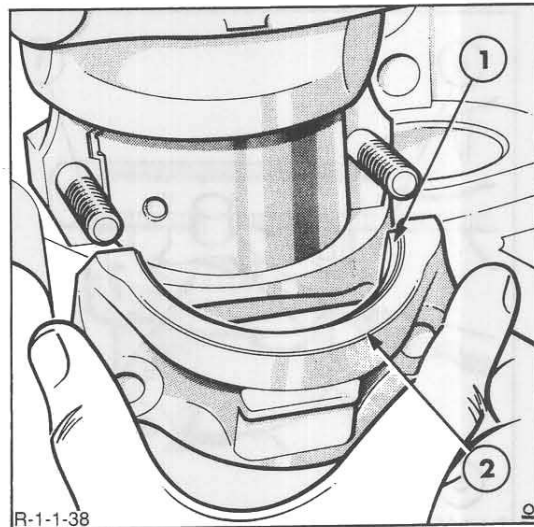
**NOTE:** Prior to installation introduce clean engine oil into the inlet port and rotate the pump shaft by hand.





**Figure 36**  
Cylinder Ridge

- 1. Cylinder Ridge
- 2. Piston



**Figure 37**  
Connecting Rod Bearing Cap Removal

- 1. Bearing Liner
- 2. Bearing Cap

## INSTALLATION

Installation of the oil pump follows the removal procedure in reverse. On installation observe the following requirements.

- Install a new gasket and tighten the bolts to the specified torque, see "Specifications" – Chapter 4.
- Remove all traces of seal material from the locating surface then install a new oil filter and seal. Apply a light, even coat of clean engine oil to the seal surface prior to installation. Hand tighten the filter until the seal contacts the locating surface then tighten an additional one-half to three-quarters of a turn.

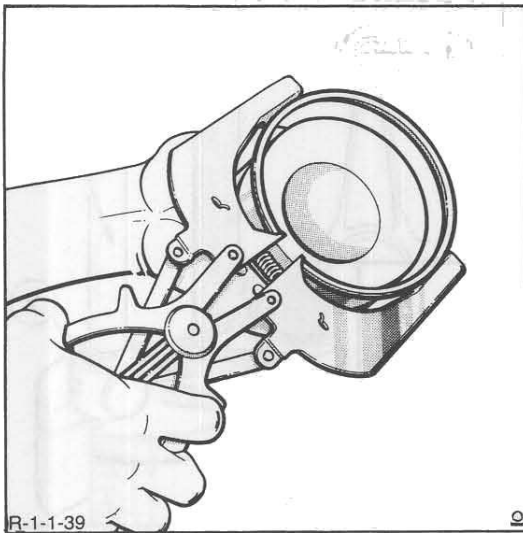
**IMPORTANT:** *Never use a tool to tighten the spin-on filter.*

## CONNECTING RODS, BEARINGS, PISTONS, RINGS AND CYLINDER BLOCK

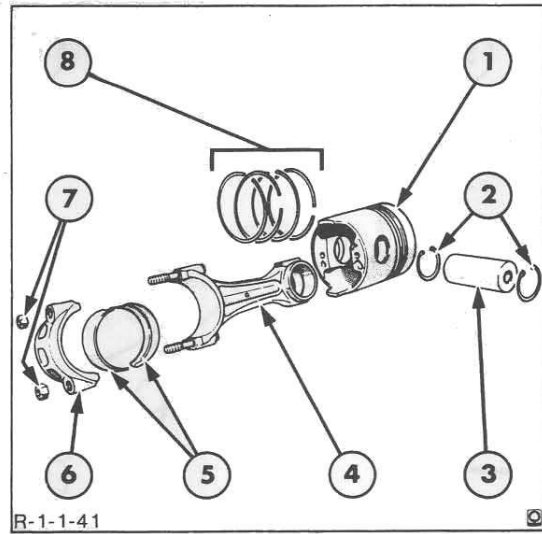
### REMOVAL

**NOTE:** *The connecting rods and pistons can be removed with the engine installed in the tractor after prior removal of the cylinder head, oil pan sump, and oil pump assembly as previously described in this Chapter.*

1. If necessary, remove any ridge from the top of the cylinder bores, Figure 36, with a cylinder ridge reamer or hand scraper. Do not cut down into the piston ring travel area. (Ridge removal is not essential when reboring or if the old pistons are not to be used. However, it may be necessary to remove a ridge in order to extract an old piston.) Do not attempt to remove and re-use a piston from a cylinder with an excessive ridge. Forcing the piston past the ridge may break the lands on the piston or the rings.



**Figure 38**  
Piston Ring Removal



**Figure 39**  
Piston and Connecting Rod Disassembled

- |                   |                   |
|-------------------|-------------------|
| 1. Piston         | 5. Bearing Liners |
| 2. Pin Retainers  | 6. Bearing Cap    |
| 3. Piston Pin     | 7. Retaining Nuts |
| 4. Connecting Rod | 8. Piston Rings   |

2. With the piston at the bottom of the stroke, remove the nuts from the bearing cap bolts and remove the bearing cap and liner, Figure 37.
3. Use the handle end of a hammer to push the piston and rod assembly out of the top of the block. Remove the bearing liner from the connecting rod.
4. 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.

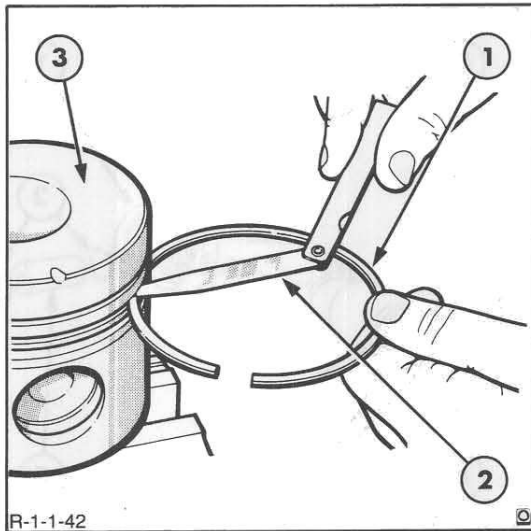
2. Use an expander to remove the piston rings, Figure 38.
3. Identify each piston and rod for reassembly, Figure 39.

## INSPECTION AND REPAIR

1. Wash the piston and connecting rod assembly in a suitable solvent and dry with a clean lint free cloth or compressed air.
2. Inspect the piston ring lands, skirts and pin bosses for damage.
3. Clean the ring grooves and using a new ring and feeler gauge check the piston ring lands for wear, Figure 40. For maximum ring clearance see "Specifications" – Chapter 4.

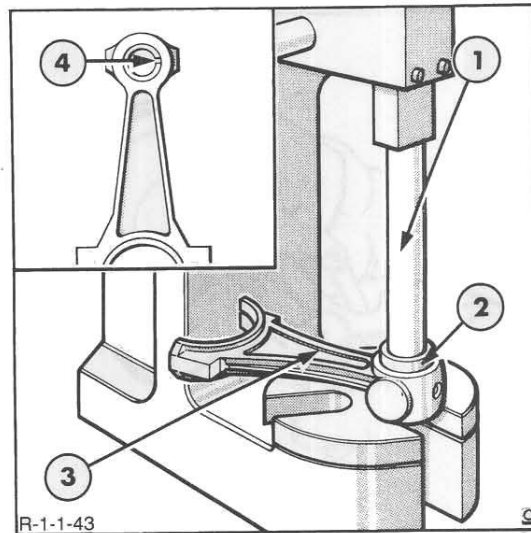
## DISASSEMBLY

1. Remove the piston pin retainer (snap ring) from each side of the piston and remove the pin.



**Figure 40**  
Checking Piston Ring Side Clearance

1. New Piston Ring
2. Feeler Gauge
3. Piston



**Figure 41**  
Connecting Rod Bushing Removal and Installation

1. Handle Tool No. 818 or 9514
2. Adaptor Tool No. 818 or 9514
3. Connecting Rod
4. Split in Bush

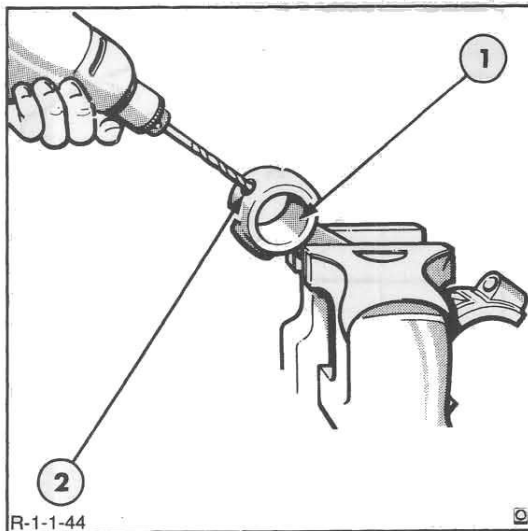
4. Check the connecting rod components for damage and place each connecting rod in an alignment fixture to check for distortion, see "Specifications" – Chapter 4.

**NOTE:** *Line up the bushings so that the split is at right angles to the connecting rod's longest axis and ensure the bushing does not protrude from either side of the rod.*

5. Check the piston pin bushings for wear or damage. Measure the outside diameter of the piston pin and the inside diameter of the connecting rod bushing. If the clearance is not within the specified limits, see "Specifications" – Chapter 4, press out the connecting rod bushing and install a new bushing using Tool No. 818 or 9514 with a suitable Adapter, Figure 41.

6. After installation of a new connecting rod bushing, use the hole in the top of the rod as a guide and drill a 0.25 in. (6.4 mm) diameter hole through one wall of the bushing, Figure 42.

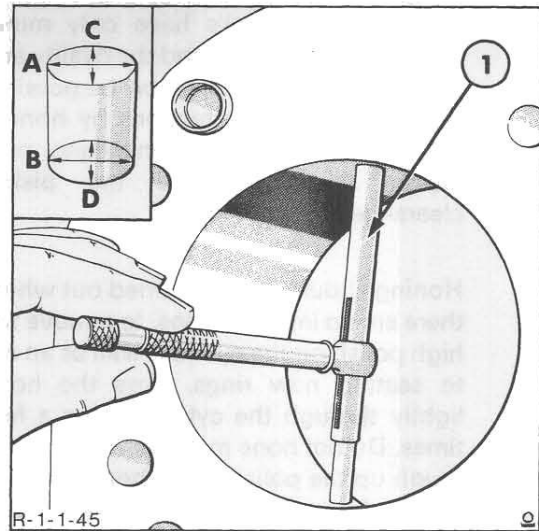
7. Use an expansion reamer to ream the bushing to obtain the specified bushing-to-piston pin clearance. Remove burrs and metal chips from the rod before fitting the piston pin.



**Figure 42**

Connecting Rod Bushing Installed

1. Connecting Rod Bushing Installed
2. Lubricating Hole



**Figure 43**

Measuring Cylinder Bore

1. Telescope Gauge

8. Check the connecting rod and main bearing clearances as described in this Chapter. If the bearing clearances exceed the specified limits, see "Specifications" – Chapter 4, then install new bearings as described in the crankshaft section of this Chapter.

A wavy cylinder wall has a series of parallel lines or rings worn around the cylinder, within the ring travel area. These irregularities can be felt by running a finger over the surface.

A scuffed cylinder can be identified by discoloured areas.

9. Clean and inspect the cylinder block. Rust around the core plugs indicates leakage and new plugs should be fitted with the specified sealant, see "Specifications" – Chapter 4.

Out-of-roundness, wear and taper can only be detected with a cylinder bore gauge, Figure 43. Measure lengthwise and crosswise to obtain dimensions 'A', 'B', 'C' and 'D', Figure 44. Dimensions 'A' compared with 'B' and dimension 'C' compared with 'D', indicates taper whilst the crosswise dimensions 'C' and 'D' compare to the lengthwise measurements 'A' and 'B' show if an out-of-round condition exists. See "Specifications" – Chapter 4.

10. Inspect and measure the cylinder bores for waviness, scratches, scuffing, out-of-round, wear and taper.

11. If the cylinder walls have only minor surface imperfections and the ovality and taper are within limits, it may be possible to remove the imperfections by honing the cylinder walls and installing new piston rings, provided the piston clearance is within limits.

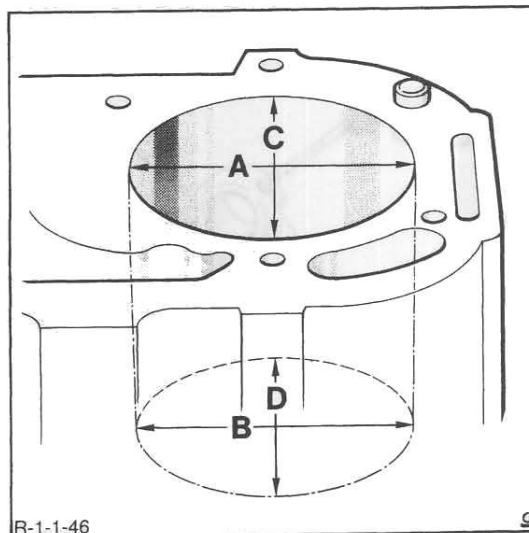
Honing should also be carried out where there are no imperfections, to remove the high polish on the cylinder wall as an aid to seating new rings. Pass the hone lightly through the cylinder bore a few times. Do not hone more than enough to rough up the polish. After honing, bores should be washed with hot water and detergent, then rinsed in cold water and dried thoroughly. The bores should then be oiled to prevent rusting.

If the cylinders are outside specification or the walls are damaged, the cylinders should be honed or bored to fit the next oversize pistons. The finished bore size can be determined by measuring the piston diameter at right angles to the piston pin and adding the appropriate piston-to-bore clearance, see "Specifications" – Chapter 4. Always bore the cylinder with the most wear first to determine the oversize pistons required.

Oversize piston are available as follows:

- 0.004 in. (0.10 mm)
- 0.020 in. (0.51 mm)
- 0.030 in. (0.76 mm)
- 0.040 in. (1.0 mm)

13. Bores to take 0.004 in. (0.10 mm) oversize pistons need only be honed. All honing should be done with a rigid hone having a grit size of 150-220. After reboring and honing, thoroughly wash and dry the cylinder block and coat the walls with engine oil.

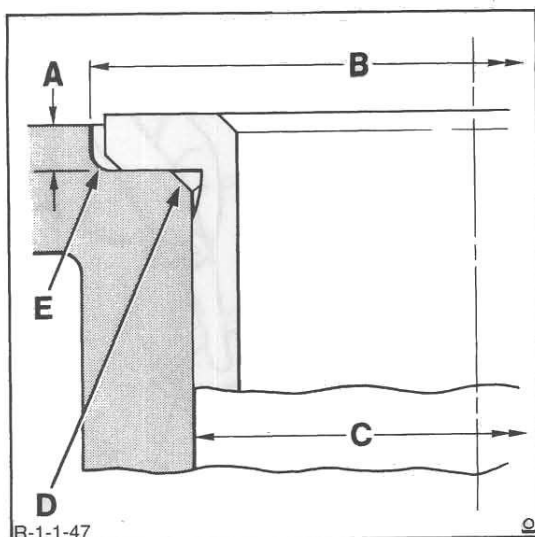


**Figure 44**  
Cylinder Bore Measurements

14. Under certain circumstances it is more expedient to resleeve a bore rather than to rebore and install oversize pistons. This occurs when:

- (a) Oil consumption is due to bore porosity which cannot be corrected by reboring.
- (b) Replacing sleeves installed in service.
- (c) The cylinder has a badly damaged bore which cannot be rectified by boring.

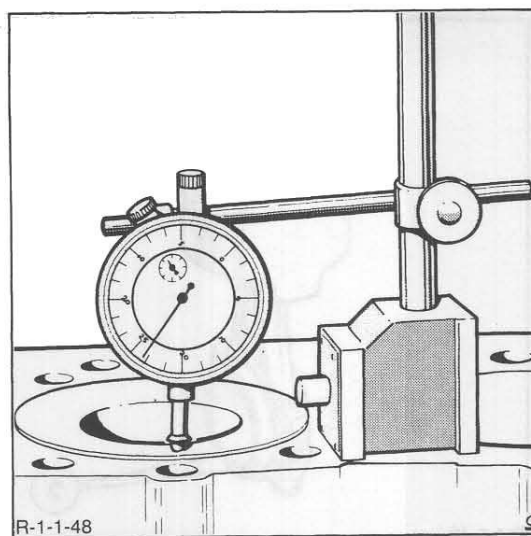
**NOTE:** When reconditioning engines equipped with sleeves, use only standard or 0.004 in (0.1016 mm) oversize pistons.



**Figure 45**

Dimensions for Machining Cylinder Bore for Thin Walled Sleeve

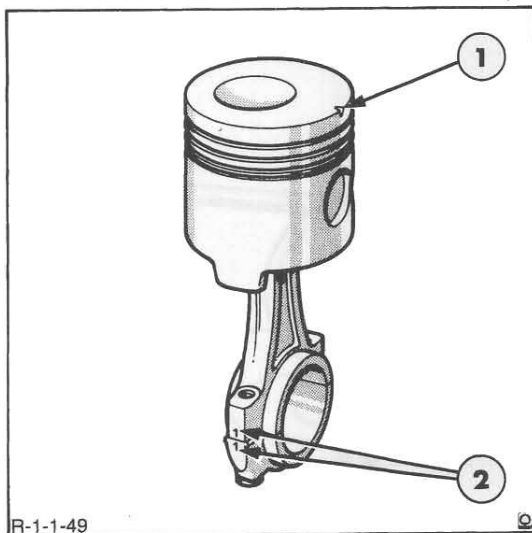
- A. 0.095 – 0.099 in. (2.41 – 2.51 mm)
- B. 4.746 – 4.753 in. (120.55 – 120.73 mm)
- C. Bore Cylinder to Average Diameter of Sleeve less 0.000 – 0.002 in. (0.00 – 0.05 mm)
- D. 0.020 – 0.030 in. (0.50 – 0.75 mm)  $\times$  45° Chamfer
- E. 0.015 in. (0.381 mm) Radius Maximum



**Figure 46**

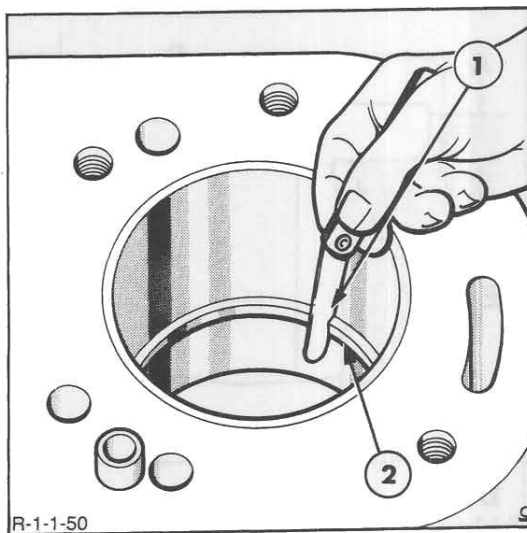
Measuring Piston-to-Block Height

15. If the cylinders are outside specification or the walls are worn or damaged the cylinder should be bored and sleeved back to standard (4.4 in., 111.76 mm).
16. A lipped thin wall sleeve for fitting to engines with 4.4 in. (111.6 mm) bore is available and the procedure for installing this sleeve is as follows:
  - (i) Measure the outside diameter of the sleeve in four places and find the average diameter. Bore the block to 0.000 – 0.002 in. (0.00 – 0.05 mm) less than this average diameter.
  - (ii) Machine the counterbore to the dimensions shown in Figure 45. The counterbore depth is critical as the sleeve must be flush with the block surface when installed.
  - (iii) Thoroughly clean and dry the bore and the outside surface of the sleeve.
  - (iv) Chill the sleeve in liquid nitrogen or dry ice and assemble to the cylinder bore ensuring the lip is bottomed in the counterbore.
  - (v) If necessary the sleeve may be machined to bring it flush with the block face, or if necessary the block face may be skimmed by up to 0.005 in. (0.13 mm) to achieve a flush condition. If the block is skimmed ensure the piston to block height dimension is maintained within specification, Figure 46, see "Specifications" – Chapter 4.
  - (vi) Bore and hone the sleeve to the diameter required. Only standard and 0.004 in. (0.10 mm) oversize pistons can be used with the thin walled 4.4 in. (11.76 mm) bore lipped sleeve.
17. Check the flatness of the cylinder block-to-head surface, see "Specifications" – Chapter 4.



**Figure 47**  
Piston Connecting Rod Alignment

1. Notch – To Front of engine
2. Cap Numbers



**Figure 48**  
Checking Piston Ring Gap

1. Feeler Gauge
2. Piston Ring

## RE-ASSEMBLY

**NOTE:** Prior to re-assembly, check the cylinder bores for taper and out-of-round as previously described in this Chapter.

1. Prior to re-assembly, check the piston-to-bore clearance as follows:

- Measure the cylinder bore diameter in a crosswise direction then measure the piston diameter at right angles to the piston pin.
- Subtract the piston diameter from the bore diameter and the resultant figure should be within the specified clearance, see "Specifications" – Chapter 4.

**NOTE:** Pistons are available in both standard and oversizes. New pistons should be installed if the clearance exceeds the specified limits.

- If the clearance is **greater** than specified, try a similar new piston. If the clearance still exceeds the specified limit, measure the other cylinder bores and pistons and determine the cylinder with the greatest clearance. Based on the greatest clearance, rebore the cylinders to take the next oversize piston as previously described in this Chapter.
  - If the clearance is **less** than specified: Hone the bore to obtain the desired clearance as previously described in this Chapter.
2. Lubricate all components with engine oil then assemble the piston to the connecting rod with the notch on the piston crown aligned with the pip on the connecting rod and install the piston pin and retainers (snap rings), Figure 47.
  3. Check the piston rings for minimum gap prior to installation in the relevant cylinder, Figure 48. Use a piston crown to squarely locate the ring in the bore. New rings should be checked for side clearance in the piston as previously described in this Chapter.



4. Use an expander to install the piston rings Figure 49, starting with the oil control ring in the bottom groove and working upwards.

The service ring set comprises:

- 1 Coiled Wire Expander or "Rail" type Expander for the Oil Control Ring
- 1 Oil Control Ring
- 3 Compression Rings

### Oil Control Ring

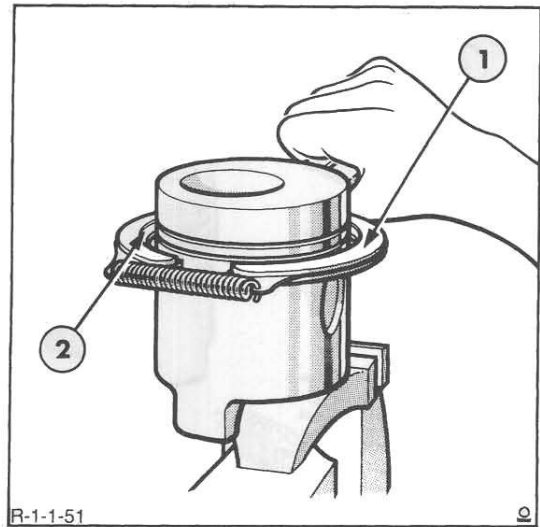
Open the coiled wire expander to fully reveal the inner guide wire. Position the coiled expander in the oil groove and insert the inner guide wire into the open end of the coil. Close the coil until the ends abut.

Position a "rail" type expander in the oil groove ensuring the ends do not overlap. Attempting to install a ring with overlapping ends will result in a broken ring and/or damaged cylinder bore. Do not cut the expander if it appears to be too large. The rings will compress to size if the correct ring compressor is used, Figure 49.

Install the cast iron ring (either side up) with the inside groove over the coiled rail expander. Position the ring gap diametrically opposite the coiled wire ends.

### 3rd Compression Ring

Dull finish with a step or chamfer on the inside diameter which must face *downwards* or a step on the outside diameter which must face *upwards* on assembly.



**Figure 49**  
Piston Ring Installation

1. Piston Ring Expander
2. Piston Ring

### 2nd Compression Ring

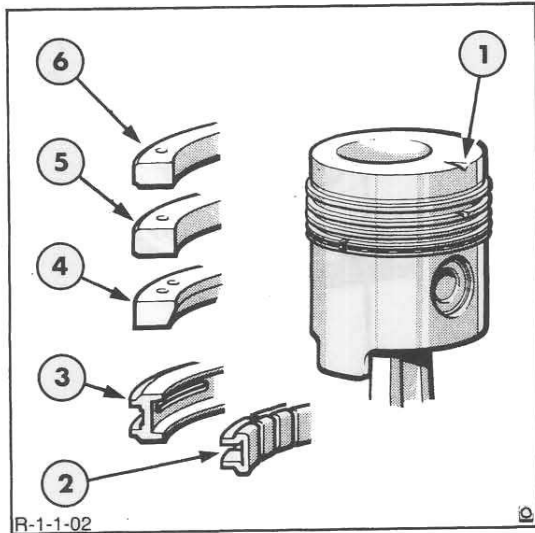
Bright chrome finish on the outside diameter with a chamfer or step on the outside diameter which must face *upwards* on assembly.

**NOTE:** To facilitate assembly, the 2nd and 3rd compression rings are marked with a punched dot or the letters 'TOP' engraved on their upper surfaces.

### Top Compression Ring

Bright chrome finish with a chamfer on the outside diameter which must face *upwards* and a step on the outside diameter which must face downwards on assembly.

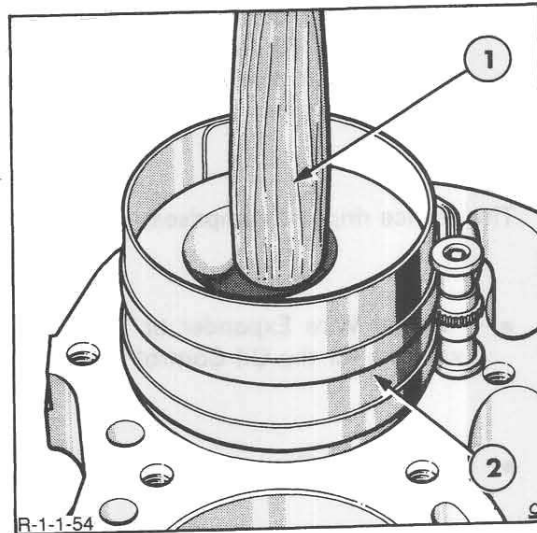




**Figure 50**  
Conventional Piston and Rings

1. Notch to Front of Engine
2. Expander for Oil Control Ring
3. Oil Control Ring
4. 1st Compression Ring
5. 2nd Compression Ring
6. Top Compression Ring

**NOTE:** Some top compression rings do not have a chamfer and may be installed either side up.



**Figure 51**  
Piston and Connecting Rod Installation

1. Hammer Handle
2. Piston Ring Compressor

1. Select the correct bearing liners, as described in the CRANKSHAFT section of this Chapter, and install in the connecting rod and cap. Ensure the bearing liner tang locates in the slots of the rod and cap.

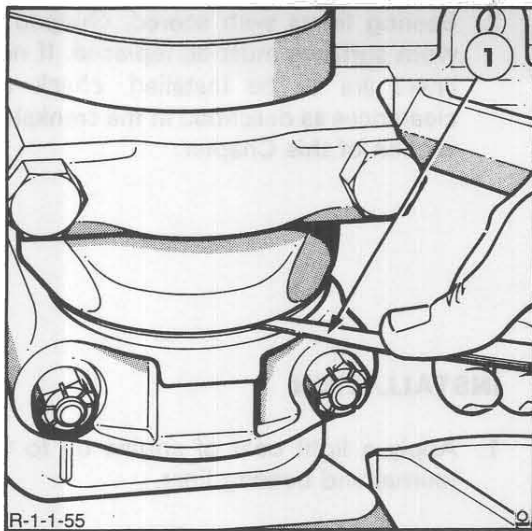
5. After installing the rings, stagger the ring gaps around the circumference of the piston at approximately 120° to each other and with no gap on the thrust side of the piston.

## INSTALLATION

**NOTE:** Before installing a piston and new rings into a used cylinder bore, remove the high polish on the cylinder wall as previously described in this Chapter.

2. Turn the crankshaft to position the No. 1 crankpin at the bottom of the stroke. Oil the piston, rings, cylinder bore and bearing liners. Use a ring compressor to install the piston into the cylinder, Figure 51. Ensure the notch on the top of the piston is towards the front of the engine.

3. Push the piston into the bore until the connecting-rod bearing liner seats on the crankpin. Install the connecting rod bearing cap with the number on the cap on the same side as the number on the rod. Install new nuts and tighten to the specified torque, see "Specifications" - Chapter 4.



**Figure 52**

### Checking Connecting Rod Bearing Side Clearance

1. Feeler Gauge
2. Piston and Rod Assembly
3. Piston and Rod Assembly
4. Use feeler gauges to check the side clearance of each connecting rod, Figure 52, see "Specifications" – Chapter 4.
5. Install the remaining piston and rod assemblies in the same manner.
6. Install the oil pump, the oil pan sump and the cylinder head as previously described in this Chapter.
7. Fill the engine with the correct grade and quantity of oil and the radiator with the correct strength and quantity of coolant; see "Specifications" – Chapter 4.
8. Start the engine and check for leaks.

## MAIN BEARINGS, FLYWHEEL AND CRANKSHAFT

**NOTE:** Replaceable bearing liners are installed in production to ensure the correct crankshaft journal-to-bearing clearance can be maintained in Service.

*The main bearings can be overhauled with the engine installed in the tractor.*

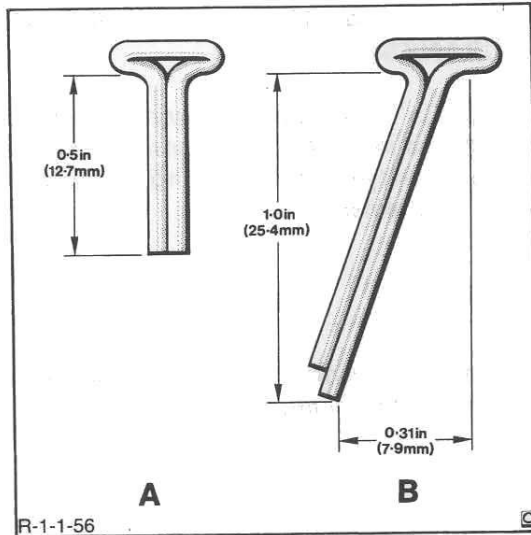
*The crankshaft can only be serviced after removal of the engine from the tractor.*

*To remove the flywheel, either remove the engine from the tractor or separate the tractor between the engine and the front transmission. See PART 10, "SEPARATING THE UNIT".*

## MAIN BEARINGS

## REMOVAL

1. Remove the oil pan, the oil pump and intermediate shaft, as previously described in this Chapter.
2. Remove the main bearing cap from the journal to which the new bearing liners are to be installed. Always install one set of bearings at a time leaving the other main bearing caps securely in place.



**Figure 53**  
Bearing Liner Removal Tools

- A. Thrust Bearing Insert Tool
- B. Main Bearing Liner Tool

3. Install a bearing liner removal tool in the crankshaft journal oil passage. Slowly turn the crankshaft counter-clockwise until the tool forces the bearing out of the cylinder block.

**NOTE:** If a bearing liner removal tool is not available, a suitable tool may be fabricated from a 1 in. (25 mm)  $\times$   $\frac{1}{8}$  in. split pin, Figure 53. The shorter pin is used to remove the thrust bearing insert.

Flatten and bend the head to 30° to conform to the angle of the oil passage in the crankshaft.

## INSPECTION AND REPAIR

1. Thoroughly clean the bearing liners, journals and caps.

2. Bearing liners with scored, chipped or worn surfaces must be replaced. If new liners are to be installed, check the clearances as described in the crankshaft section of this Chapter.

## INSTALLATION

1. Apply a light coat of engine oil to the journal and bearing liner.

2. Locate the liner installation tool in the crankshaft journal oil passage and position the liner on the journal with the plain end of the liner at the tang side of the cylinder block. Slowly turn the crankshaft clockwise until the bearing is fully located. Remove the installation tool.

3. Lubricate the bearing cap and liner and install the liner into the cap. Position the bearing cap with the locking tang towards the camshaft side of the engine and install the retaining bolts. Tighten the bolts to the specified torque, see "Specifications" – Chapter 4.

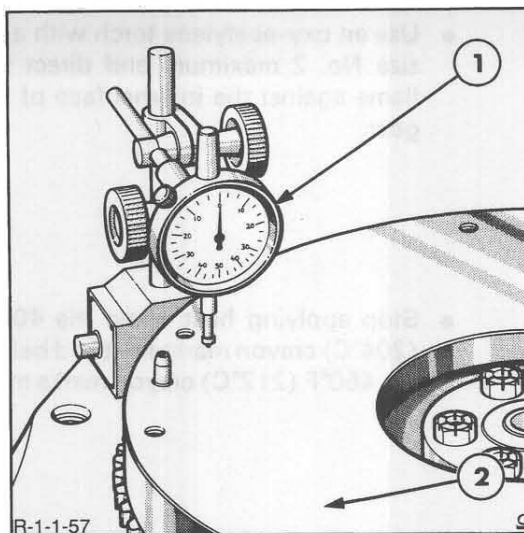
4. If a new thrust bearing liner is installed, the bearing must be aligned as described in the crankshaft section of this Chapter.

5. Install the oil pump, the intermediate shaft and the oil pan sump.

## FLYWHEEL

### REMOVAL

1. Separate the tractor between the engine and the front transmission, see PART 10, "SEPARATING THE UNIT".



**Figure 54**  
Checking Flywheel Run-Out

1. Dial Indicator Gauge
2. Flywheel

2. Prior to removal, rotate the flywheel and use a dial indicator to measure the run-out, Figure 54, see "Specifications" – Chapter 4. If the flywheel is outside the specification check the mating surfaces of the flywheel and the crankshaft for correct seating.

- Cut the old ring gear free from the flywheel.

3. Withdraw the flywheel attaching bolts and carefully remove the flywheel.

- Thoroughly clean the mating surfaces of the new ring gear and the flywheel.

### INSPECTION AND REPAIR

1. Inspect the flywheel ring gear and renew if the teeth are damaged. Check the flywheel for damage due to a loosely or improperly fitted ring gear.

- Use temperature indicating crayons to mark the side face of the ring gear at six equally spaced locations. Mark with a 400°F (204°C) crayon at a point 0.5 in. (13 mm) below the root of the teeth and mark with a 450°F (212°C) crayon at a point just below the root of the teeth.

2. A damaged flywheel ring gear should be removed and renewed as follows:

- Use an oxy-acetylene torch with a tip size No. 2 maximum and direct the flame against the internal face of the gear.

- Stop applying heat when the 400°F (204°C) crayon marks melt and before the 450°F (212°C) crayon marks melt.

- Quickly place the hot gear on the flywheel with the flat face against the shoulder on the flywheel. Quench the gear with water.

## **INSTALLATION**

1. Clean the crankshaft rear flange and the mating surface of the flywheel.
2. Establish the correct alignment of the flywheel to crankshaft mounting holes and install the flywheel. Tighten the attaching bolts to the specified torque and re-check the flywheel run-out, see "Specifications" – Chapter 4.
3. Re-assemble the tractor, see PART 10, "SEPARATING THE UNIT."

## **CRANKSHAFT**

### **REMOVAL**

1. Remove the engine from the tractor, see PART 10, "SEPARATING THE UNIT", and place on an engine stand.
2. Remove the flywheel and engine rear cover plate as previously described in this Chapter.
3. Remove the crankshaft pulley and engine front cover as previously described in this Chapter.

**NOTE:** *If the crankshaft is removed with the cylinder head in position, ensure all timing marks are realigned prior to re-assembly. This action will prevent possible interference between the valves and pistons during re-assembly.*

4. Remove the oil pan sump, the oil pump and intermediate shaft as previously described in this Chapter.
6. Remove the connecting rod and main bearing caps and liners and identify to facilitate re-assembly.
7. Carefully lift the crankshaft out of the cylinder block.

## INSPECTION AND REPAIR

**NOTE:** Current production engines may have a crankshaft with main or crankpin journals ground 0.010 in. (0.25 mm) undersize. These are identified with the letters '010 MUS' and/or '010 PUS' respectively. The letters are stamped on one of the crankshaft counterbalance weights.

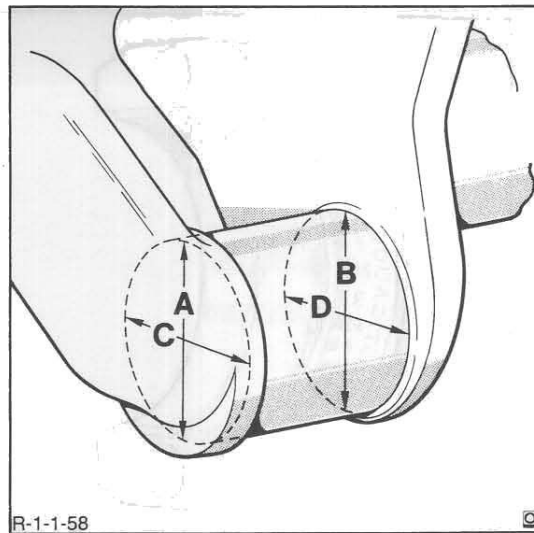


Figure 55

Crankshaft Journal Measurements

1. If the crankshaft gear teeth are excessively worn or chipped, install a new crankshaft gear which must be fully located on the shoulder of the crankshaft.

If the journal exceeds the specified wear limit, refinish the journals to the next undersize bearing, see "Specifications" – Chapter 4. Always reproduce the original journal side radii and after refinishing chamfer the oil holes.

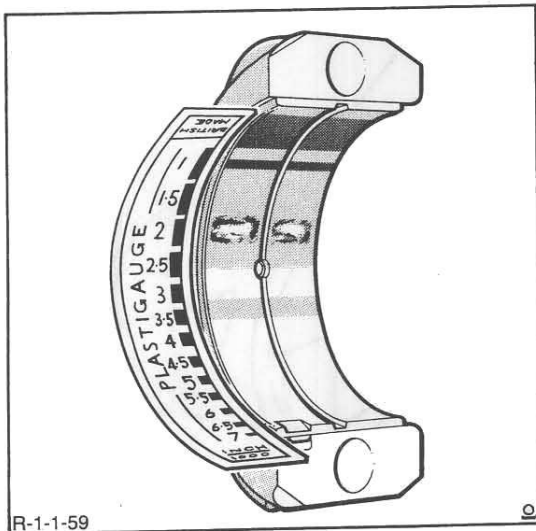
2. Clean the crankshaft and drilled passages. Dress minor imperfections with an oil stone and re-finish severely marked journals to the next undersize bearing.

4. Examine the rear oil seal journal for score marks, remove minor imperfections with fine emery cloth and if severely damaged renew the crankshaft.

3. Measure the diameter of each journal in four places to determine out-of-round, taper or wear, Figure 55. Measurement 'A' compared with 'B' indicates vertical taper whilst measurement 'C' compared with 'D' indicates horizontal taper. Measurements 'A' and 'B' compared with 'C' and 'D' indicate journal out-of-round.

## RE-ASSEMBLY

1. Check the crankshaft bearing clearance with micrometers or preferably using Plastigauge as follows:
  - Position a piece of correct size Plastigauge across the full width of the bearing cap and approximately 0.25 in. (6.35 mm) off centre.



**Figure 56**  
Checking Crankshaft Bearing Clearance Using  
Plastigauge

2. Standard size liners are colour coded red or blue and are available in a Copper Lead or Aluminium Tin alloy, see "Specifications" – Chapter 4.

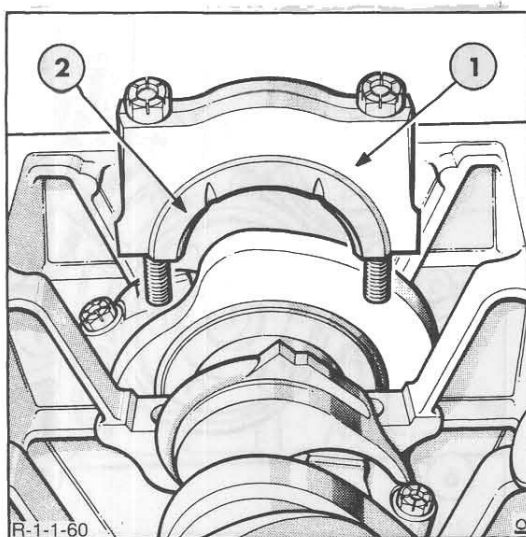
**IMPORTANT:** *The engine may be assembled with liners of different material but liners of the same material must be installed on the same journal.*

- Install the cap and tighten the bolts to the specified torque, see "Specifications" – Chapter 4.
- Remove the cap and use the scale to check the width of the flattened Plastigauge, Figure 56. The width of the Plastigauge at the widest point establishes the minimum clearance and at the narrowest point the maximum clearance. The difference between the two readings is the taper.

**NOTE:** *Normally, main bearing journals wear evenly and will not be out-of-round. However, if a liner is fitted to an out-of-round journal which is within specifications, ensure the liner to be fitted suits the maximum diameter of the journal.*

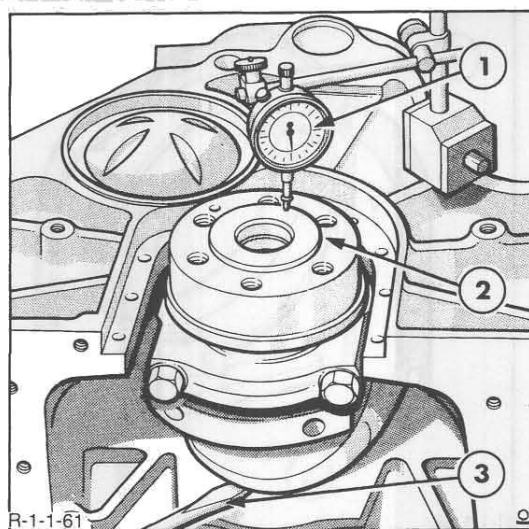
The red liners have a thinner wall section than the blue liners and provide greater clearance. A combination of red and blue liners may be required to obtain the desired clearance. If the clearance is greater than specified when two blue liners are used, a 0.002 in. (0.05 mm) undersize liner with either a red, blue or another 0.002 in. (0.05 mm) undersize liner should be installed. If any of these combinations of liners do not produce the specified clearance, refinish the crankshaft and fit undersize bearings, see "Specifications" – Chapter 4.

3. Position the bearing liners in the block and caps and coat with oil. If the crankshaft has been refinished fit the correct undersize main bearing liners. Ensure the bearing surfaces are clean and the bearing liners tangs align with the slots in the block and cap.



**Figure 57**  
Thrust Bearing Assembly

1. Bearing Cap
2. Flange Type Liner

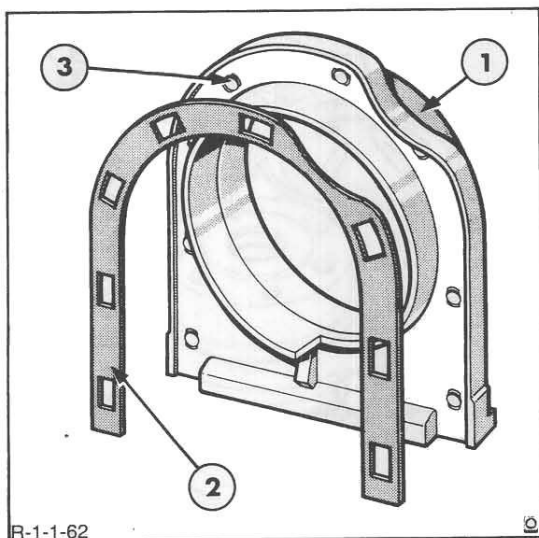


**Figure 58**  
Checking Crankshaft End Play

1. Dial Indicator Gauge
2. Crankshaft
3. Lever

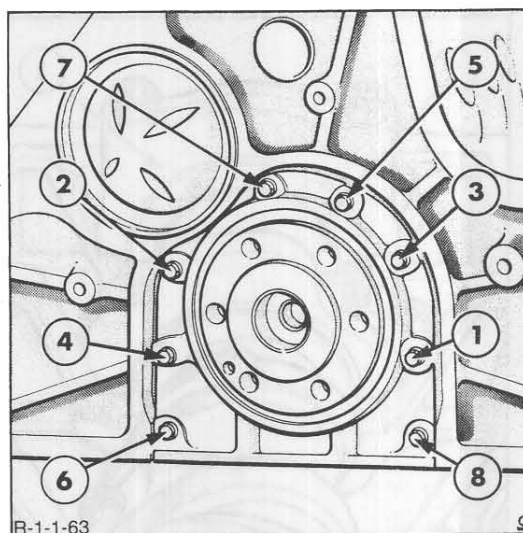
4. Align the timing mark on the crankshaft gear with that of the camshaft drive gear and install the crankshaft. Install the thrust bearing cap with the flange-type bearing liner, Figure 57, first. Then, install the remaining bearing caps in their original location.
5. Tighten all bearing cap bolts (except the thrust bearing cap) to the specified torque. The thrust bearing cap bolts should be finger tight only.
6. Pry the crankshaft forward against the thrust surface of the bearing. Hold the crankshaft forward and pry the bearing cap rearwards; care must be taken not to pry against the flange of the bearing liner. This will align the thrust surfaces of both halves of the bearing. Hold the forward pressure on the crankshaft and tighten the bearing cap bolts to the specified torque, see "Specifications" – Chapter 4.
7. Check the crankshaft end play with a dial indicator gauge, Figure 58. Pry the crankshaft towards the front of the engine and set the dial indicator to zero. Pry the crankshaft towards the rear of the engine and note the reading on the dial. If the end play exceeds the specified limit, install a new thrust bearing liner. If the end play is less than the specified limit, inspect the thrust bearing surfaces for burrs, scratches, or dirt. If the thrust surfaces are not defective or dirty, realign the thrust bearings following the procedure given in Operation No. 6.
8. Install the crankshaft rear oil as detailed below:
  - (i) Peel the protective paper backing from the gasket and stick the gasket to the retainer. Ensure that the gasket holes align with the bosses of the retainer, Figure 59.





**Figure 59**  
Crankshaft Oil Seal Retainer

1. Retainer
2. Gasket
3. Raised Bosses



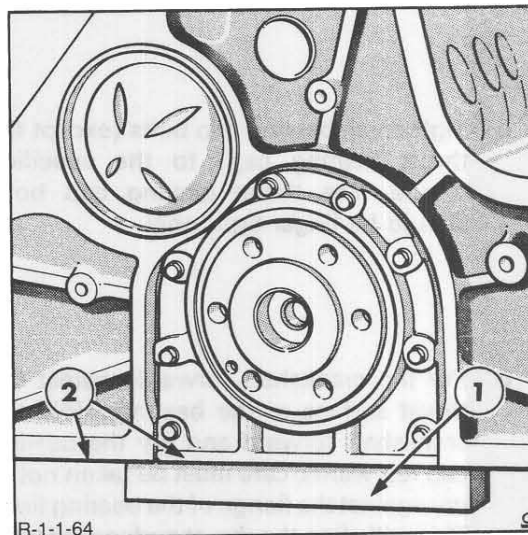
**Figure 60**  
Seal Retainer Bolt Tightening Sequence

(ii) Install the retainer and gasket onto the block, apply a low strength thread locking compound to the bolt threads, see "Specifications" – Chapter 4, and secure into position with the eight bolts.

(iii) Tighten the bolts in sequence, as shown in Figure 60, to the initial specified torque, see "Specifications" – Chapter 4.

(iv) Ensure that the base of the retainer is flush with the cylinder block, Figure 61, then tighten the bolts in the same sequence to the final specified torque, see "Specifications" – Chapter 4.

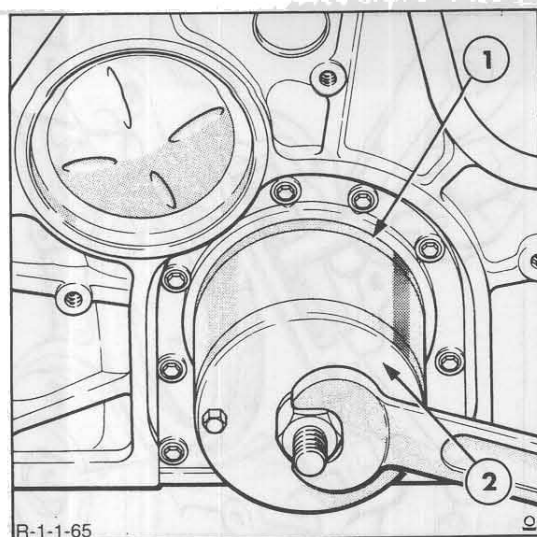
(v) Apply a liberal coating of clean engine oil to the rear oil seal retainer, seal and journal. The new seal should, preferably, be mounted on the crankshaft and then the tool bolted to the crankshaft and used to install the seal squarely.



**Figure 61**  
Retainer - Block Alignment

1. Straight Edge
2. These Two Faces to be Flush

**NOTE:** Do not pre-install the seal into the retainer. To ensure seal concentricity it must only be assembled after the retainer has been bolted to the cylinder block.



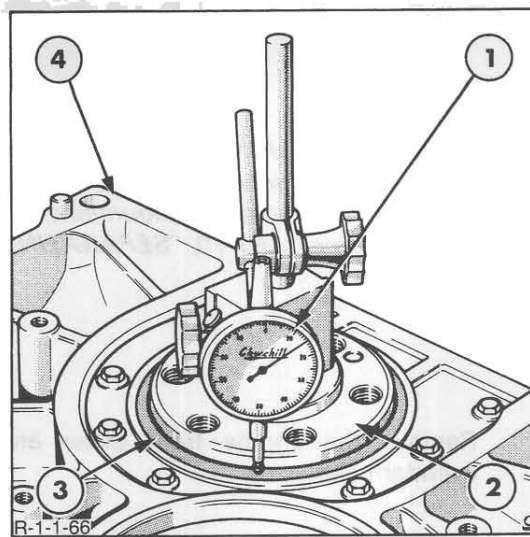
**Figure 62**  
Crankshaft Oil Seal Installation

1. Crankshaft Oil Seal
2. Tool No. FT 6212

(vi) Install the centre stock of tool No. FT 6212 to the crankshaft flange and secure with the two screws, Figure 62. Assemble the cylinder end plate assembly to the centre stock and secure with the nut and washer as shown in Figure 62. Gradually tighten the nut until the outer diameter of the tool abuts the retainer. The tool must not be overtightened as stress and distortion could be imposed on the retainer.

**NOTE:** The first seal replacement should be pushed into the retainer with the plain end of the tool and the second and subsequent seals with the stepped end of the tool which will reposition the seal 0.060 in. (1.52 mm) further in.

(vii) Remove the tool



**Figure 63**  
Checking Rear Main Bearing Crankshaft Oil Seal Run-Out

1. Dial Indicator Gauge
2. Crankshaft
3. Crankshaft Oil Seal
4. Cylinder Block

(viii) Mount a dial indicator gauge on the end of the crankshaft, Figure 63, rotate the crankshaft and check the run out of the seal does not exceed 0.015 in. (0.38 mm).

9. Install the correct bearing liners in the connecting rod and cap. If the journals are standard size select the correct bearing liners as for main bearings in Steps 1 and 2. Ensure the bearing liner tangs locate in the slots of the rod and cap.

10. Install the connecting rod bearing cap, as previously detailed in this Chapter, with the number on the cap on the same side as the number on the rod. Install new nuts and tighten to the specified torque, see "Specifications" – Chapter 4.

## INSTALLATION

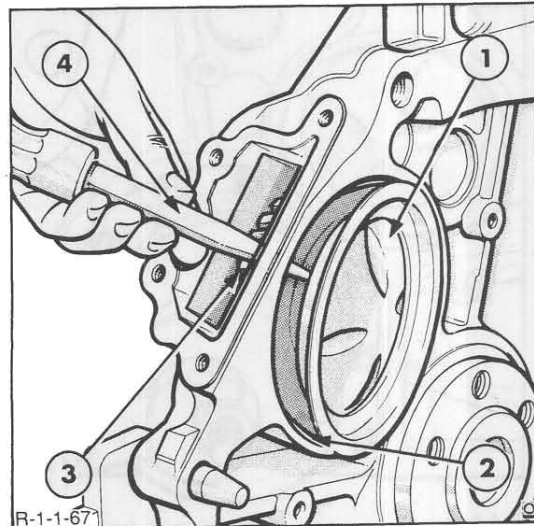
1. Installation of the components to effect complete re-assembly of the engine follows the removal procedure in reverse.

## CAMSHAFT

### REMOVAL

**NOTE:** The camshaft bearings and/or tappets can only be serviced with the engine removed from the tractor and mounted on an engine stand. See PART 10, "SEPARATING THE UNIT".

1. Remove the engine front cover and cylinder head.



**Figure 64**  
Camshaft Rear Cover Plate Removal

2. Remove the oil pump drive gear and shaft.

1. Rear Cover Plate
2. Sealant
3. Hydraulic Pump Drive Gear
4. Punch

3. Check the camshaft end play as previously described in this Chapter. If the clearance exceeds the specified limit, see "Specifications" – Chapter 4, install a new thrust plate during re-assembly.

7. For engines without a gear on the rear end of the camshaft, the camshaft can be withdrawn from the front of the engine. If the camshaft is equipped with a gear, the flywheel and rear cover plate must be removed and the camshaft rear cover driven out with a punch, Figure 64. Remove the key and spacer from the front of the camshaft and carefully withdraw the camshaft from the rear of the engine.

4. Invert the engine on the stand and remove the oil pan sump if the camshaft bearings and/or the tappets are to be removed.

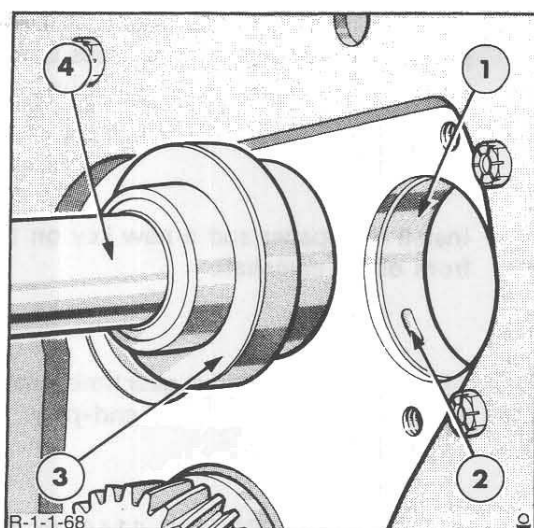
8. Lift out the tappets and place in a numbered rack to facilitate re-assembly.

5. Withdraw the bolt and flat washer and remove the camshaft gear.

6. Withdraw the bolts and lockwashers and remove the camshaft thrust plate.

### INSPECTION AND REPAIR

1. Inspect the camshaft journals and lobes for damage, pitting or heat discolouration. If any of these conditions exist, install a new camshaft.



**Figure 65**  
Camshaft Bearing Removal and Installation

1. Bearing
2. Oil Hole
3. Tool No. FT 6203 or 1255
4. Tool No. N 6261-A or 1443

2. Inspect the oil pump drive gear on the camshaft for broken or worn teeth. Check the mating gear on the oil pump drive shaft. If any damage is apparent, install a new camshaft and/or oil pump drive gear.

3. Check each tappet for signs of chipping or other damage. Measure the diameter and renew tappets if worn beyond the limits specified see "Specifications" – Chapter 4.

4. Measure the diameter and out-of-round of the bearing journals. If the journals exceed the specified limits, see "Specifications" – Chapter 4, install a new camshaft.

## Camshaft Bearings

1. Inspect the camshaft bearings for pitting or scoring. Measure the clearance between the internal diameter of the bearings and the outside diameter of the respective camshaft journals.

If the clearance exceeds the specified limit, see "Specifications" – Chapter 4, remove and install new bearings, using Remover/Replacer Tool No. FT 6203 or 1255 and Handle, Tool No. N 6261-A or 1443, Figure 65.

### 2. Camshaft Bearing Removal:

- Position Tool No. FT 6203 or 1255 against the camshaft bearing to be removed and attach Tool No. N 6261-A or 1443, Figure 65.

- Drive the camshaft bearing from the bearing bore.

### 3. Camshaft Bearing Installation:

- Align the oil holes of the new camshaft bearing with the oil holes in the engine block then drive the new bearing into place using Tool No. FT 6203 or 1255 and Handle, Tool No. N 6261-A or 1443.

**NOTE:** *A positive alignment check can only be made with the crankshaft removed, when a 0.18 in. (4.6 mm) diameter rod may be passed down the oil passage from the crankshaft main bearing. The liner is correctly positioned when the end of the rod passes through the oil hole in the liner.*

## **INSTALLATION**

1. Installation of the camshaft follows the removal procedure in reverse. On installation observe the following requirements:

- Apply petroleum jelly to each tappet foot and coat the tappet body with oil. Install the tappets in the bores from which they were removed.

- Oil the camshaft journals and apply petroleum jelly to the cam lobes before carefully installing the camshaft into the engine.

- Install the spacer and a new key on the front of the camshaft.

- Align the camshaft drive gear timing mark and re-check the camshaft end-play.

- Apply sealant ESE-M2G-114A to the sealing flange of a new camshaft cover plate when installing.

# PART 1

## ENGINE SYSTEMS

### Chapter 2

#### 4-CYLINDER DIESEL ENGINE

Section	Page
A. 4-CYLINDER DIESEL ENGINE – DESCRIPTION AND OPERATION	1
B. 4-CYLINDER DIESEL ENGINE – OVERHAUL	6

#### A. 4-CYLINDER DIESEL ENGINE – DESCRIPTION AND OPERATION

This Chapter describes the overhaul and repair of the 4-cylinder direct injection diesel engine.

and one oil control ring all located above the piston pin.

The engine Figure 1, features a cross flow cylinder head with the inlet and exhaust manifolds on opposite sides of the head. The combustion chamber is formed in the crown of the piston which has three compression

The cylinder head assembly incorporates the valves, valve springs and the spring retainers. Valve guides are an integral part of the cylinder head with replaceable valve seats pressed into the valve ports.

The following chart shows the 4-cylinder diesel engine options available.

Model	Ford 555C	Ford 555C (Turbocharged)	Ford 655C	Ford 655C (Turbocharged)
No. of Cylinders	4	4	4	4
Bore	4.4 in. (111.8 mm)	4.4 in. (111.8 mm)	4.4 in. (111.8 mm)	4.4 in. (111.8 mm)
Stroke	4.2 in. (106.7 mm)	4.2 in. (106.7 mm)	4.4 in. (111.8 mm)	4.2 in. (106.7 mm)
Displacement	256 in <sup>3</sup> (4195 cm <sup>3</sup> )	256 in <sup>3</sup> (4195 cm <sup>3</sup> )	268 in <sup>3</sup> (4393 cm <sup>3</sup> )	256 in <sup>3</sup> (4195 cm <sup>3</sup> )

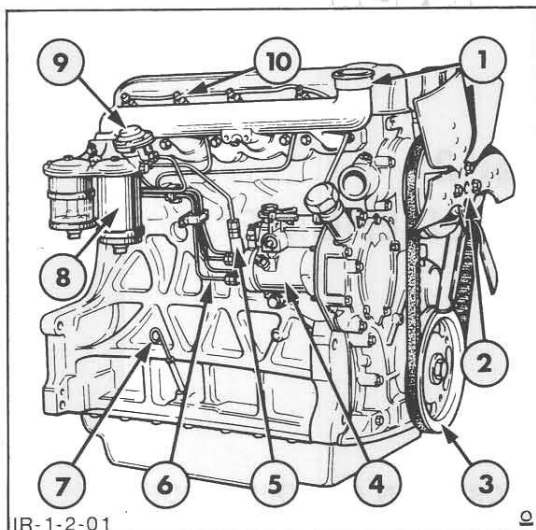


Figure 1

4-Cylinder Diesel Engine with DPS Distributor Type Fuel Injection Pump

- |                            |                            |
|----------------------------|----------------------------|
| 1. Inlet Manifold          | 6. High Pressure Fuel Pipe |
| 2. Fan                     | 7. Oil Level Indicator     |
| 3. Crankshaft Pulley       | 8. Fuel Filters            |
| 4. Injection Pump          | 9. Hand Primer             |
| 5. Low Pressure Fuel Inlet | 10. Injector               |

Valve lash is maintained by self-locking adjusting screws. The camshaft runs in four replaceable bearings, and is driven by the camshaft drive gear in mesh with the camshaft and crankshaft gears. Camshaft thrust is controlled by a plate secured to the block and located between the camshaft gear and the front journal of the camshaft. A helical gear mounted on the rear of the camshaft drives the tractor hydraulic system pump, optional on some tractor models.

The cylinder head bolts are evenly spaced in a six-point pattern around each cylinder. Diesel engine injectors are mounted outside the rocker cover.

The engine cylinder heads are designed with the entire face of the cylinder head flat. The combustion chambers are recessed into the piston crowns.

### Cylinder Head Assembly

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 on the right hand side, and the exhaust on the left. The water outlet connection and thermostat are attached to the front of the cylinder head.

Valve guides are integral with the cylinder head, and valves with oversize stems are available for service. Special replaceable cast alloy valve seats are pressed into each valve port, and exhaust valves are fitted with positive valve rotators. Intake valves use umbrella-type seals while the exhaust valves use a square section O-ring.

### Crankshaft Assembly

The crankshaft is supported in the cylinder block by five main bearings and the crankshaft end thrust is suppressed by a thrust bearing located on the centre main bearing.

A crankshaft driven dynamic balancer, installed on the 4-cylinder engines, counteracts out-of-balance forces and thereby reduces engine vibration. The balancer housing is bolted to the bottom of the cylinder block and contains two meshing gears which are driven and timed from a gear machined on the crankshaft.

Front and rear crankshaft oil sealing is effected by one piece, single lip type seals.



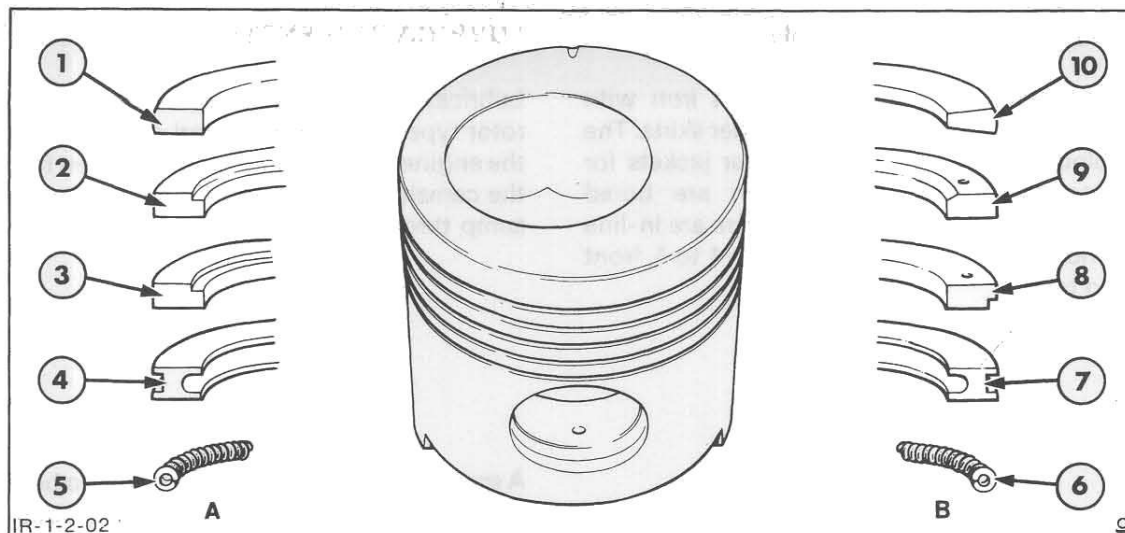


Figure 2  
Piston and Rings

A. Naturally Aspirated

1. Top Compression Ring
2. 2nd Compression Ring
3. 1st Compression Ring
4. Oil Control Ring
5. Expander for Oil Control Ring

B. Turbocharged

6. Expander for Oil Control Ring
7. Oil Control Ring
8. 1st Compression Ring
9. Top Compression Ring
10. Top Compression 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 copper lead or aluminum tin alloy 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.

### Pistons

Pistons are an aluminium alloy with combustion chambers recessed into the piston crowns. Each piston, Figure 2, has three compression rings and one oil control ring, all of which are located above the piston pin.

### Connecting Rods

The piston connecting rods are of 'I' section, with replaceable bronze piston pin bushings and for the turbocharged engines a centrally drilled hole facilitates both pressure lubrication of the piston pin bushing and cooling of the piston crown. Full-floating piston pins are retained by two snap rings in each piston.

### Manifolds

The aluminium intake and cast iron exhaust manifolds are on opposite sides of the cylinder head for better heat distribution in the head, and less heat transfer to the intake manifold. All tractors are fitted with vertical exhaust systems.

The intake manifolds are connected through tubing to the air cleaner. The diesel engine intake manifold is provided with a tapped hole for installation of a thermostart or an ether cold starting aid kit.

**NOTE:** On tractors where cold start equipment is not installed, the plug in the manifold should remain securely installed at all times, since considerable damage to the cylinder bores could result from its absence. The cylinder bores and turbocharger 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, which are bored integral with the block. Cylinders are in-line and vertical, and numbered from 1 to 4, front to rear.

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 idler gear, which is attached to the front of the cylinder block. The idler gear drives the camshaft gear and the injection pump drive gear.

The camshaft gear, attached to the front of the camshaft by a bolt, lock washer, flat washer and a spacer, is keyed to maintain the position of the gear and the drive shaft. All the timing gears can be checked by observing the timing punch marks on the gears.

### **LUBRICATION SYSTEM**

Lubrication of the engine is maintained by a rotor type oil pump mounted at the base of the engine block. The oil pump is driven from the camshaft and draws oil from the engine sump through a wire mesh screen.

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

Oil passes from the pump to an external, throw-away, spin-on type filter incorporating a relief valve which permits oil to be bypassed, if filter blockage occurs, and so ensures engine lubrication at all times.

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

The main gallery also supplies oil to the crankshaft main bearings and to the connecting rod journals via drillings in the crankshaft. Drilled passages from each main bearing direct oil to the camshaft bearings.

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

An intermittent flow of oil is directed to the valve rocker arm shaft assembly via a drilled passage in the cylinder block located vertically above No. 1 camshaft bearing. This drilling aligns with a corresponding hole in the cylinder head.

The timing gears are lubricated by oil from the cam follower chamber and the pressure lubricated camshaft drive gear bushing.

As the camshaft turns, holes in the camshaft and camshaft bearing align and a regulated stream of oil is directed to the cylinder head and on up the rocker arm shaft support bolt to the rocker shaft.

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

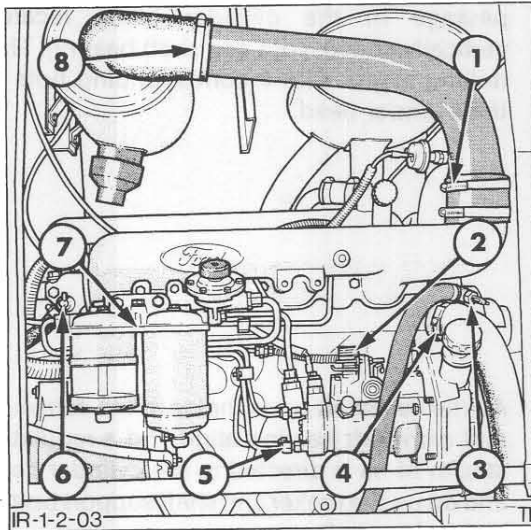
The oil flows from the shaft through drilled holes in each rocker arm bushing to lubricate both ends of the arms. Excess oil flows down the push rods and assists in lubricating the cam followers before draining back into the sump through cored openings in the block.

Cylinder walls, piston and piston pins are splash lubricated by the connecting rods and rotating crankshaft.

As previously described the piston connecting rods for the turbocharged engines have a centrally drilled hole which facilitates both pressure lubrication of the piston pin bushing and cooling of the piston crown.

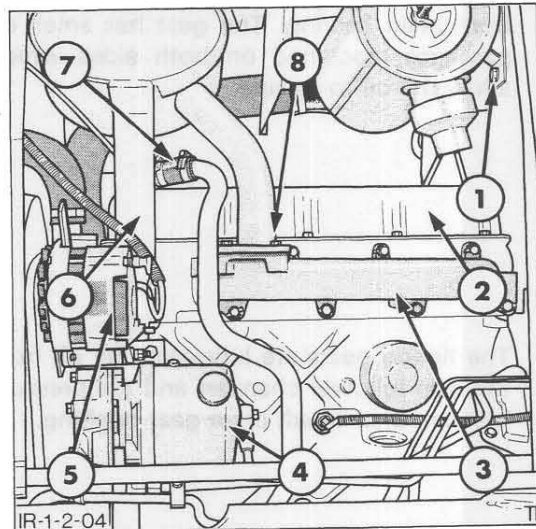
For the Ford 655C and turbocharged engines, a water-to-oil type oil cooler, located in the base of the radiator is connected into the lubrication system main oil gallery and cools a proportion of the circulating oil. A restrictor at the oil outlet limits the flow to the cooler and maintains internal lubrication at low engine speeds. Return oil from the cooler is fed back to the engine sump via a pipe tapped into the skirt of the cylinder block.

## B. 4-CYLINDER DIESEL ENGINE - OVERHAUL



**Figure 3**  
Engine Installation Right-Hand

- |                                   |                              |
|-----------------------------------|------------------------------|
| 1. Air Cleaner to Intake Manifold | 5. High Pressure Pipes       |
| 2. Throttle Connection            | 6. Rear Heater Tap           |
| 3. Front Heater Tap               | 7. Fuel Filter               |
| 4. Lower Radiator Hose            | 8. Air Cleaner Tube and Hose |



**Figure 4**  
Engine Installation Left-Hand

- |                               |                            |
|-------------------------------|----------------------------|
| 1. Air Cleaner Retaining Bolt | 5. Alternator              |
| 2. Valve Rocker Cover         | 6. Exhaust Muffler Bracket |
| 3. Exhaust Manifold           | 7. Ventilation Tube        |
| 4. P.A.S. Pump                | 8. Exhaust Muffler Pipe    |

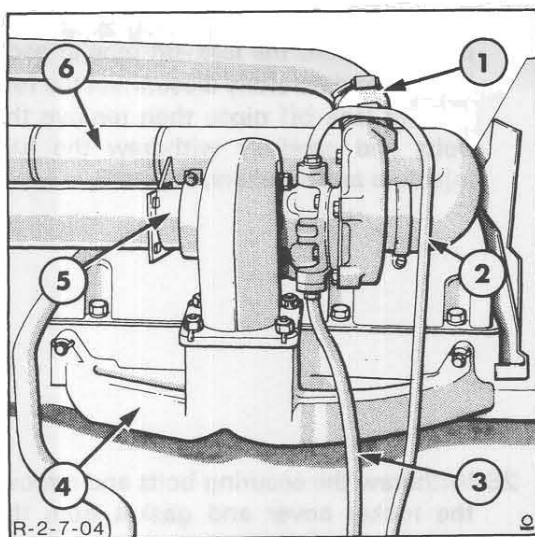
### CYLINDER HEAD, VALVES AND RELATED PARTS

#### REMOVAL

With reference to Figures 3 and 4

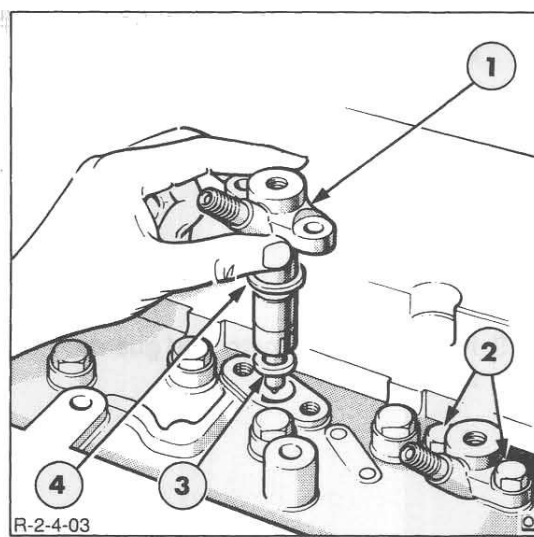
**NOTE:** The cylinder head can be removed with the engine installed in the tractor.

1. Disconnect the battery:
2. Remove the engine side panels.
3. Drain the coolant from the radiator and engine cylinder block.
4. Shut-off the heater hose taps then disconnect and plug the heater hoses (where fitted).
5. Remove the radiator top hose.
6. Remove the exhaust muffler extension pipe.
7. Remove the air cleaner pre-cleaner.
8. Remove the air cleaner to intake manifold tube and hoses.
9. Remove the top hood panel.
10. Remove the exhaust muffler.



**Figure 5**  
Turbocharger Installed

1. Turbocharger to Intake Manifold Tube
2. Oil Supply Tube
3. Oil Return Tube
4. Exhaust Manifold
5. Exhaust Outlet Pipe
6. Air Cleaner to Turbocharger Tube



**Figure 6**  
Fuel Injector Removal

1. Fuel Injector Assembly
2. Fuel Injector Mounting Bolts
3. Copper Washer
4. Cork Washer

11. Shut-off the fuel tank tap then disconnect the low pressure fuel lines and remove the fuel filters from the inlet manifold and cap the exposed openings.

14. Disconnect and remove the rocker cover ventilation tube.

12. Disconnect and remove the injector fuel pipes from the fuel injection pump and the injectors. Cap the exposed openings in the pump, injectors and tubes.

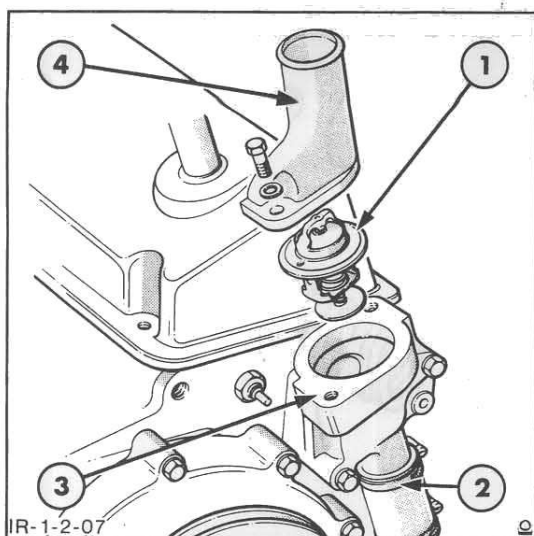
15. Disconnect the cold start equipment and plug the exposed openings (where fitted).

13. Disconnect the thermostart fuel pipe at the intake manifold and plug the exposed openings.

16. Disconnect the alternator, oil pressure, coolant temperature sender, air cleaner restriction indicator, fuel injection pump solenoid, horn and cold start wiring harness connections (where fitted).

17. Remove the turbocharger, where fitted, see "FUEL SYSTEMS" – Part 2.

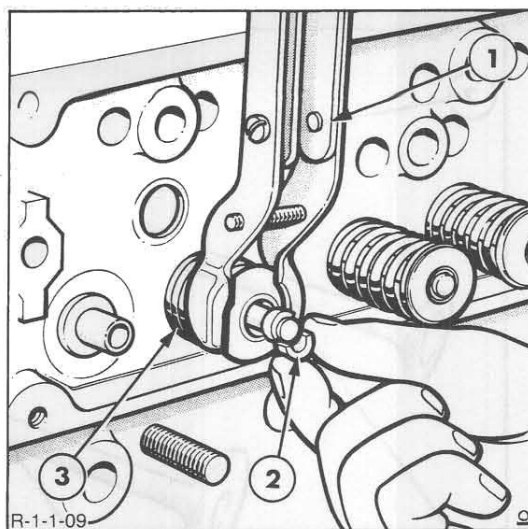
18. Remove the front engine harness and secure with tape clear of the engine.
  19. Remove the alternator and guard (where fitted).
  20. Remove the exhaust pipe and bracket.
  21. Bend back the lock tabs, withdraw the attaching bolts and remove the exhaust manifold and gasket.
  22. Remove the air cleaner assembly.
  23. Withdraw the retaining bolts and lockwashers and remove the inlet manifold and gasket.
  24. Clean the area surrounding the fuel injectors. Hold the leak-off pipe at each injector and carefully disconnect the fuel injector leak-off pipes then remove the bolts and carefully withdraw the fuel injectors and washers, Figure 6.
  25. Withdraw the securing bolts and remove the rocker cover and gasket from the cylinder head.
  26. Check the push rods for straightness by rotating the rods with the valve closed and identify any bent rods.
  27. Loosen the rocker shaft retaining bolts, which also serve as cylinder head bolts, evenly and alternately. Remove the rocker shaft assembly.
- NOTE:** *Leave the bolts in the rocker shaft supports during removal as they retain the support on the shaft.*



**Figure 7**

Coolant Outlet and Thermostat Removal

1. Thermostat
2. By-Pass Tube
3. Thermostat Housing
4. Coolant Outlet Connection



**Figure 8**

Valve Removal

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

28. Remove each push rod in turn and place in a numbered rack so that it can be replaced in the same position when assembling the engine.

29. Remove the remaining cylinder head bolts and washers working inwards from the ends to the centre of the head.

30. Lift the cylinder head from the block. If necessary lever the head off on the pads provided, taking care not to damage the cylinder head or block faces.

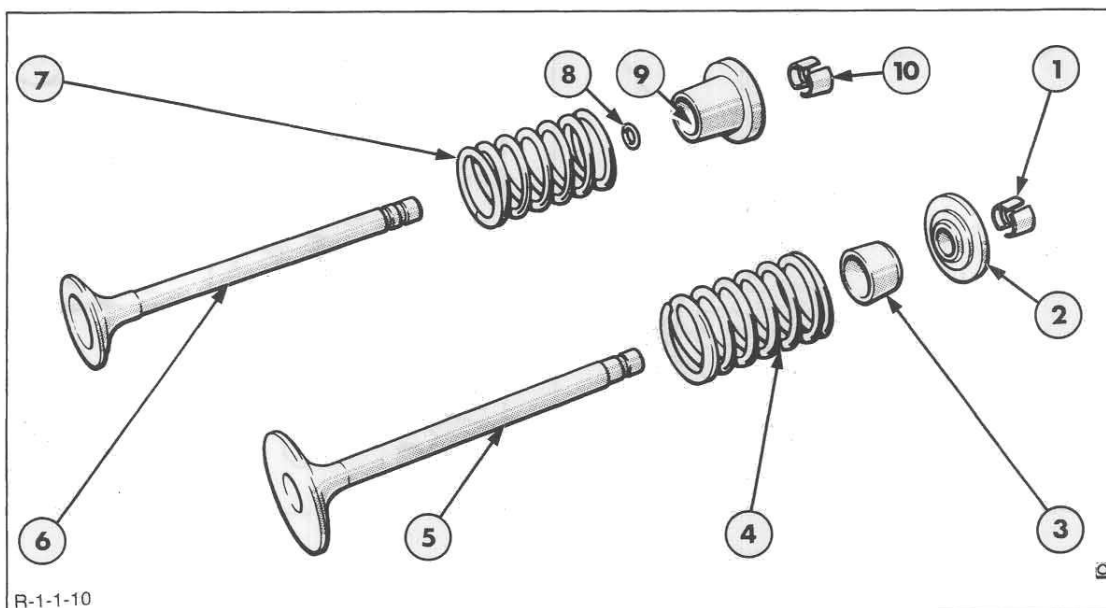
## DISASSEMBLY

### Thermostat

1. Remove the coolant outlet connection and the thermostat and gasket, Figure 7.

### Cylinder Head

1. Clean the head and remove carbon deposits from around the valve heads.
2. Using a valve spring compressor, Figure 8 remove the retainer locks, spring retainers/rotators, springs and seals from each valve, Figure 9.
3. Withdraw the valves and place in a numbered rack.



**Figure 9**  
Valve Assembly Components

- |                                     |   |
|-------------------------------------|---|
| 1. Inlet Valve Spring Retainer Lock | 6. Exhaust Valve                        |
| 2. Inlet Valve Spring Retainer      | 7. Exhaust Valve Spring                 |
| 3. Inlet Valve Seal                 | 8. Exhaust Valve Seal                   |
| 4. Inlet Valve Spring               | 9. Exhaust Valve Spring Retainer        |
| 5. Inlet Valve                      | 10. Exhaust Valve Spring Retainer Locks |

### Rocker Shaft Assembly

1. Remove the cylinder head bolts which pass through the rocker shaft supports and slide the rocker shaft components from the shaft, Figure 10.

2. Inspect the cylinder head for damage and, if necessary, remove nicks and burrs from the gasket faces using a suitable abrasive. Ensure all traces of abrasive material are removed after repair.

## INSPECTION AND REPAIR

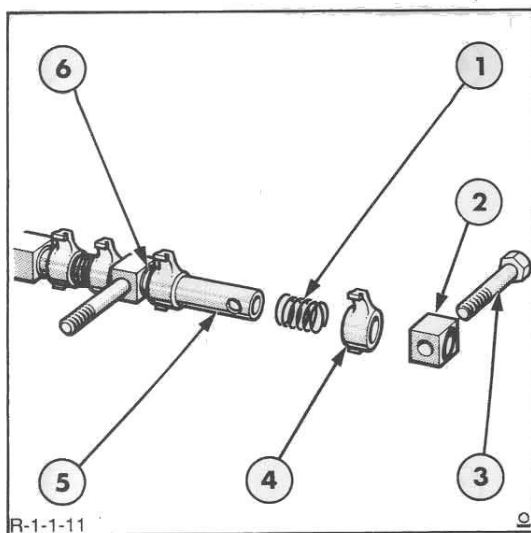
### Cylinder head

1. Scrape all gasket surfaces clean then wash the cylinder head in a suitable solvent and thoroughly dry with a lint free cloth or compressed air. Clean the valve guide bores with a valve guide cleaning tool.

**NOTE:** Ensure the injector washers have been removed from the injector bores prior to cleaning.

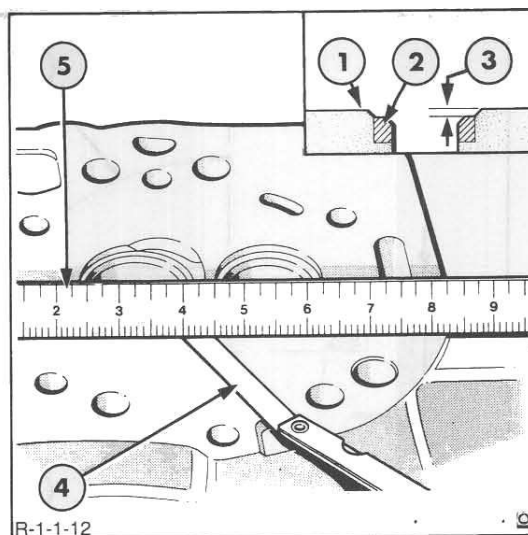
3. Use a straight edge and feeler gauges to check the flatness of the cylinder head in all directions, Figure 11. For flatness requirement see "Specifications" – Chapter 4.

**NOTE:** If the cylinder head exceeds the flatness specification it may be skimmed providing the depth from the lower face of the valve insert to the cylinder head face is not less than 0.064 in. (1.63 mm), see the inset of Figure 12.



**Figure 10**  
Rocker Shaft Disassembled

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



**Figure 11**  
Measuring Cylinder Head Flatness

- |                       |                  |
|-----------------------|------------------|
| 1. Cylinder Head Face | 4. Feeler Gauge  |
| 2. Valve Seat Insert  | 5. Straight Edge |
| 3. Minimum Depth      |                  |

4. If the head has been skimmed, determine that all the cylinder head bolt faces will bottom. Place the cylinder head, less gasket, on the block and install all the head bolts.

5. Install all the bolts finger tight and ensure the rocker shaft supports are fitted with long bolts. Using a feeler gauge, check the clearance between the underside of the bolt heads and the cylinder head or rocker shaft support.

6. If a 0.010 in. (0.25 mm) feeler gauge can be inserted under the bolt head then the bolts are bottoming and the cylinder block thread must be increased in depth. Use a  $\frac{9}{16} \times 13$  UNC-2A thread tap. The head bolts should be marked so they are reinstalled in the holes in which they were checked.

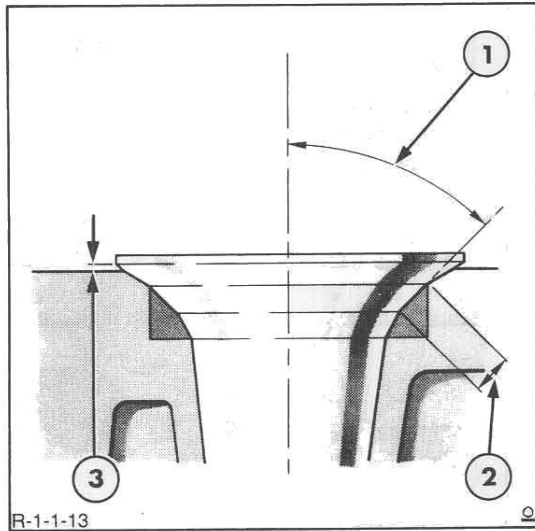
### Valve Seats

1. Examine the valve seat inserts and reface if pitted but renew if loose or damaged. If necessary, install an oversize insert by machining the seat counterbore in the cylinder head, see "Specifications" – Chapter 4. The insert must be chilled in dry-ice prior to installation.

**NOTE:** Valve seat inserts of 0.010 in. (0.25 mm) and 0.020 in. (0.5 mm) oversize on diameter are sometimes installed in cylinder heads in production. Heads fitted with oversize inserts are stamped <sup>SO10</sup>OS or <sup>SO20</sup>OS on the exhaust manifold side in line with the valve seat concerned.

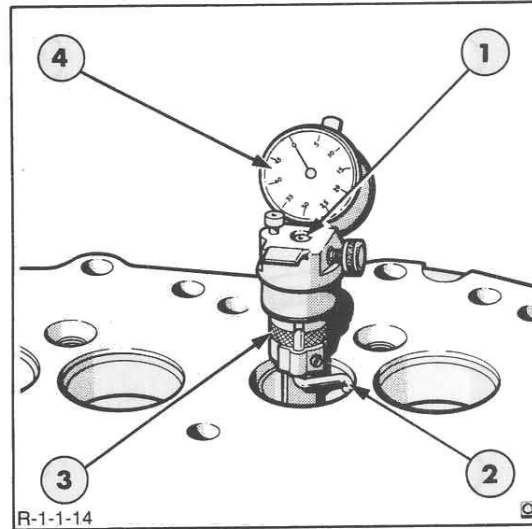
2. When replacing exhaust valve seat inserts ensure the replacement inserts are of the correct type as the size and material specification varies for the different engine types.





**Figure 12**  
Valve Seat Dimensions

1. Valve Seat Angle:  
45°00' – 45°30' Exhaust 30°00' – 30°30' Inlet
2. Valve Seat Width:  
Inlet 0.080 – 0.102 in. (2.032 – 2.590 mm)  
Exhaust 0.084 – 0.106 in. (2.133 – 2.692 mm)
3. Valve Head Protrusion



**Figure 13**  
Checking Valve Seat Concentricity

1. Gauge Pilot
2. Pointer to Ride on Valve Seat Face
3. Sleeve for Rotating Pointer
4. Dial Gauge

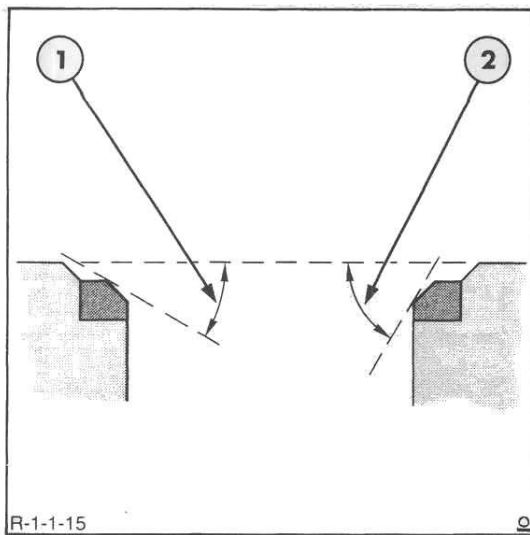
3. Check the width of the valve seat inserts and, if necessary, reface by grinding to the dimensions shown in Figure 12.

**NOTE:** Refacing of the valve seat should always be co-ordinated with refacing of the valve to ensure a compression tight fit.

4. Measure the concentricity of the valve seat with a suitable gauge, as shown in Figure 13. If the valve seat runout exceeds the specified figure, see "Specifications" – Chapter 4, reface the seat.
5. Using a seat cutter with the correct angle (refer to Figure 11 and "Specifications," Chapter 4) remove only enough stock from the seat to clean up the pits and grooves, or to correct the seat eccentricity. After refacing, the seat width must be within the specified limit.
6. If the refaced seat exceeds this width, narrow the seat by removing stock from the top or bottom of the seat. If the seat measures less than this width, widen the seat.

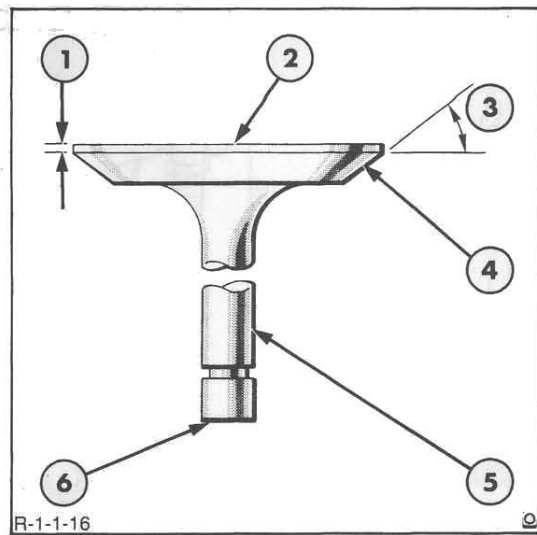
7. Rotate a new or refaced valve lightly in the seat, using Prussian Blue. If the blue is transferred to the valve face the specified distance (valve head protrusion) below the upper edge of the valve face, Figure 12, the contact is satisfactory. If the blue is transferred to the valve face above or below this point, raise or lower the seat as follows:-

Lower the valve seat by removing stock from the top of the seat with a 30° grinding wheel for exhaust valves – 15° grinding wheel for inlet valves, Figure 14. Raise the seat by removing stock from the bottom of the seat with a 60° grinding wheel for exhaust valves – 45° grinding wheel for inlet valves.



**Figure 14**  
Raising/Lowering Valve Seats

1. Use 30° or 15° grinding wheel for lowering the seat
2. Use 60° or 45° grinding wheel for raising the seat



**Figure 15**  
Critical Valve Measurements and Inspection Checks

- |                     |               |
|---------------------|---------------|
| 1. Valve Head Edge  | 4. Valve Face |
| 2. Valve Head       | 5. Valve Stem |
| 3. Valve Face Angle | 6. Valve Tip  |

## Valves

1. The critical inspection points of the valves are shown in Figure 15. 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.

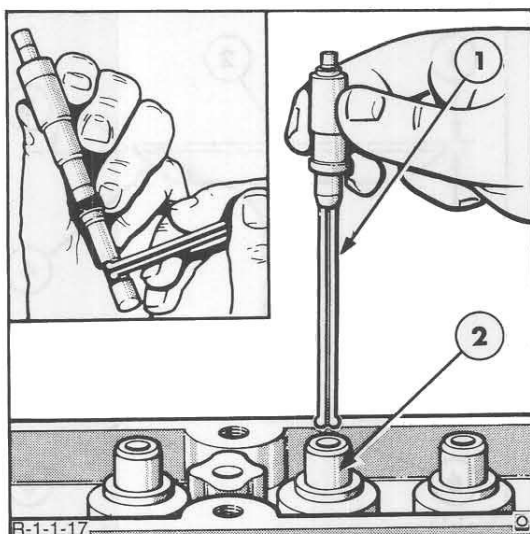
2. Check for bent stems and correct diameter.

3. Check maximum valve face eccentricity.

4. Any valve refacing operation should be closely coordinated with the valve seat refacing operation so that the finished angle of the valve is 0,5° less than the valve seat to provide an interference angle for better seating. Adjust the valve refacing tool to obtain a face angle of 44,5° or 29,5°, Figure 15.

Remove only enough stock to clean up the pits and grooves. Check the edge of the valve head; if less than the specified figure, see "Specifications" – Chapter 4, install a new valve.

5. Remove all grooves or score marks from the valve stem tip, then chamfer as necessary. Do not remove more than 0,010 in. (0,25 mm) from the tip.



**Figure 16**  
Measuring Valve Guide

1. Telescopic Gauge
2. Valve Guide

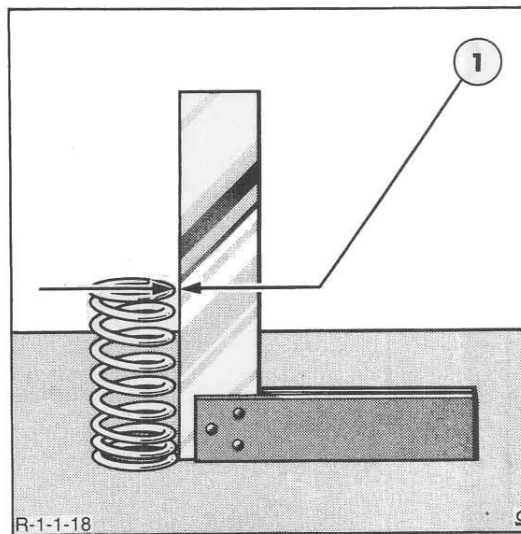
### Valve Guides

1. Using a telescopic gauge and micrometer, measure the valve to guide clearance, Figure 16. If the clearance exceeds the specified limits, see "Specifications" – Chapter 4, ream the valve guide to fit the next oversize valve.

**NOTE:** Production cylinder heads may have one or more 0.015 in. (0.38 mm) oversize valve guides and valves installed. Such cylinder heads have 15 or <sup>VO15</sup><sub>OS</sub> stamped on the exhaust manifold side of the head opposite the valve(s) concerned.

2. Use Kit No. FT 6202 or 2136 to ream out the valve guide to accept an oversize valve. The kit contains three reamers and pilot combinations as follows:

- 0.003 in. (0.076 mm) Oversize Reamer and Standard Diameter Pilot.



**Figure 17**  
Checking Valve Spring Squareness

1. Maximum Out-of-Squareness 0.06 in. (1.52 mm)

- 0.015 in. (0.38 mm) Oversize Reamer and 0.003 in. (0.076 mm) Oversize Pilot.
- 0.030 in. (0.76 mm) Oversize Reamer and 0.015 in. (0.38 mm) Oversize Pilot.

When going from a standard valve stem to an oversize always use the reamers in sequence. After reaming a valve guide, always check the valve seating and reface if necessary.

### Valve Springs

1. Renew worn or damaged valve springs. Check for squareness and reject if out-of-squareness exceeds 0.06 in. (1.52 mm), Figure 17. Check the free length and loaded length of each valve spring, see "Specifications" – Chapter 4. Ensure the valve spring retainer locks are in good condition.

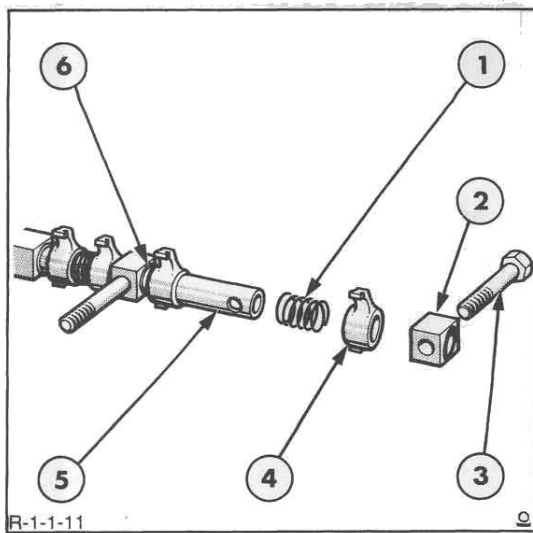


Figure 18

Rocker Shaft Components

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

### Rocker Shaft Assembly

1. Inspect the rocker arm adjusting screws and the push rod ends of the rocker arms for stripped or worn threads. Check the ball end of the screws for nicks, scratches, or excessive wear.

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.

2. Check the rocker arm locating springs and spacers for breaks or other damage.
3. Check the rocker arms and rocker shaft internal and external diameters respectively. If these are not within specified limits, install a new part. If the shaft meets specifications, clean it thoroughly in a suitable solvent and thoroughly dry with compressed air ensuring the oil passages are clear of obstructions.

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

### Thermostat

1. For inspection and repair of the coolant outlet or thermostat, see 'Cooling System' – Chapter 3.

## RE-ASSEMBLY

### Cylinder Head

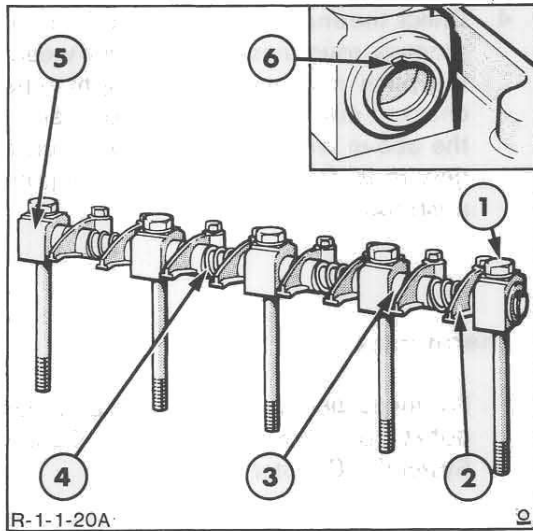
1. Insert each valve in the guide bore from which it was removed and lap in position to ensure an even seat around the valve. Withdraw the valve and ensure removal of all traces of lapping compound.

2. Lubricate all components with clean engine oil prior to installation.

Use a valve spring compressor to reassemble the valves, valve springs, retainers and retainer locks. For the exhaust valves install a new sealing ring in the second groove from the top of the valve stem.

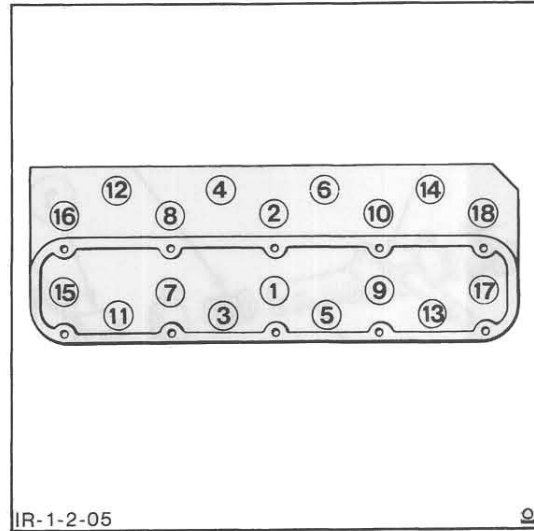
### Thermostat

1. Install the thermostat (spring end towards the head), coolant outlet and a new gasket.



**Figure 19**  
Rocker Arm Shaft Assembly

- |               |                             |
|---------------|-----------------------------|
| 1. Bolt       | 4. Spring                   |
| 2. Rocker Arm | 5. Rocker Arm Shaft         |
| 3. Spacer     | Support                     |
|               | 6. Groove at Front of Shaft |



**Figure 20**  
Cylinder Head Bolt Tightening Sequence

### Rocker Shaft Assembly

1. Lubricate each end of the pushrods with clean engine oil and insert each rod in its original position. Ensure that the ball end of each rod is seated in its tappet socket.
2. Coat all rocker shaft components with clean engine oil.

The rocker shaft has an identification groove at one end of the shaft. Position the mark upwards, Figure 19, and use this end as the front of the shaft, thereby ensuring the oil holes and grooves in the shaft face downwards.

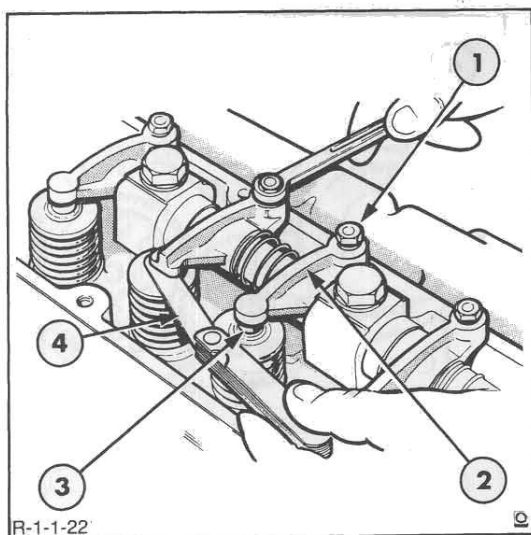
3. Start assembling by securing a rocker shaft support with a long cylinder head retaining bolt.

Ensure the springs and spacers are in their correct position, as shown in Figure 19, then proceed with the assembly. Place a long cylinder head retaining bolt in the last (front) support to keep the complete assembly together.

### INSTALLATION

Installation of the cylinder head and related components follows the removal procedure in reverse. On installation observe the following requirements:

- Install new cylinder head, intake and exhaust manifold gaskets.



**Figure 21**  
Setting Valve Lash

1. Adjuster Screw
2. Rocker Arm
3. Valve Stem
4. Feeler Gauge

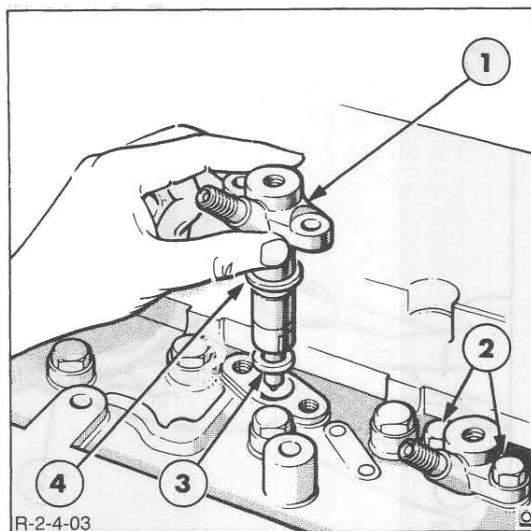
- Tighten the cylinder head retaining bolts in the sequence shown in Figure 20 and progressively in three steps as follows:

- (i) Torque to 115 lbf.ft. (156 Nm)
- (ii) Torque to 140 lbf.ft. (190 Nm)
- (iii) Torque to 160 lbf.ft. (217 Nm)

Do **NOT** oil the bolts before installation.

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

- Rotate the engine and set the valve lash, Figure 21. See "Specifications" – Chapter 4.



**Figure 22**  
Fuel Injector Installation

1. Fuel Injector Assembly
2. Fuel Injector Mounting Bolts
3. Copper Washer
4. Cork Washer

- Install the injectors with new seat washers and cork seals, Figure 22.

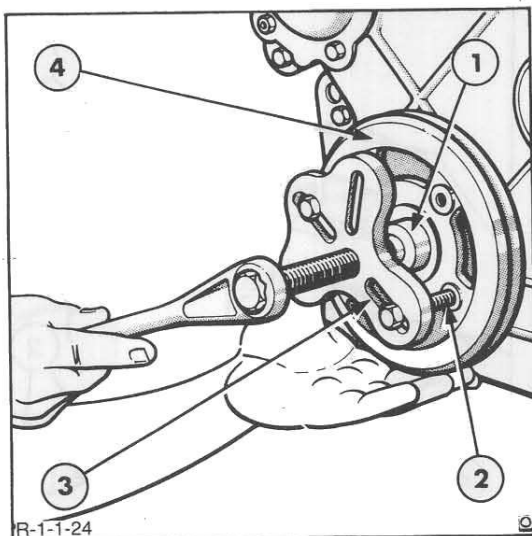
- Install the injector lines and leak-off pipe with new washers.

**NOTE:** Hold the leak-off plastic tube securely to prevent pivoting when tightening the banjo fitting bolts to the specified torque. See "Specifications" – Chapter 4.

- Use new lock tabs for the exhaust manifold retaining bolts and bend the tabs to effect retention.

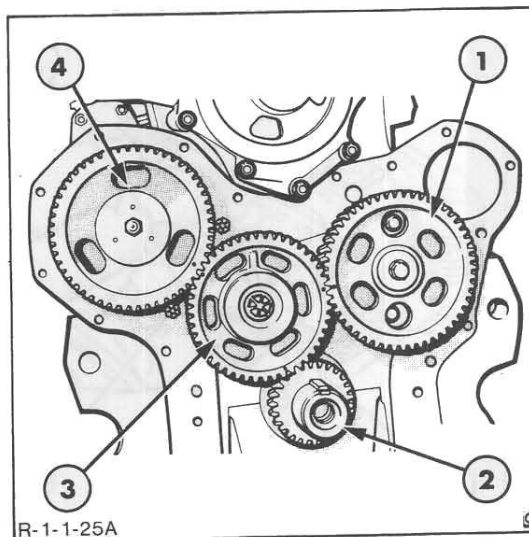
- Tighten all nuts and bolts to the specified torques. See "Specifications" – Chapter 4.

- Operate the engine and check for fluid leaks.



**Figure 23**  
Crankshaft Pulley Removal

1. Shaft Protector No. 625-A or 9212
2. 7/16 in. x 14 UNC Bolt
3. Puller No. 518 or 9539
4. Crankshaft Pulley



**Figure 24**  
Timing Gears

1. Camshaft Gear
2. Crankshaft Gear
3. Camshaft Drive Gear
4. Injection Pump Drive Gear

## ENGINE FRONT COVER AND TIMING GEARS

### REMOVAL

**NOTE:** The engine front cover and timing gears can only be serviced after removing the radiator and front axle. See PART 10, "SEPARATING THE UNIT".

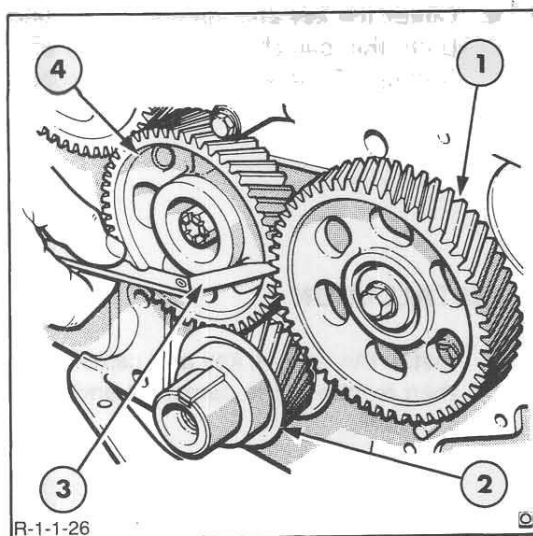
1. Drain the engine oil and remove the oil pan.
2. Remove the fan drive belt and withdraw the bolt and washer from the centre of the crankshaft pulley.
3. Using Puller No. 518 or 9539 and Shaft Protector No. 625-A or 9212, remove the crankshaft pulley, Figure 23.
4. Support a suitable container under the power steering pump and reservoir assembly.

Disconnect the pump pressure and return tubes and allow the oil to drain. Plug the disconnected tubes and ports to prevent the entry of dirt.

Extract the two bolts retaining the pump in the timing gear casing then remove the pump from the engine and drain the remaining oil from the reservoir.

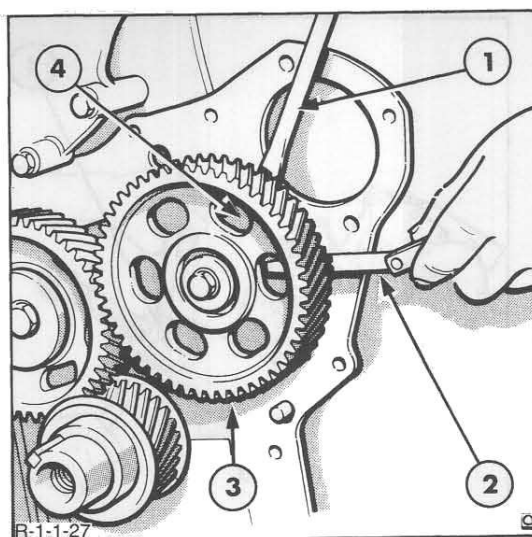
5. Withdraw the retaining bolts then remove the front cover and gasket. Remove the oil slinger.
6. Before removing the timing gears, Figure 24, use a dial indicator or feeler gauges, to measure the backlash between each set of mating gears, Figure 25. Rotate the gears and check the backlash at four equidistant points on the gears. Renew the gears if the backlash exceeds the specified limits, see "Specifications" - Chapter 4.





**Figure 25**  
Measuring Timing Gear Backlash

1. Camshaft Gear
2. Oil Slinger (Reference Only)
3. Feeler Gauge
4. Camshaft Drive Gear



**Figure 26**  
Measuring Camshaft End Play

1. Pry Bar
2. Feeler Gauge
3. Camshaft Gear
4. Thrust Plate

7. Pry the camshaft gear away from the thrust plate and using a dial indicator or feeler gauges, measure the clearance, Figure 26. Install a new camshaft thrust plate if the camshaft end play exceeds the specified limits, see "Specifications" – Chapter 4.

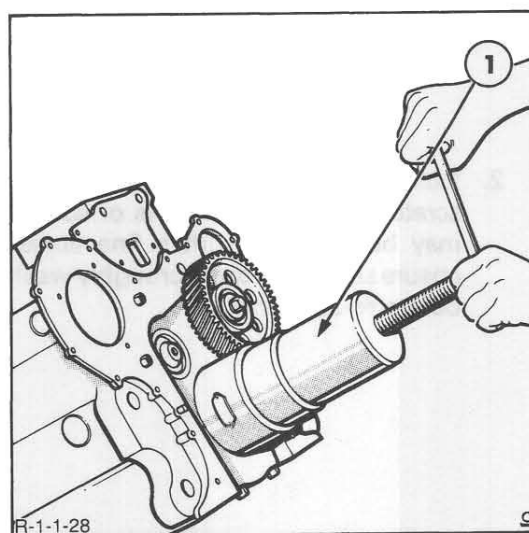
10. Remove the crankshaft gear using Tool No. CPT 6040B or 2134, Figure 27.

**NOTE:** The crankshaft gear should only be removed if it shows signs of wear.

8. Remove the self-locking bolt that retains the camshaft drive gear and adaptor to the cylinder block then remove gear and adaptor, Figure 24.

Remove the retaining bolt and washer, then remove the camshaft gear from the end of the camshaft, Figure 24.

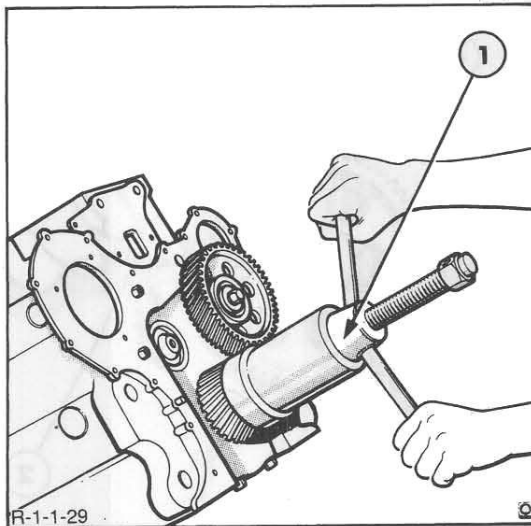
9. Remove the retaining nut and washer then remove the drive gear from the injection pump drive shaft using puller described in "Fuel Systems" – Part 2.



**Figure 27**  
Crankshaft Gear Removal

1. Puller Tool No. CPT 6040-B or 2134





**Figure 28**  
Crankshaft Gear Installation

1. Replacer Tool No. CT6069-A or 2134 and Tool No. CT6069-1 or 1237.

4. Check the key and keyway in the end of both the camshaft and crankshaft for damage. Renew the keys if necessary.

## INSTALLATION

1. Install the spacer, key and camshaft gear then re-check the camshaft end play.

2. Locate the key then use Tool No. CT6069-A or 2134 and CT6069-1 or 1237 to install the crankshaft gear, Figure 28.

## INSPECTION AND REPAIR

1. Wash the gears and adapter in a suitable solvent and dry with a clean lint free cloth or compressed air.

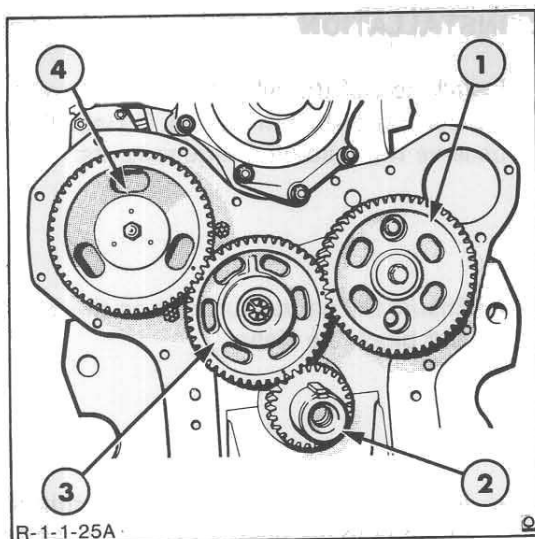
3. Position No. 1 piston at Top Dead Centre and install the camshaft drive gear and adapter with the timing marks aligned with those of the other gears.

2. Examine the gear teeth for wear, burrs or scratches. Any minor burrs or scratches may be removed with a fine abrasive; ensure such parts are thoroughly washed before re-assembly.

Tighten the bolt to the specified torque and re-check the backlash between the gears, see "Specifications" – Chapter 4.

3. Ensure the camshaft drive gear adapter oil passage is free from obstruction and the drive gear bushing is not damaged.

4. Assemble the fuel injection pump to the engine front plate. Check No. 1 piston is at T.D.C. and install the injection pump drive gear with the timing mark aligned with that of the camshaft drive gear, Figure 29.

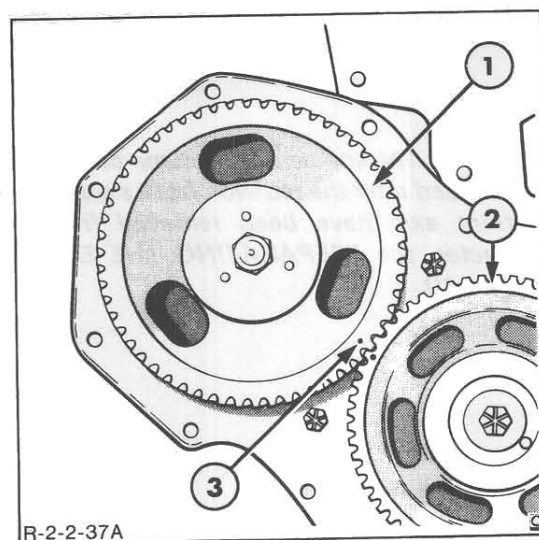


**Figure 29**  
Aligning the Timing Gears

1. Camshaft Gear
2. Crankshaft Gear
3. Camshaft Drive Gear
4. Injection Pump Drive Gear

**NOTE:** Engines with a DPS distributor type fuel injection pump have a common fuel injection pump drive gear. This gear features timing marks identified by a punch mark. When installing the pump drive gear, ensure that timing mark aligns with the camshaft drive gear timing mark, Figure 30.

5. Install a new dust seal in the front cover. Lubricate the oil seal with petroleum jelly and use a 530-S or 9210 adaptor to press the seal into the front cover. Check after installation to ensure the spring is correctly positioned in the seal.
6. Locate the oil slinger onto the crankshaft with the dished face outwards.
7. Position a new gasket on the engine front plate and install the front cover ensuring the cover aligns with the dowel pins. Tighten the bolts to the specified torque, see "Specifications" – Chapter 4.



**Figure 30**  
DPS – Distributor Type Fuel Injection Pump Drive Gear to Camshaft Drive Gear Timing

1. Pump Drive Gear
2. Camshaft Drive Gear
3. Timing Mark


8. Lubricate the crankshaft pulley spacer and slide over the key. Replace the pulley hub and tap onto the crankshaft. Tighten the securing bolt to the specified torque, see "Specifications" – Chapter 4.
9. Install the oil pan with a new gasket and tighten the bolts to the specified torque, see "Specifications" – Chapter 4.
10. Install the power steering pump and reservoir assembly and tighten the bolts to the specified torque, see "Specifications" – Chapter 4. Reconnect the pressure and return tubes and tighten the unions to the specified torque, see "Specifications" – Chapter 4.
11. Refill the engine and power steering reservoir with the correct grade and quantity of oil, see "Specifications" – Chapter 4.
12. Install the radiator and front axle – see PART 10, "SEPARATING THE UNIT", then operate the engine and check for fluid leaks.

## **OIL PAN SUMP**

### **REMOVAL**

**NOTE:** *The engine oil pan sump can only be serviced after the radiator, front support and front axle have been removed from the tractor, see "SEPARATING THE UNIT" – Part 10.*

1. Drain the engine oil and remove the oil level indicator.
  
2. Remove the oil pan sump retaining bolts and the two oil pan sump to transmission case attaching bolts then lower the sump.

 **WARNING:** *Due to the weight of the cast iron sump, exercise great care on removal. If necessary use an hydraulic jack to lower the oil pan sump to the floor.*

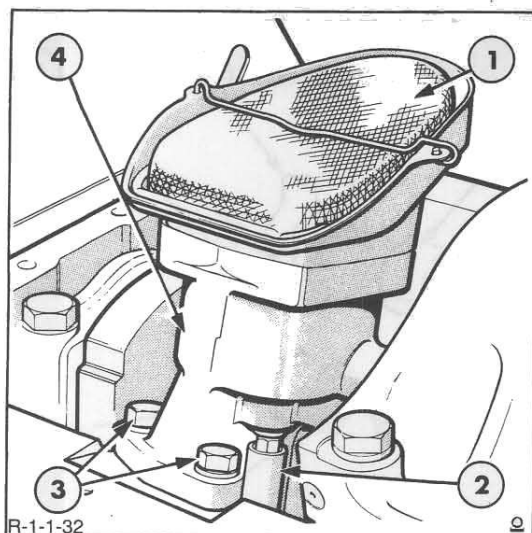
### **INSPECTION AND REPAIR**

1. Scrape all gasket material from the gasket surface then wash the oil pan sump in a suitable solvent and dry with a clean lint free cloth or compressed air.
  
2. Inspect the sump for cracks, damaged drain plug threads or distorted gasket surface.

### **INSTALLATION**

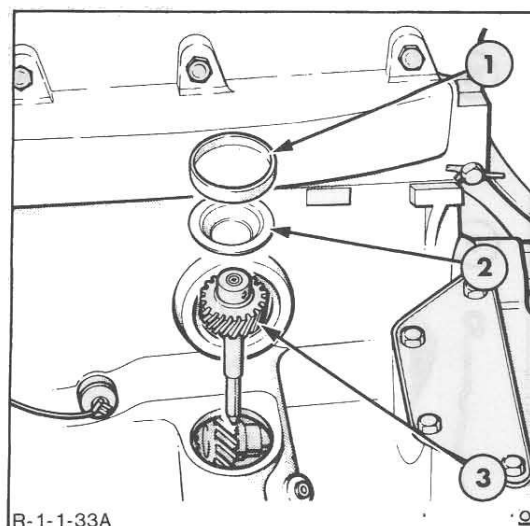
Installation of the oil pan sump follows the removal procedure in reverse. On installation observe the following requirements:

- Ensure the gasket surfaces on the oil pan and block are clean.
  
- Install a new gasket and apply a thin film of sealer to the gasket, front cover and oil pan, see "Specifications" – Chapter 4.
  
- Position the oil pan and install a bolt finger tight at each corner.
  
- Install a new gasket to the oil drain plug and install the plug, then tighten to the specified torque, see "Specifications" – Chapter 4.
  
- Fill the radiator with the correct strength and quantity of coolant see "Specifications" – Chapter 4.
  
- Fill the engine with the correct grade and quantity of oil, see "Specifications" – Chapter 4.
  
- Operate the engine and check for oil and coolant leaks.



**Figure 31**  
Oil Pump and Filter Screen

1. Filter Screen
2. Intermediate Shaft
3. Oil Pump Retaining Bolts
4. Oil Pump



**Figure 32**  
Oil Pump Drive Gear Removal

1. Welch Plug
2. Driveshaft Adaptor
3. Oil Pump Driveshaft and Gear Assembly

## OIL PUMP

### REMOVAL

1. Remove the oil pan sump as previously described in this Chapter.

4. Remove the welch plug then withdraw the driveshaft adaptor assembly and the oil pump drive shaft and gear assembly, Figure 32.

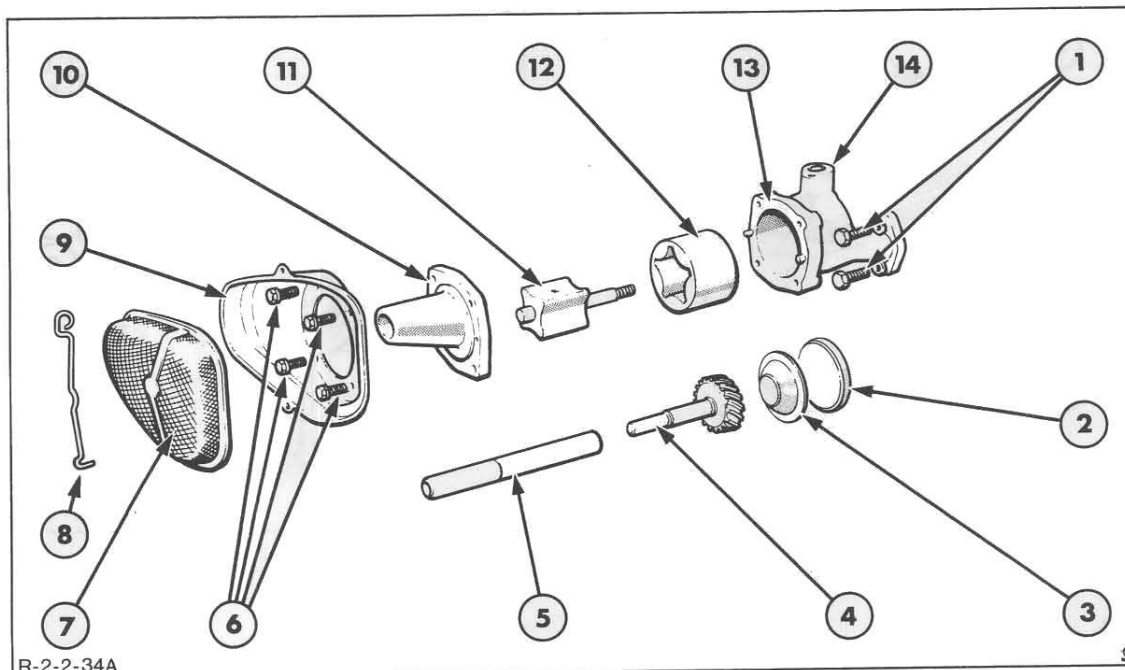
2. Remove the oil pump with the filter screen, Figure 31. Withdraw the intermediate shaft.

3. Remove the engine oil filter and discard.

### DISASSEMBLY

With reference to Figure 33.

1. Remove the spring clip and detach the pump screen.
2. Withdraw the retaining screw and washer assemblies then separate the inner and outer covers from the body and extract the rotor and shaft assembly.



**Figure 33**  
Oil Pump Assembly

- |  |                                    |
|--|------------------------------------|
| 1. Oil Pump Retaining Bolts              | 8. Spring                          |
| 2. Welch Plug                            | 9. Outer Cover                     |
| 3. Driveshaft Adaptor                    | 10. Inner Cover                    |
| 4. Oil Pump Driveshaft and Gear Assembly | 11. Inner Rotor and Shaft Assembly |
| 5. Intermediate Shaft                    | 12. Outer Rotor                    |
| 6. Screw and Washer Assemblies           | 13. Body                           |
| 7. Screen                                | 14. Pressure Relief Valve Assembly |

3. Insert a self-tapping screw into the relief valve plug and pull the plug out of the body. Withdraw the relief valve and spring.

3. Use a straight edge and feeler gauges to measure the end play between the inner rotor and the pump body and measure the clearance between the outer rotor and the pump body, Figure 34.

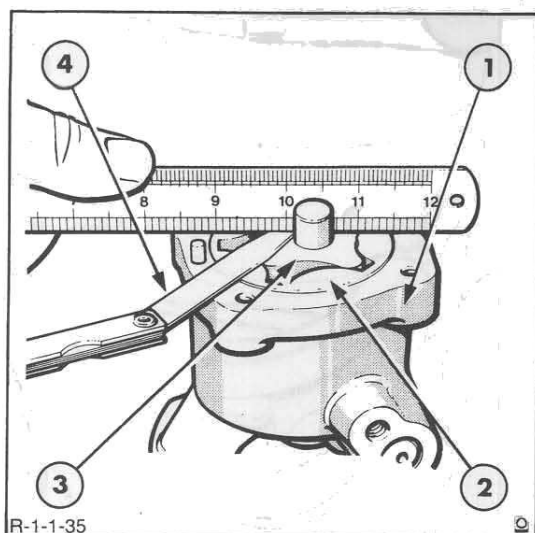
### INSPECTION AND REPAIR

1. Wash all parts in a suitable solvent and dry with a clean lint free cloth or compressed air.

4. Use feeler gauges to measure the clearance between the periphery of the outer rotor and the pump body, Figure 35.

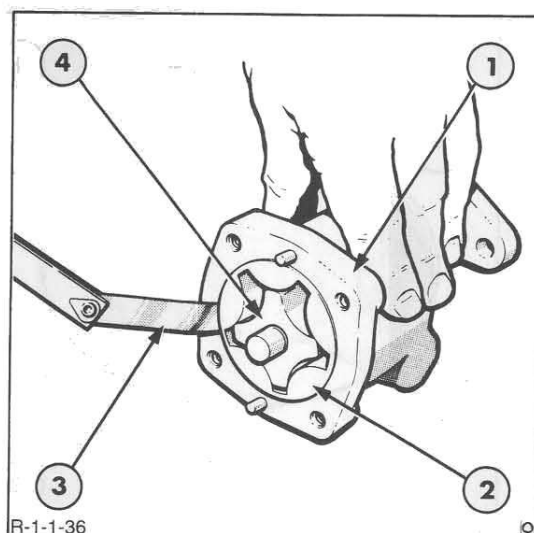
2. Inspect the inside of the pump cover and body for excessive wear.

5. Check the relief valve spring tension, see "Specifications" – Chapter 4.



**Figure 34**  
Measuring Oil Pump Clearance

- |                |                 |
|----------------|-----------------|
| 1. Pump Body   | 3. Inner Rotor  |
| 2. Outer Rotor | 4. Feeler Gauge |



**Figure 35**  
Measuring Outer Rotor to Pump Body Clearance

- |                |                 |
|----------------|-----------------|
| 1. Pump Body   | 3. Feeler Gauge |
| 2. Outer Rotor | 4. Inner Rotor  |

**NOTE:** If the rotor end float or rotor-to-body clearance are greater than the limits stated in "Specifications" – Chapter 4, the inner and outer rotors must be renewed as an assembly.

1. Insert the relief valve and spring into the pump body and press the plug into position.

6. Inspect the relief valve for wear and check for freedom of movement within the bore.

2. Install the outer rotor into the pump body, then insert the inner rotor and shaft assembly.

7. Check the oil pump drive gear for worn or damaged teeth.

3. Replace the inner and outer covers on the pump body and secure with the four screws and washers.

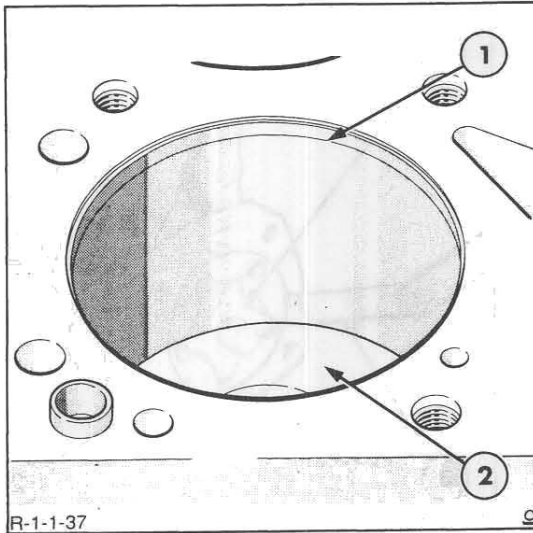
8. Examine the intermediate drive shaft socket ends for wear.

4. Replace the screen and secure in position with the spring clip.

## RE-ASSEMBLY

Coat all parts with clean engine oil when assembling.

**NOTE:** Prior to installation introduce clean engine oil into the inlet port and rotate the pump shaft by hand.



**Figure 36**  
Cylinder Ridge

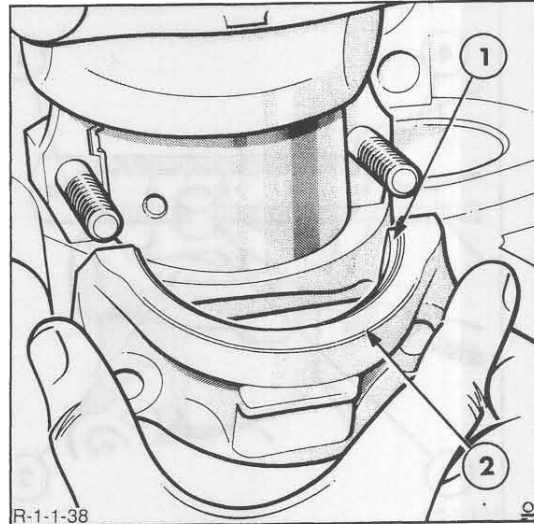
1. Cylinder Ridge
2. Piston

## INSTALLATION

Installation of the oil pump follows the removal procedure in reverse. On installation observe the following requirements.

- Install a new gasket and tighten the bolts to the specified torque, see "Specifications" – Chapter 4.
- Remove all traces of seal material from the locating surface then install a new oil filter and seal. Apply a light, even coat of clean engine oil to the seal surface prior to installation. Hand tighten the filter until the seal contacts the locating surface then tighten an additional one-half to three-quarters of a turn.

**IMPORTANT:** *Never use a tool to tighten the spin-on filter.*



**Figure 37**  
Connecting Rod Bearing Cap Removal

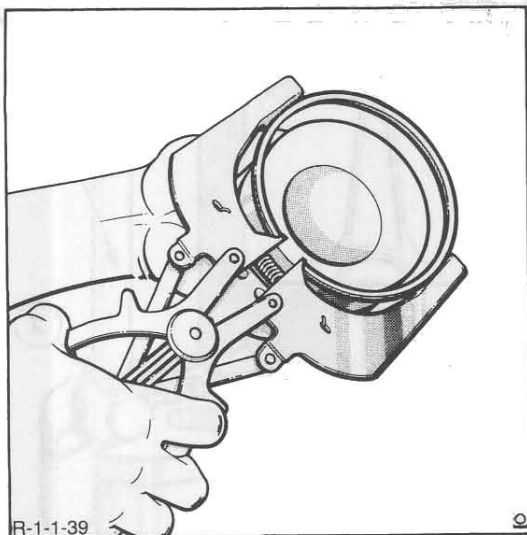
1. Bearing Liner
2. Bearing Cap

## CONNECTING RODS, BEARINGS, PISTONS, RINGS AND CYLINDER BLOCK

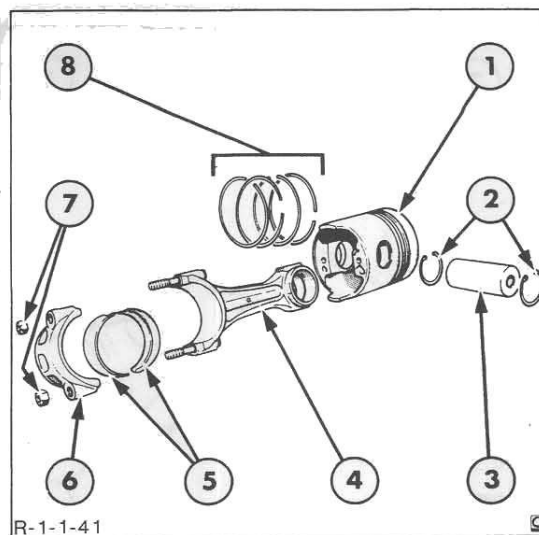
### REMOVAL

**NOTE:** *The connecting rods and pistons can be removed with the engine installed in the tractor after prior removal of the cylinder head, oil pan sump, and oil pump assembly as previously described in this Chapter.*

1. If necessary, remove any ridge from the top of the cylinder bores, Figure 36, with a cylinder ridge reamer or hand scraper. Do not cut down into the piston ring travel area. (Ridge removal is not essential when reboring or if the old pistons are not to be used. However, it may be necessary to remove a ridge in order to extract an old piston.) Do not attempt to remove and re-use a piston from a cylinder with an excessive ridge. Forcing the piston past the ridge may break the lands on the piston or the rings.



**Figure 38**  
Piston Ring Removal



**Figure 39**  
Piston and Connecting Rod Disassembled

- |                   |                   |
|-------------------|-------------------|
| 1. Piston         | 5. Bearing Liners |
| 2. Pin Retainers  | 6. Bearing Cap    |
| 3. Piston Pin     | 7. Retaining Nuts |
| 4. Connecting Rod | 8. Piston Rings   |

2. With the piston at the bottom of the stroke, remove the nuts from the bearing cap bolts and remove the bearing cap and liner, Figure 37.

3. Use the handle end of a hammer to push the piston and rod assembly out of the top of the block. Remove the bearing liner from the connecting rod.

4. 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.

3. Identify each piston and rod for reassembly, Figure 39

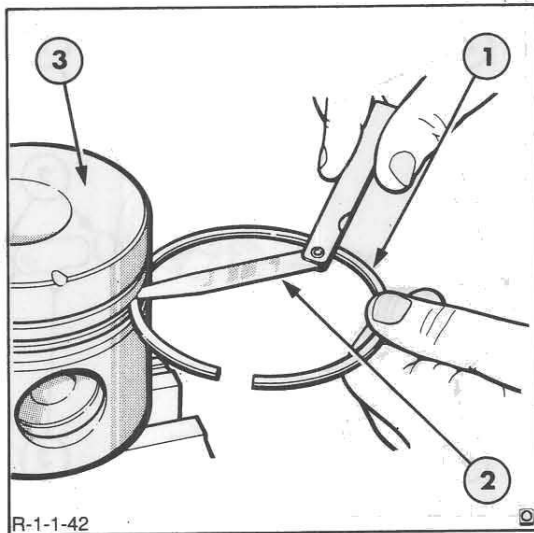
## DISASSEMBLY

1. Remove the piston pin retainer (snap ring) from each side of the piston and remove the pin.
2. Use an expander to remove the piston rings, Figure 38.

## INSPECTION AND REPAIR

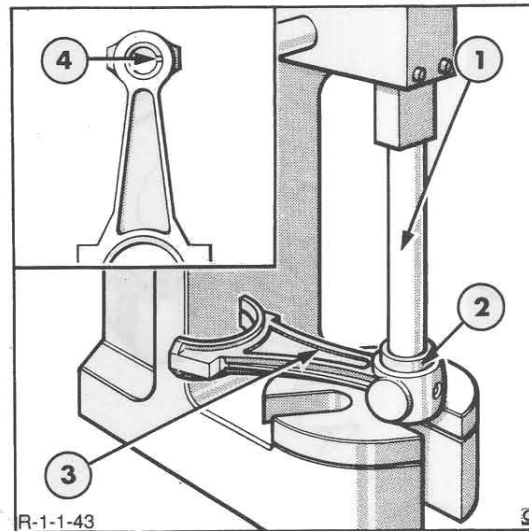
1. Wash the piston and connecting rod assembly in a suitable solvent and dry with a clean lint free cloth or compressed air.
2. Inspect the piston ring lands, skirts and pin bosses for damage.
3. Clean the ring grooves and using a new ring and feeler gauge check the piston ring lands for wear, Figure 40. For maximum ring clearance see "Specifications" – Chapter 4.





**Figure 40**  
Checking Piston Ring Side Clearance

1. New Piston Ring
2. Feeler Gauge
3. Piston



**Figure 41**  
Connecting Rod Bushing Removal and Installation

1. Handle Tool No. 818 or 9514
2. Adaptor Tool No. 818 or 9514
3. Connecting Rod
4. Split in Bush

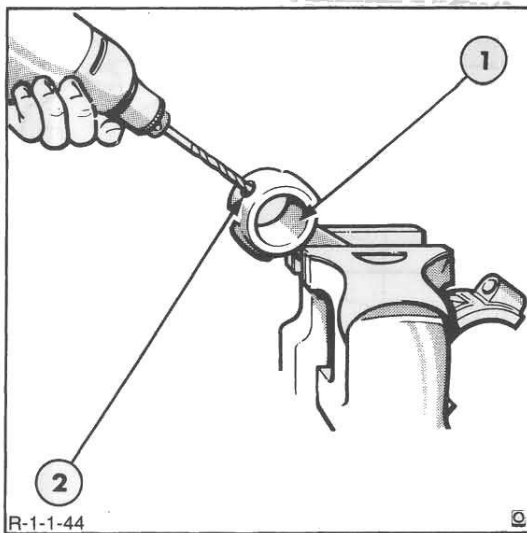
4. Check the connecting rod components for damage and place each connecting rod in an alignment fixture to check for distortion, see "Specifications" – Chapter 4.

**NOTE:** Line up the bushings so that the split is at right angles to the connecting rod's longest axis and ensure the bushing does not protrude from either side of the rod.

5. Check the piston pin bushings for wear or damage. Measure the outside diameter of the piston pin and the inside diameter of the connecting rod bushing. If the clearance is not within the specified limits, see "Specifications" – Chapter 4, press out the connecting rod bushing and install a new bushing using Tool No. 818 or 9514 with a suitable Adapter, Figure 41.

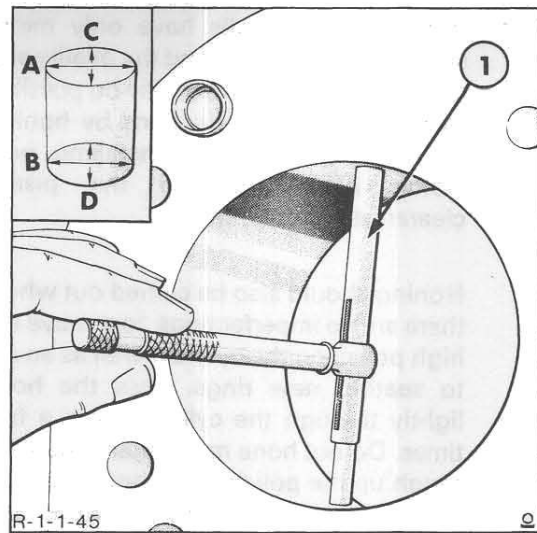
6. After installation of a new connecting rod bushing, use the hole in the top of the rod as a guide and drill a 0.25 in. (6.4 mm) diameter hole through one wall of the bushing, Figure 42.

7. Use an expansion reamer to ream the bushing to obtain the specified bushing-to-piston pin clearance. Remove burrs and metal chips from the rod before fitting the piston pin.



**Figure 42**  
Connecting Rod Bushing Installed

1. Connecting Rod Bushing Installed
2. Lubricating Hole



**Figure 43**  
Measuring Cylinder Bore

1. Telescope Gauge

8. Check the connecting rod and main bearing clearances as described in this Chapter. If the bearing clearances exceed the specified limits, see "Specifications" – Chapter 4, then install new bearings as described in the crankshaft section of this Chapter.

A wavy cylinder wall has a series of parallel lines or rings worn around the cylinder, within the ring travel area. These irregularities can be felt by running a finger over the surface.

A scuffed cylinder can be identified by discoloured areas.

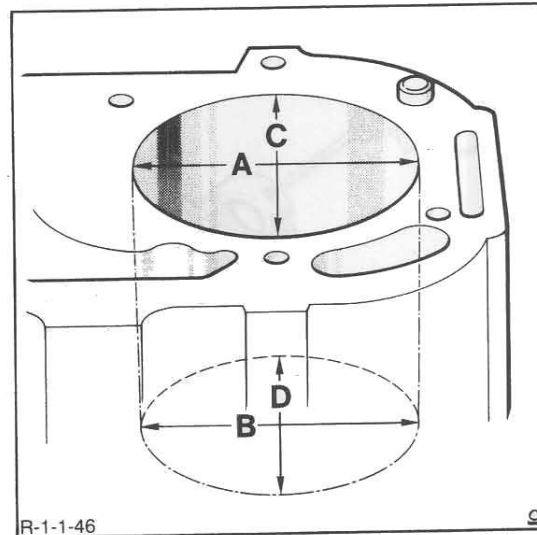
9. Clean and inspect the cylinder block. Rust around the core plugs indicates leakage and new plugs should be fitted with the specified sealant, see "Specifications" – Chapter 4.

Out-of-roundness, wear and taper can only be detected with a cylinder bore gauge, Figure 43. Measure lengthwise and crosswise to obtain dimensions 'A', 'B', 'C' and 'D', Figure 44. Dimensions 'A' compared with 'B' and dimension 'C' compared with 'D', indicates taper whilst the crosswise dimensions 'C' and 'D' compare to the lengthwise measurements 'A' and 'B' show if an out-of-round condition exists. See "Specifications" – Chapter 4.

10. Inspect and measure the cylinder bores for waviness, scratches, scuffing, out-of-round, wear and taper.

11. If the cylinder walls have only minor surface imperfections and the ovality and taper are within limits, it may be possible to remove the imperfections by honing the cylinder walls and installing new piston rings, provided the piston clearance is within limits.

Honing should also be carried out where there are no imperfections, to remove the high polish on the cylinder wall as an aid to seating new rings. Pass the hone lightly through the cylinder bore a few times. Do not hone more than enough to rough up the polish. After honing, bores should be washed with hot water and detergent, then rinsed in cold water and dried thoroughly. The bores should then be oiled to prevent rusting.



**Figure 44**  
Cylinder Bore Measurements

12. If the cylinders are outside specification or the walls are damaged, the cylinders should be honed or bored to fit the next oversize pistons. The finished bore size can be determined by measuring the piston diameter at right angles to the piston pin and adding the appropriate piston-to-bore clearance, see "Specifications" – Chapter 4. Always bore the cylinder with the most wear first to determine the oversize pistons required.

Oversize piston are available as follows:

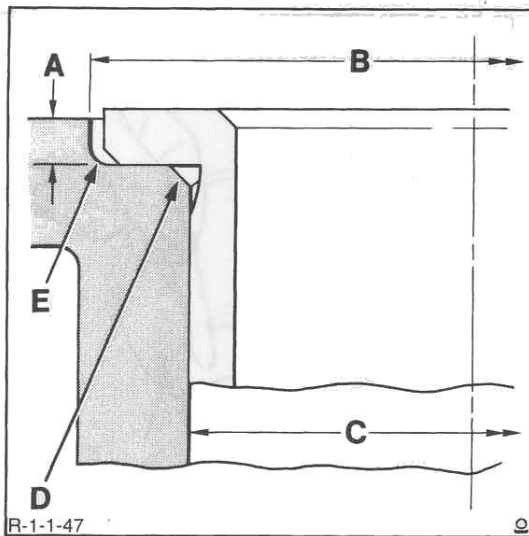
- 0.004 in. (0.10 mm)
- 0.020 in. (0.51 mm)
- 0.030 in. (0.76 mm)
- 0.040 in. (1.0 mm)

13. Bores to take 0.004 in. (0.10 mm) oversize pistons need only be honed. All honing should be done with a rigid hone having a grit size of 150-220. After reboring and honing, thoroughly wash and dry the cylinder block and coat the walls with engine oil.

14. Under certain circumstances it is more expedient to resleeve a bore rather than to rebore and install oversize pistons. This occurs when:

- (a) Oil consumption is due to bore porosity which cannot be corrected by reboring.
- (b) Replacing sleeves installed in service.
- (c) The cylinder has a badly damaged bore which cannot be rectified by boring.

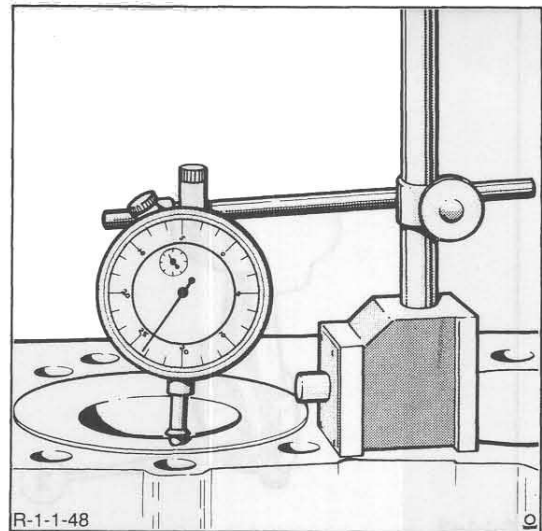
**NOTE:** When reconditioning engines equipped with sleeves, use only standard or 0.004 in. (0.1016 mm) oversize pistons.



**Figure 45**

Dimensions for Machining Cylinder Bore for Thin Walled Sleeve

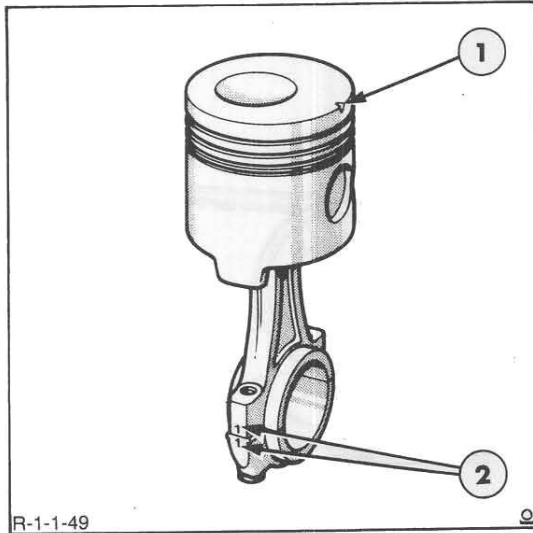
- A. 0.095 – 0.099 in. (2.41 – 2.51 mm)
- B. 4.746 – 4.753 in. (120.55 – 120.73 mm)
- C. Bore Cylinder to Average Diameter of Sleeve less 0.000 – 0.002 in. (0.00 – 0.05 mm)
- D. 0.020 – 0.030 in. (0.50 – 0.75 mm)  $\times$  45° Chamfer
- E. 0.015 in. (0.381 mm) Radius Maximum



**Figure 46**

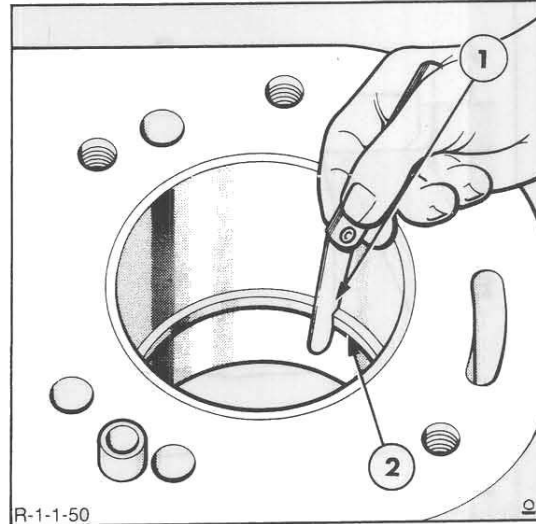
Measuring Piston-to-Block Height

15. If the cylinders are outside specification or the walls are worn or damaged the cylinder should be bored and sleeved back to standard (4.4 in., 111.76 mm).
16. A lipped thin wall sleeve for fitting to engines with 4.4 in. (111.6 mm) bore is available and the procedure for installing this sleeve is as follows:
  - (i) Measure the outside diameter of the sleeve in four places and find the average diameter. Bore the block to 0.000 – 0.002 in. (0.00 – 0.05 mm) less than this average diameter.
  - (ii) Machine the counterbore to the dimensions shown in Figure 45. The counterbore depth is critical as the sleeve must be flush with the block surface when installed.
  - (iii) Thoroughly clean and dry the bore and the outside surface of the sleeve.
  - (iv) Chill the sleeve in liquid nitrogen or dry ice and assemble to the cylinder bore ensuring the lip is bottomed in the counterbore.
  - (v) If necessary the sleeve may be machined to bring it flush with the block face, or if necessary the block face may be skimmed by up to 0.005 in. (0.13 mm) to achieve a flush condition. If the block is skimmed ensure the piston to block height dimension is maintained within specification, Figure 46, see "Specifications" – Chapter 4.
  - (vi) Bore and hone the sleeve to the diameter required. Only standard and 0.004 in. (0.10 mm) oversize pistons can be used with the thin walled 4.4 in. (11.76 mm) bore lipped sleeve.
17. Check the flatness of the cylinder block-to-head surface, see "Specifications" – Chapter 4.



**Figure 47**  
Piston Connecting Rod Alignment

1. Notch – To Front of engine
2. Cap Numbers



**Figure 48**  
Checking Piston Ring Gap

1. Feeler Gauge
2. Piston Ring

## RE-ASSEMBLY

**NOTE:** Prior to re-assembly, check the cylinder bores for taper and out-of-round as previously described in this Chapter.

1. Prior to re-assembly, check the piston-to-bore clearance as follows:

- Measure the cylinder bore diameter in a crosswise direction then measure the piston diameter at right angles to the piston pin.
- Subtract the piston diameter from the bore diameter and the resultant figure should be within the specified clearance, see "Specifications" – Chapter 4.

**NOTE:** Pistons are available in both standard and oversizes. New pistons should be installed if the clearance exceeds the specified limits.

- If the clearance is **greater** than specified, try a similar new piston. If the clearance still exceeds the specified limit, measure the other cylinder bores and pistons and determine the cylinder with the greatest clearance. Based on the greatest clearance, rebore the cylinders to take the next oversize piston as previously described in this Chapter.

- If the clearance is **less** than specified: Hone the bore to obtain the desired clearance as previously described in this Chapter.

2. Lubricate all components with engine oil then assemble the piston to the connecting rod with the notch on the piston crown aligned with the pin on the connecting rod and install the piston pin and retainers (snap rings), Figure 47.
3. Check the piston rings for minimum gap prior to installation in the relevant cylinder, Figure 48. Use a piston crown to squarely locate the ring in the bore. New rings should be checked for side clearance in the piston as previously described in this Chapter.

4. Use an expander to install the piston rings, starting with the oil control ring in the bottom groove and working upwards.

The service ring set comprises:

- 1 Coiled Wire Expander or "Rail" type Expander for the Oil Control Ring
- 1 Oil Control Ring
- 3 Compression Rings

### Oil Control Ring

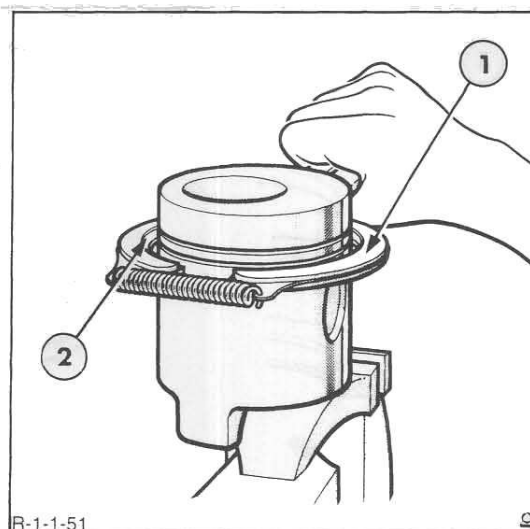
Open the coiled wire expander to fully reveal the inner guide wire. Position the coiled expander in the oil groove and insert the inner guide wire into the open end of the coil. Close the coil until the ends abut.

Position a "rail" type expander in the oil groove ensuring the ends do not overlap. Attempting to install a ring with overlapping ends will result in a broken ring and/or damaged cylinder bore. Do not cut the expander if it appears to be too large. The rings will compress to size if the correct ring compressor is used, Figure 51.

Install the cast iron ring (either side up) with the inside groove over the coiled rail expander. Position the ring gap diametrically opposite the coiled wire ends.

### 3rd Compression Ring

Dull finish with a step or chamfer on the inside diameter which must face *downwards* or a step on the outside diameter which must face *upwards* on assembly.



**Figure 49**  
Piston Ring Installation

1. Piston Ring Expander
2. Piston Ring

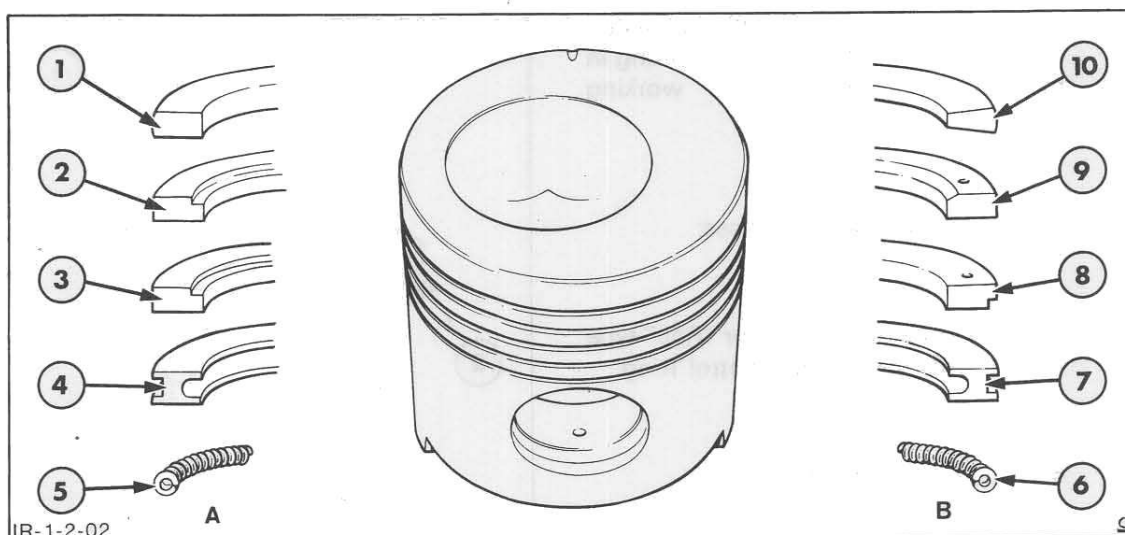
### 2nd Compression Ring

Bright chrome finish on the outside diameter with a chamfer or step on the outside diameter which must face *upwards* on assembly.

**NOTE:** To facilitate assembly, the 2nd and 3rd compression rings are marked with a punched dot or the letters 'TOP' engraved on their upper surfaces.

### Top Compression Ring

Bright chrome finish with a chamfer on the outside diameter which must face *upwards* and a step on the outside diameter which must face downwards on assembly.



**Figure 50**  
Piston and Rings

**A. Naturally Aspirated**

1. Top Compression Ring
2. 2nd Compression Ring
3. 1st Compression Ring
4. Oil Control Ring
5. Expander for Oil Control Ring

**B. Turbocharged**

6. Expander for Oil Control Ring
7. Oil Control Ring
8. 1st Compression Ring
9. 2nd Compression Ring
10. Top Compression Ring

**NOTE:** Some top compression rings do not have a chamfer and may be installed either side up.

For the turbocharged 4-cylinder engine, the top compression ring is keystone tapered and may be installed either side up.

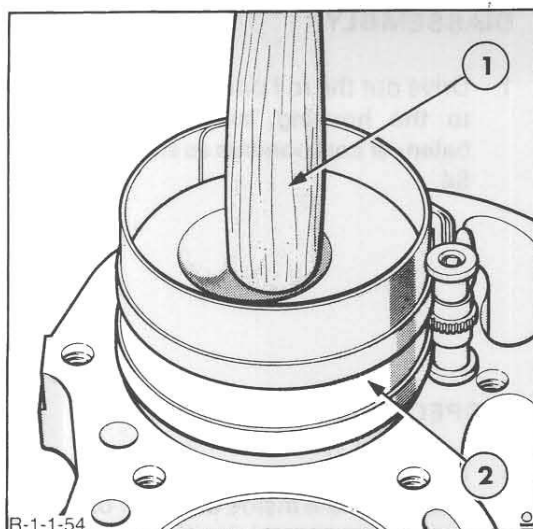
5. After installing the rings, stagger the ring gaps around the circumference of the piston at approximately 120° to each other and with no gap on the thrust side of the piston.

**INSTALLATION**

**NOTE:** Before installing a piston and new rings into a used cylinder bore, remove the high polish on the cylinder wall as previously described in this Chapter.

1. Select the correct bearing liners, as described in the CRANKSHAFT section of this Chapter, and install in the connecting rod and cap. Ensure the bearing liner tang locates in the slots of the rod and cap.
2. Turn the crankshaft to position the No. 1 crankpin at the bottom of the stroke. Oil the piston, rings, cylinder bore and bearing liners. Use a ring compressor to install the piston into the cylinder, Figure 51. Ensure the notch on the top of the piston is towards the front of the engine.
3. Push the piston into the bore until the connecting-rod bearing liner seats on the crankpin. Install the connecting rod bearing cap with the number on the cap on the same side as the number on the rod. Install new nuts and tighten to the specified torque, see "Specifications" – Chapter 4.

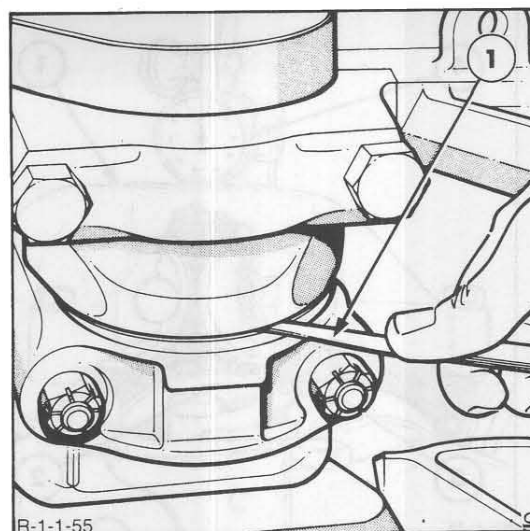




**Figure 51**

Piston and Connecting Rod Installation

1. Hammer Handle
2. Piston Ring Compressor



**Figure 52**

Checking Connecting Rod Bearing Side Clearance

1. Feeler Gauge

4. Use feeler gauges to check the side clearance of each connecting rod, Figure 52, see "Specifications" – Chapter 4.

5. Install the remaining piston and rod assemblies in the same manner.

6. Install the oil pump, the oil pan sump and the cylinder head as previously described in this Chapter.

7. Fill the engine with the correct grade and quantity of oil and the radiator with the correct strength and quantity of coolant, see "Specifications" – Chapter 4.

8. Start the engine and check for leaks.

## BALANCER, MAIN BEARINGS, FLYWHEEL AND CRANKSHAFT

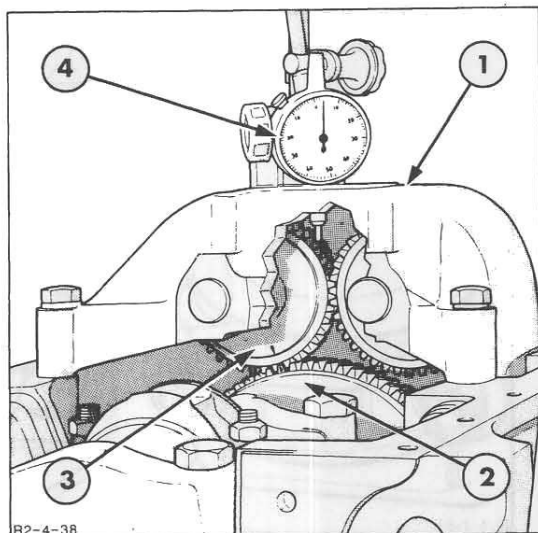
**NOTE:** Replaceable bearing liners are installed in production to ensure the correct crankshaft journal-to-bearing clearance can be maintained in Service.

*The main bearings can be overhauled with the engine installed in the tractor.*

*The crankshaft can only be serviced after removal of the engine from the tractor.*

*To remove the flywheel, either remove the engine from the tractor or separate the tractor between the engine and the front transmission. See PART 10, "SEPARATING THE UNIT".*





**Figure 53**  
Checking Balancer Backlash

1. Balancer Housing
2. Crankshaft Gear
3. Balancer Drive Gear
4. Dial Indicator Gauge

## BALANCER

### REMOVAL

1. Remove the oil pan sump as previously described in this Chapter.
2. Use a dial indicator gauge to check the backlash between the crankshaft gear and the balancer drive gear, Figure 53. Position the dial plunger perpendicular to the face of one of the drive gear teeth then rock the drive gear to measure the backlash. Take the backlash reading at 90° intervals around the drive gear. If the backlash exceeds the specified limits see "Specifications" – Chapter 4, install new balancer gears.
3. Withdraw the retaining bolts and remove the balancer assembly.

### DIASSEMBLY

1. Drive out the roll pins securing the shafts to the housing, and disassemble the balancer components as shown in Figure 54.

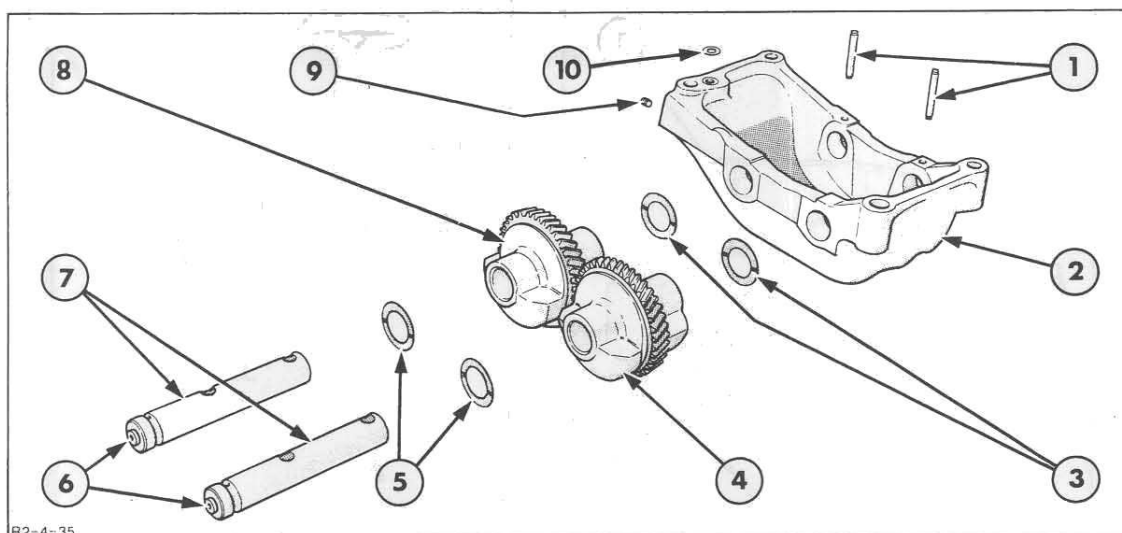
### INSPECTION AND REPAIR

1. Measure the outside diameter of the shafts and the inside diameter of the gear bushings and establish the clearance, see "Specifications" – Chapter 4. If the bushing clearance exceeds the specification, replace the shaft and/or gear assembly and re-check the clearance.
2. Examine the shafts and balance gear teeth for wear and damage and replace where necessary.

3. Ensure the lubrication holes in the shafts are free from obstruction.

### RE-ASSEMBLY

1. Position the balancer gears and thrust washers in the housing with the timing marks aligned and facing the roll pin side of the balancer. Install the shafts from the opposite side and secure with the roll pins, Figure 55.
2. Use the feeler gauges to measure the end float of the assembled gears.



**Figure 54**  
Dynamic Balancer Components

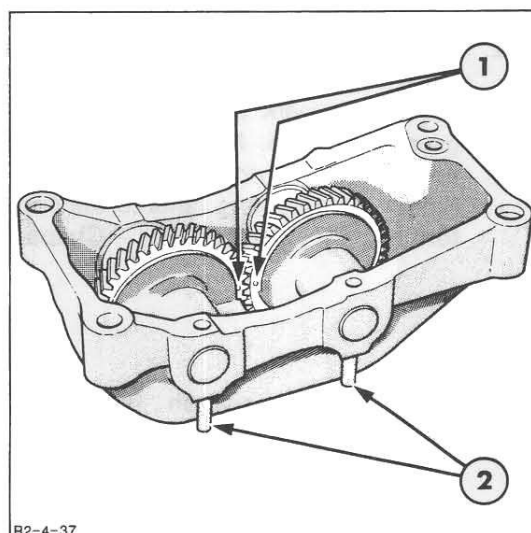
- |                   |               |
|-------------------|---------------|
| 1. Roll Pins      | 6. Plugs      |
| 2. Housing        | 7. Shafts     |
| 3. Thrust Washers | 8. Drive Gear |
| 4. Driven Gear    | 9. Plug       |
| 5. Thrust Washers | 10. Gasket    |

- Position a dial indicator gauge perpendicular to the tooth of one gear and hold the other gear firmly.

Rock the free gear to measure the backlash.

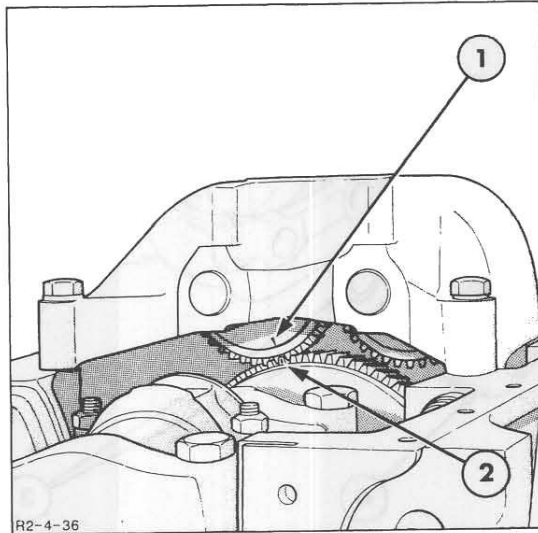
Take the backlash readings at 90° intervals around the gear.

If the end float or backlash exceeds the specified limits, see "Specifications" – Chapter 4, replace one or both of the gears and re-check.



**Figure 55**  
Balancer Gear Assembly

- Balancer Gear Timing Marks
- Roll Pins



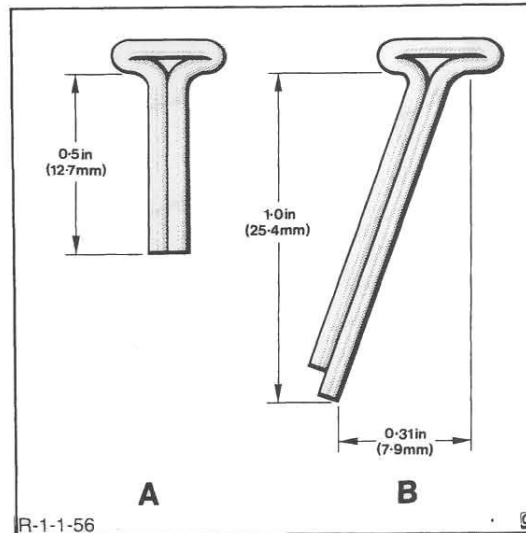
**Figure 56**

Timing the Balancer to the Crankshaft

1. Balancer Drive Gear Timing Mark
2. Crankshaft Gear Timing Mark

## INSTALLATION

1. Clean all mating surfaces and install a new gasket around the lubrication passage.
2. Rotate the crankshaft until the timing mark on the crankshaft gear aligns with the timing mark on the balancer drive gear, Figure 56. Position the balancer housing on the dowels then install and tighten the retaining bolts to the correct torque, see "Specifications" – Chapter 4.
3. Recheck the backlash between the crankshaft gear and the balancer drive gear as previously described in this Chapter.
4. Replace the oil pan.



**Figure 57**

Bearing Liner Removal Tools

- A. Thrust Bearing Insert Tool
- B. Main Bearing Liner Tool

## MAIN BEARINGS

### REMOVAL

1. Remove the oil pan, the oil pump and intermediate shaft, as previously described in this Chapter.
2. Remove the main bearing cap from the journal to which the new bearing liners are to be installed. Always install one set of bearings at a time leaving the other main bearing caps securely in place.
3. Install a bearing liner removal tool in the crankshaft journal oil passage. Slowly turn the crankshaft counter-clockwise until the tool forces the bearing out of the cylinder block.

**NOTE:** If a bearing liner removal tool is not available, a suitable tool may be fabricated from a 1 in. (25 mm)  $\times$   $\frac{1}{8}$  in. split pin, Figure 57. The shorter pin is used to remove the thrust bearing insert.

Flatten and bend the head to 30° to conform to the angle of the oil passage in the crankshaft.

### INSPECTION AND REPAIR

1. Thoroughly clean the bearing liners, journals and caps.
2. Bearing liners with scored, chipped or worn surfaces must be replaced. If new liners are to be installed, check the clearances as described in the crankshaft section of this Chapter.

### INSTALLATION

1. Apply a light coat of engine oil to the journal and bearing liner.
2. Locate the liner installation tool in the crankshaft journal oil passage and position the liner on the journal with the plain end of the liner at the tang side of the cylinder block. Slowly turn the crankshaft clockwise until the bearing is fully located. Remove the installation tool.

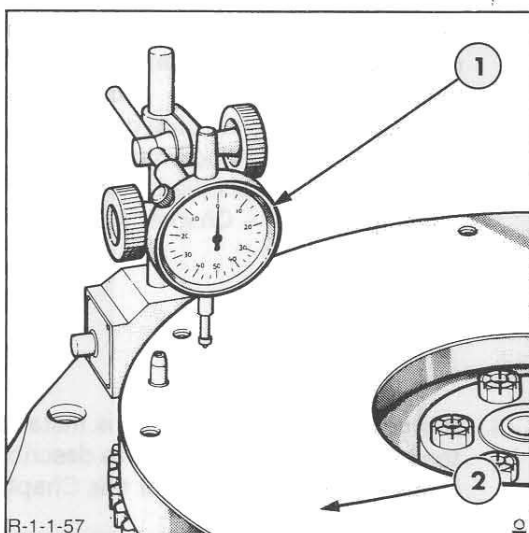
3. Lubricate the bearing cap and liner and install the liner into the cap. Position the bearing cap with the locking tang towards the camshaft side of the engine and install the retaining bolts. Tighten the bolts to the specified torque, see "Specifications" – Chapter 4.
4. If a new thrust bearing liner is installed, the bearing must be aligned as described in the crankshaft section of this Chapter.

5. Install the oil pump, the intermediate shaft, the balancer and the oil pan sump.

### FLYWHEEL

#### REMOVAL

1. Separate the tractor between the engine and the front transmission, see PART 10, "SEPARATING THE UNIT".
2. Prior to removal, rotate the flywheel and use a dial indicator to measure the run-out, Figure 58, see "Specifications" – Chapter 4. If the flywheel is outside the specification check the mating surfaces of the flywheel and the crankshaft for correct seating.



**Figure 58**  
Checking Flywheel Run-Out

1. Dial Indicator Gauge
2. Flywheel

3. Withdraw the flywheel attaching bolts and carefully remove the flywheel.

## INSPECTION AND REPAIR

1. Inspect the flywheel ring gear and renew if the teeth are damaged. Check the flywheel for damage due to a loosely or improperly fitted ring gear.

2. A damaged flywheel ring gear should be removed and renewed as follows:

- Cut the old ring gear free from the flywheel.

- Thoroughly clean the mating surfaces of the new ring gear and the flywheel.
- Use temperature indicating crayons to mark the side face of the ring gear at six equally spaced locations. Mark with a 400°F (204°C) crayon at a point 0.5 in. (13 mm) below the root of the teeth and mark with a 450°F (212°C) crayon at a point just below the root of the teeth.
- Use an oxy-acetylene torch with a tip size No. 2 maximum and direct the flame against the internal face of the gear.
- Stop applying heat when the 400°F (204°C) crayon marks melt and before the 450°F (212°C) crayon marks melt.
- Quickly place the hot gear on the flywheel with the flat face against the shoulder on the flywheel. Quench the gear with water.

## INSTALLATION

1. Clean the crankshaft rear flange and the mating surface of the flywheel.
2. Establish the correct alignment of the flywheel to crankshaft mounting holes and install the flywheel. Tighten the attaching bolts to the specified torque and re-check the flywheel run-out, see "Specifications" – Chapter 4.

3. Re-assemble the tractor, see PART 10, "SEPARATING THE UNIT."
5. Remove the connecting rod and main bearing caps and liners and identify to facilitate re-assembly.
6. Carefully lift the crankshaft out of the cylinder block.

### CRANKSHAFT

#### REMOVAL

1. Remove the engine from the tractor, see PART 10, "SEPARATING THE UNIT", and place on an engine stand.
2. Remove the flywheel and engine rear cover plate as previously described in this Chapter.
3. Remove the crankshaft pulley and engine front cover as previously described in this Chapter.

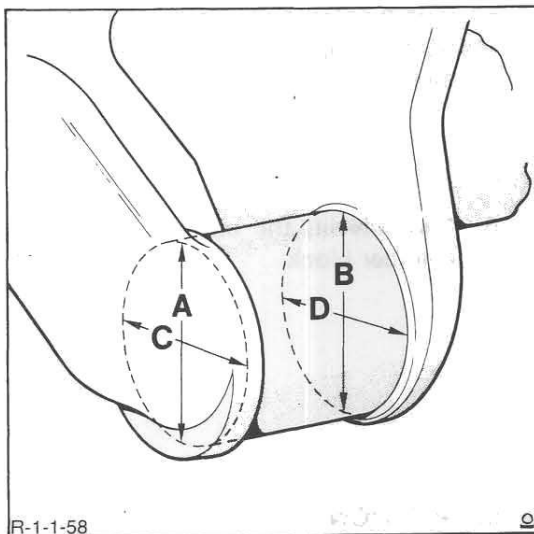
**NOTE:** *If the crankshaft is removed with the cylinder head in position, ensure all timing marks are realigned prior to re-assembly. This action will prevent possible interference between the valves and pistons during re-assembly.*

4. Remove the oil pan sump, the oil pump and intermediate shaft and the balancer as previously described in this Chapter.

#### INSPECTION AND REPAIR

**NOTE:** *Current production engines may have a crankshaft with main or crankpin journals ground 0.010 in. (0.25 mm) undersize. These are identified with the letters '010 MUS' and/or '010 PUS' respectively. The letters are stamped on one of the crankshaft counterbalance weights.*

1. If the crankshaft gear teeth are excessively worn or chipped, install a new crankshaft gear which must be fully located on the shoulder of the crankshaft.
2. Clean the crankshaft and drilled passages. Dress minor imperfections with an oil stone and re-finish severely marked journals to the next undersize bearing.
3. Measure the diameter of each journal in four places to determine out-of-round, taper or wear, Figure 59. Measurement 'A' compared with 'B' indicates vertical taper whilst measurement 'C' compared with 'D' indicates horizontal taper. Measurements 'A' and 'B' compared with 'C' and 'D' indicate journal out-of-round.



**Figure 59**  
Crankshaft Journal Measurements

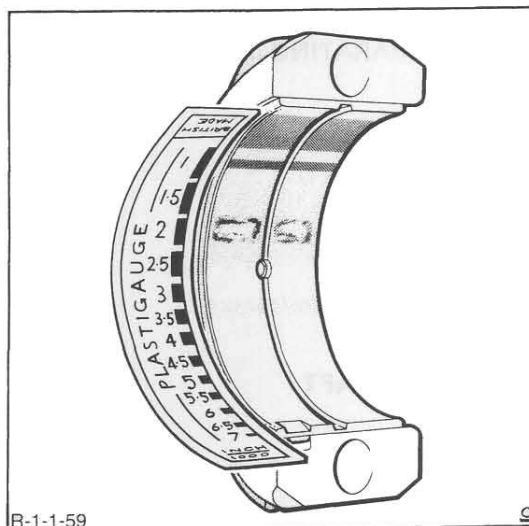
If the journal exceeds the specified wear limit, refinish the journals to the next undersize bearing, see "Specifications" – Chapter 4. Always reproduce the original journal side radii and after refinishing chamfer the oil holes.

4. Examine the rear oil seal journal for score marks, remove minor imperfections with fine emery cloth and if severely damaged renew the crankshaft.

## RE-ASSEMBLY

1. Check the crankshaft bearing clearance with micrometers or preferably using Plastigauge as follows:

- Position a piece of correct size Plastigauge across the full width of the bearing cap and approximately 0.25 in. (6.35 mm) off centre.



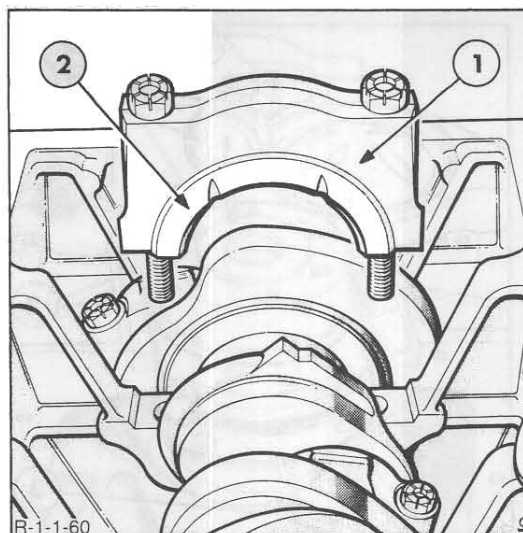
**Figure 60**  
Checking Crankshaft Bearing Clearance Using Plastigauge

- Install the cap and tighten the bolts to the specified torque, see "Specifications" – Chapter 4.
- Remove the cap and use the scale to check the width of the flattened Plastigauge, Figure 60. The width of the Plastigauge at the widest point establishes the minimum clearance and at the narrowest point the maximum clearance. The difference between the two readings is the taper.

**NOTE:** Normally, main bearing journals wear evenly and will not be out-of-round. However, if a liner is fitted to an out-of-round journal which is within specifications, ensure the liner to be fitted suits the maximum diameter of the journal.

2. Standard size liners are colour coded red or blue and are available in a Copper Lead or Aluminium Tin alloy, see "Specifications" – Chapter 4.

**IMPORTANT:** *The engine may be assembled with liners of different material but liners of the same material must be installed on the same journal.*



**Figure 61**

Thrust Bearing Assembly

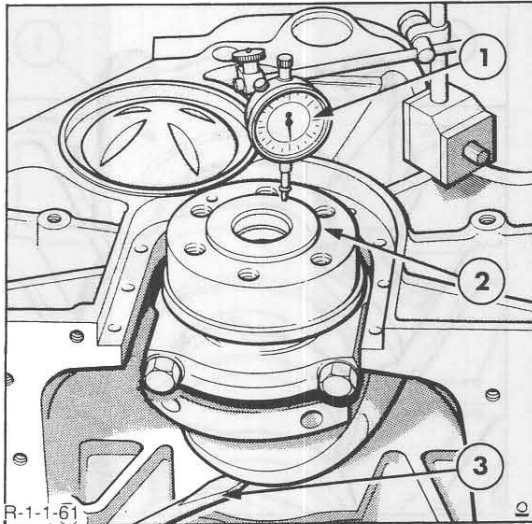
1. Bearing Cap
2. Flange Type Liner

The red liners have a thinner wall section than the blue liners and provide greater clearance. A combination of red and blue liners may be required to obtain the desired clearance. If the clearance is greater than specified when two blue liners are used, a 0.002 in. (0.05 mm) undersize liner with either a red, blue or another 0.002 in. (0.05 mm) undersize liner should be installed. If any of these combinations of liners do not produce the specified clearance, refinish the crankshaft and fit undersize bearings, see "Specifications" – Chapter 4.

3. Position the bearing liners in the block and caps and coat with oil. If the crankshaft has been refinished fit the correct undersize main bearing liners. Ensure the bearing surfaces are clean and the bearing liners tangs align with the slots in the block and cap.

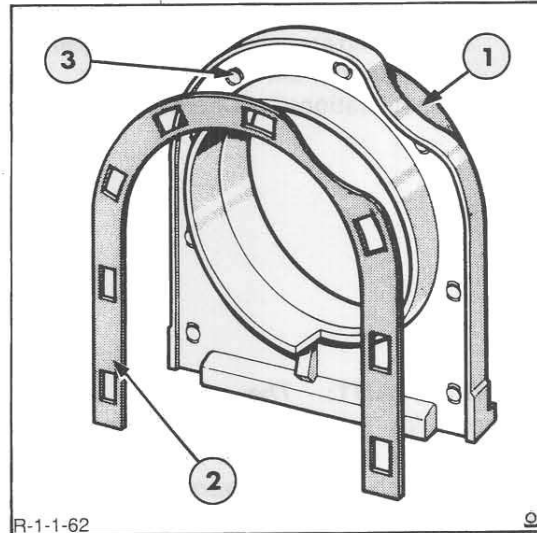
4. Align the timing mark on the crankshaft gear with that of the camshaft drive gear and install the crankshaft. Install the thrust bearing cap with the flange-type bearing liner, Figure 61, first. Then, install the remaining bearing caps in their original location.
5. Tighten all bearing cap bolts (except the thrust bearing cap) to the specified torque. The thrust bearing cap bolts should be finger tight only.
6. Pry the crankshaft forward against the thrust surface of the bearing. Hold the crankshaft forward and pry the bearing cap rearwards; care must be taken not to pry against the flange of the bearing liner. This will align the thrust surfaces of both halves of the bearing. Hold the forward pressure on the crankshaft and tighten the bearing cap bolts to the specified torque, see "Specifications" – Chapter 4.





**Figure 62**  
Checking Crankshaft End Play

- |                         |               |
|-------------------------|---------------|
| 1. Dial Indicator Gauge | 2. Crankshaft |
|                         | 3. Lever      |



**Figure 63**  
Crankshaft Oil Seal Retainer

- |             |                  |
|-------------|------------------|
| 1. Retainer | 3. Raised Bosses |
| 2. Gasket   |                  |

7. Check the crankshaft end play with a dial indicator gauge, Figure 62. Pry the crankshaft towards the front of the engine and set the dial indicator to zero. Pry the crankshaft towards the rear of the engine and note the reading on the dial. If the end play exceeds the specified limit, install a new thrust bearing liner. If the end play is less than the specified limit, inspect the thrust bearing surfaces for burrs, scratches, or dirt. If the thrust surfaces are not defective or dirty, realign the thrust bearings following the procedure given in Operation No. 6.

- (ii) Install the retainer and gasket onto the block, apply a low strength thread locking compound to the bolt threads, see "Specifications" – Chapter 4, and secure into position with the eight bolts.

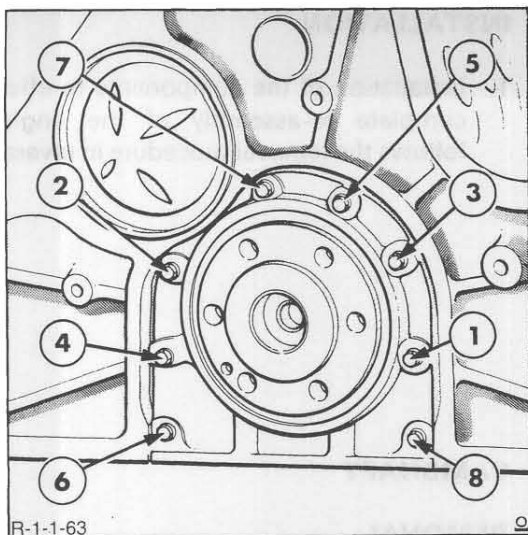
- (iii) Tighten the bolts in sequence, as shown in Figure 64, to the initial specified torque, see "Specifications" – Chapter 4.

- (iv) Ensure that the base of the retainer is flush with the cylinder block, Figure 65, then tighten the bolts in the same sequence to the final specified torque, see "Specifications" – Chapter 4.

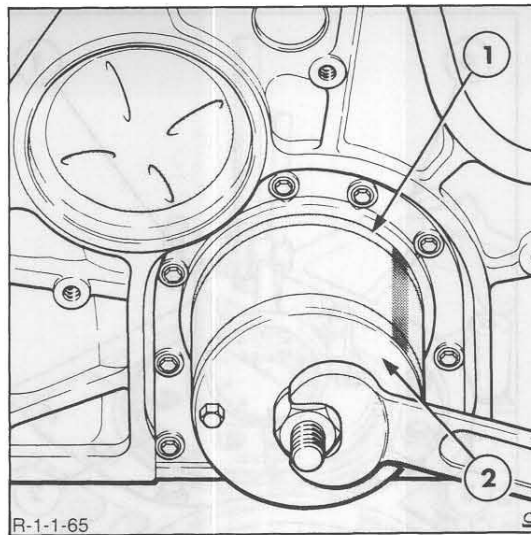
8. Install the crankshaft rear oil as detailed below:

- (i) Peel the protective paper backing from the gasket and stick the gasket to the retainer. Ensure that the gasket holes align with the bosses of the retainer, Figure 63.

**NOTE:** Do not pre-install the seal into the retainer. To ensure seal concentricity it must only be assembled after the retainer has been bolted to the cylinder block.



**Figure 64**  
Seal Retainer Bolt Tightening Sequence

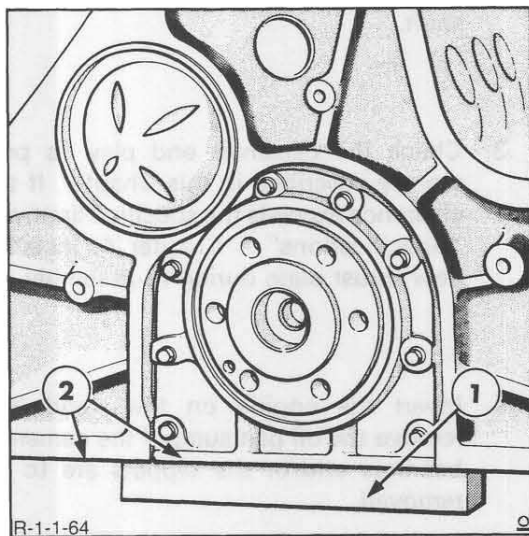


**Figure 66**  
Crankshaft Oil Seal Installation

1. Crankshaft Oil Seal
2. Tool No. FT 6212

(v) Apply a liberal coating of clean engine oil to the rear oil seal retainer, seal and journal. The new seal should, preferably, be mounted on the crankshaft and then the tool bolted to the crankshaft and used to install the seal squarely.

(vi) Install the centre stock of tool No. FT 6212 to the crankshaft flange and secure with the two screws, Figure 65. Assemble the cylinder end plate assembly to the centre stock and secure with the nut and washer as shown in Figure 66. Gradually tighten the nut until the outer diameter of the tool abuts the retainer. The tool must not be overtightened as stress and distortion could be imposed on the retainer.



**Figure 65**  
Retainer - Block Alignment

1. Straight Edge
2. These Two Faces to be Flush

**NOTE:** The first seal replacement should be pushed into the retainer with the plain end of the tool and the second and subsequent seals with the stepped end of the tool which will reposition the seal 0.060 in. (1.52 mm) further in.

(vii) Remove the tool

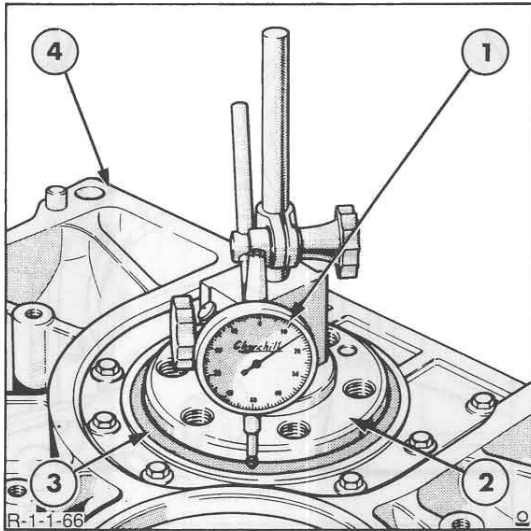


Figure 67

Checking Rear Main Bearing Crankshaft Oil Seal Run-Out

1. Dial Indicator Gauge
2. Crankshaft
3. Crankshaft Oil Seal
4. Cylinder Block

(viii) Mount a dial indicator gauge on the end of the crankshaft, Figure 67, rotate the crankshaft and check the run out of the seal does not exceed 0.015 in. (0.38 mm).

9. Install the correct bearing liners in the connecting rod and cap. If the journals are standard size select the correct bearing liners as for main bearings in Steps 1 and 2. Ensure the bearing liner tangs locate in the slots of the rod and cap.

10. Install the connecting rod bearing cap, as previously detailed in this Chapter, with the number on the cap on the same side as the number on the rod. Install new nuts and tighten to the specified torque, see "Specifications" – Chapter 4.

## INSTALLATION

1. Installation of the components to effect complete re-assembly of the engine follows the removal procedure in reverse.

## CAMSHAFT

### REMOVAL

**NOTE:** The camshaft bearings and/or tappets can only be serviced with the engine removed from the tractor and mounted on an engine stand. See PART 10, "SEPARATING THE UNIT".

1. Remove the engine front cover and cylinder head.

2. Remove the oil pump drive gear and shaft.

3. Check the camshaft end play as previously described in this Chapter. If the clearance exceeds the specified limit, see "Specifications" – Chapter 4, install a new thrust plate during re-assembly.

4. Invert the engine on the stand and remove the oil pan sump if the camshaft bearings and/or the tappets are to be removed.

5. Withdraw the bolt and flat washer and remove the camshaft gear.