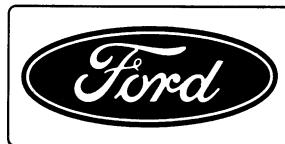


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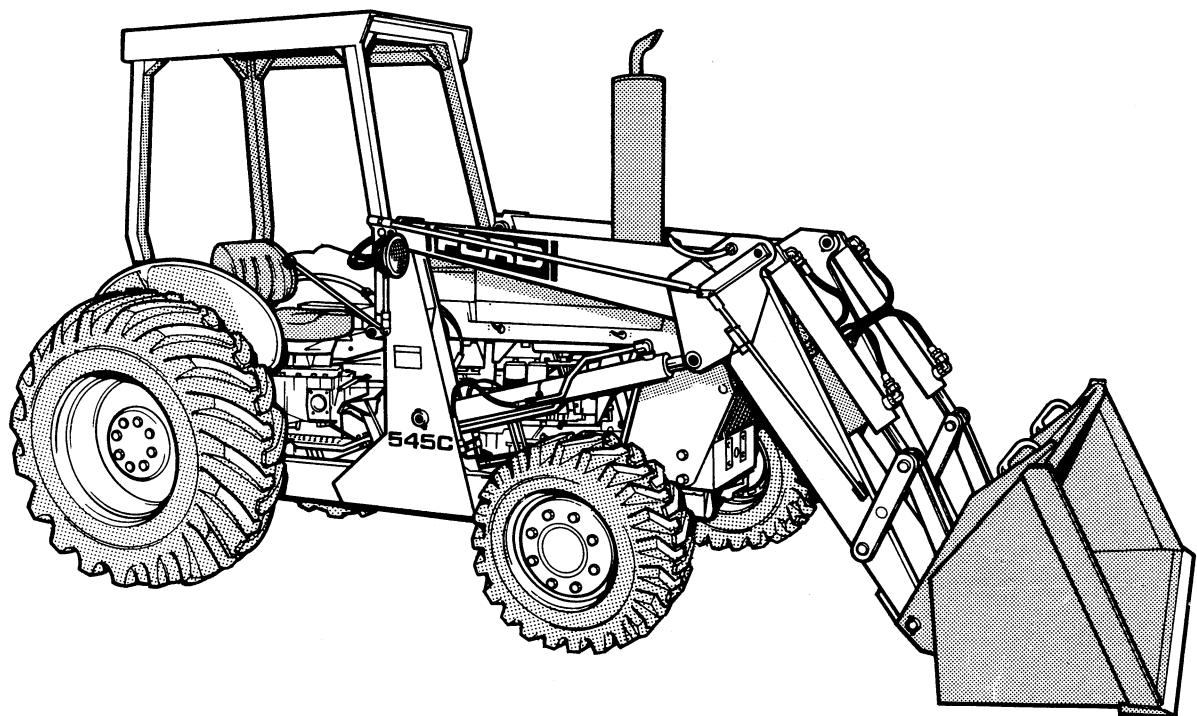


FORD

NEW HOLLAND

Repair Manual

Tractor Loader 345C – 445C – 545C



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Reprinted

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.

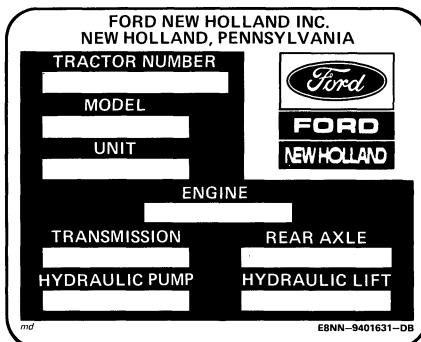
The Manual is divided into twelve Parts each sub-divided in turn into Chapters. Each Chapter contains information on general operating principles, detailed inspection and overhaul and, where applicable, specific trouble shooting, special tools and specifications. Any reference in this Manual to right, 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.

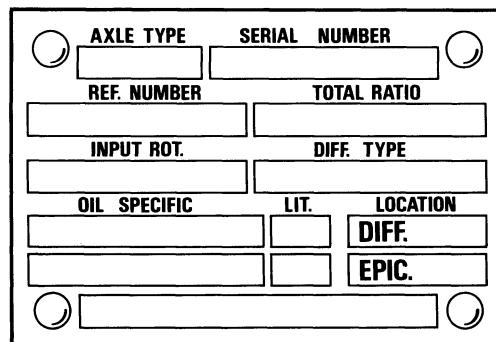
PRODUCTION DATE CODES AND SERIAL NUMBERS

A vehicle identification plate is located inside the right hand hood panel. If your tractor is equipped with four wheel drive option, then a similar plate is affixed to the rear right-hand side of the front axle casing. Whenever effecting repair or overhaul of the Ford Tractor Loader, the relevant information should be noted and used when referring to service bulletins or ordering parts.



IND 300

Vehicle Identification Plate



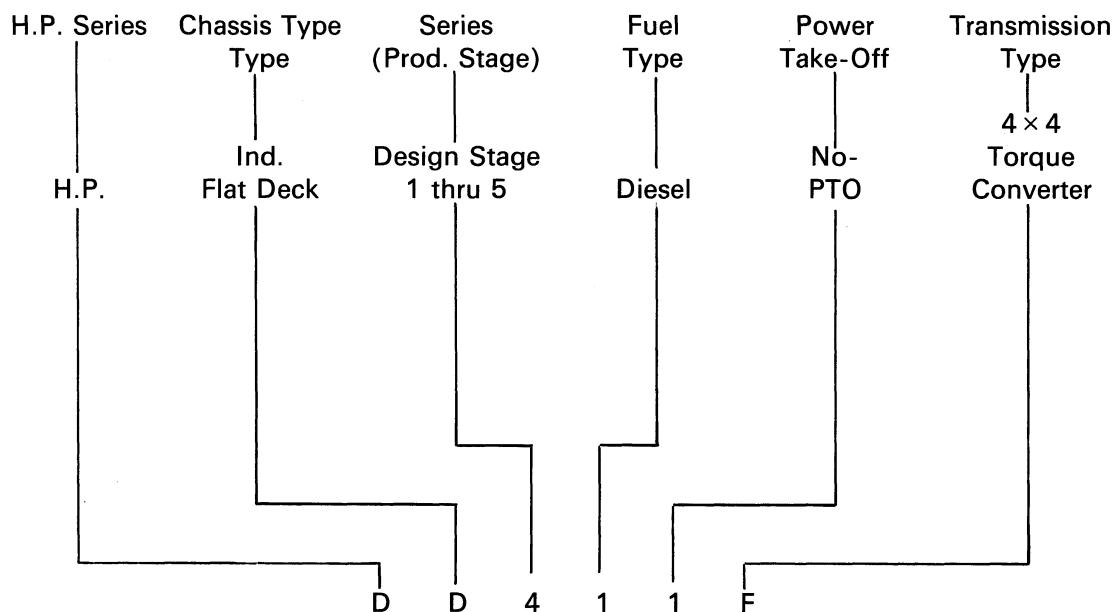
T1

Four Wheel Drive Axle Identification Plate (Optional)

The vehicle identification plate is stamped with the following information:

- TRACTOR NUMBER – Serial number prefixed by the letter 'A'.
- MODEL – Production model code.
- UNIT – Production unit date code.
- ENGINE – Engine production date code.
- TRANSMISSION – Transmission production date code.
- REAR AXLE – Rear axle production date code.
- HYD. PUMP – Hydraulic pump production date code.
- HYD. LIFT – Hydraulic power lift production date code.

MODEL NUMBER – CODE



KEY TO PRODUCTION DATE CODES

First Number YEAR	First Letter MONTH	Second Number DAY OF MONTH	Second Letter PRODUCTION SHIFT
8 – 1988	A – Jan	H – Aug.	
9 – 1989	B – Feb.	J – Sept.	
0 – 1990	C – March	K – Oct	
1 – 1991	D – April	L – Nov	
2 – 1992	E – May	M – Dec	
3 – 1993	F – June		
4 – 1994	G – July		

Example of Production Unit Date Code 9 L 0 3 B

Year of Final Assembly (1989) Month of Year (November) Day of Month (Third) Shift Period (Day)

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 practiced 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/in² (6.9 bar) (7 kgf/cm²). 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.
- Certain repair or overhaul procedures may necessitate “seperating the tractor”, either at the engine/front transmission or front transmission/rear transmission locations. These operations are simplified by the use of the Tractor Splitting Kit/Stands. Should this equipment not be available, then every consideration must be given to stability balance and weight of the components, especially if a cab is installed.
- Use footsteps or working platforms when servicing those areas of a tractor that are not within easy reach.
- Before loosening any hoses or tubes connecting implements to remote control valves, etc., switch off the engine, remove all pressure in the lines by operating levers several times. This will remove the danger of personal injury by oil pressure.
- 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.
- When equipment or implements are required to be attached to the hydraulic linkage, either for testing purposes or for transportation, then “position control” should be used.
- 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.
- Observe recommended precautions as indicated in this Repair Manual when dismantling the air conditioning system as escaping refrigerant can cause frostbite.
- 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.

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

SERVICE TECHNIQUES

A. SERVICE SAFETY

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

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

B. SERVICE TECHNIQUES

Clean the exterior of all components before carrying out any form of repair. Dirt and abrasive dust can reduce the efficient working life of a component and lead to costly replacement.

Time spent on the preparation and cleanliness of working surfaces will pay dividends in making the job easier and safer and will result in overhauled components being more reliable and efficient in operation.

Use cleaning fluids which are known to be safe. Certain types of fluid can cause damage to 'O' rings and cause skin irritation. Solvents should be checked that they are suitable for the cleaning of components and also that they do not risk the personal safety of the user.

Replace 'O' rings, seals or gaskets whenever they are disturbed. Never mix new and old seals or 'O' rings, regardless of condition. Always lubricate new seals and 'O' rings with hydraulic oil before installation.

When replacing component parts use the correct tool for the job.

HOSES AND TUBES

Always replace hoses and tubes if the cone end or the end connections are damaged.

When installing a new hose loosely connect each end and make sure the hose takes up the designed position before tightening the connection. Clamps should be tightened sufficiently to hold the hose without crushing and to prevent chafing.

The hoses are the arteries of the unit, be sure they are in good condition when carrying out repairs or maintenance otherwise the machine's output and productivity will be affected.

After hose replacement to a moving component check the hose does not foul by moving the component through the complete range of travel.

Be sure any hose which has been installed is not kinked or twisted.

Hose connections which are damaged, dented, crushed or leaking, restrict oil flow and the productivity of the components being served. Connectors which show signs of movement from the original swaged position have failed, and will ultimately separate completely.

A hose with a chafed outer cover will allow water entry. Concealed corrosion of the wire reinforcement will subsequently occur along the hose length with resultant hose failure.

Ballooning of the hose indicates an internal leakage due to structural failure. This condition rapidly deteriorates and total hose failure soon occurs.

Kinked, crushed, stretched or deformed hoses generally suffer internal structural damage which can result in oil restriction, a reduction in the speed of operation and ultimate hose failure.

Free-moving, unsupported hoses must never be allowed to touch each other or related working surfaces. This causes chafing which reduces hose life.

PART 1

ENGINE SYSTEMS

Chapter 1

3-CYLINDER DIESEL ENGINE

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B.	3-CYLINDER DIESEL ENGINE – OVERHAUL	6

Chapter 2

COOLING SYSTEM

Section		Page
A.	COOLING SYSTEM – DESCRIPTION AND OPERATION	1
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Chapter 3

TROUBLE SHOOTING, SPECIFICATION AND SPECIAL TOOLS

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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	1
B. 3-CYLINDER DIESEL ENGINE – OVERHAUL	6

A. 3-CYLINDER DIESEL ENGINE – DESCRIPTION AND OPERATION

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

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 with the exception of the Ford 545C which has two compression and one oil control ring.

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 3-cylinder diesel engine options available.

Model	Ford 345C	Ford 455C	Ford 545C
No. of Cylinders	3	3	3
Bore	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)
Displacement	192 in ³ (3147 cm ³)	192 in ³ (3147 cm ³)	201 in ³ (3247 cm ³)

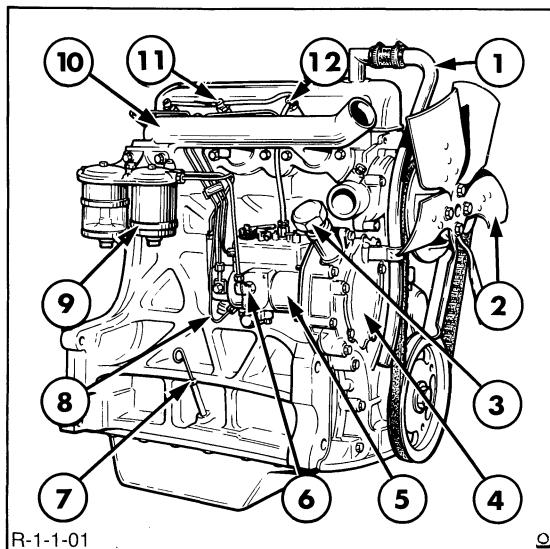


Figure 1
3-Cylinder Diesel Engine with DPA Distributor Type
Fuel Injection Pump

1. Ventilation Tube	7. High Pressure Fuel Pipe
2. Fan	8. Starter Motor
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

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.

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 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.

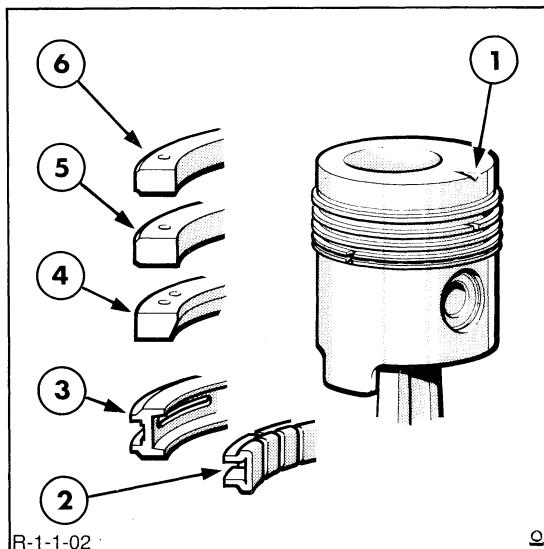


Figure 2
Conventional Piston and Rings

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

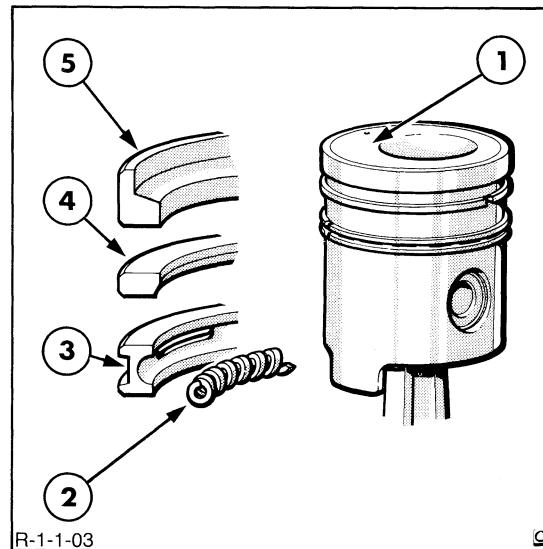


Figure 3
Headland Piston and Rings

1. Dimple to Front of Engine
2. Expander for Oil Control Ring
3. Oil Control Ring
4. 1st Compression Ring
5. 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.

An exception to the above is the Ford 545C engine which utilises an autothermic 3-ring headland piston, Figure 3. These pistons have steel inserts cast into the thrust faces of the piston skirt which control the expansion of the piston. In addition, the piston features an L-shaped head-land ring which eliminates the dead volume which normally exists between the head-land of the piston and the cylinder wall, and a top ring insert which is mechanically locked to the piston crown.

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.

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 by-passed, 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.

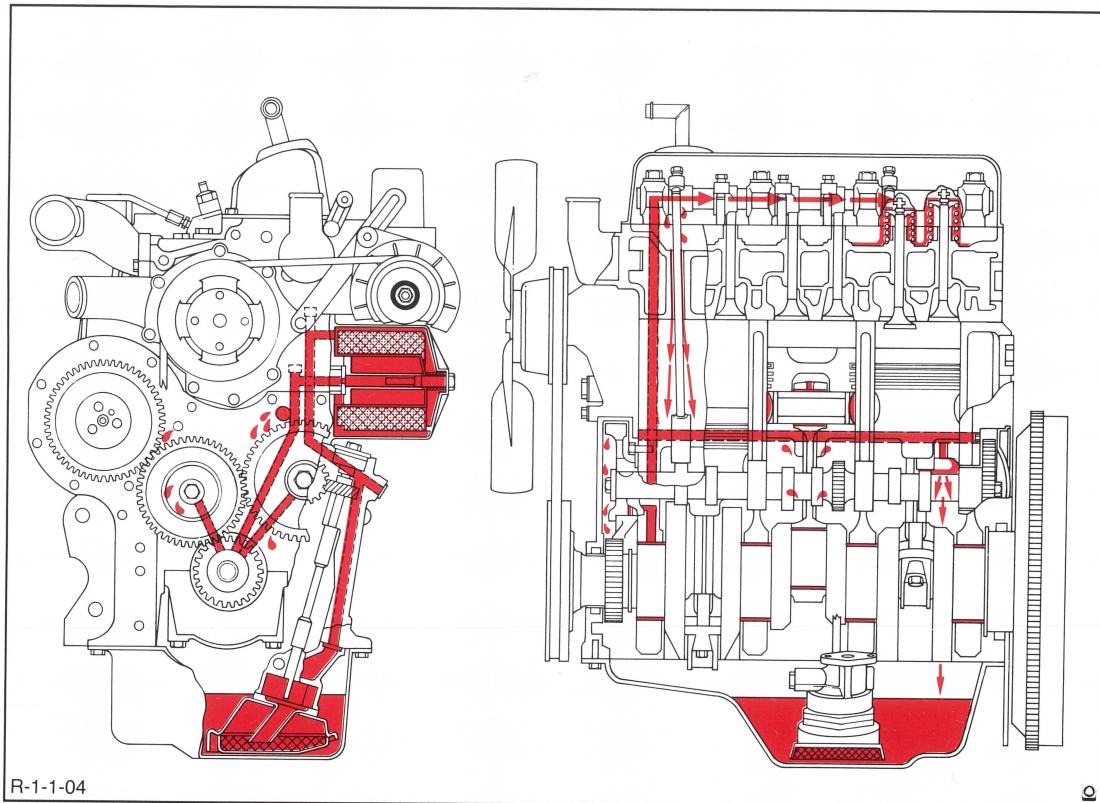


Figure 4
3-Cylinder Engine Lubrication System

 Lubrication Oil

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.

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

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

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.

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.

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 5 and 6.

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

1. Disconnect the battery and remove the battery and battery tray.
2. Drain the coolant from the radiator and engine cylinder block:
 - Remove the radiator top hose.
3. Remove the vertical exhaust muffler.
4. Remove the left and right-hand hood assemblies.
5. Disconnect the air inlet hose at the intake manifold.
6. Shut-off the fuel tank tap:
 - Disconnect the low pressure fuel lines and remove the fuel filters from the inlet manifold and cap the exposed openings.
7. Disconnect and remove the rocker cover ventilation tube.
8. Disconnect the cold start equipment and plug the exposed openings (where fitted).
9. 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).

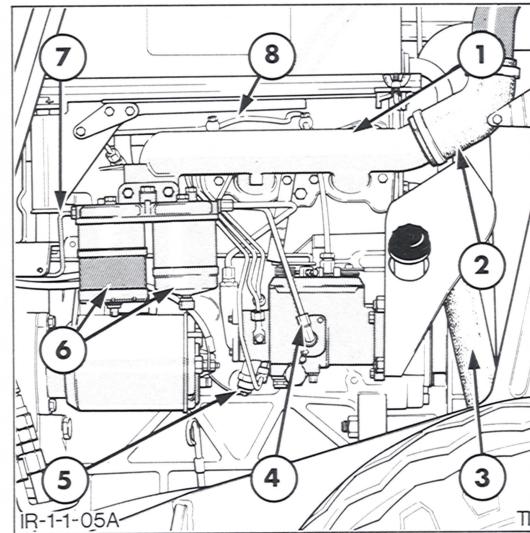


Figure 5
Engine Installation Right-Hand

- 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.

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

7. Disconnect and remove the rocker cover ventilation tube.

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

9. 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).

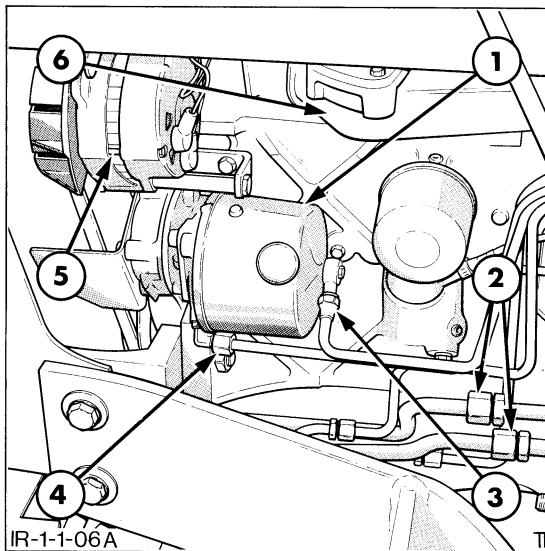


Figure 6
Engine Installation Left-Hand

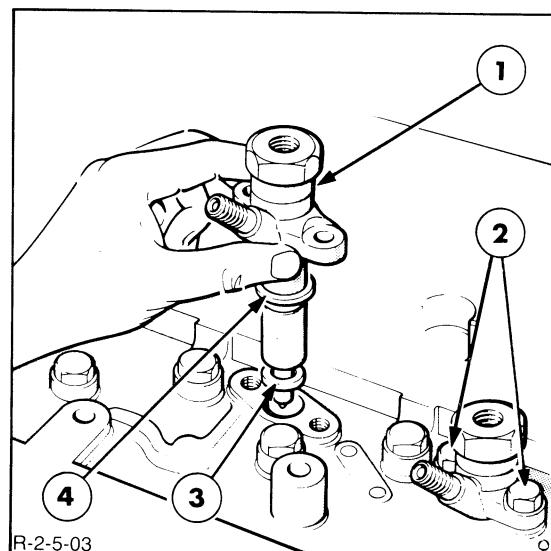


Figure 7
Fuel Injector Removal

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

10. Remove the front engine harness and secure with tape clear of the engine.
11. Remove the alternator and guard (where fitted).
12. Remove the exhaust pipe and bracket.
13. Bend back the lock tabs, withdraw the attaching bolts and remove the exhaust manifold and gasket.
14. Remove the two bolts securing the fuel tank to the hood rear support.
15. Withdraw the retaining bolts and lockwashers and remove the inlet manifold and gasket.
16. 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 7.
17. Withdraw the securing bolts and remove the rocker cover and gasket from the cylinder head.
18. Check the push rods for straightness by rotating the rods with the valve closed and identify any bent rods.
19. 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.*

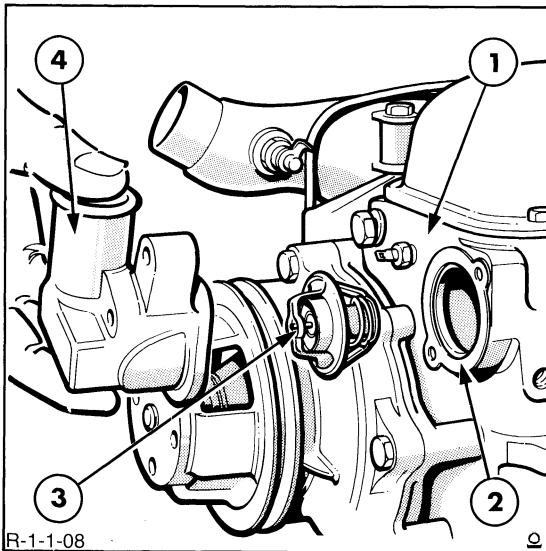


Figure 8
Coolant Outlet and Thermostat Removal

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

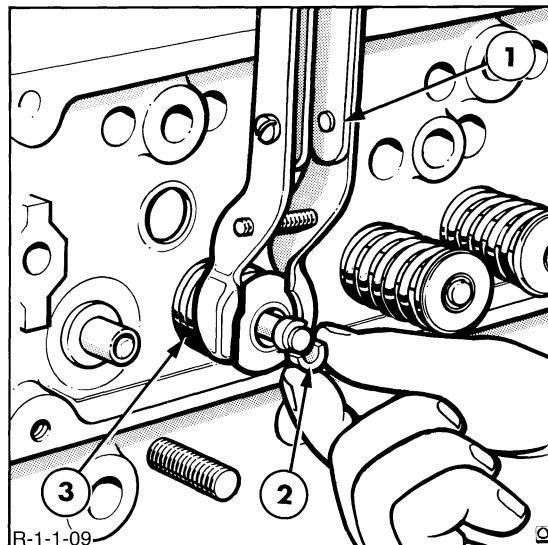


Figure 9
Valve Removal

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

20. 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.

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

22. 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 8.

Cylinder Head

1. Clean the head and remove carbon deposits from around the valve heads.

2. Using a valve spring compressor, Figure 9 remove the retainer locks, spring retainers/rotators, springs and seals from each valve, Figure 10.

3. Withdraw the valves and place in a numbered rack.

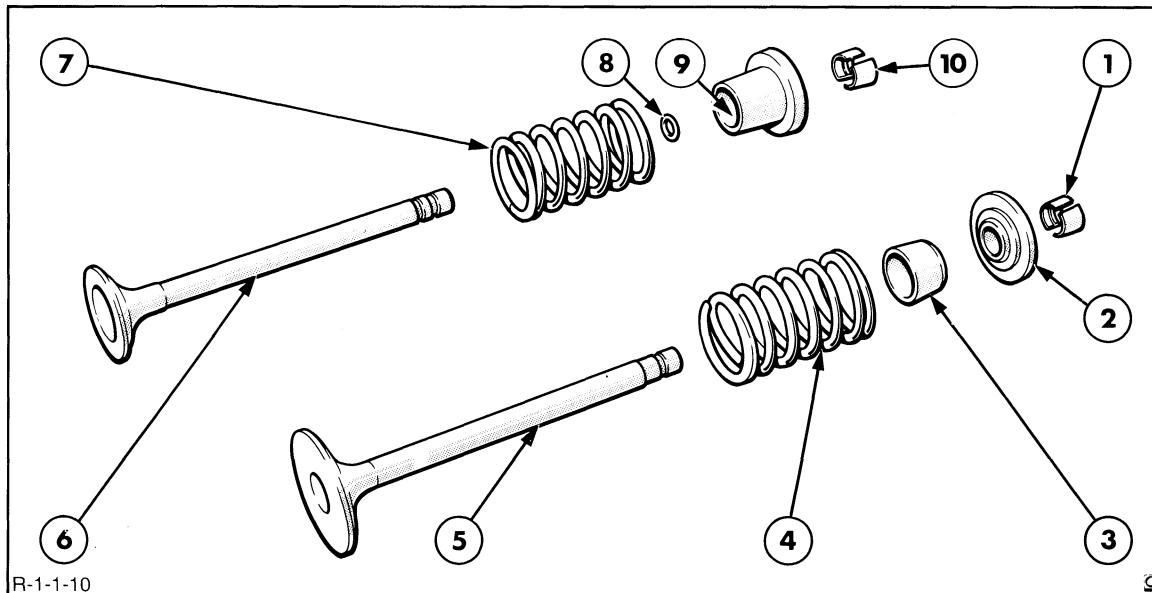


Figure 10
Valve Assembly Components

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 11.

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 3.

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.

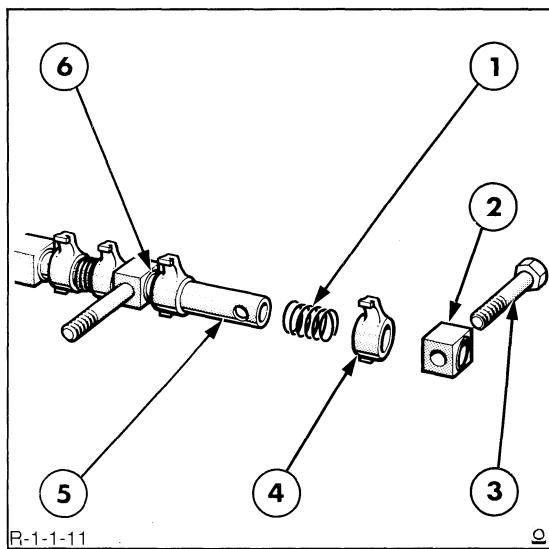


Figure 11
Rocker Shaft Disassembled

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

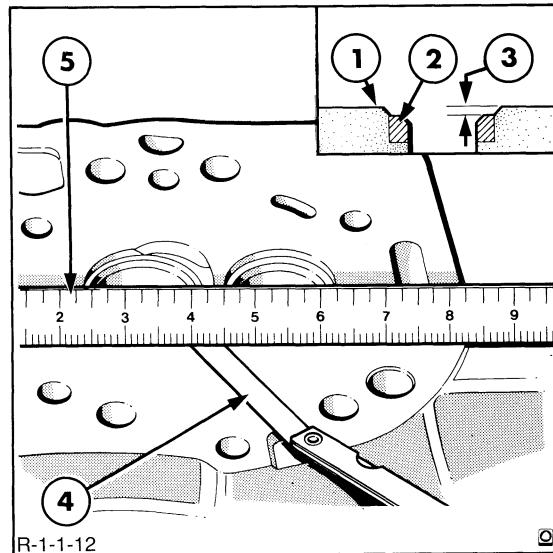


Figure 12
Measuring Cylinder Head Flatness

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

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 3. 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 $\frac{.010}{os}$ or $\frac{.020}{os}$ 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.

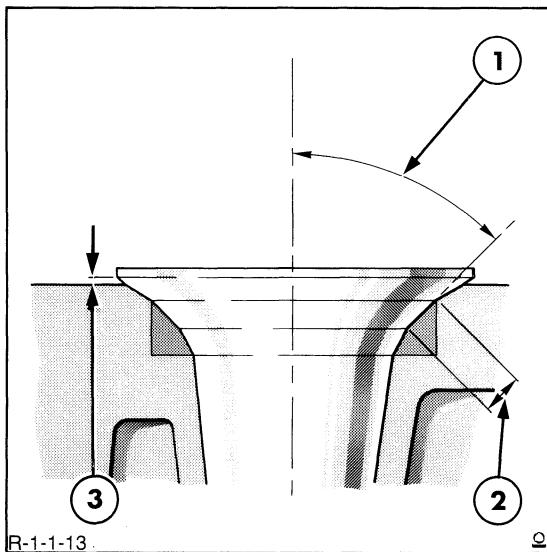


Figure 13
Valve Seat Dimensions

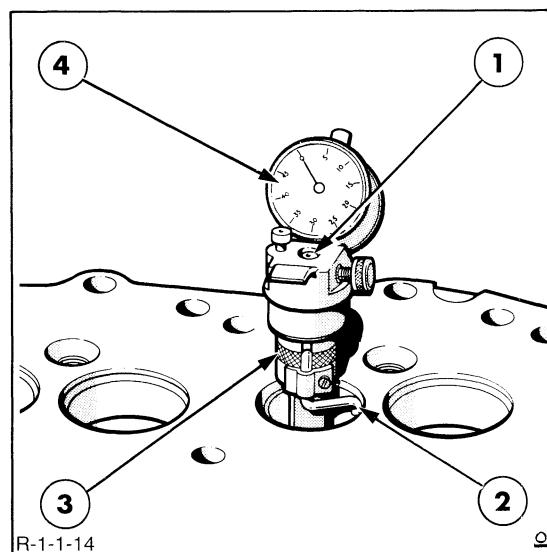


Figure 14
Checking Valve Seat Concentricity

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 13.
4. Measure the concentricity of the valve seat with a suitable gauge, as shown in Figure 14. If the valve seat runout exceeds the specified figure, see "Specifications" – Chapter 3, reface the seat.
5. Using a seat cutter with the correct angle (refer to Figure 12 and "Specifications," Chapter 3) 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.

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 13, 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 15. Raise the seat by removing stock from the bottom of the seat with a 60° grinding wheel.

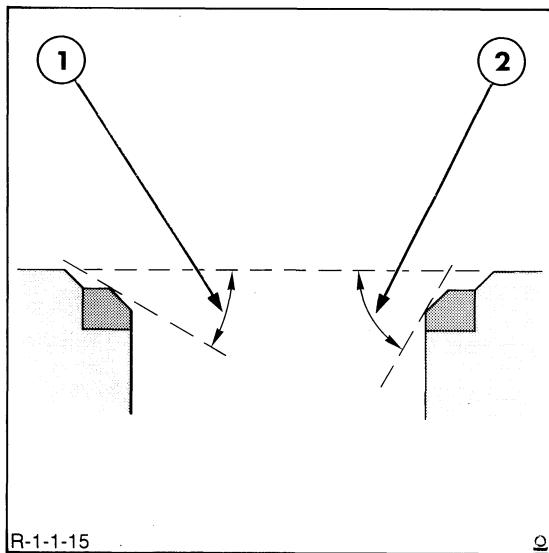


Figure 15
Raising/Lowering Valve Seats

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

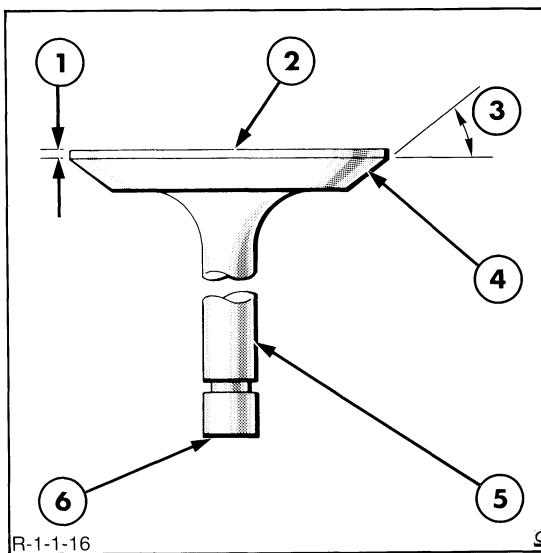


Figure 16
Critical Valve Measurements and Inspection Checks

1. Valve Head Edge
2. Valve Head
3. Valve Face Angle (45,5°)
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 16.
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 3, 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.

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.

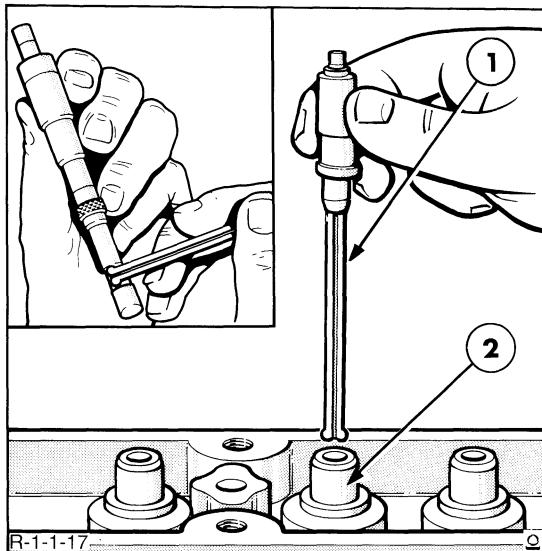


Figure 17
Measuring Valve Guide

1. Telescopic Gauge
2. Valve Guide

Valve Guides

1. Using a telescopic gauge and micrometer, measure the valve to guide clearance, Figure 17. If the clearance exceeds the specified limits, see "Specifications" – Chapter 3, 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 $\frac{V015}{OS}$ 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.

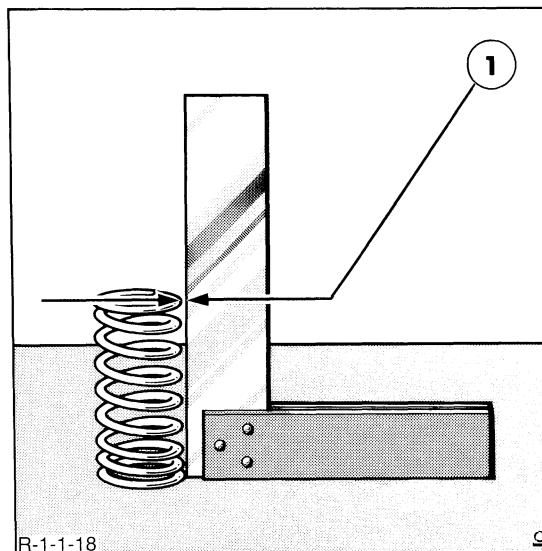


Figure 18
Checking Valve Spring Squareness

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 18. Check the free length and loaded length of each valve spring, see "Specifications" – Chapter 3. Ensure the valve spring retainer locks are in good condition.

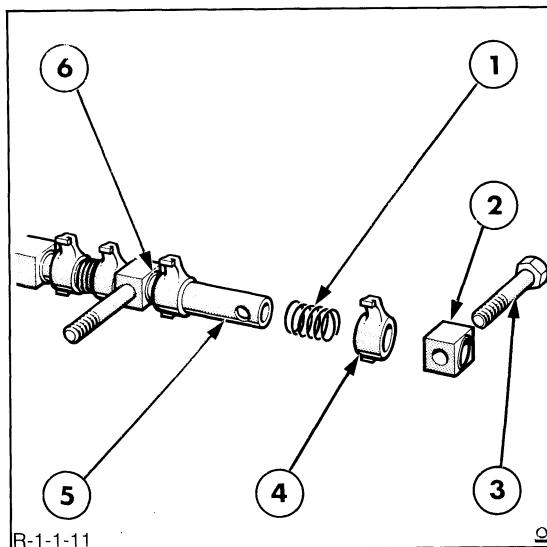


Figure 19
Rocker Shaft Components

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.
2. 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.
3. Check the rocker arm locating springs and spacers for breaks or other damage.
4. 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.

5. 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 2.

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.

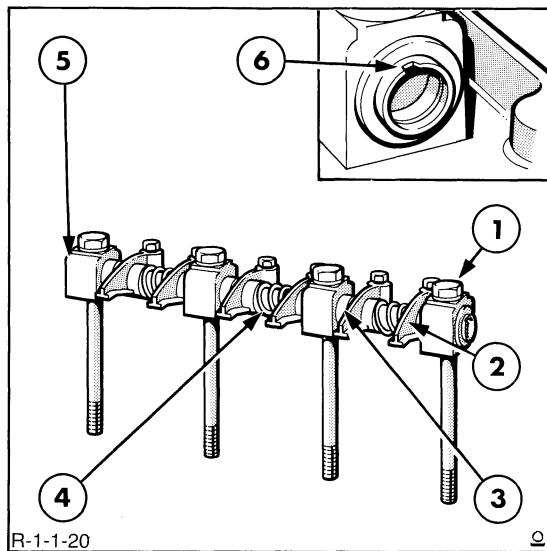


Figure 20
Rocker Arm Shaft Assembly

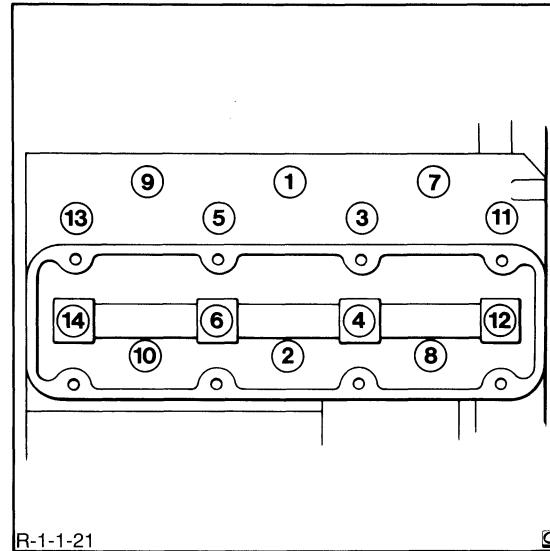


Figure 21
Cylinder Head Bolt Tightening Sequence

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.
3. The rocker shaft has an identification groove at one end of the shaft. Position the mark upwards, Figure 20, and use this end as the front of the shaft, thereby ensuring the oil holes and grooves in the shaft face downwards.
4. Start assembling by securing a rocker shaft support with a long cylinder head retaining bolt.
5. Ensure the springs and spacers are in their correct position, as shown in Figure 20, 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.

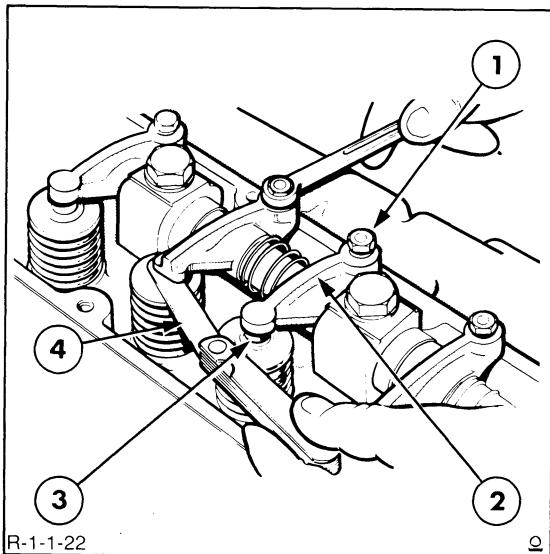


Figure 22
Setting Valve Lash

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

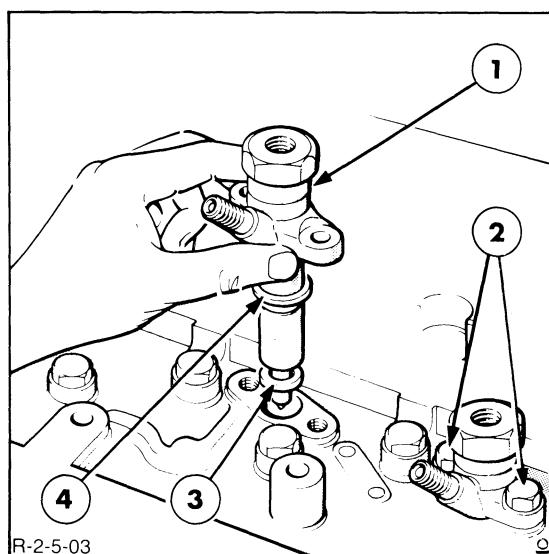


Figure 23
Fuel Injector Installation

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 21 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 22. See "Specifications" – Chapter 3.

- Install the injectors with new seat washers and cork seals, Figure 23.
- 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 3.

- 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 3.
- Operate the engine and check for fluid leaks.

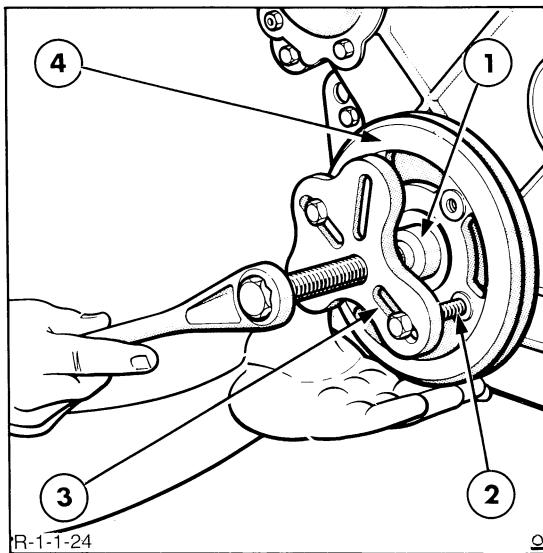


Figure 24
Crankshaft Pulley Removal

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

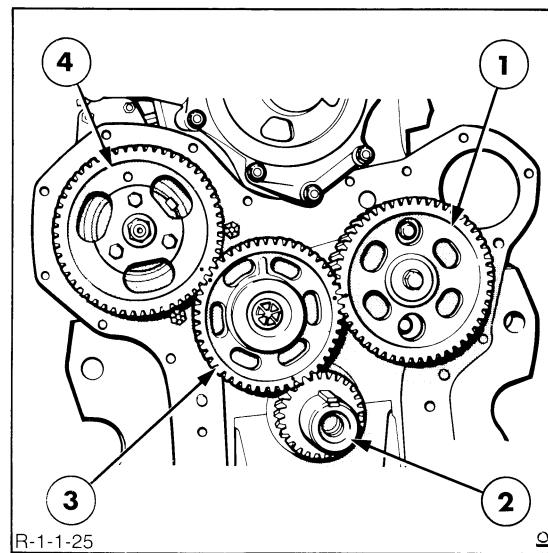


Figure 25
Timing Gears

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 11, "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 24.
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 25, use a dial indicator or feeler gauges, to measure the backlash between each set of mating gears, Figure 26. 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 3.

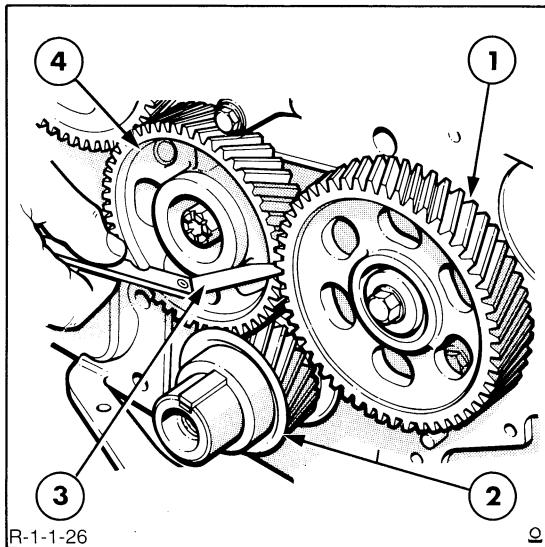


Figure 26
Measuring Timing Gear Backlash

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

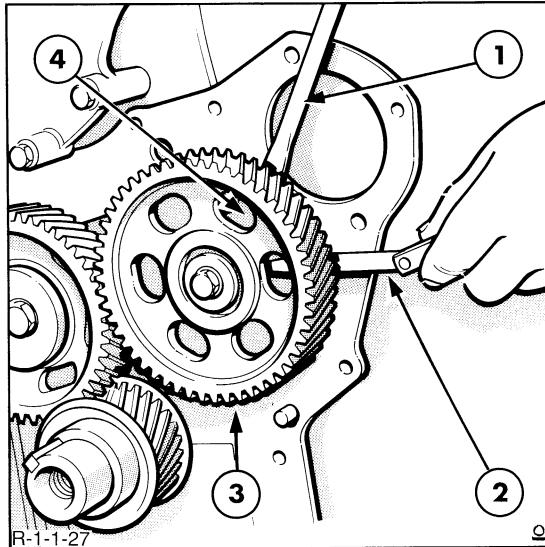


Figure 27
Measuring Camshaft End Play

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 27. Install a new camshaft thrust plate if the camshaft end play exceeds the specified limits, see "Specifications" – Chapter 3.

10. Remove the self-locking bolt that retains the camshaft drive gear and adapter to the cylinder block then remove gear and adaptor, Figure 25.

11. Remove the retaining bolt and washer, then remove the camshaft gear from the end of the camshaft, Figure 25.

12. Remove the three bolts and then remove the drive gear from the injection pump hub, Figure 25.

13. Remove the crankshaft gear using Tool No. CPT 6040B or 2134, Figure 28.

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

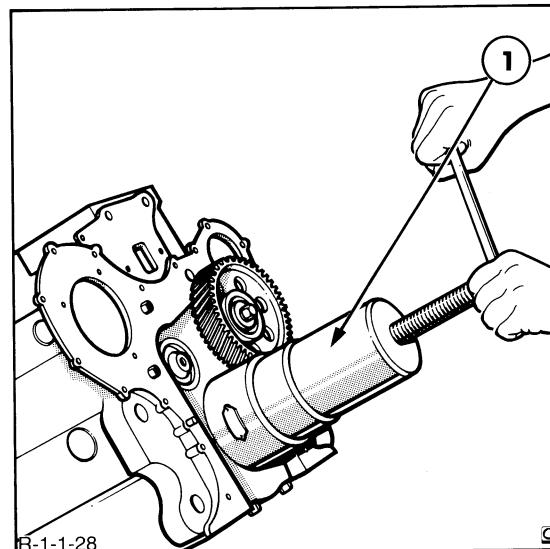


Figure 28
Crankshaft Gear Removal

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

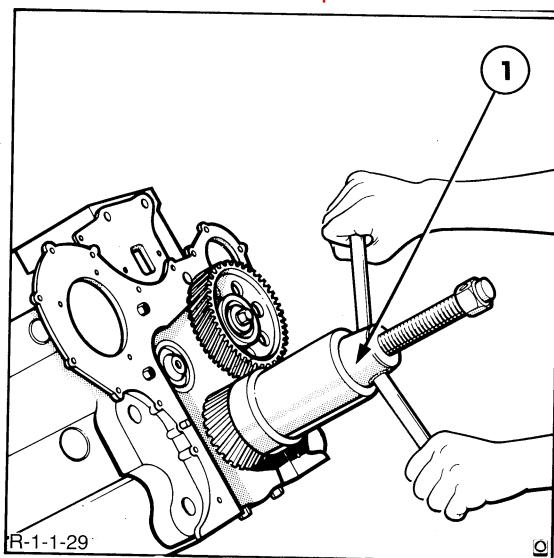


Figure 29
Crankshaft Gear Installation

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 29.

INSPECTION AND REPAIR

1. Wash the gears and adapter in a suitable solvent and dry with a clean lint free cloth or compressed air.
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.
3. Ensure the camshaft drive gear adapter oil passage is free from obstruction and the drive gear bushing is not damaged.
4. 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.
5. Tighten the bolt to the specified torque and re-check the backlash between the gears, see "Specifications" – Chapter 3.
6. 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 30.

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