

Please cut where indicated and insert the label into the plastic pocket on the spine of the binder.



**D SERIES TLB
TRACTOR
SERVICE**

**455D, 555D, 575D,
655D, 675D**

**Vol. 1
40045541**



**D SERIES TLB
TRACTOR
SERVICE**

**455D, 555D, 575D,
655D, 675D**

**Vol. 2
40045541**



D SERIES BACKHOE LOADER REPAIR MANUAL CONTENTS

SECTION 1 -- ENGINE

SECTION 2 -- FUEL SYSTEMS

SECTION 3 -- ELECTRICAL SYSTEM

SECTION 4 -- TRANSMISSION

SECTION 5 -- REAR AXLE AND BRAKES

SECTION 6 -- POWER TAKE-OFF

SECTION 7 -- STEERING AND FRONT AXLE

SECTION 8 -- HYDRAULIC SYSTEM, CONTROLS AND FRAME

SECTION 9 -- CAB

SECTION 10 -- SEPARATING THE TRACTOR

SECTION 11 -- ACCESSORIES

INTRODUCTION

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 Service Manual provides general directions for accomplishing service and repair work with tested, effective techniques. Following them will help insure 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.

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.

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 tractor as it is.

PRODUCTION DATE CODES AND UNIT SERIAL NUMBERS

FIGURE 0-1

Vehicle Identification Plate

FIGURE 0-3

Cab Identification Plate

FIGURE 0-2

Four Wheel Drive Front Axle Identification Plate

FIGURE 0-4

Backhoe Identification Plate

The vehicle identification plate, Figure 0-1, 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 optional Four-Wheel Drive front axle, Figure 0-2, is located on the rear right-hand side of the front axle casing.

The Cab/ROPS identification plate, Figure 0-3, is located on the right-hand 'B' pillar of the cab/ROPS frame.

The identification plate for the backhoe assembly, Figure 0-4, is attached to the rear left-hand side of the main frame on the sideshift models, or attached to the side frame under the left-hand rear fender on center pivot models.

Whenever repairing the tractor, the serial number information should be noted and used when referring to Service Bulletins or ordering parts.

PRECAUTIONARY STATEMENTS

PERSONAL SAFETY

Throughout this manual and on machine decals, you will find precautionary statements (“CAUTION”, “WARNING”, and “DANGER”) followed by specific instructions. These precautions are intended for the personal safety of you and those working with you. Please take the time to read them.



CAUTION: THE WORD “CAUTION” IS USED WHERE A SAFE BEHAVIORAL PRACTICE ACCORDING TO OPERATING AND MAINTENANCE INSTRUCTIONS AND COMMON SAFETY PRACTICES WILL PROTECT THE OPERATOR AND OTHERS FROM ACCIDENT INVOLVEMENT.



WARNING: THE WORD “WARNING” DENOTES A POTENTIAL OR HIDDEN HAZARD WHICH HAS A POTENTIAL FOR SERIOUS INJURY. IT IS USED TO WARN OPERATORS AND OTHERS TO EXERCISE EVERY APPROPRIATE MEANS TO AVOID A SURPRISE INVOLVEMENT WITH MACHINERY.



DANGER: THE WORD “DANGER” DENOTES A FORBIDDEN PRACTICE IN CONNECTION WITH A SERIOUS HAZARD.

FAILURE TO FOLLOW THE “CAUTION”, “WARNING”, AND “DANGER” INSTRUCTIONS MAY RESULT IN SERIOUS BODILY INJURY OR DEATH.

MACHINE SAFETY

Additional precautionary statements (“ATTENTION” and “IMPORTANT”) are followed by specific instructions. These statements are intended for machine safety.

ATTENTION: The word “ATTENTION” is used to warn the operator of potential machine damage if a certain procedure is not followed.

IMPORTANT: The word “IMPORTANT” is used to inform the reader of something he needs to know to prevent minor machine damage if a certain procedure is not followed.

SAFETY PRECAUTIONS

Practically all service work involves the need to drive the tractor. The operator's manual, supplied with each tractor, contains detailed safety precautions relating to driving, operating and servicing the 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 reassembly 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

Clothing

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 many cause loss of vision. Wear eye protection when engaged in chiseling, grinding, discing, welding, and painting.

Breathing Protection

Fumes, dust and paint spray are unpleasant and harmful. Wear respiratory protection.

Hearing Protection

Loud noise may damage your hearing, and the greater the exposure the worse the damage. 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 mineral spirit and paraffin may harm the skin.

Foot Protection

Wear protective footwear with reinforced toe-caps to protect your feet from falling objects. Additionally oil-resistant soles will help to avoid slipping.

EQUIPMENT CONSIDERATIONS

Machine Shields

Before using any machine, check to be sure that the machine shields are in position and serviceable. These shields not only prevent parts of the body or clothing from coming into 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 be sure 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 safe if used correctly. Any misuse may cause injury.

Never use compressed air to blow dust or dirt away from your work area unless the correct type of nozzle is used.

Compressed air is not a cleaning agent; it will only move dust and dirt 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 worn jaws.

Spanners or files as hammers; or drills, clevis pins, or bolts as punches.

Use a copper or brass drift, rather than a hammer, for removing or replacing hardened pins.

For dismantling, overhaul and reassembly of major and sub-components, always use the Special Service Tools recommended. These will reduce the work effort, labor 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 be sure that the cable is not worn or frayed and that the plugs and sockets are intact. Make sure you know where the nearest disconnect switch is located for your equipment.

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, and can cause skin irritation. Check to be sure

that solvents 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 realized. Everyone must be constantly on guard.

- Extinguish matches, cigars, and cigarettes 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 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, and fine dusts all settle upon the skin and clothing. 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 bypass 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.

If it is necessary to raise the tractor for ease of servicing or repair, be sure that safe and stable supports are installed, beneath axle housings, casings, etc., before beginning.

Use footsteps or working platforms when servicing those areas of a tractor that are not within easy reach.

Prior to pressure testing, be sure that 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 or engage the safety locks before leaving the tractor.

If high lift attachments are mounted to a unit, beware of overhead power, electric or telephone cables when traveling. Keep the attachment near to ground level to increase stability.

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 tires 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 tires, beware of over inflation - constantly check the pressure. Over inflation can cause tires to burst and result in personal injury.

Safety precautions are usually the result of a 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.

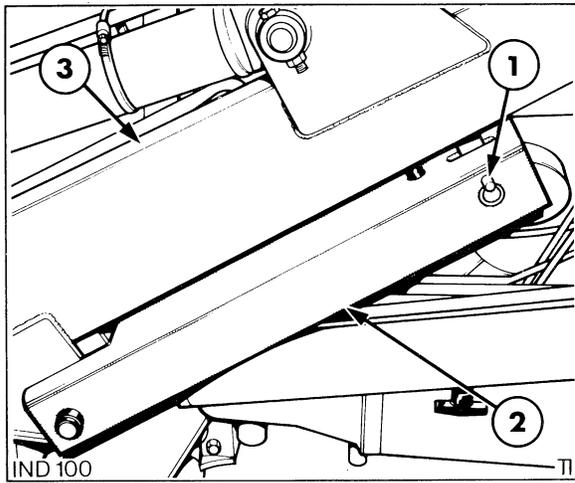


FIGURE 0-5

Loader Arm Support Stored

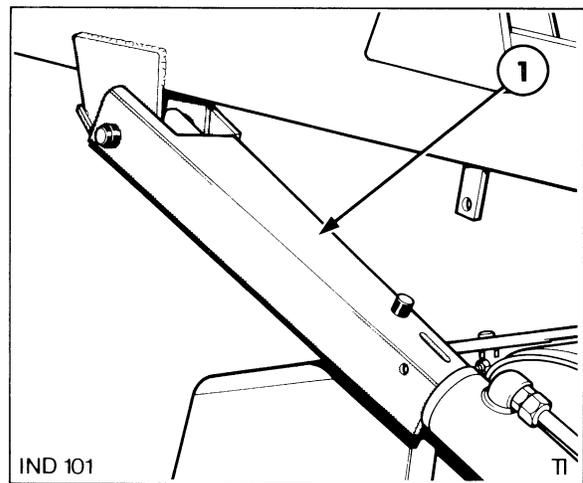


FIGURE 0-6

Loader Arm Support Installed

LOADER ARM SUPPORT

The Ford D-Series tractors 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 pin and hairpin cotter pin (1), Figure 0-5.



WARNING: TO AVOID PERSONAL INJURY, NEVER WORK BENEATH OR AROUND AN UNSUPPORTED LOADER. ALWAYS INSTALL THE LOADER ARM SUPPORT.

To install the support, raise the loader to full height, then remove 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 0-6. Do not apply down pressure on the loader lift cylinders.

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.



WARNING: TO AVOID SERIOUS INJURY WHILE SERVICING THE UNIT, ALWAYS BE SURE THAT 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.

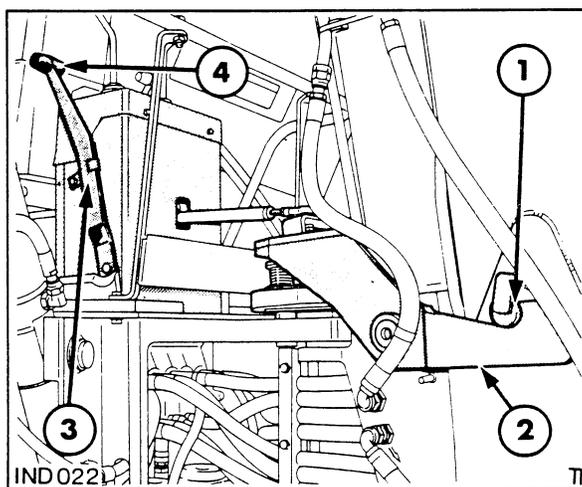


FIGURE 0-7

Boom/Swing Transport Lock

- 1 Boom latch pin
- 2 Boom latch
- 3 Lever latch
- 4 Lever

BACKHOE SAFETY LOCK

The D-Series backhoes use a safety lock to secure the backhoe boom in a fully raised and centered position.

Engage the lock whenever servicing the tractor with the backhoe raised off the ground.

To engage the lock, raise and center the boom, move the lever (4) toward the operator until the boom latch (2) engages the boom latch pin (1), move lever into the lever latch (3), Figure 0-7.



WARNING: NEVER WORK UNDER THE BACKHOE WITHOUT THE BACKHOE SAFETY LOCK SECURELY ENGAGED.

SECTION 1

ENGINE

3-CYLINDER DIESEL ENGINE

DESCRIPTION AND OPERATION

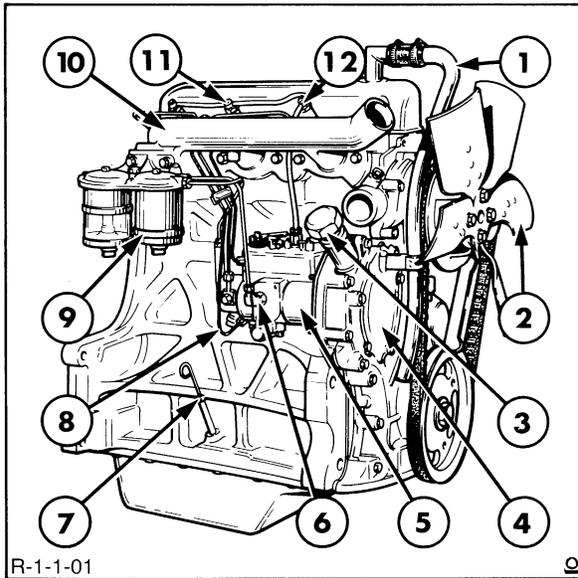


FIGURE 1-1

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

- 1 Ventilation tube
- 2 Fan
- 3 Oil filler cap
- 4 Timing cover
- 5 Injection pump
- 6 Low pressure fuel inlet
- 7 Oil level indicator
- 8 High pressure fuel pipe
- 9 Fuel filters
- 10 Inlet manifold
- 11 Rocker cover
- 12 Injector

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

The engine, Figure 1-1, 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 two compression and one oil control ring all located above the piston ring.

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

GENERAL SPECIFICATIONS

		Ford Model 455D
No. of Cylinders		3
Displacement:	in ³ cm ³	201 3294
Bore:	in mm	4.4 111.8
Stroke:	in mm	4.4 111.8 1
Compression Ratio		16.3:1
Firing Order		1-2-3
Rated Engine Speed (rev/min)		2200
Idle Speed (rev/min)		600-850
Maximum No Load Speed (rev/min)		2350-2400

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. The fuel 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

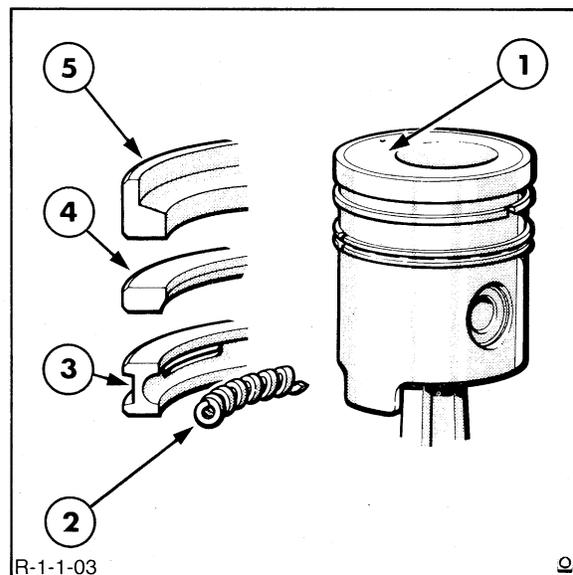


FIGURE 1-2

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

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.

Pistons

Pistons are an aluminum alloy with combustion chambers recessed into the piston crowns. The engine utilizes an 3-ring headland piston, Figure 1-2. 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 headland ring which eliminates the dead volume which normally exists between the headland 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 head distribution in the head, and less heat transfer to the intake manifold. All tractors use vertical exhaust systems.

The intake manifolds are connected through tubing to the air cleaner. The intake manifold is provided with a tapped hole for installation of a thermostart or the optional 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.

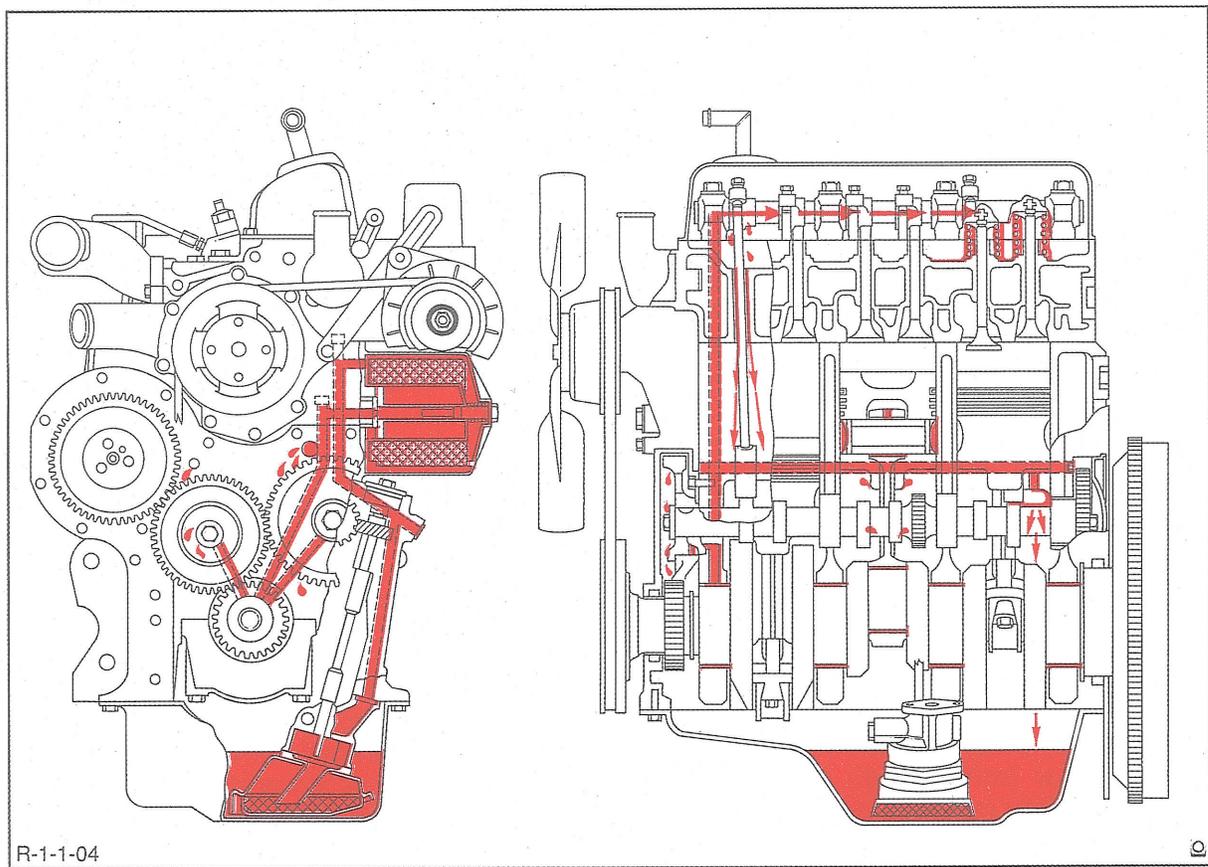
Cylinder Block Assembly

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 to 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 to the drive shaft. All the timing gears can be checked by observing the timing punch marks on the gears.



Lubrication Oil

FIGURE 1-3

3-Cylinder Engine Lubrication System

LUBRICATION SYSTEM

Figure 1-3

Lubrication of the engine is maintained by a rotary 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 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.

SECTION 1 - ENGINE

The main gallery also supplies oil to the crankshaft main bearing 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.

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.

ENGINE OIL CAPACITIES (Less Oil Filter)	U.S. qts.	Liters
455D	6	5.65

ENGINE OIL CAPACITIES (With Oil Filter)	U.S. qts.	Liters
455D	7	6.6

OVERHAUL

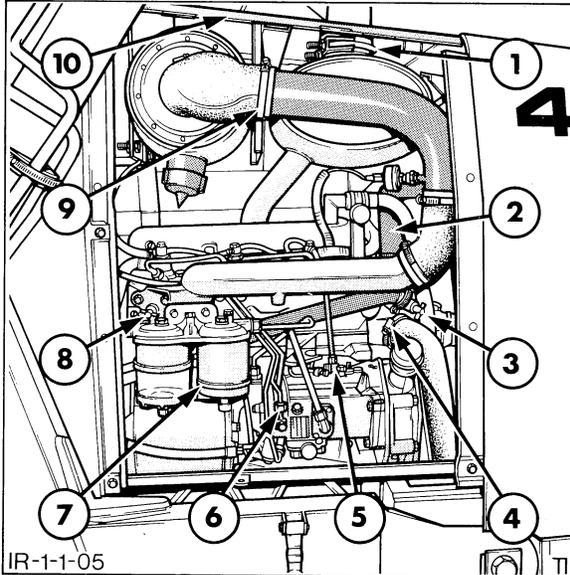


FIGURE 1-4

Engine Installation Right-Hand

- 1 Muffler pipe
- 2 Top radiator hose
- 3 Front heater tap
- 4 Bottom radiator hose
- 5 Fuel return pipe
- 6 High pressure pipe
- 7 Fuel filters
- 8 Rear heater tap
- 9 Air cleaner tube and pipe
- 10 Top hood panel

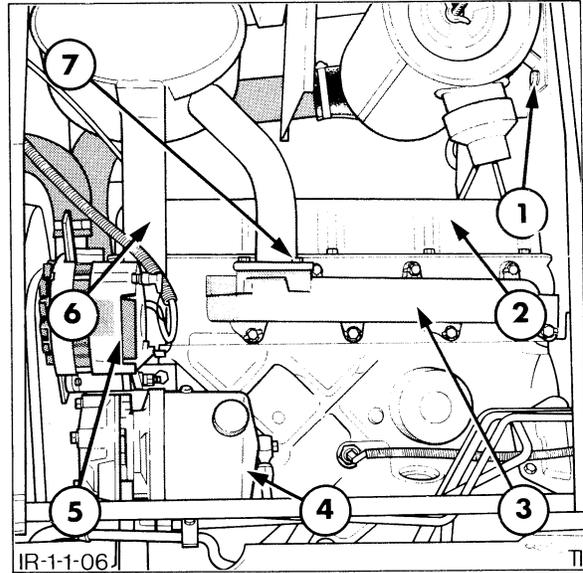


FIGURE 1-5

Engine Installation Left-Hand

- 1 Air cleaner retaining bolts
- 2 Rocker cover
- 3 Exhaust manifold
- 4 Steering pump
- 5 Alternator
- 6 Exhaust muffler bracket
- 7 Exhaust muffler pipe

CYLINDER HEAD, VALVES AND RELATED PARTS

Figures 1-4 and 1-5

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.
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.
11. Shut off the fuel tank tap, then disconnect the low pressure fuel lines, 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.
14. Disconnect and remove the rocker cover ventilation tube.
15. Disconnect the optional cold start equipment 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.
17. Remove the front engine harness and secure with tape clear of the engine.
18. Remove the alternator.
19. Bend back the lock tabs, withdraw the attaching bolts and remove the exhaust manifold and gasket.
20. Remove the air cleaner assembly.
21. Remove the retaining bolts and lock washers and remove the intake manifold and gasket.
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 remove the fuel injectors and washers, Figure 1-6.
23. Withdraw the securing bolts and remove the rocker cover and gasket from the cylinder head.
24. Check the push rods for straightness by rotating the rods with the valve closed and identify any bent rods.
25. Loosen the rocker shaft retaining bolts, which also serve as cylinder head bolts, evenly and alternately. Remove the rocker shaft assembly.

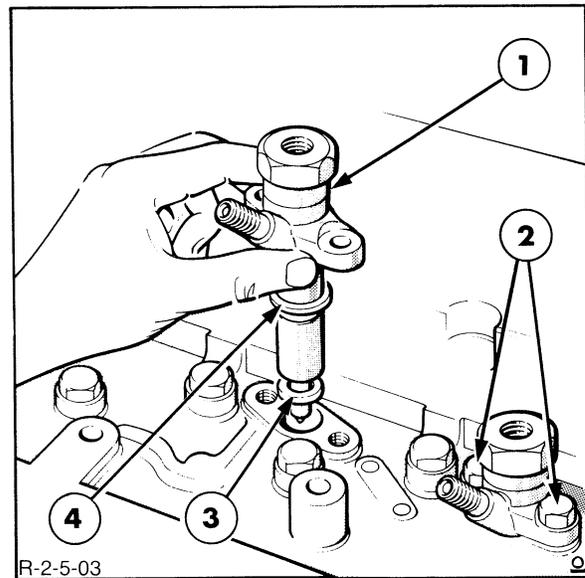


FIGURE 1-6

Fuel Injector Removal

- 1 Fuel injector assembly
- 2 Fuel injector mounting bolts
- 3 Copper washer
- 4 Cork washer

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

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.
27. Remove the remaining cylinder head bolts and washers working inward from the ends to the center of the head.
28. Lift the cylinder head from the block. If necessary, pry the head off on the pads provided, taking care not to damage the cylinder head or block faces.

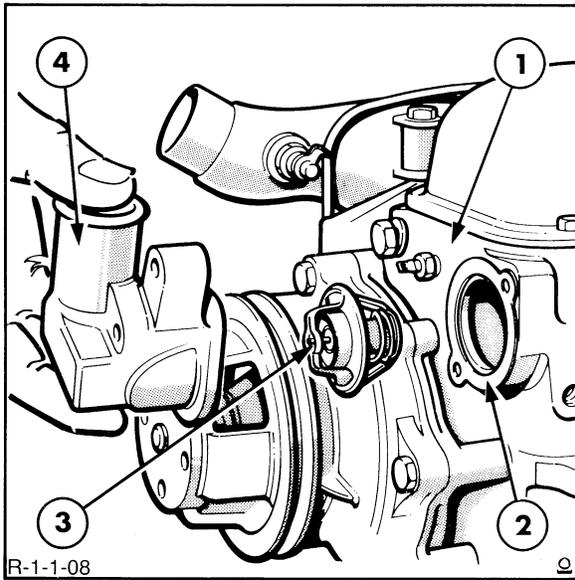


FIGURE 1-7

Coolant Outlet and Thermostat Removal

- 1 Cylinder head
- 2 Gasket
- 3 Thermostat
- 4 Coolant outlet connection

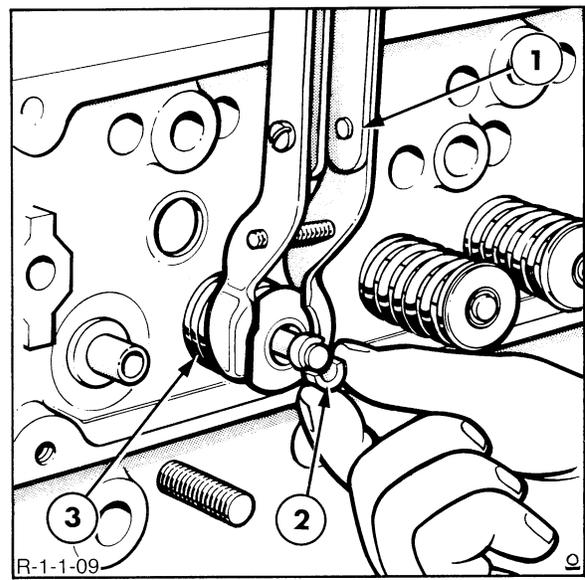


FIGURE 1-8

Valve Removal

- 1 Valve spring compressor
- 2 Retainer locks
- 3 Valve spring

DISASSEMBLY**Thermostat**

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

Cylinder Head

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

2. Using a valve spring compressor, Figure 1-8, remove the retainer locks, spring retainers/rotators, springs and seals from each valve, Figure 1- 9.

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

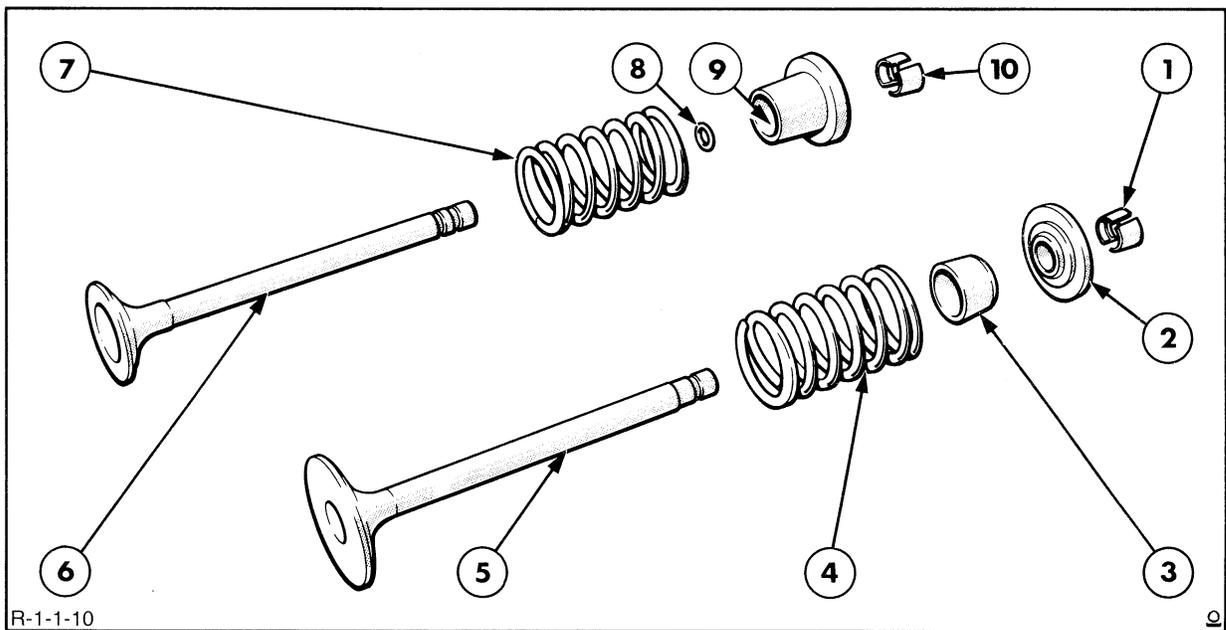


FIGURE 1-9

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

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

Rocker Shaft Disassembled

- 1 Spring
- 2 Shaft Support
- 3 Retaining bolt
- 4 Rocker arm
- 5 Shaft
- 6 Spacer

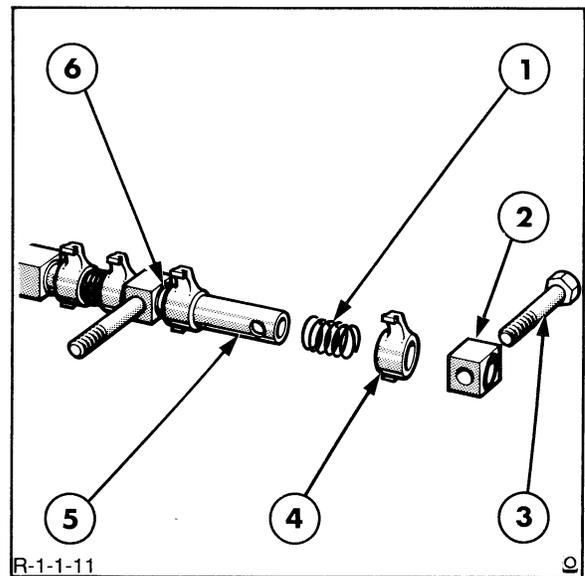


FIGURE 1-10

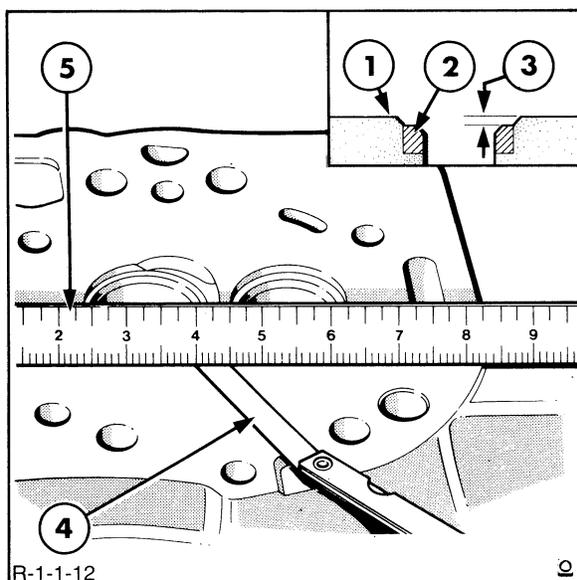


FIGURE 1-11

Measuring Cylinder Head Flatness

- 1 Cylinder head face
- 2 Valve seat insert
- 3 Minimum depth
- 4 Feeler gauge
- 5 Straight edge

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: Be sure that the injector washers have been removed from the injector bores prior to cleaning.

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

3. Use a straightedge and feeler gauges to check the flatness of the cylinder head in all directions, Figure 1-11. It should be flat within 0.003" (0.08 mm) in any 6" measurement and flat within 0.006" (0.15 mm) in any total measurement span.

NOTE: If the cylinder head exceeds the flatness specification, it may be machined providing the depth from the lower face of the valve insert to the cylinder head face is not less than 0.064" (1.63 mm), see the inset of Figure 1-11.

Valve Guide Bore Diameter

0.3728"-0.3735" (9.469 mm - 9.487 mm)

Head to Block Surface Flatness

0.003" (0.08 mm) in any 6" (152 mm) or 0.006" (0.15 mm) overall limit.

4. If the head has been machined, 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 the bolts finger tight and be sure that the rocker shaft supports use 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" (0.25 mm) or larger feeler gauge can be inserted under the bolt head, then the bolts are bottoming; the cylinder block thread must be increased in depth. Use a 9/16 x 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 replace if loose or damaged. If necessary, install an oversized insert by

machining the seat counterbore in the cylinder head, see the chart below. The insert must be chilled in dry-ice prior to installation.

	Exhaust Valve Insert	Intake Valve Seat Insert
Insert Oversize	Counterbore Diameter in Cylinder Head	Counterbore Diameter in Cylinder Head
0.010" (0.254 mm)	1.607" - 1.608" (40.82 mm - 40.84 mm)	1.907" - 1.908" (43.44 mm - 43.46 mm)
0.020" (0.508 mm)	1.617" - 1.618" (41.07 mm - 41.10 mm)	1.917" - 1.918" (43.69 mm - 43.72 mm)
0.030" (0.762 mm)	1.627" - 1.628" (41.33 mm - 41.36 mm)	1.927" - 1.928" (32.95 mm - 43.97 mm)

NOTE: Valve seat inserts of 0.010" (0.25 mm) and 0.020" (0.5 mm) oversize on diameter are sometimes installed in cylinder heads in production. Heads with oversize inserts are stamped ^{S010}OS or ^{S020}OS on the exhaust manifold side in line with the valve seat concerned.

2. When replacing exhaust valve seat inserts, be sure that the replacement inserts are of the correct type as the size and material specification varies for different engine types.
3. Check the width of the valve seat inserts and, if necessary, reface by grinding to the dimensions shown in Figure 1-12.

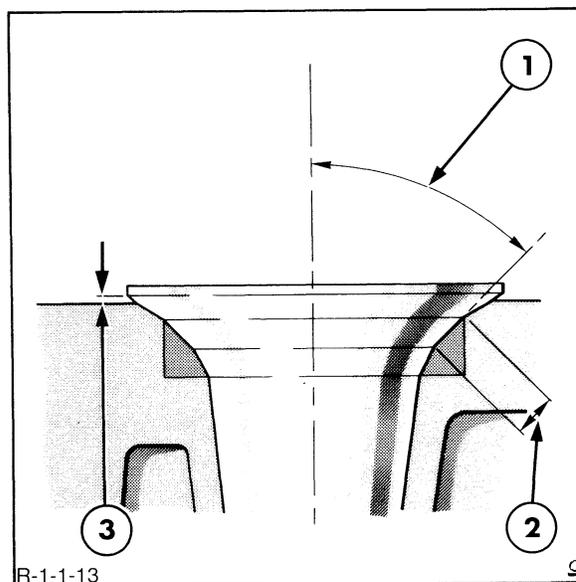


FIGURE 1-12

Valve Seat Dimensions

- 1 Valve seat angle:
45.0° - 45.3° 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

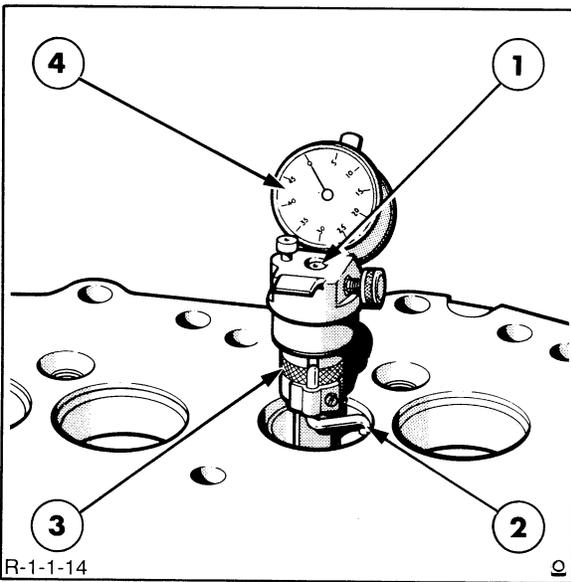


FIGURE 1-13

Checking Valve Seat Concentricity

- 1 Gauge pilot
- 2 Pointer to ride on valve seat face
- 3 Sleeve to rotating pointer
- 4 Dial gauge

4. Measure the concentricity of the valve seat with a suitable gauge, as shown in Figure 1-13. If the valve seat runout exceeds the specified figure below, reface the seat.
5. Using a seat cutter with the correct angle (refer to Figure 1-12), 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.

VALVE SEATS

Exhaust Valve Seat Angle	45.0° - 45.3°
Intake Valve Seat Angle	45.0° - 30.3°
Interference Angle Valve Face to Valve Seat	.3° - 1.15°
Seat Runout	0.0015" (0.038 mm) Total Indicator Reading Max.
Seat Width	
Exhaust	0.084" - 0.106" (2.13 mm - 2.69 mm)
Intake	0.080" - 0.102" (2.03 mm - 2.59 mm)

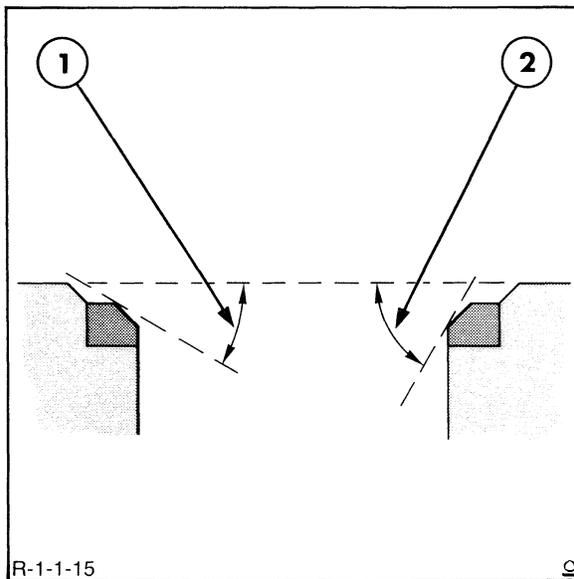


FIGURE 1-14

Raising/Lowering Valve Seats

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

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. See Figure 1-14.

NOTE: Refacing of the valve seat should always be coordinated 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 1-12, 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 1-14. Raise the seat by removing stock from the bottom of the seat with a 60° grinding wheel.

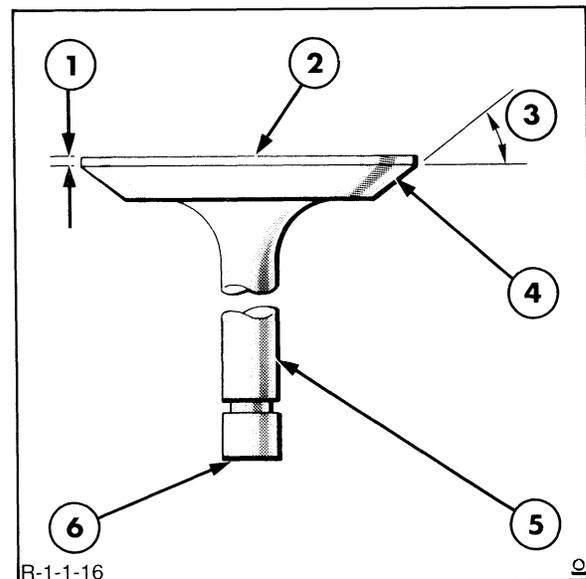


FIGURE 1-15

Critical Valve Measurements and Inspection Checks

- 1 Valve head edge
- 2 Valve head
- 3 Valve face angle (45.5°)
- 4 Valve face
- 5 Valve stem
- 6 Valve tip

Valves

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

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 below, 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" (0.25 mm) from the tip.

Valve Guides

1. Using a telescopic gauge and micrometer, measure the valve to guide clearance, Figure 1-16. If the clearance exceeds the specified limits, ream the valve guide to fit the next oversize valve.

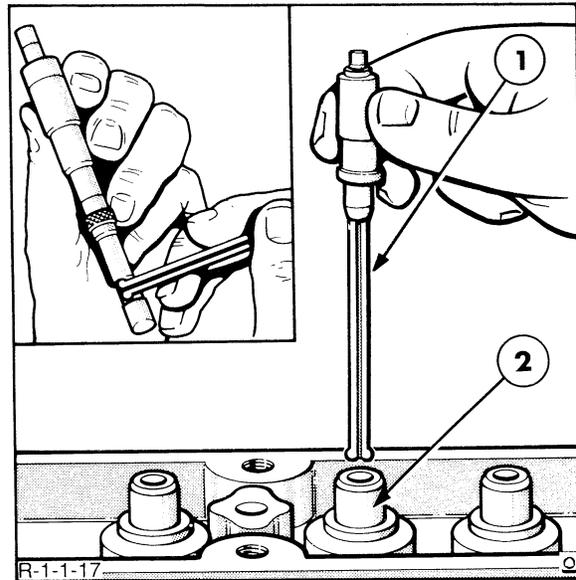


FIGURE 1-16

Measuring Valve Guide

- 1 Telescopic gauge
- 2 Valve guide

EXHAUST VALVES - 455D

Face Angle	44.15° - 44.30° Relative to Head of Valve
Stem Diameter	Std: 0.3701" - 0.3708" (9.401 mm - 9.418 mm) 0.003" (0.076 mm) Oversize: 0.3731" - 0.3738" (9.477 mm - 9.495 mm) 0.015" (0.38 mm) Oversize: 0.3851" - 0.3858" (9.781 mm - 9.799 mm) 0.030" (0.76 mm) Oversize: 0.4001" - 0.4008" (10.163 mm - 10.180 mm)
Head Diameter	1.495" - 1.505" (37.97 mm - 38.23 mm)
Stem-to-Guide Clearance	0.0020" - 0.0037" (0.051 mm - 0.094 mm)
Lash Clearance (Cold)	0.017" - 0.021" (0.43 mm - 0.53 mm)

INTAKE VALVES - 455D

Face Angle	44.15° - 44.30° Relative to Head of Valve
Stem Diameter	Std: 0.3711" - 0.3718" (9.426 mm - 9.444 mm) 0.003" (0.076 mm) Oversize: 0.3741" - 0.3748" (9.502 mm - 9.520 mm) 0.015" (0.381 mm) Oversize: 0.3861" - 0.3868" (9.807 mm - 9.825 mm) 0.030" (0.762 mm) Oversize: 0.4011" - 0.4018" (10.188 mm - 10.206 mm)
Head Diameter	1.800" - 1.810" (45.72 mm - 45.97 mm)
Stem-to-Guide Clearance	0.0010" - 0.0027" (0.025 mm - 0.069 mm)
Lash Clearance (Cold)	0.014" - 0.018" (0.36 mm - 0.46 mm)

NOTE: Production cylinder heads may have one or more 0.015" (0.38 mm) oversize valve guides and valves installed. Such cylinder heads have 15 or V_{OS}^{015} stamped on the exhaust manifold side of the head opposite the valve(s) concerned.

- 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" (0.076 mm) Oversize Reamer and Standard Diameter Pilot

0.015" (0.38 mm) Oversize Reamer and 0.003" (0.076 mm) Oversize Pilot

0.030" (0.76 mm) Oversize Reamer and 0.015" (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.

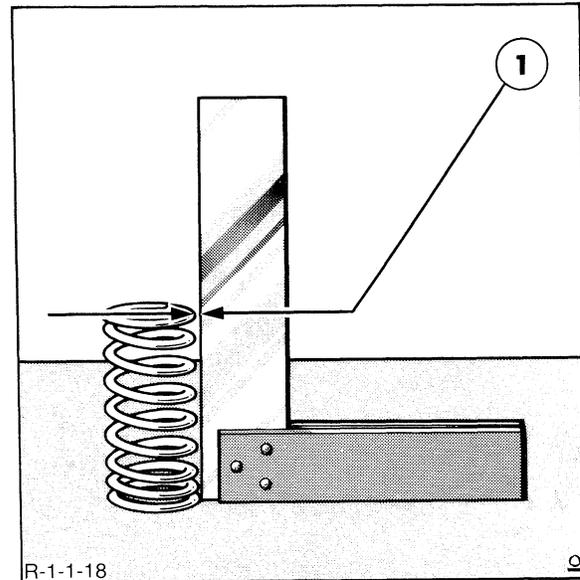


FIGURE 1-17

Checking Valve spring Squareness

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

Valve Springs

- Replace worn or damaged valve springs. Check for squareness and reject if out-of-squareness exceeds 0.06" (1.52 mm), Figure 1-17. Check the free length and loaded length of each valve spring as shown below. Be sure that the valve spring retainer locks are in good condition.

VALVE SPRINGS

Number per Valve	1
Free Length	2.15" (54.6 mm)
Load at 1.74" Length (44.20 mm)	61 lbs. - 69 lbs. (27.7 kg - 31.3 kg)
Load at 1.32" Length (33.53 mm)	125 lbs. - 139 lbs. (57.8 kg - 63.1 kg)

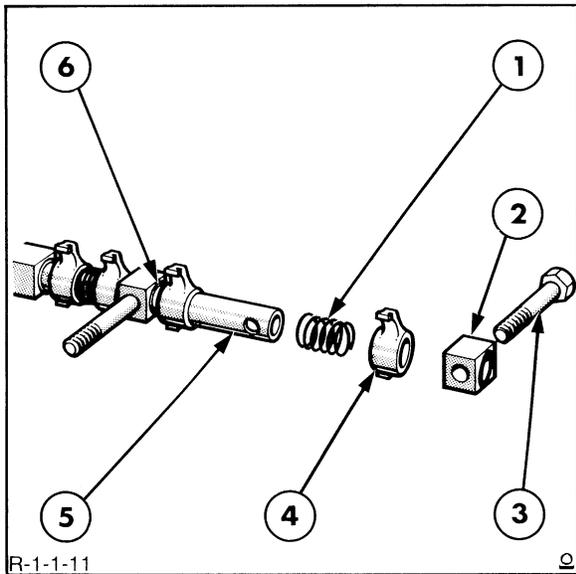


FIGURE 1-18

Rocker Shaft Components

- | | |
|------------------|--------------|
| 1 Spring | 4 Rocker arm |
| 2 Shaft support | 5 Shaft |
| 3 Retaining bolt | 6 Spacer |

Rocker Shaft Assembly**Figure 1-18**

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

Thermostat

For inspection and repair of the coolant outlet or thermostat, see the "Cooling System" section of this manual.

REASSEMBLY**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

Install the thermostat (spring end towards the head), coolant outlet and a new gasket, torquing the mounting bolts to 18 ft. lbs. (24 N·m).

ROCKER ARM SHAFT

Shaft Diameter	1.000" - 1.001" (25.40 mm - 25.43 mm)
Support Diameter (Internal diameter)	1.002" - 1.004" (25.45 mm - 25.20 mm)

ROCKER ARM

Inside Diameter	1.003" - 1.004" (25.48 mm - 25.50 mm)
-----------------	---------------------------------------

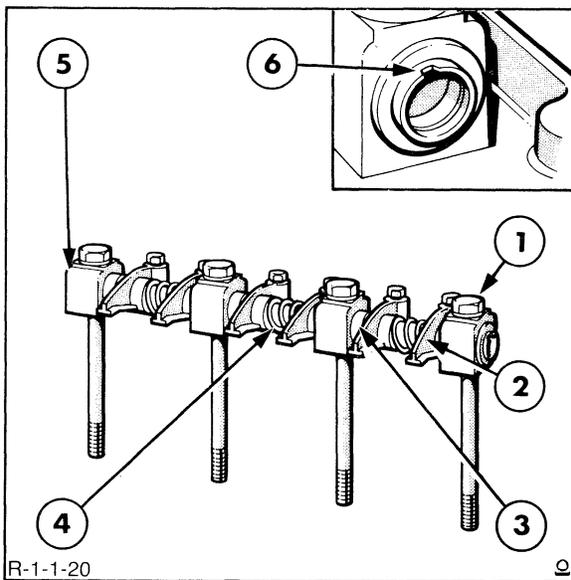


FIGURE 1-19

Rocker Arm Shaft Assembly

- 1 Bolt
- 2 Rocker arm
- 3 Spacer
- 4 Spring
- 5 Rocker arm shaft support
- 6 Groove at front of shaft

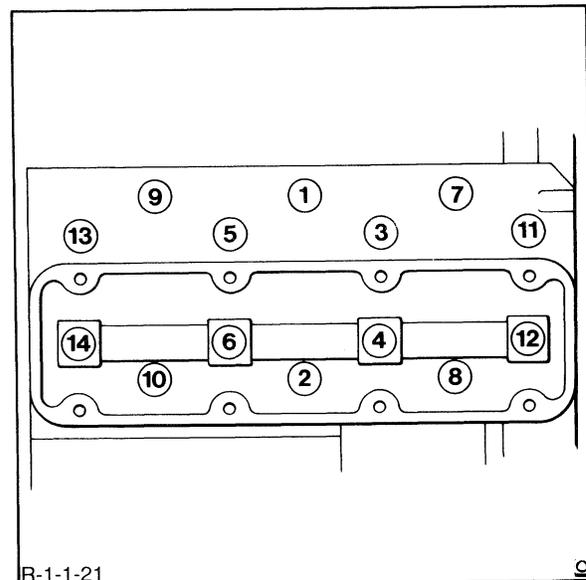


FIGURE 1-20

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. Be sure 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 1-19, 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.
4. Be sure that the springs and spacers are in their correct position, as shown in Figure 1-19, 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.
- Tighten the cylinder head retaining bolts in the sequence shown in Figure 1-20 and progressively in three steps as follows:
 1. Torque to 115 ft. lbs. (156 N·m)
 2. Torque to 140 ft. lbs. (190 N·m)
 3. Torque to 160 ft. lbs. (217 N·m)

Do NOT oil the bolts before installation.

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

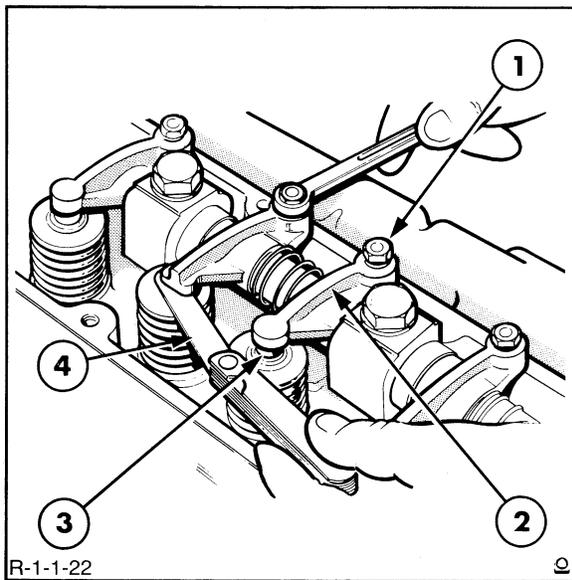


FIGURE 1-21

Setting Valve Lash

- 1 Adjuster screw
- 2 Rocker arm
- 3 Valve stem
- 4 Feeler gauge

- Rotate the engine and set the valve lash, Figure 1-21, as follows:

Intake

0.014" - 0.018" (0.36 mm - 0.46 mm)

Exhaust

0.017" - 0.021" (0.43 mm - 53 mm)

- Install the injectors with new seat washers and cork seals, Figure 1-22, torquing the mounting bolts to 17 ft. lbs. (23 N·m).
- Install the injector lines and leak-off pipe with new washers, torquing the line nuts to 18 ft. lbs. (24 N·m).

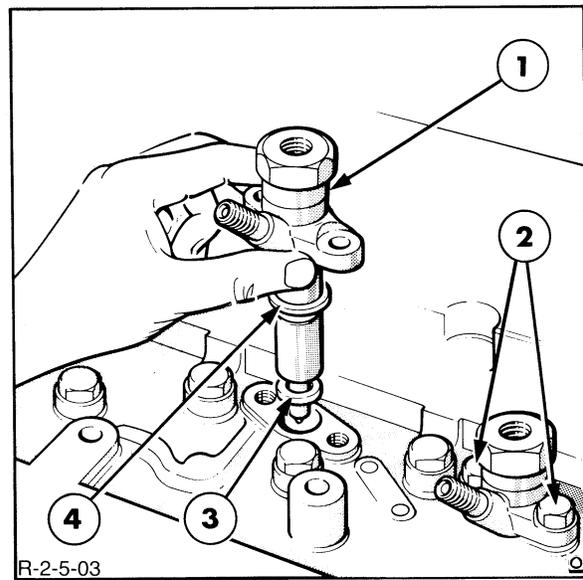


FIGURE 1-22

Fuel Injector Installation

- 1 Fuel injector assembly
- 2 Fuel injector mounting bolts
- 3 Cooper washer
- 4 Cork washer

NOTE: Hold the leak-off plastic tube securely to prevent pivoting when tightening the banjo fitting bolts to 8 ft. lbs. (11 N·m).

- Use new lock tabs for the exhaust manifold retaining bolts and bend the tabs to lock, after torquing the bolts to 28 ft. lbs. (35 N·m).
- Tighten all nuts and bolts to the specified torques. See "Specifications" at the end of this section of the manual.
- Operate the engine and check for fluid leaks.
- Install the intake manifold torquing its mounting bolts to 26 ft. lbs. (35 N·m).

VALVE TIMING - 455D

Intake Opening	14° Before Top Dead Center
Intake Closing	38° After Bottom Dead Center
Exhaust Opening	41° Before Bottom Dead Center
Exhaust Closing	11° After Top Dead Center

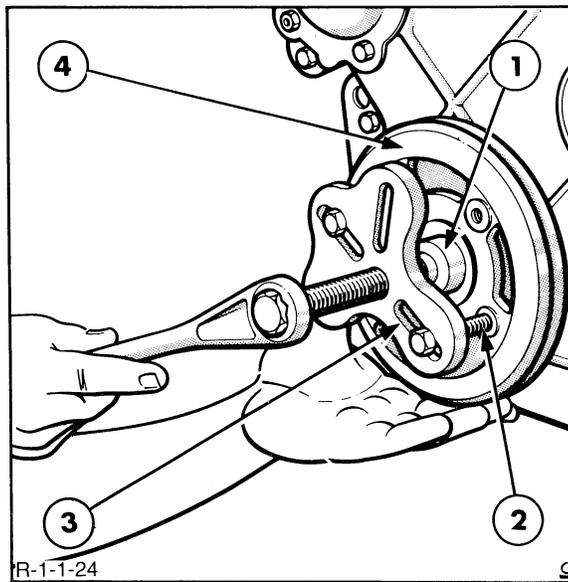


FIGURE 1-23

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

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 Section 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 center of the crankshaft pulley.
3. Using Puller No. 518 or 9539 and Shaft Protector No. 625-A or 9212, remove the crankshaft pulley, Figure 1-23.
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. Remove 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. Remove the retaining bolts, then remove the front cover and gasket. Remove the oil slinger.

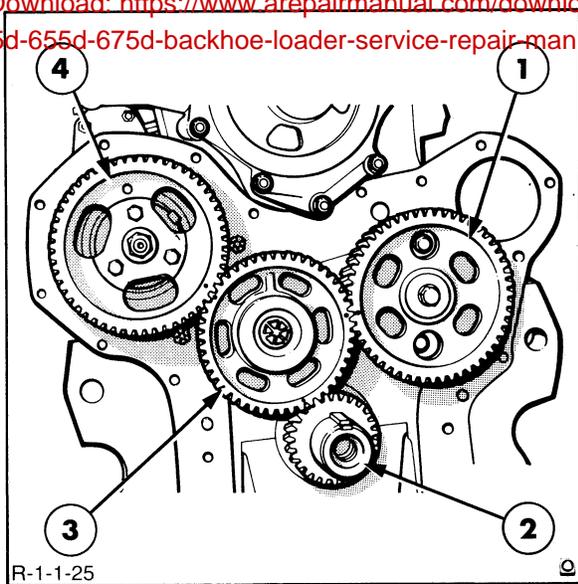


FIGURE 1-24

Timing Gears

- 1 Camshaft gear
- 2 Crankshaft gear
- 3 Camshaft drive gear
- 4 Injection pump drive gear

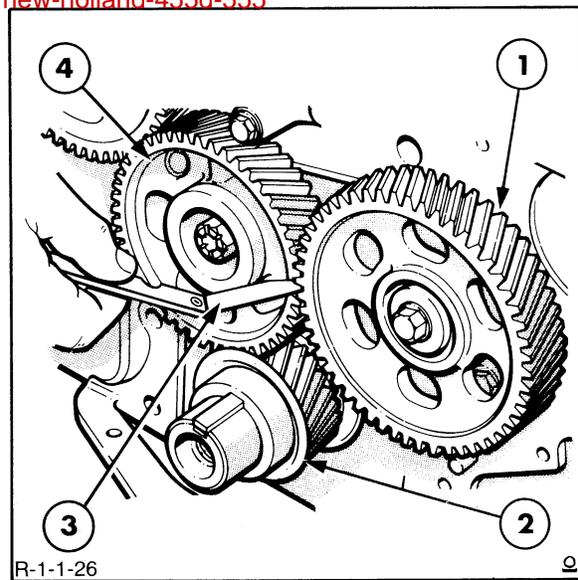


FIGURE 1-25

Measuring Timing Gear Backlash

- 1 Camshaft gear
- 2 Oil slinger (reference only)
- 3 Feeler gauge
- 4 Camshaft drive gear

8. Before removing the timing gears, Figure 1-24, use a dial indicator or feeler gauges to measure the backlash between each set of mating gears, Figure 1-25. Rotate

the gears and check the backlash at four equidistant points on the gears. Replace the gears if the backlash exceeds the specified limits shown below.

CAMSHAFT DRIVE GEAR	
Number of Teeth	47
End Play	0.001" - 0.011" (0.025 mm - 0.28 mm)
Bushing Inside Diameter	2.005" - 2.0015" (50.813 mm - 50.838 mm)
Adaptor Outside Diameter	1.9985" - 1.9990" (50.762 mm - 50.775 mm)
Backlash with Crankshaft Gear	0.001" - 0.009" (0.025 mm - 0.23 mm)
Backlash with Camshaft Gear	0.001" - 0.009" (0.025 mm - 0.23 mm)
Backlash with Fuel Injection Pump Drive	0.001" - 0.012" (0.025 mm - 0.30 mm)
CAMSHAFT GEAR	
Number of Teeth	52
Timing Gear Backlash	0.003" - 0.008" (0.08 mm - 0.20 mm)