FOREWORD

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

There are numerous variations in procedures, techniques, tools, and parts for servicing equipment, as well as in the skill of the individual doing the work. This manual cannot possibly anticipate all such variations and provide advice or cautions as to each. Accordingly, anyone who departs from the instructions provided in this Manual must first establish that he does not compromise his own personal safety nor the safety of others by his choice of methods or tools.

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

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

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

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

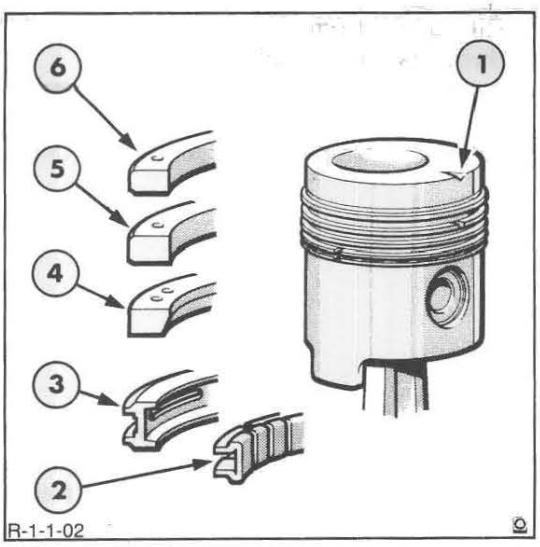


Figure 2
Conventional Piston and Rings

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

Pistons

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

Connecting Rods

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

Manifolds

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

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

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

Cylinder Block Assembly

The cylinder block is alloy cast iron with heavy webbing and deep cylinder skirts. The block features full length water jackets for cooling the cylinders, which are bored integral with the block. Cylinders are in-line and vertical, and numbered from 1 to 3, front to rear.

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

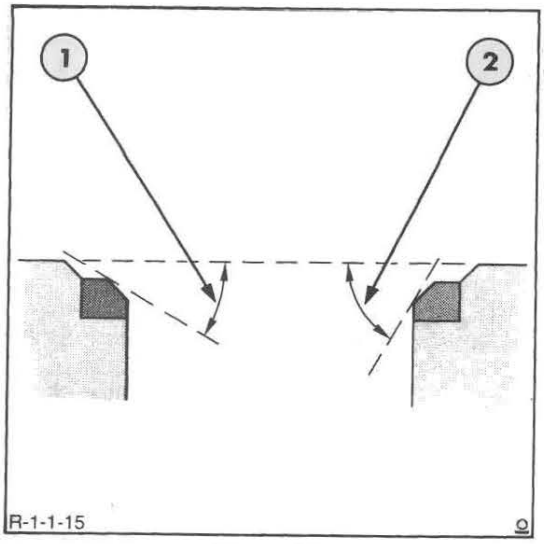


Figure 14
Raising/Lowering Valve Seats

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

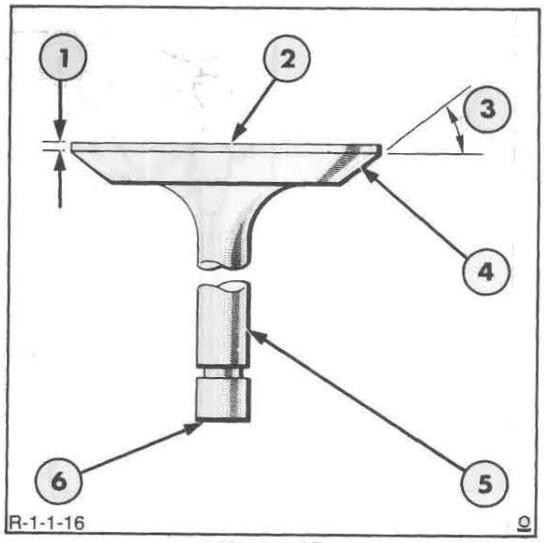


Figure 15
Critical Valve Measurements and Inspection Checks

1. Valve Head Edge
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 16. Inspect the valve face and the edge of the valve head for pits, grooves, scores, or other defects. Inspect the stem for a bent condition and the end of the stem for grooves or scores. Check the valve head for cracks, erosion, warpage, or burn. Minor defects such as small pits or grooves, can be removed. Check the valve tip for pits or grooves and replace the valve if such a condition exists. Discard valves that are severely damaged.

2. Check for bent stems and correct diameter.

3. Check maximum valve face eccentricity.

4. Any valve refacing operation should be closely coordinated with the valve seat refacing operation so that the finished angle of the valve is 0,5° less than the valve seat to provide an interference angle for better seating. Adjust the valve refacing tool to obtain a face angle of 45,5°, Figure 15.

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

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

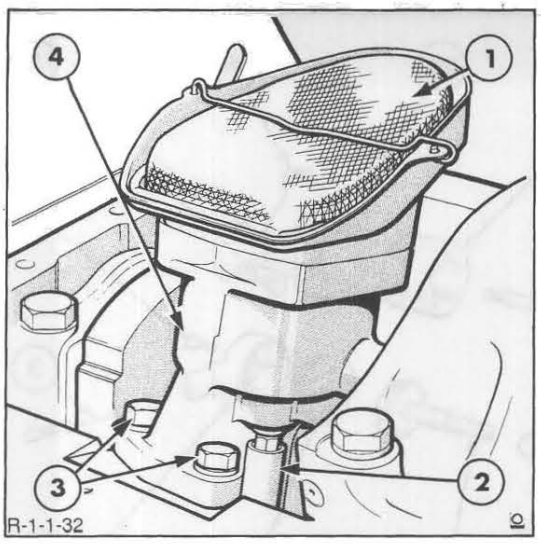


Figure 31
Oil Pump and Filter Screen

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

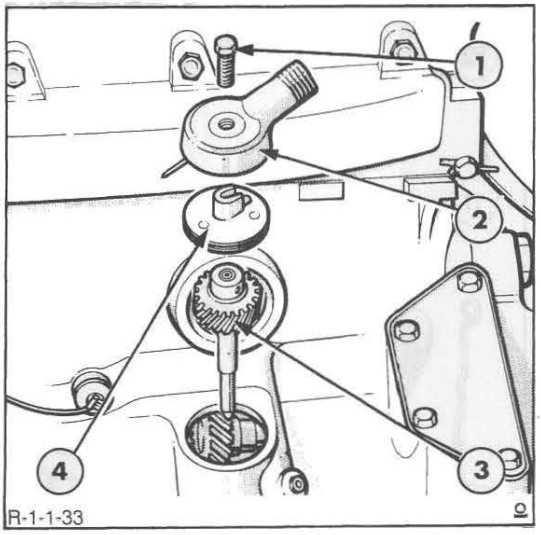


Figure 32
Oil Pump Drive Gear Removal

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

OIL PUMP

REMOVAL

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

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

3. Disconnect the proofmeter drive cable from the driveshaft adapter, where fitted, and remove the engine oil filter.

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

DISASSEMBLY

With reference to Figure 33.

1. Remove the spring clip and detach the pump screen.

2. Withdraw the retaining screw and washer assemblies then separate the inner and outer covers from the body and extract the rotor and shaft assembly.

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

The service ring set comprises:

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

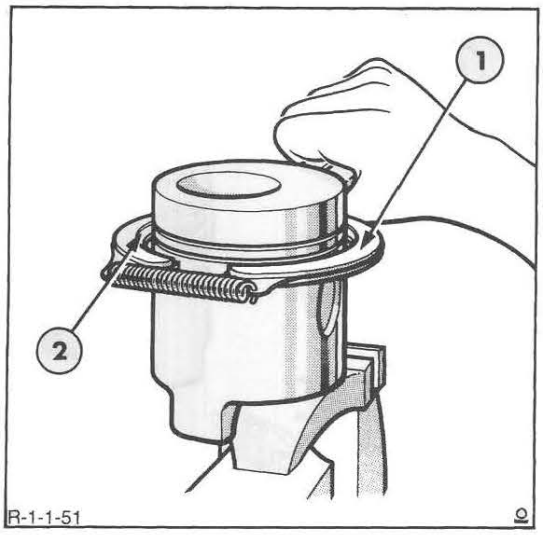


Figure 49
Piston Ring Installation

1. Piston Ring Expander
2. Piston Ring

Oil Control Ring

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

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

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

3rd Compression Ring

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

2nd Compression Ring

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

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

Top Compression Ring

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

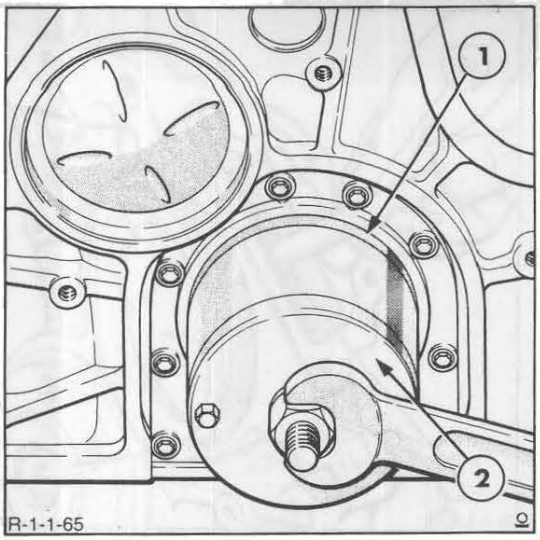


Figure 62
Crankshaft Oil Seal Installation

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

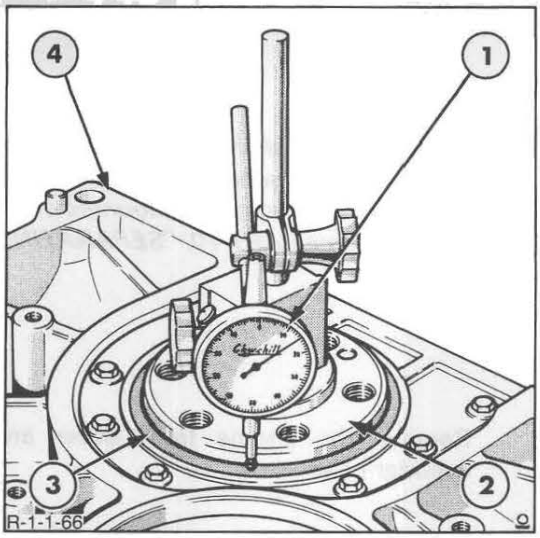


Figure 63
Checking Rear Main Bearing Crankshaft Oil Seal Run-Out

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

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

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

(vii) Remove the tool

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

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

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

INSTALLATION

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

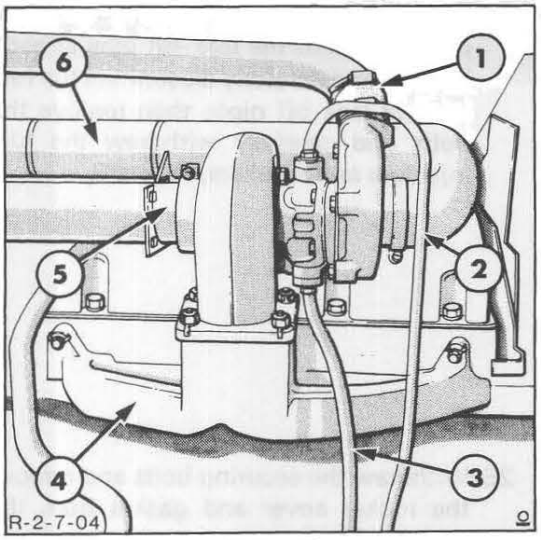


Figure 5
Turbocharger Installed

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

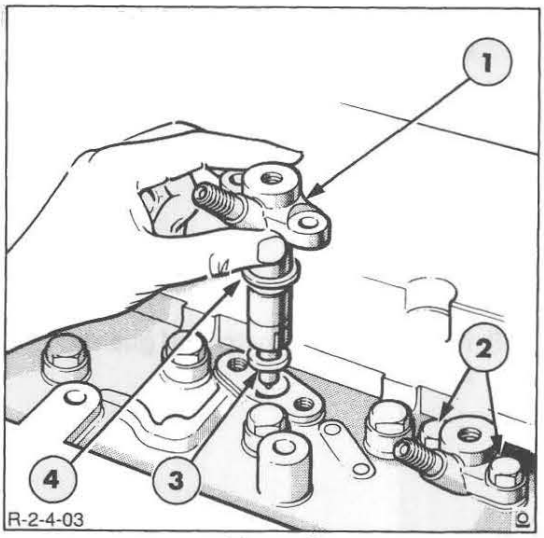


Figure 6
Fuel Injector Removal

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

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

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

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

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

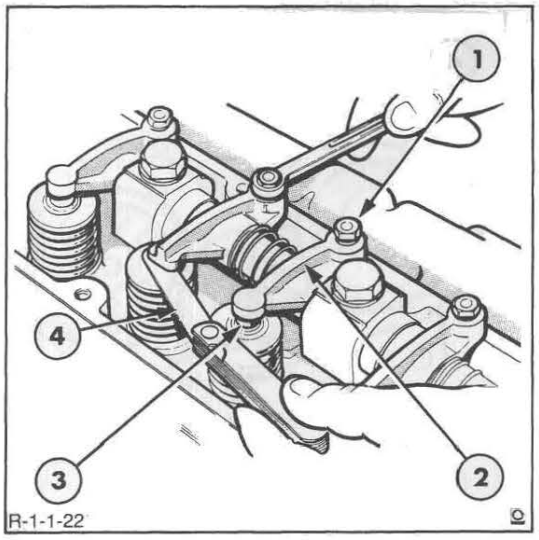


Figure 21
Setting Valve Lash

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

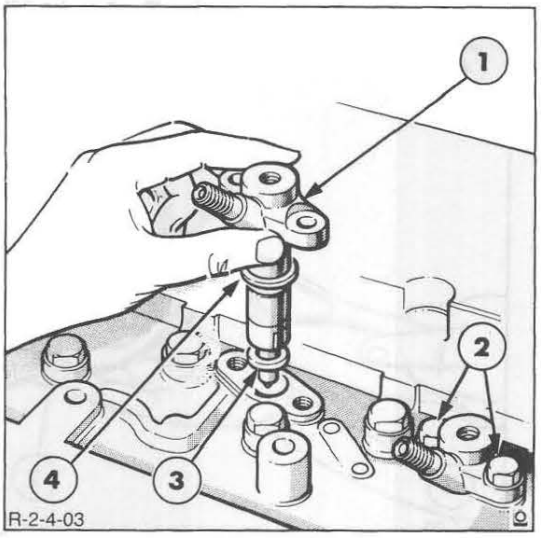


Figure 22
Fuel Injector Installation

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

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

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

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

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

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

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

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

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

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

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

- Operate the engine and check for fluid leaks.

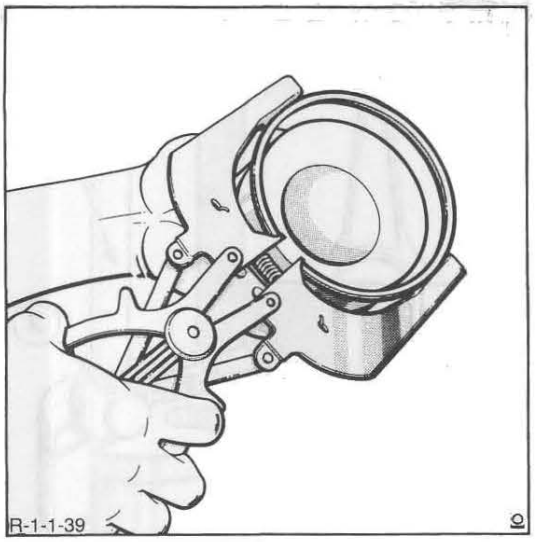


Figure 38
Piston Ring Removal

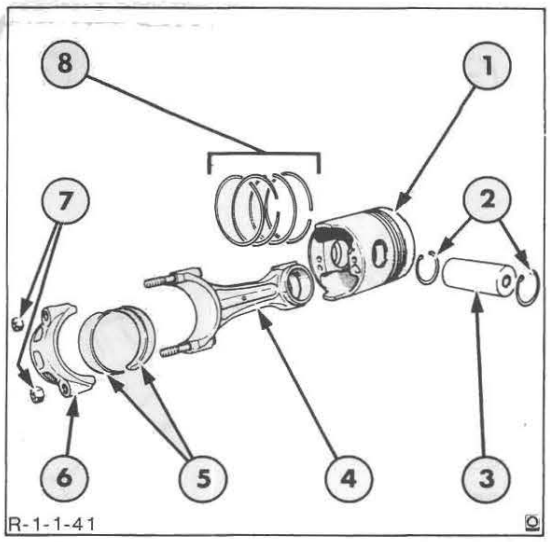


Figure 39
Piston and Connecting Rod Disassembled

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

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

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

4. Turn the crankshaft to bring each piston to the bottom of its stroke and repeat this procedure. Keep the bearing caps and liners with their respective connecting rods.

DISASSEMBLY

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

2. Use an expander to remove the piston rings, Figure 38.

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

INSPECTION AND REPAIR

1. Wash the piston and connecting rod assembly in a suitable solvent and dry with a clean lint free cloth or compressed air.

2. Inspect the piston ring lands, skirts and pin bosses for damage.

3. Clean the ring grooves and using a new ring and feeler gauge check the piston ring lands for wear, Figure 40. For maximum ring clearance see "Specifications" – Chapter 4.

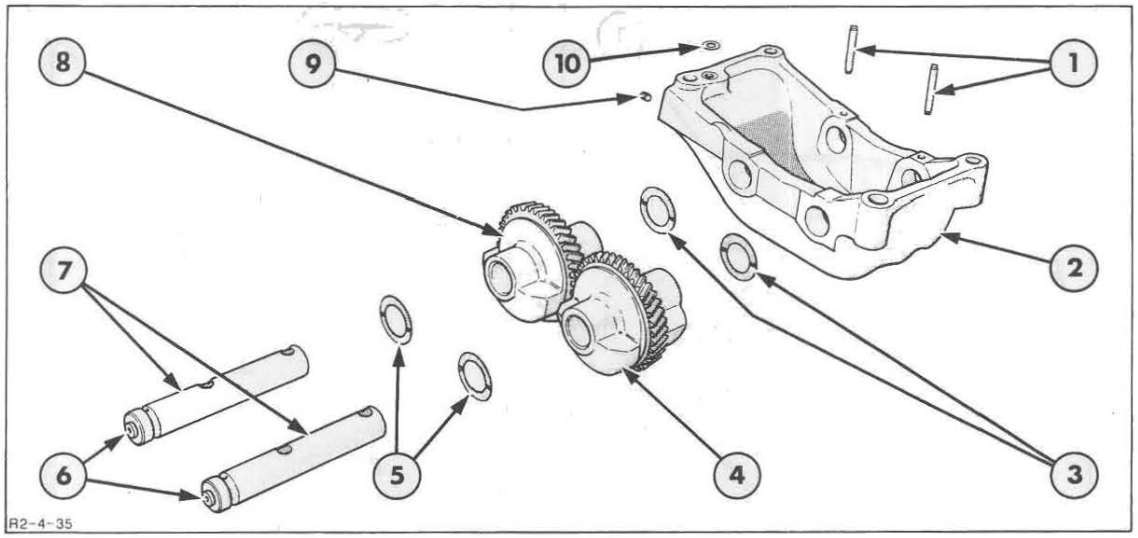


Figure 54
Dynamic Balancer Components

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

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

   Rock the free gear to measure the backlash.

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

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

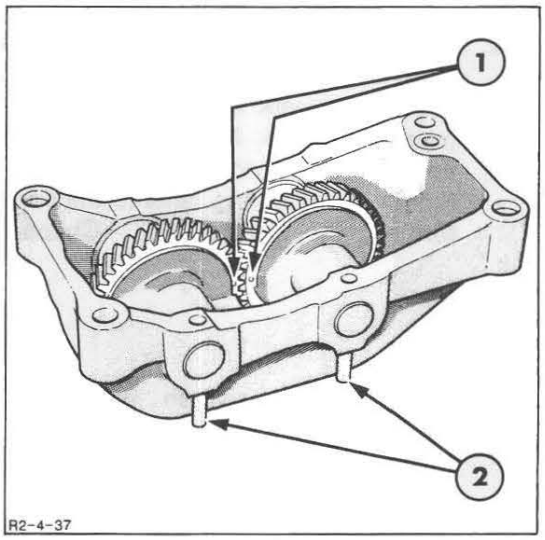


Figure 55
Balancer Gear Assembly

1. Balancer Gear Timing Marks
2. Roll Pins

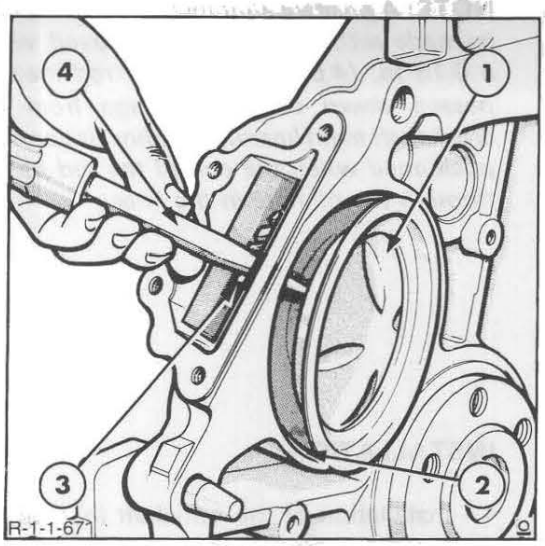


Figure 68
Camshaft Rear Cover Plate Removal

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

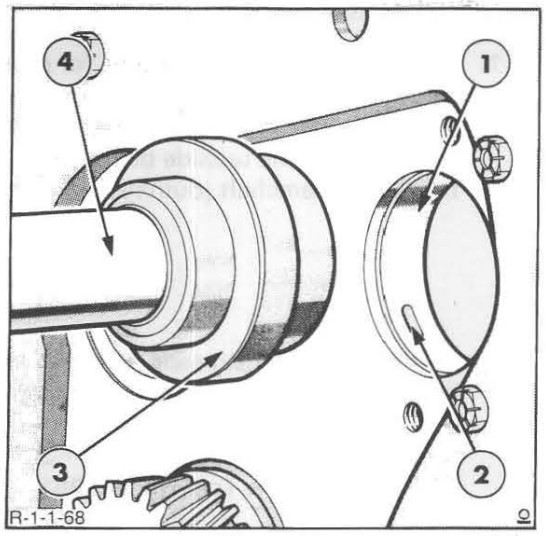


Figure 69
Camshaft Bearing Removal and Installation

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

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

7. For engines without a gear on the rear end of the camshaft, the camshaft can be withdrawn from the front of the engine. If the camshaft is equipped with a gear, the flywheel and rear cover plate must be removed and the camshaft rear cover driven out with a punch, Figure 68. Remove the key and spacer from the front of the camshaft and carefully withdraw the camshaft from the rear of the engine.

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

INSPECTION AND REPAIR

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

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

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

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

7. Install a new gasket and assemble the front and rear halves of the pump together and tighten the bolts to the specified torque, see 'Specifications' – Chapter 4.

8. Install the fan on the pulley and tighten the bolts to the specified torque, see 'Specifications' – Chapter 4.

INSTALLATION

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

   - Install a new pump gasket.
   - Adjust the alternator drive belt tension, see PART 3, 'Electrical Systems'.
   - After installation of the radiator, fill the cooling system and run the engine to check for leaks.

ROCKER ARM SHAFT

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

ROCKER ARM

Inside Diameter	1.003–1.004 in (25.48 – 25.50 mm)

TAPPETS

Clearance to Bore	0.0006–0.0021 in (0.015–0.053 mm)
Tappet Diameter	0.9889–0.9894 in (25.118–25.130 mm)
Tappet Bore Diameter	0.9900–0.9910 in (25.15–25.17 mm)

CAMSHAFT

Bearing Journal Diameter	2.3895–2.3905 in (60.696–60.719 mm)
Bearing Clearance	0.0010–0.0030 in (0.025–0.076 mm)
End Play	0.0010–0.0070 in (0.025–0.18 mm)

CONNECTING RODS

Small End Bushing (Internal Diameter)	
Normally Aspirated	1.5003–1.5006 in (38.108–38.115 mm)
Turbocharged	1.6253–1.6256 in (41.283–41.290 mm)
Clearance Bushing-to-Piston-Pin	0.0005–0.0007 in (0.013–0.018 mm)
Side Float	0.0070–0.0130 in (0.18–0.33 mm)
Maximum Twist	0.0120 in (0.30 mm)
Maximum Bend	0.0040 in (0.10 mm)

PISTON PIN

Outside Diameter Normally Aspirated Engine	1.4997–1.5000 in (38.092–38.100 mm)
Turbocharged Engine	1.6247–1. 6250 in (41.267–41.275 mm)

PART 2
FUEL SYSTEMS

Chapter 1
FUEL SYSTEM – GENERAL

Chapter 2
FUEL INJECTION PUMP – DPA DISTRIBUTOR TYPE

Chapter 3
FUEL INJECTION PUMP – DPS DISTRIBUTOR TYPE

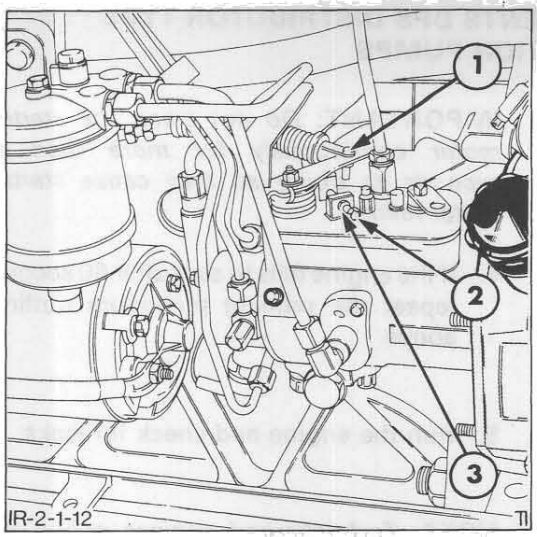


Figure 12
Injection Pump Adjustment Screws

1. Throttle Cable Connection
2. Idle Speed Adjustment Screw
3. Idle Speed Adjustment Screw Locknut

IDLE SPEED ADJUSTMENT

1. With the engine running and at normal operating temperature, disconnect the throttle linkage at the injection pump, Figure 12.

2. Loosen the locknut and adjust the idle speed stop screw until the specified idle speed is obtained, see "Specifications" – Chapter 8, and reconnect the throttle linkage.

3. Operate the throttle several times and check that the idle speed obtained corresponds with the reading in step 2.

MAXIMUM NO-LOAD SPEED ADJUSTMENT

IMPORTANT: *The maximum no-load speed screw is adjusted and sealed at the factor for correct fuel delivery and maximum no-load speed. If the maximum no-load speed is above or below the specified range, see "Specifications" – Chapter 8, then adjustment may be made as follows:-*

1. With the engine running and at normal operating temperature, disconnect the throttle linkage at the fuel injection pump, Figure 12.

2. Cut and remove the maximum no-load speed stop screw sealing wire and remove the locking sleeve.

3. Set the throttle lever at the injection pump to the maximum no-load speed position then loosen the locknut and adjust the screw until the specified maximum no-load speed is obtained. Tighten the locknut to the specified torque, see "Specifications" – Chapter 8, and secure the adjustment with a new sealing wire and locking sleeve.

4. Ensure the throttle linkage can be reconnected to the injection pump and adjust the linkage length, if necessary.

5. Reconnect the throttle linkage and re-check the maximum no-load and idle speeds can be obtained using the hand and foot throttles.

The throttle linkage adjustment procedure for the Ford 455C models follows the same procedure described for the Ford 555C and 655C models in Section C of this Chapter.

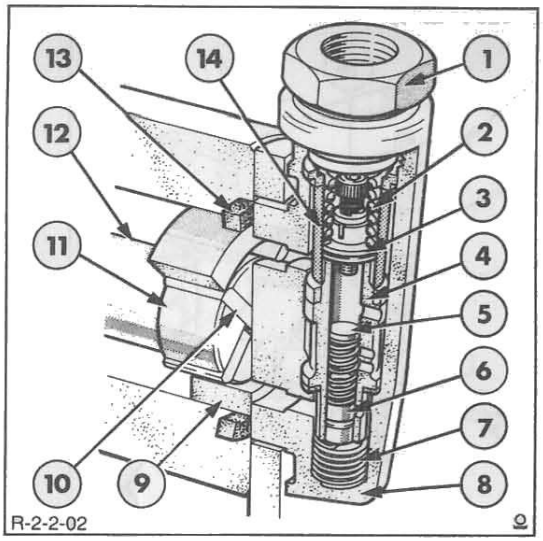


Figure 2
Cut-Away of Regulating Valve and Transfer Pump Assembly

1. Fuel Inlet Connection
2. Regulating Spring
3. Transfer Pressure Adjuster
4. Regulating Sleeve
5. Peg and Spring
6. Regulating Piston
7. Priming Spring
8. End Plate
9. Eccentric Liner
10. Blades
11. Transfer Pump Rotor
12. Distributor Rotor
13. Rubber Sealing Ring
14. Filter

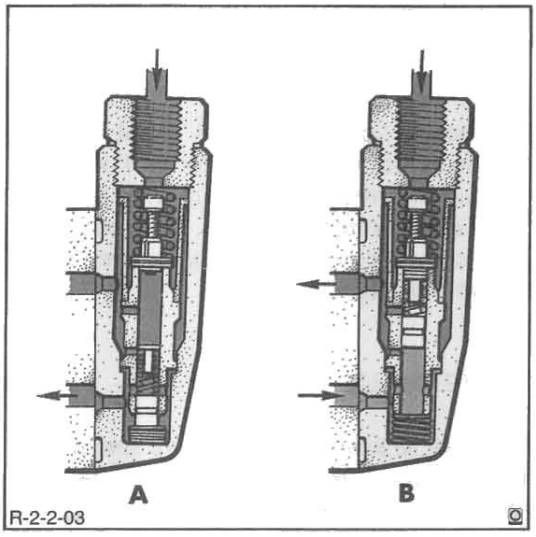


Figure 3
Operation of Regulating Valve

Feed Pressure
Transfer Pressure
A Priming
B Regulating

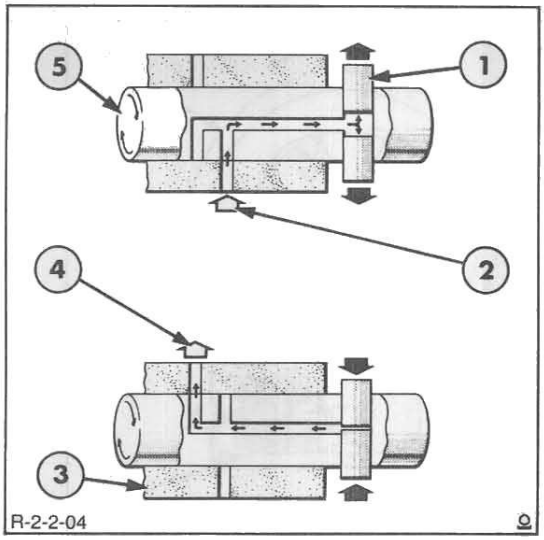


Figure 4
Distributing Head Operation

1. Pump Plungers
2. Fuel Inlet Port
3. Hydraulic Head
4. Fuel Outlet Port
5. Rotor

The maximum fuel setting is controlled by limiting the outward travel of the plungers and this is effected by two pump rotor adjusting plates. These plates have eccentric slots into which engage the lugs on the pump plunger roller shoes. Rotation of the plates controls the travel of the plungers and thus the maximum fuel injected.

An advance device, Figure 5 is provided to automatically advance injection pump timing with increased engine speed. This is effected by fuel at transfer pressure acting on the face of the advance piston so moving the piston and cam ring against the resistance of the advance springs. As transfer pressure increases with engine speed an increasing movement of the cam ring is effected up to a fully advanced position just before maximum engine speed.

The fuel injection pump contains a mechanical governor which controls the metering valve allowing a constant engine speed to be maintained regardless of engine loading.

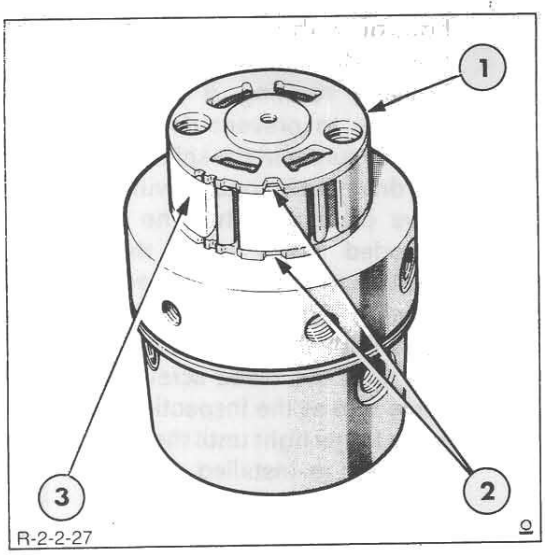


Figure 27
Top Adjusting Plate Positioned on Rotor

1. Top Adjusting Plate
2. Fuel Adjustment Slots
3. Rotor

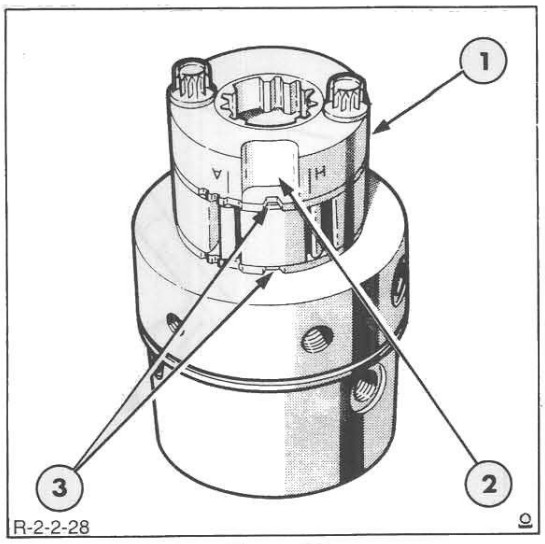


Figure 28
Drive Plate Positioned on Rotor

1. Drive Plate
2. Cut-out
3. Fuel Adjustment Slots

(iv) Install the top adjusting plate, into position, Figure 27. The holes are offset and correct assembly of the adjusting plate is possible only when the fuel adjustment slots are in line with the corresponding fuel adjustment slots on the bottom adjusting plate, Figure 27.

(v) Slide the roller into the hydraulic head and finger tighten the transfer pump rotor.

(vi) Install the drive plate, Figure 28, and tighten the securing screws to:

Direct torque 28 Nm (250 lbf in.)
Indirect torque 20 Nm (180 lbf in.)

NOTE: *Indirect torque is applied when using a torque wrench, setting adaptor 7144-482, and spanner 7144-511A with a 5.0 in (127.0 mm) setting distance.*

Slacken the screws off and retighten to the torque setting first used.

8. Tighten the transfer pump rotor to the specified torque, see 'Specifications' – Chapter 8.

9. Connect tool No. 7144-262 to the fuel outlet specified in the Test Plan, Chapter 8, connecting directly into the pump body. Connect the other end of the tool to an injector testing machine. Operate the injector testing machine until fuel flows from the pressure relief valve on tool No. 7144-262 indicating that the correct pressure is being produced at the pump rotor. Turn the pump rotor until the plungers and rollers are forced to their maximum fuel position.

TEST MACHINE SPECIFICATION

Test Injectors

Two different types of test injector will be required for testing fuel injection pumps fitted to the Ford Tractor range.

1. Injectors fitted with the ISO 4010 delay pintle type nozzle, principally for high speed, indirect injection engine applications, are required for testing in-line pumps.

2. Injectors fitted with orifice plates (ISO 7440*), principally for direct injection engine applications, are required for testing distributor pumps.

   Use only the nozzle type specified in the individual Test Plan, together with the appropriate nozzle holder.
   "Pending ISO confirmation

Test injectors are available from Leslie Hartridge Limited, Tingewick Road, Buckingham, MK18 1EF, England, in sets of 4, 6, 8 or 12. The appropriate part number is dependent on the test nozzle required and the test machine type.

These injectors are essential for accurate pump calibration and are manufactured to a standard which will ensure minimum line to line scatter, consistent results between sets and accurate maximum fuel setting. ENSURE THAT TEST NOZZLE TYPE AND OPENING PRESSURE ARE AS SPECIFIED IN THE INDIVIDUAL TEST PLAN, e.g. delay pintle type ISO 4010 at 172-0+3 bar opening pressure (identified by ISO 4010 marked on their shank).

The use of the ISO nozzle means that test injectors can be serviced in the workshop by changing the nozzles only. Test nozzles are available from Leslie Hartridge in sets of 6 or 8.

NOTE: *Test injectors should be checked as follows:-*

Weekly or every 100 pumps – Check and reset open pressure. Check seat leakage, nozzle backleakage and replace nozzle where appropriate.

Every 1,000 pumps – Replace the test nozzle.

High Pressure Pipes:

Refer to the individual pump test plan.

Pipes to conform to the requirements of ISO 4093, viz:

1. "The pipes may be of any ferrous material, usually cold-drawn mild steel, and shall have a smooth internal bore, free from any cracks or other structural weaknesses and from corrosion or other matter likely to cause damage to the fuel injection system.

2. After making the end connections, any closing-in of the pipe shall be removed by inserting a reamer of the nominal internal diameter of the pipe to a depth of at least twice that of the length of the deformed end of the pipe. Any closing-in of the ends after extended use shall also be eliminated in a similar manner.

3. The radius of any bend subsequently made in fabricating the pipes shall be not less than 16 mm for 6 mm pipes, measured from the centre line of the pipe.

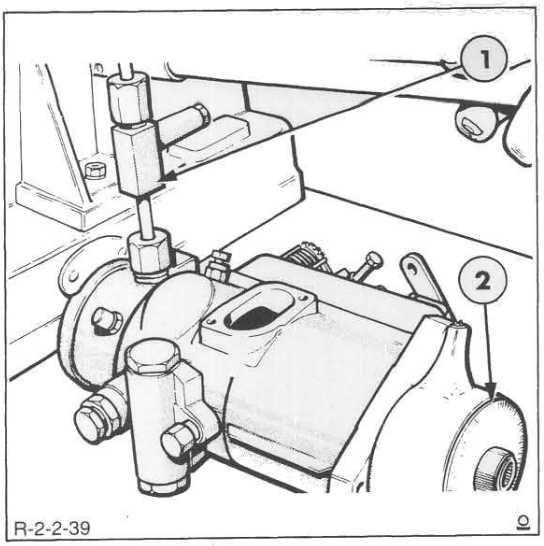


Figure 43
Setting the Pump Timing Mark

1. Tool No. 7144-262
2. Tool No. 7244-26

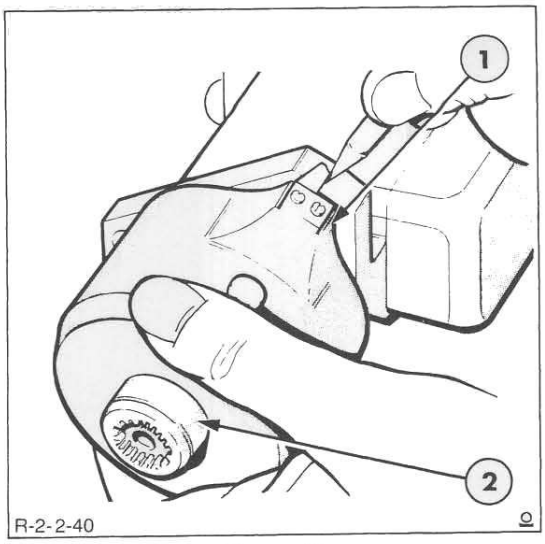


Figure 44
Scribing the Pump Timing Mark

1. Tool No. 7244-26
2. Quill Shaft

To set the pump timing, after testing proceed as follows:

(i) Remove the non-return valve from the specified outlet see Test Plan, Specifications, Chapter 8 of the hydraulic head and connect the adaptor pipe of tool No. 7144-262 directly to the outlet of the hydraulic head.

(ii) Connect the outer end of the adaptor pipe to an injector tester and pump the tester until fuel flows from the pressure relief valve in the pipe indicating that the required pressure has been obtained.

(iii) Set the pump flange marking gauge tool No. 7244-26 to the specified indexing figure see Test Plan Specification, Chapter 8 and using a suitable quill shaft install it onto the pump drive hub.

(iv) Turn the gauge and hub in the direction of pump rotation, the fuel pressure will cause the plungers and rollers to move to their outermost position. When the rollers contact the cam lobes, resistance to further rotation is encountered, this being the setting point for the pump, Figure 43.

(v) With the pump held in this position a line should be scribed on the pump flange along the guide on the gauge, Figure 44.

INJECTION PUMP STORAGE

If after overhaul, an injection pump is being stored the body should be left filled with substitute oil and all connections sealed with dust plugs and caps.

If the pump is stored for a period of six months or more it is recommended that the unit be tested to the Test Plan again before putting the pump into service.

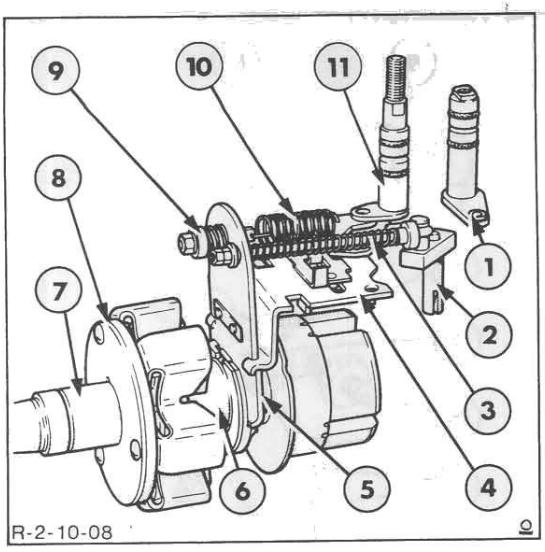


Figure 8
Variable Speed Mechanical Governor

1. Fuel Shut-off Shaft
2. Metering Valve
3. Governor Link Arm and Spring
4. Control Bracket
5. Governor Arm
6. Thrust Sleeve
7. Drive Shaft
8. Governor Flyweight Assembly
9. Idling Spring and Peg
10. Main Governor Spring
11. Throttle Shaft

Fuel at priming pressure enters the regulating sleeve and acts on the upper face of the regulating piston. The piston is forced to the lower end of the sleeve, compressing the priming spring and uncovering the priming ports. Fuel then passes through the priming ports and the lower fuel passage to the outlet side of the transfer pump and into the fuel passages within the hydraulic head.

Variable Speed Governor

The variable speed governor, Figure 8, is of the mechanical fly-weight type giving accurate control of the engine at maximum and intermediate speeds. The governor flyweight assembly is mounted on the drive shaft and is entirely contained within the pump body.

Movement of the governor flyweights, which pivot outwards when under centrifugal force set up by drive shaft rotation, actuates a thrust sleeve. The sleeve, sliding along the drive shaft, causes the governor arm to pivot about a fulcrum on the control bracket and this movement is transmitted by the governor link to the metering valve which rotates to change the quantity of fuel entering the filling ports. Rotating the metering valve changes the flow area between the groove in the valve and the metering port. The amount of fuel that enters the filling ports is therefore changed by varying the effective area of the metering orifice.

The governor link arm and spring are located in the upper part of the pump enclosed by the control cover which houses the throttle shaft and manual fuel shut-off.

The mechanical governor takes control of fuel delivery at maximum and intermediate speeds when the centrifugal force generated by the flywheel balances the force applied to the governor control arm by the tension of the main control spring. Fuel output is varied by governor action as the control arm operates the metering valve through the governor link.

During idle running with the speed control lever in the minimum speed position all tension is removed from the main control spring and the governor force is balanced by the idling spring carried on the spring peg. This provides more sensitive response at low RPM when the governor force is minimal thus ensuring an even engine speed.

The spring tension is dependent on the position of the speed control lever thereby giving variable speed control and enabling the driver to select governed speed according to operating requirements.

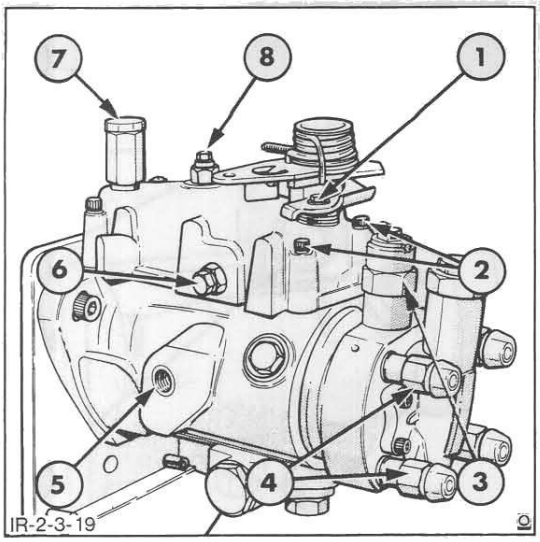


Figure 19
Governor Control Cover Components

1. Fuel Shut-Off Setbolt
2. Governor Control Cover Screws
3. Solenoid Shut-off Valve
4. Delivery Valves
5. Drain Plug
6. Maximum Fuel Adjustment Screw
7. Pressurising Valve
8. Vent Screw

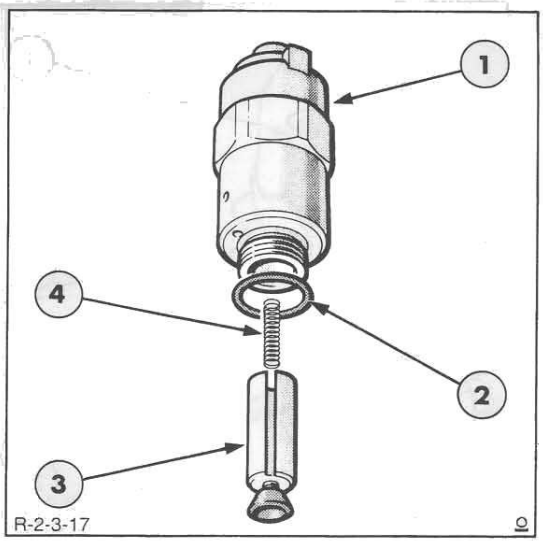


Figure 20
Solenoid Shut-off Valve Components

1. Solenoid Valve
2. Rubber 'O' Ring
3. Piston
4. Spring

Pressurising Valve

1. Unscrew and remove the pressurising valve holder, Figure 19, from the governor control cover. Remove and discard the dowty washer from the valve.

Solenoid Shut-Off Valve

1. Remove the solenoid from the hydraulic head complete with plunger and spring, Figure 20. Discard the rubber 'O' ring from the solenoid.

NOTE: *The solenoid plunger and body are a matched assembly and should not be separated.*

Throttle Lever Assembly

1. Unscrew and remove the self locking nut from the throttle shaft. Remove the washer from inside the spring guide.

2. Remove the throttle lever assembly from the shaft complete with the break back spring and spring guides, Figure 21. Remove the cap washer from the lever shaft.

3. Loosen the setbolt in the manual fuel shut-off lever, Figure 19, and remove complete with lock washer and plain washer. Lift the lever complete with spring from the governor control cover. Remove the cap washer from the lever shaft.

INSPECTION OF COMPONENTS

The following information lists the possible defects and indicates the main items which may require replacement. The inspection requirements listed are the minimum advisable.

If any part in a mated assembly is damaged or worn, the complete assembly must be renewed. The following items must be considered as mated parts.

HEAD AND ROTOR ASSEMBLY,
ROLLERS AND SHOES,
ADVANCE PISTON AND BODY,
LATCH VALVE AND BODY,
CAM RING AND SCROLL PLATES,
DRIVE SHAFT HOUSING AND BUSH,
SOLENOID PLUNGER AND BODY.

1. Check for damage to internal and external threads, especially on the transfer and distributor rotor, hydraulic head, studs, inlet and outlet connections.

2. Look for distorted or fractured springs. Check that all springs quoted in the Parts List for the particular pump are present. In cases of fouling or malfunctioning, ensure the correct springs are fitted.

3. Check for any signs of scoring, wear or corrosion to machined surfaces, including the pump body and bush, drive shaft, rear bearing, hydraulic head bore, cam ring, scroll plates, end plates, auto-advance device location and end plate locating face.

4. When fitting new 'O' rings and oil seals, care must be taken to use protection caps, etc. to avoid damage. Inspection of seals after assembly is recommended. Internal seals should be dipped in clean test oil prior to being assembled, external seals should be lightly coated with grease.

5. Inspect for wear and damage to drive shafts, splines and associated parts. If the thrust faces of the housing are worn, check the drive shaft end float.

6. Inspect for wear and scoring of all mechanical governor linkages, shafts, pivot points, arms and weights.

7. Inspect for nicked, scratched, worn, corroded or otherwise damaged pump plungers and their mated bores.

NOTE: *Great care must be taken with pump plungers and bores.*

Plungers must only be removed from the bore if there is a need to inspect them and then only for the short time required for inspection. Ensure that each plunger is correctly replaced in the end of the bore from which it came. Plungers and bores must be cleaned with clean test oil and assembled wet. The plungers should be retained in the bore of the rotor with the plastic retainer. C.A.V. Part No. 7174-62, or with suitable synthetic rubber tubing.

The rotor must be assembled to the hydraulic head and the complete assembly immersed in a covered bath of clean test oil until required for assembly.

8. Examine the transfer pump for chipped, broken or worn transfer pump blades. The blades are not interchangeable, and replacement blades MUST be of the same type.

9. Inspect for damage to rollers and shoes. Examine roller surfaces and check for free rotation in shoes. Roller and shoe assemblies must be kept together.

10. Inspect all small orifices for blockage, e.g., delivery valve bodies, latch valve, head locating fitting and clear any restriction with dry compressed air.

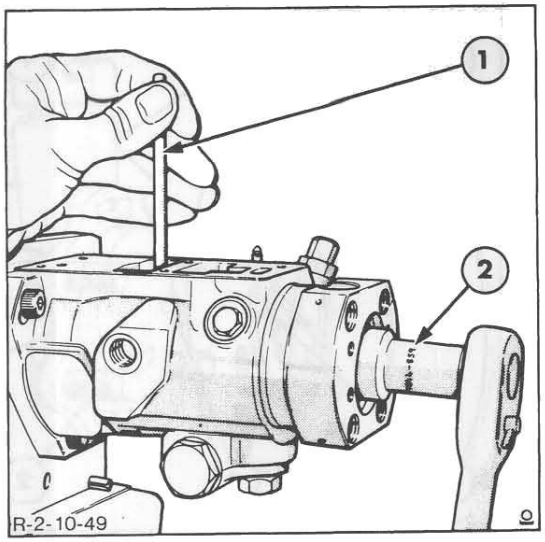


Figure 51
Loosening Transfer Pump Rotor

1. Tommy Bar
2. Box Spanner Tool No. 7044-889

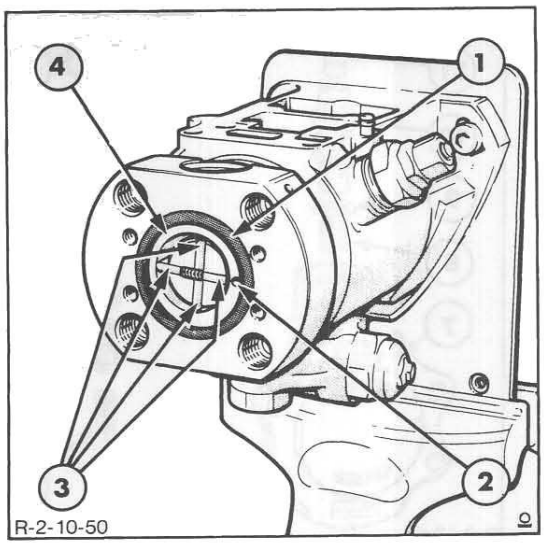


Figure 52
Transfer Pump Components

1. Rubber Seal
2. Rotation Slot
3. Transfer Pump Blades
4. Pump Eccentric Liner

Transfer Pump

1. To prevent the drive shaft from turning, insert a suitable tommy bar of 4mm (0.157in) diameter through the front aperture in the pump housing and through the hole in the drive shaft as shown, Figure 51.

2. Insert the Special Box Spanner, Tool No. 7044-889, into the slots in the transfer pump rotor and tighten the rotor to the specified torque, see "Specifications" – Chapter 8.

NOTE: *The transfer pump rotor must be tightened in the opposite direction to the pump rotation.*

3. Ensure when the rotor is fitted, that the transfer pump blades, Figure 52, all slide freely in the slots of the rotor and then remove.

4. Before assembling the transfer pump liner into the hydraulic head, ensure that the direction of the rotation slot in the side of the liner is positioned correctly at 3 o'clock, when viewed from the rotor end.

5. Insert the liner into the hydraulic head. Dip the transfer pump blades in clean test oil and insert the blades and springs into the slots of the transfer pump rotor. Check again that the blades move freely.

6. Lubricate the transfer pump rubber sealing ring with clean test oil and fit into the recess between the liner and hydraulic head.

TEST MACHINE SPECIFICATION

Test Injectors

Two different types of test injector will be required for testing fuel injection pumps fitted to the Ford Tractor range.

1. Injectors fitted with the ISO 4010 delay pintle type nozzle, principally for high speed, indirect injection engine applications, are required for testing in-line pumps.

2. Injectors fitted with orifice plates (ISO 7440*), principally for direct injection engine applications, are required for testing distributor pumps.

   Use only the nozzle type specified in the individual Test Plan, together with the appropriate nozzle holder.

   "Pending ISO confirmation."

Test injectors are available from Leslie Hartridge Limited, Tingewick Road, Buckingham, MK18 1EF, England, in sets of 4, 6, 8 or 12. The appropriate part number is dependent on the test nozzle required and the test machine type.

These injectors are essential for accurate pump calibration and are manufactured to a standard which will ensure minimum line to line scatter, consistent results between sets and accurate maximum fuel setting. ENSURE THAT TEST NOZZLE TYPE AND OPENING PRESSURE ARE AS SPECIFIED IN THE INDIVIDUAL TEST PLAN, e.g. delay pintle type ISO 4010 at 172-0 + 3 bar opening pressure (identified by ISO 4010 marked on their shank).

The use of the ISO nozzle means that test injectors can be serviced in the workshop by changing the nozzles only. Test nozzles are available from Leslie Hartridge in sets of 6 or 8.

NOTE: *Test injectors should be checked as follows:-*

Weekly or every 100 pumps - Check and reset open pressure. Check seat leakage, nozzle backleakage and replace nozzle where appropriate.
Every 1,000 pumps - Replace the test nozzle.

High Pressure Pipes:

Refer to the individual pump test plan.

Pipes to conform to the requirements of ISO 4093, viz:

1. "The pipes may be of any ferrous material, usually cold-drawn mild steel, and shall have a smooth internal bore, free from any cracks or other structural weaknesses and from corrosion or other matter likely to cause damage to the fuel injection system.

2. After making the end connections, any closing-in of the pipe shall be removed by inserting a reamer of the nominal internal diameter of the pipe to a depth at least twice that of the length of the deformed end of the pipe. Any closing-in of the ends after extended use shall also be eliminated in a similar manner.

3. The radius of any bend subsequently made in fabricating the pipes shall be not less than 16mm for 6mm pipes, measured from the centre line of the pipe.

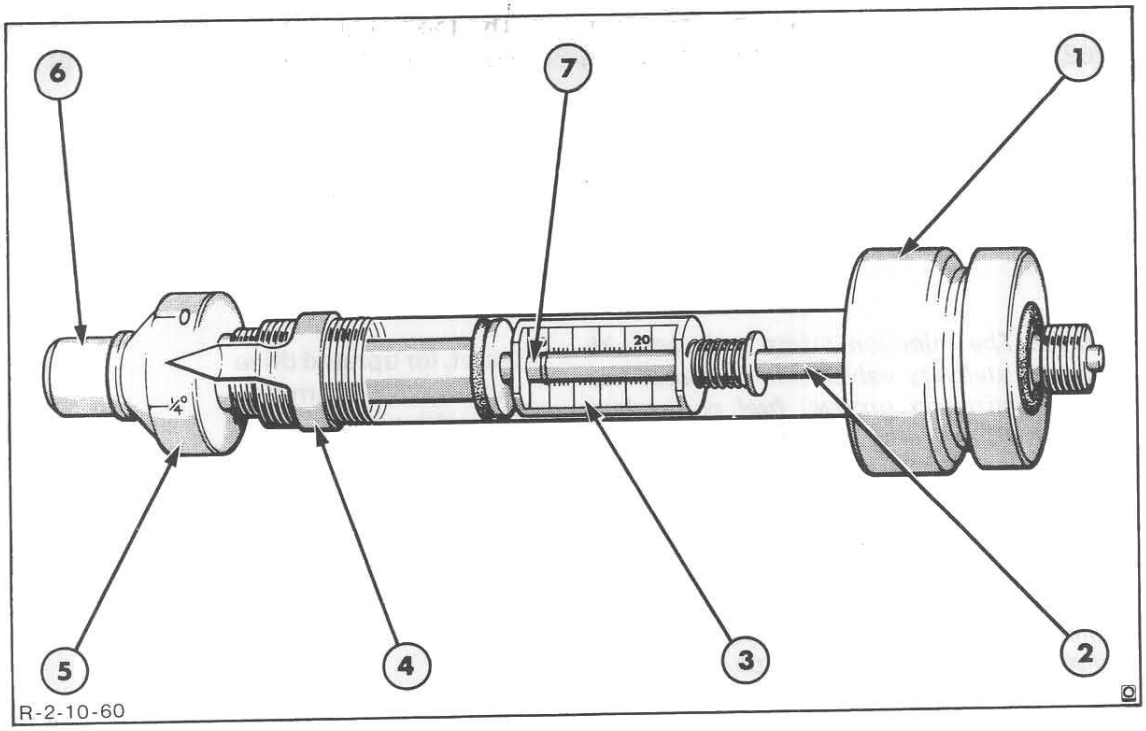


Figure 62
Advance Gauge, Tool No. 7244-447

1. Locking ring
2. Spindle
3. Scale
4. Pointer
5. Vernier adjuster
6. Vent screw
7. Datum line on spindle

To measure the advance at various pump speeds, read the value in degrees on the graduated scale opposite the datum line on the spindle.

If the datum line on the spindle is between two graduations, proceed as follows:-

Turn the vernier adjuster clockwise to move the scale until the lower degree graduation line corresponds with the datum line on the spindle. The reading indicated on the vernier adjuster, opposite the pointer, indicates the fraction of a degree to be added to the lower reading.

NOTE: *Before changing the pump speed and measuring a new advance value, return the venier adjuster ANTI-CLOCKWISE to the zero position.*

Timing the Injection Pump

All pumps require timing. See the "Test Plan" for the relevant setting figure.

After completion of the previous tests, remove the pump from the test machine and drain by loosening the plug on the pumpbody.

Remove the delivery valve on the fuel outlet specified for timing on the "Test Plan".

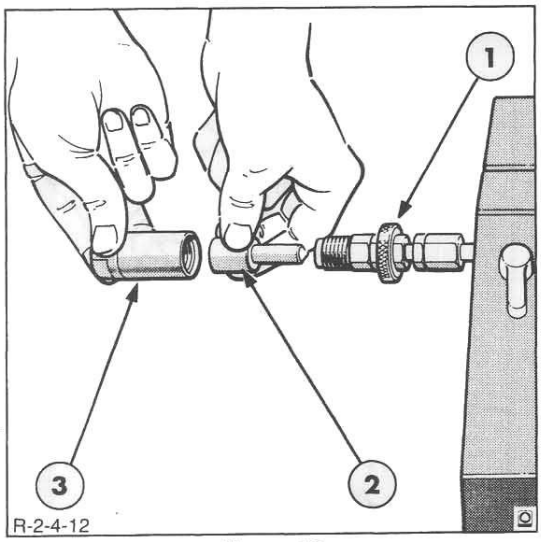


Figure 12
Reverse Flushing the Nozzle

1. Reverse Flush Nozzle Adaptor, Tool No. CT9024 or 8124
2. Nozzle
3. Nozzle Retaining Nut

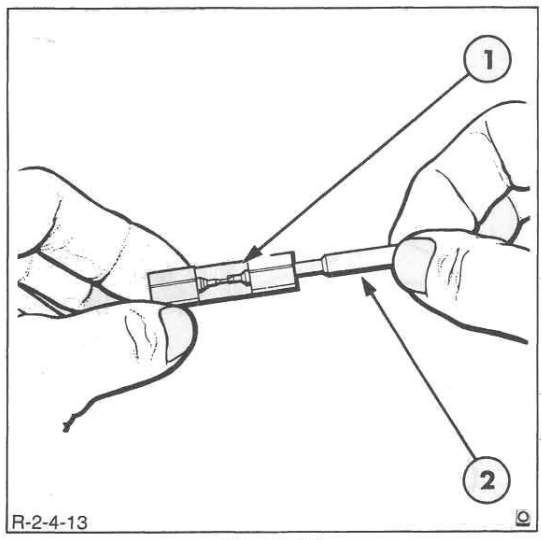


Figure 13
Cleaning Needle Valve Tip

1. Needle Valve Scraper
2. Needle Valve

4. If the nozzle leak-back test time was less than five seconds or the valve sticks, the valve and nozzle should be lapped together by placing the tip end of the nozzle in a drill chuck having a speed of 450 rev/min or less. Spread a small amount of tallow over the valve surface. Insert the valve into the rotating nozzle, centralise and apply slight pressure as the chuck turns.

NOTE: *Do not lap the valve for more than five seconds at a time. Allow the parts to cool between lapping.*

5. Prior to reassembly, the lift of the injector needle must be rechecked with a dial indicator. Maximum allowable lift is 0.4 mm.

RE-ASSEMBLY

1. Clean all parts in fuel oil prior to re-assembly. Rinse all parts in clean fuel oil and assemble the components whilst still wet.

2. Position the nozzle and valve assembly onto the nozzle holder and ensure the dowel pin holes are correctly located, Figure 14. Hold the injector body in the fixture, install the retaining nut with a new washer and tighten to the correct torque, see "Specifications" – Chapter 8.

3. Install the spindle, spring disc, spring and adjusting nut. Turn the nut until spring pressure is felt.

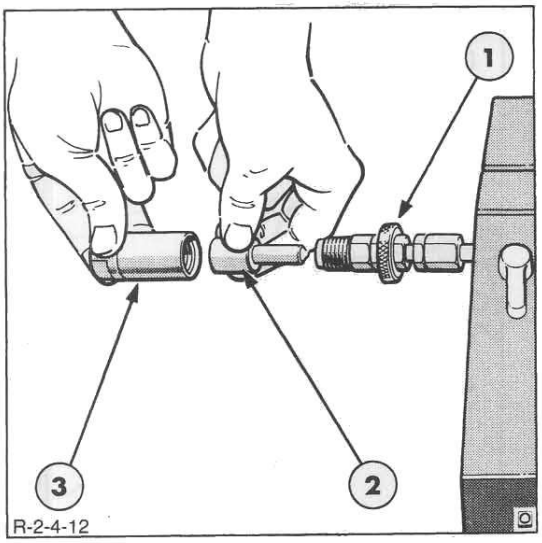


Figure 12
Reverse Flushing the Nozzle

1. Reverse Flush Nozzle Adaptor, Tool No. CT9024 or 8124
2. Nozzle
3. Nozzle Retaining Nut

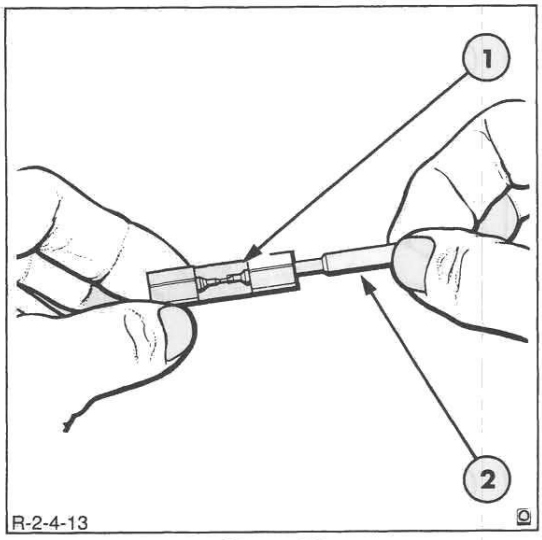


Figure 13
Cleaning Needle Valve Tip

1. Needle Valve Scraper
2. Needle Valve

5. Use a Reverse Flush Nozzle Adaptor, Tool No. CT 9024, on the injector tester, Figure 12, and reverse flush the nozzle to remove the carbon loosened during cleaning operation 4.

6. Inspect the needle valve and body for scoring or pitting and ensure there are no deposits of carbon or corrosion. Check that the spray holes and fuel galleries are clean and that no blueing is present. The needle valve must move freely within the nozzle body.

7. Clean the top of the needle valve using a needle valve scraper, Figure 13.

8. Clean the nozzle retaining nut using a brass wire brush and check that the threads are not damaged and are free from carbon deposits.

RE-ASSEMBLY

1. Ensure all parts are absolutely clean and undamaged prior to re-assembly. Rinse all parts in clean fuel oil and assemble the components whilst still wet.

2. Place the shims, spring and spring seat into the injector body bore. Place the injector body into the holding fixture.

3. Assemble the needle valve into the nozzle body and then position the dowelled adaptor plate onto the nozzle body. Insert this assembly into the nozzle retaining nut.

4. Carefully assemble the dowelled adaptor plate and the nozzle retaining nut assembly onto the injector body, Figure 14, and tighten the retaining nut to the specified torque value, see "Specifications" – Chapter 8.

B. TURBOCHARGER – OVERHAUL

REMOVAL

1. Remove the engine side covers, release the exhaust muffler pipe clamp and remove the pipe.

2. Remove the exhaust muffler by removing the turbocharger to exhaust muffler clamp, Figure 4, and support bracket.

3. Disconnect the air cleaner to turbocharger tube and the turbocharger to intake manifold tube by loosening the tube hose clamps.

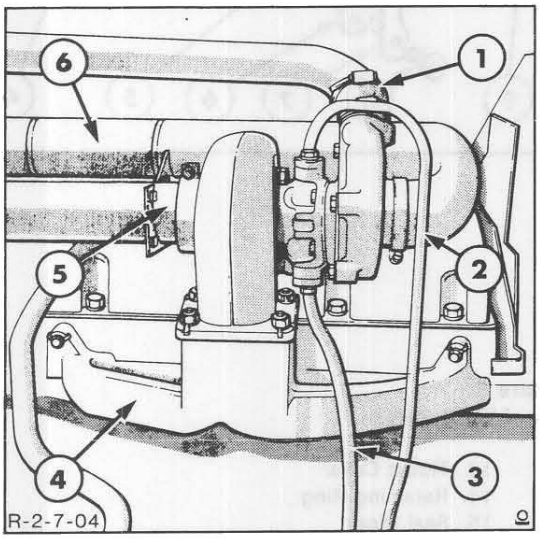


Figure 4
Turbocharger Installed

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

4. Disconnect the oil supply and return tubes from the turbocharger. Cap the ends of the tubes and the oil ports of the turbocharger to prevent future bearing failures due to entry of foreign material.

5. Remove the turbocharger and gasket from the exhaust manifold. Cover the opening in the exhaust manifold to prevent the entry of dirt which could cause damage to the turbine wheel blades after installation and start-up.

DISASSEMBLY

With reference to Figure 5.

1. Clean the exterior of the turbocharger using a non-caustic cleaning solvent to remove accumulated surface matter before disassembly.

2. Match-mark the compressor housing, turbine housing and centre housing with a punch or scribe to facilitate orienting the housings during reassembly.

3. Bend down the tabs of lockplates, then remove the bolts, lockplates, clamps and housings.

NOTE: *Exercise care when removing the compressor housing to avoid damaging the compressor wheel blades.*

Tap the turbine housing with a soft faced hammer if force is needed for removal.

PART 2
FUEL SYSTEMS

Chapter 8
TROUBLE SHOOTING, SPECIFICATIONS, TEST PLANS AND SPECIAL TOOLS

A. TROUBLE SHOOTING – DIESEL ENGINES

IMPORTANT: *Whenever effecting a repair the reason for the cause of the problem must be investigated and corrected to avoid repeat failures.*

The following tables list problems and their possible causes with recommended remedial action.

GENERAL

PROBLEM	POSSIBLE CAUSES	REMEDY
Fuel not reaching injection pump	1. Fuel shut-off valve closed	1. Check the fuel shut-off valve at the fuel tank is in the 'ON' position
	2. Restricted fuel filters	2. Check and flush the fuel filters clean
	3. Air in system	3. Bleed the fuel filters
	4. Fuel leakage.	4. Check the fuel lines and connectors for damage
Fuel reaching nozzles but engine but will not start	1. Low cranking speed	1. Check the cranking speed
	2. Incorrect throttle adjustment	2. Check the throttle control rod travel
	3. Incorrect pump timing	3. Check the pump timing
	4. Fuel leakage	4. Check the fuel lines and connectors for leakage
	5. Faulty injectors	5. See injector trouble shooting
	6. Low compression	6. Check the engine compression

B. TROUBLE SHOOTING – TURBOCHARGER

It is important when trouble shooting a suspected turbocharger malfunction to keep in mind that a turbocharger cannot compensate for incorrect engine operating procedures; deficiencies of the engine air intake, fuel, or exhaust systems; or for damaged engine components such as valves, pistons, rings, liners, etc. Replacing a good turbocharger with another will not correct engine deficiencies.

Consequently, systematic trouble shooting of a suspected turbocharger failure is essential for two very important reasons. First, it must be determined what, if anything, is wrong with the turbocharger so that it can be repaired. Second, it must be determined what action will prevent a recurrence of the failure.

In many cases, the evidence required to determine the cause of a malfunction is destroyed in the process of removing the turbocharger from the engine. For example, if a turbocharger failed as the result of a faulty installation (such as loose duct connections that permitted ingestion of dirt by the compressor), this fact would not be evident once the turbocharger was removed from the engine.

Furthermore, failure to take appropriate steps to assure correct installation (such as repairing or replacing defective clamps or ducting could cause the replacement unit to fail in a similar manner.

The following Trouble Shooting Chart contains information pertaining to probable failure modes of turbocharged engines, possible causes for such failures, and the maintenance action required to remedy each possible cause. It is not represented that this information is all-inclusive. On the contrary, this information should be considered primarily as representative of the methods or techniques that should be employed in trouble shooting a turbocharged engine malfunction.

In general, those trouble shooting procedures that can be performed with the least effort and in the least amount of time should be performed first. No removal or disassembly procedures should be performed until all visual inspections and sensory tests (sight and feel) that can be accomplished with the turbocharger installed have been performed. The possible causes and procedure are generally arranged in the order of ease of accomplishment.

TURBOCHARGER TROUBLE SHOOTING CHART

SYMPTOMS	POSSIBLE CAUSES
1. Engine lacks power or emits black smoke	• Dirty Air Cleaner (See Notes A and H) • Loose compressor-to-intake manifold connections (See notes B and C) • Leak at engine intake at turbocharger mounting flange (See Notes D, F, & G)

E. TEST PLANS

TEST PLAN – FORD 455C, 201 cu.in. (3294 cc) Engine

DPA DISTRIBUTOR TYPE FUEL INJECTION PUMP – TYPE NUMBER 3238 F800 – 809

PUMP SPECIFICATION

Rotation (looking on drive end)	Clockwise
Governor type	Mechanical all-speed
Governor link length	54.0 mm ± 0.3 mm
Governor Arm hole	No: 3
Throttle lever link hole	No: 1
Diameter of Plungers	7.0 mm (4 off)
Drive Arrangement	Unsupported, quill shaft
Advance type	Automatic speed

Special features
Solenoid shut-off device, 12 volts
Transfer pressure adjuster in end plate

ISO TEST CONDITIONS (IMPORTANT: Read explanatory notes)

These figures, for service use only, have been compiled on, and must only be used on, a test machine conforming to International Standard ISO 4008.

Test oil	ISO 4113 at temperature 40 ± 2°C
Inlet feed pressure	1.5 bar
Nozzles	ISO 4010
Nozzle opening pressure	172 + 3 − 0 bar
H.P. outlet connections	Original
H.P. pipes	ISO 4093.2

- Screw transfer pressure adjuster fully out and then 2.5 turns in before commencing test.
- Fit auto-advance gauge and set to zero before commencing test.
- Fit pressure gauge to measure cambox pressure using special bleed-off connection.
- Where marked thus * use 30 seconds glass draining time and allow fuel to settle for 15 seconds before taking readings unless stated otherwise by the test bench manufacturer's instructions.
- A 1.0 mm shim is fitted to the piston spring cap on assembly.
  This must NOT be removed.
  No additional shimming is required.
- Note 1 Critical fuel deliveries are given in mm^3/stroke. Hence the tester must determine the number of strokes applicable in accordance with the test m/c manufacturer's instructions.

PART 3
ELECTRICAL SYSTEM

Chapter 1
WIRING, LIGHTS AND CONTROLS

Chapter 2
BATTERY

Chapter 3
STARTING SYSTEM

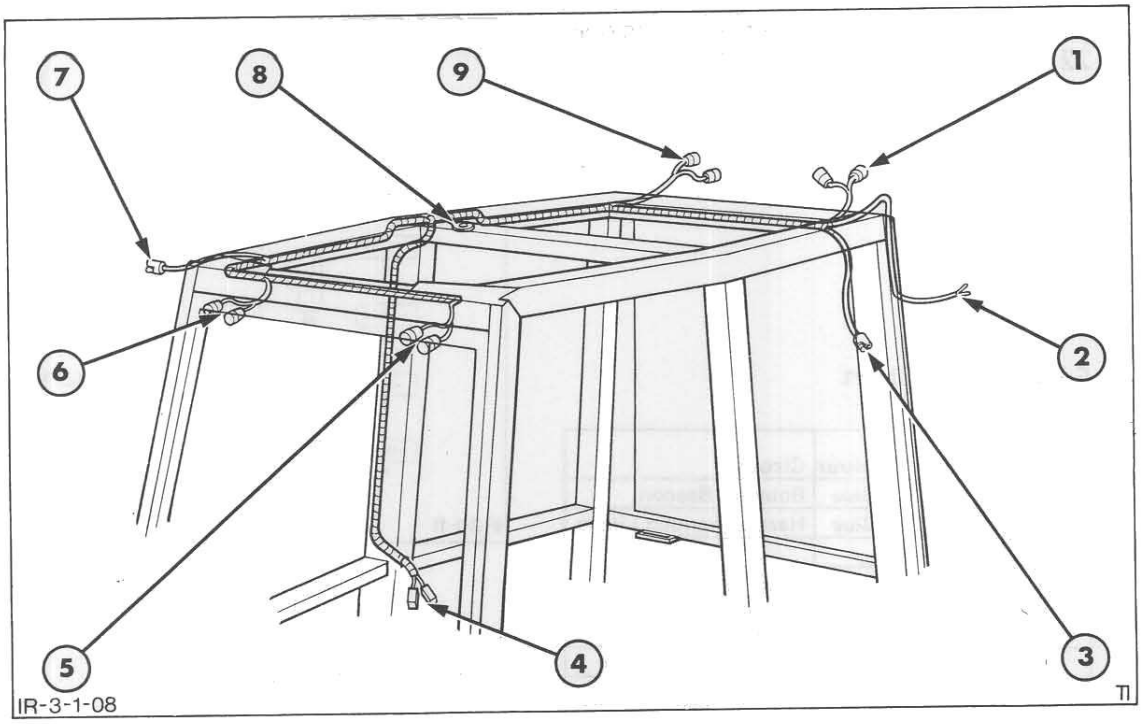


Figure 9
Roof Harness Connections With Roll Over Protection Frame

1. Rear Work Light
2. License Plate Light
3. Rear Rotating Beacon
4. Connection to Instrument and Lighting Harness
5. Front Work Light
6. Front Working Light
7. Front Rotating Beacon
8. Earth
9. Rear Work Light

FUSES AND RELAYS

The fusebox, Figure 10, is located at the rear of the instrument console on the right-hand side of the unit. To gain access to the fuses, withdraw the retaining screws and remove the fuse cover.

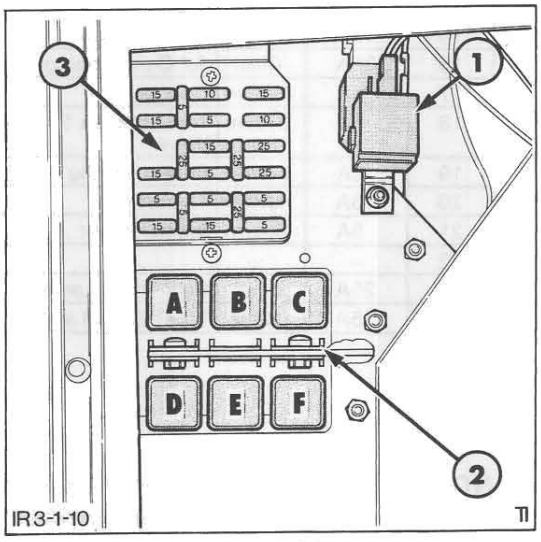


Figure 10
Fuses and Relays

1. Warning Buzzer
2. Relays
3. Fuses

A Starter Relay
B Warning Light Earthing Relay
C Air Conditioning Relay
D Front Work Lamp Relay
E Rear Work Lamp Relay
F Warning Buzzer Relay

The six relays used in the engine starting, worklamp, air conditioning and warning buzzer circuits are positioned below the fuse box assembly. Reference should be made to Figure 10 for relay identification.

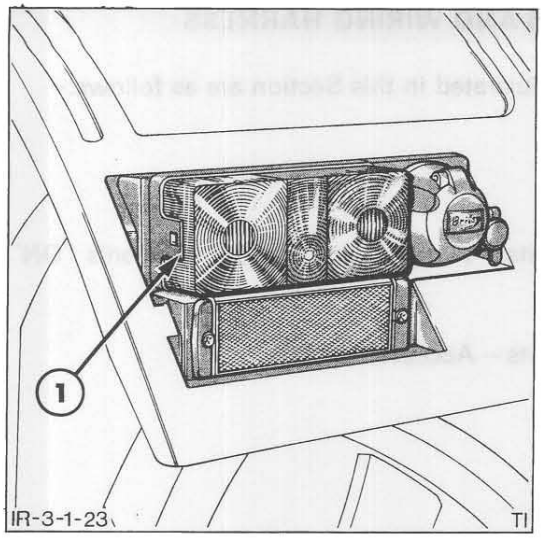


Figure 22
Rear, Stop and Indicator Lights

1. Tang

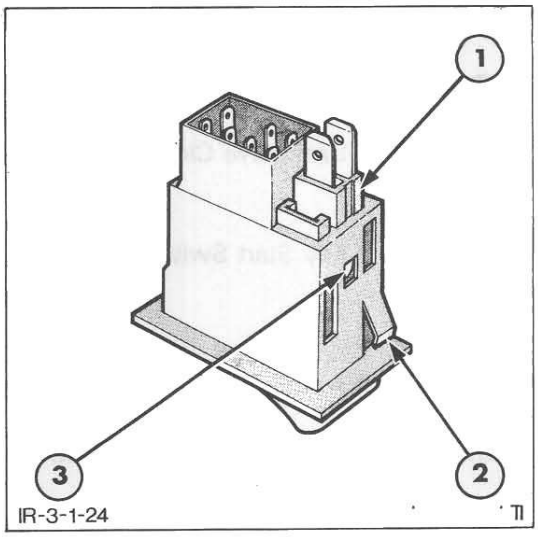


Figure 23
Rocker Switch Bulb Replacement

1. Bulb Retainer
2. Sprung Tang
3. Tang

Interior Lamp

The interior lamp bulbs are accessible after removal of the moulded plastic lens cover. Depress the cover and rotate approximately 5° clockwise to remove. The bulb may be removed by exerting outward pressure on one of the retaining tangs and sliding the opposite end of the bulb from its retaining tang. Installation of the bulb and lens cover follow the removal procedure in reverse.

Rocker Switch Bulb

Certain of the rocker switches are internally illuminated, the bulb being removable from the rear of the switch assembly. To gain access, remove the instrument panel.

The switch assembly is retained by a sprung tang at either end. Press in the tangs and remove the switch assembly from the console.

To change a bulb, press in the tang using a small screwdriver and pull the bulb retainer from the back of the switch, refer to Figure 23. The bulb is of the capless type, rated at 1.2W and is a push fit in the retainer. After changing the bulb, push the retainer into the back of switch until the tang locates in the aperture.

Instrument Panel Bulb

The warning and panel light bulbs are removable from the front of the instrument panel. To gain access, remove the panel lens. The bulb is of the capless type, rated at 1.2W and is a push fit in the retainer, Figure 24.

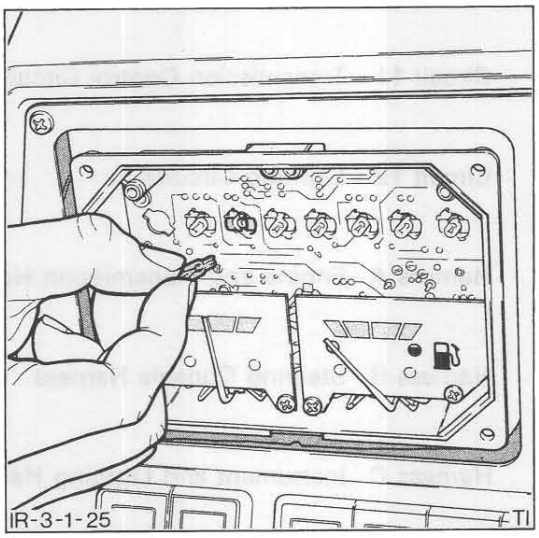
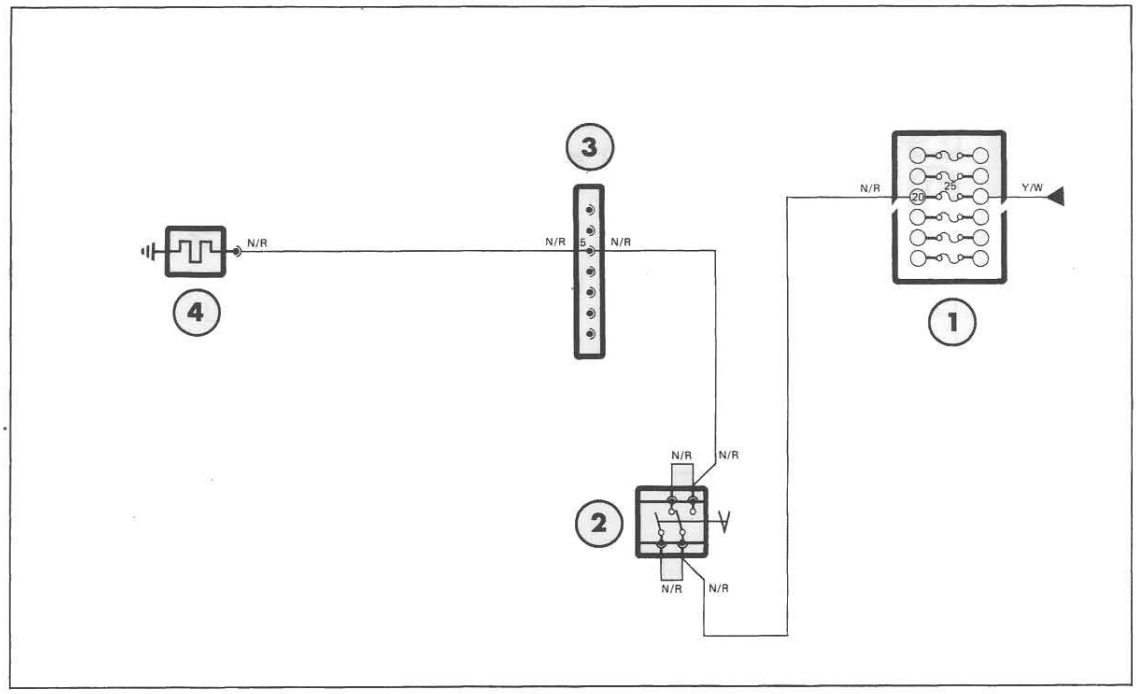


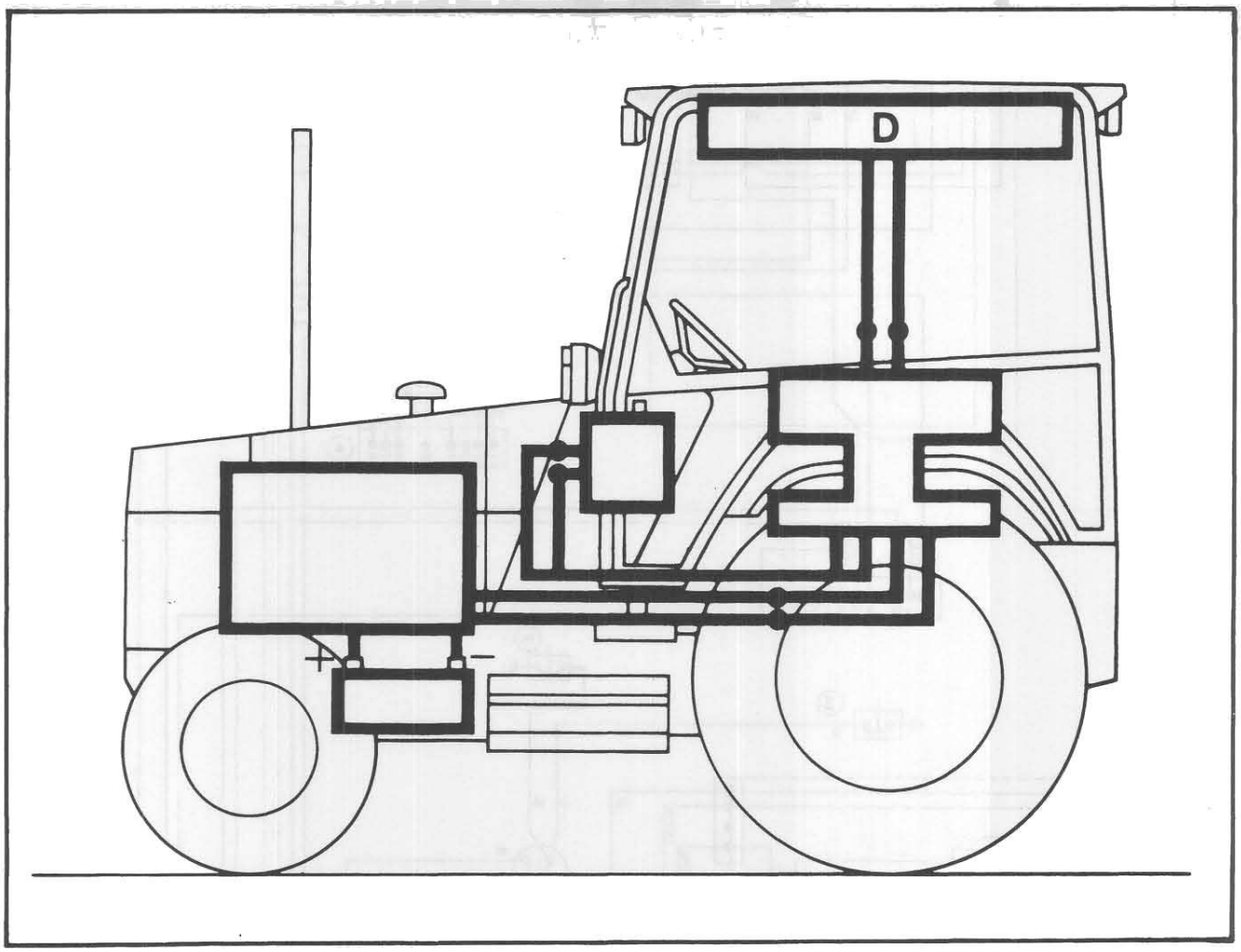
Figure 24
Instrument Panel Bulb Replacement



Circuit 5
Thermostart Circuit

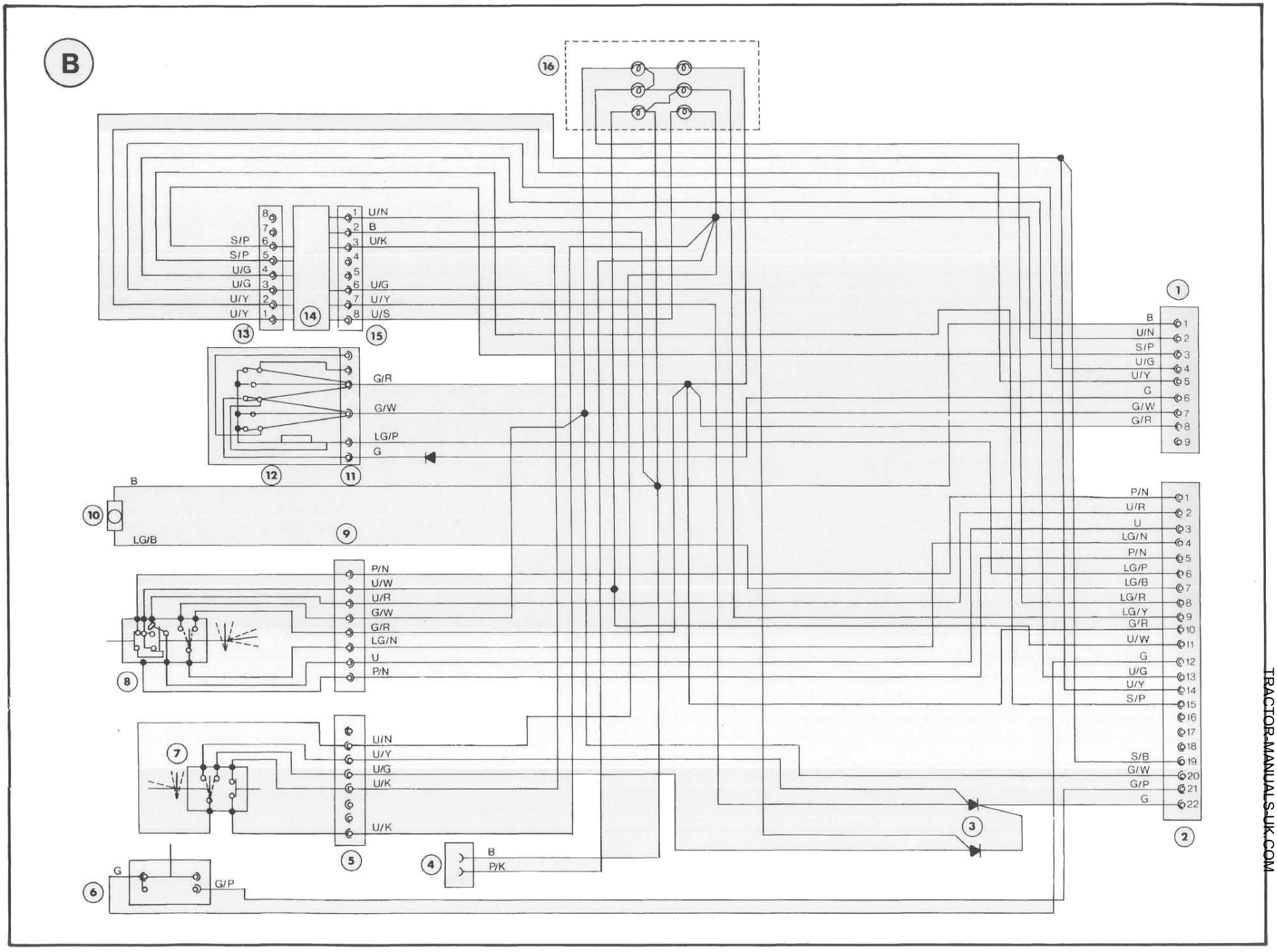
1. Fuse Box
2. Rocker Switch
3. Main Under Floor Connector (7 Pin)
4. Thermostart

NOTE: *Key Start Switch MUST be ON when operating the thermostart cold start.*



D. ROOF HARNESS

WIRING COLOUR CODES			
B – Black		P – Purple	
G – Green		R – Red	
K – Pink		S – Grey	
LG – Light Green		U – Blue	
N – Brown		W – White	
O – Orange		Y – Yellow	



The lower temperature at which a battery is required to operate the more necessary it is that the battery is maintained in a fully charged, condition. For example a battery with a low specific gravity of 1.225 at 27°C (80°F) will operate the starting motor at warm ambient temperatures but may fail, due to lower battery efficiency at a low temperature.

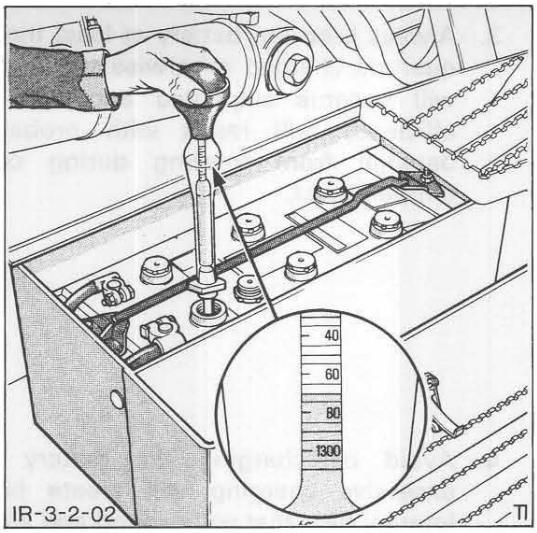


Figure 2
Battery Hydrometer

The following table lists the effect of temperature on the efficiency of a typical battery.

Temperature	Efficiency of a Fully Charged Battery
26.5°C (80°F)	100%
10.0°C (50°F)	82%
–1.0°C (30°F)	64%
–6.5°C (20°F)	58%
–12.0°C (10°F)	50%
–17.0°C (0°F)	40%
–23.0°C (–10°F)	33%

CHARGING

Maximum battery life can be obtained when the correct care and periodic inspection is given. It is important that output capacity should not be exceeded by constant and excessive overloading, and that charging requirements be maintained.

When servicing a battery the following steps should be observed:

1. Maintain the electrolyte to the recommended level which is generally approximately 0.25 in. (5.0 mm) above the plates otherwise the acid will reach a high concentration that will damage the separators and impair the performance of the plates.

2. Use only distilled water for topping up.

Testing Field Coils for Open Circuits

1. Connect the voltmeter positive lead to the starting motor field terminal.
2. Connect the voltmeter negative lead to the battery negative terminal.
3. Attach a jumper lead between the battery positive terminal and to one of the insulated brushes. The voltmeter should indicate battery voltage.
4. Repeat the complete test with the jumper lead connected to the other insulated brush. The voltmeter should indicate battery voltage.
5. Disconnect the voltmeter positive lead from the starting motor field terminal and connect it to the eyelet wire. Connect the jumper lead between the battery positive terminal and, in turn, to each of the insulated brushes. The voltmeter should indicate battery voltage.

NOTE: *If no voltage is indicated in Steps 3, 4 and 5, an open circuit exists in the field coils and new coils must be installed.*

Testing Field Coils for Grounded Circuits

1. Connect and voltmeter positive lead to the starting motor field terminal.
2. Connect the voltmeter negative lead to the battery negative terminal.
3. Attach a jumper lead between the battery positive terminal and the starting motor frame.
4. The voltmeter reading should indicate zero voltage. If a reading is indicated, the field coils are grounded and new coils must be installed.

Brush Inspection

To gain access to the brushes, complete steps 1 to 7 of the disassembly procedure.

1. Check the movements of the brushes in their holders. If the brushes are sticking, clean them with a suitable solvent and if necessary, smooth the sides of the brushes with a fine abrasive or a smooth file.
2. Check the brushes for wear, if they are worn to less than the length specified, install new brushes see 'Specifications' – Chapter 5.
3. Check the brush spring tension by positioning a spring scale hook under the brush spring. Pull the spring scale radially. Install new springs if the tension is less than specified. See 'Specifications' – Chapter 5.
4. Install a new brush end plate assembly if the insulators between the field brush holders and the end plate are defective.

Brush Removal and Installation

1. Unsolder the field brush leads from the field coils.
2. Unsolder the ground brush leads from the brush holders.
3. Install the new brushes, soldering the leads using a 300 watt soldering iron and resin core solder.
4. Ensure the new brushes move freely in the holders. If necessary, smooth the sides of the brushes with a fine abrasive or a smooth file.

Armature Assembly and Armature Bushing

1. Inspect the armature for damage to the core and wire areas. If damaged install a new armature; do not attempt to machine the core.

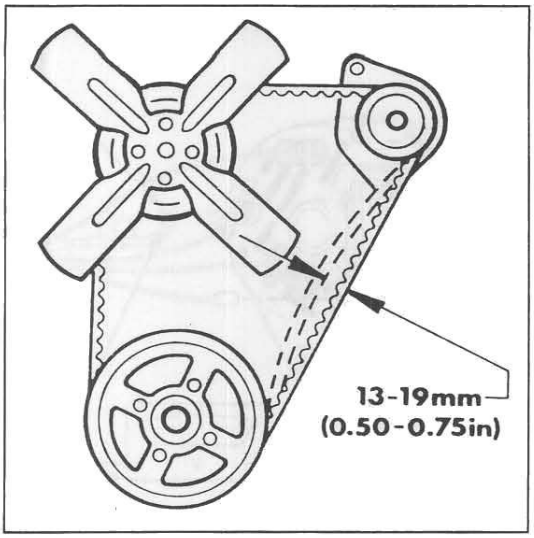


Figure 7
Drive Belt Deflection

PRELIMINARY CHECKS

Prior to electrical testing, thoroughly inspect the charging and electrical system.

Check all leads and connections for continuity and tightness.

1. Check the Battery

With an hydrometer, check the battery is at least 70% charged and in good condition.

2. Check the Drive Belt

Ensure the alternator drive belt and pulley are in satisfactory condition. Allow 0.50 – 0.75 in. (13 – 19 mm) deflection when moderate finger pressure is applied to the longest run of the belt, Figure 7.

3. Check the Warning Light

Turn on the key start switch and check the warning light is fully illuminated.

If the warning light is not fully illuminated, check the bulb. If the bulb is not the cause of the fault, carry out the Alternator Output Lead Test as detailed under "Initial Tests" in this Chapter.

If the warning light is illuminated, start the engine and run above the idling speed when the warning light should be extinguished.

If the warning light does not go out, stop the engine and remove the charge indicator lead. If the warning light is extinguished a faulty temperature sensor or alternator component is indicated. Conduct the "Battery Temperature Sensor Circuit Test" and "Alternator Components Tests" as detailed in this Chapter.

If the warning light remains illuminated, check for a shorting to frame in the area between the charge indicator lead and the warning light.

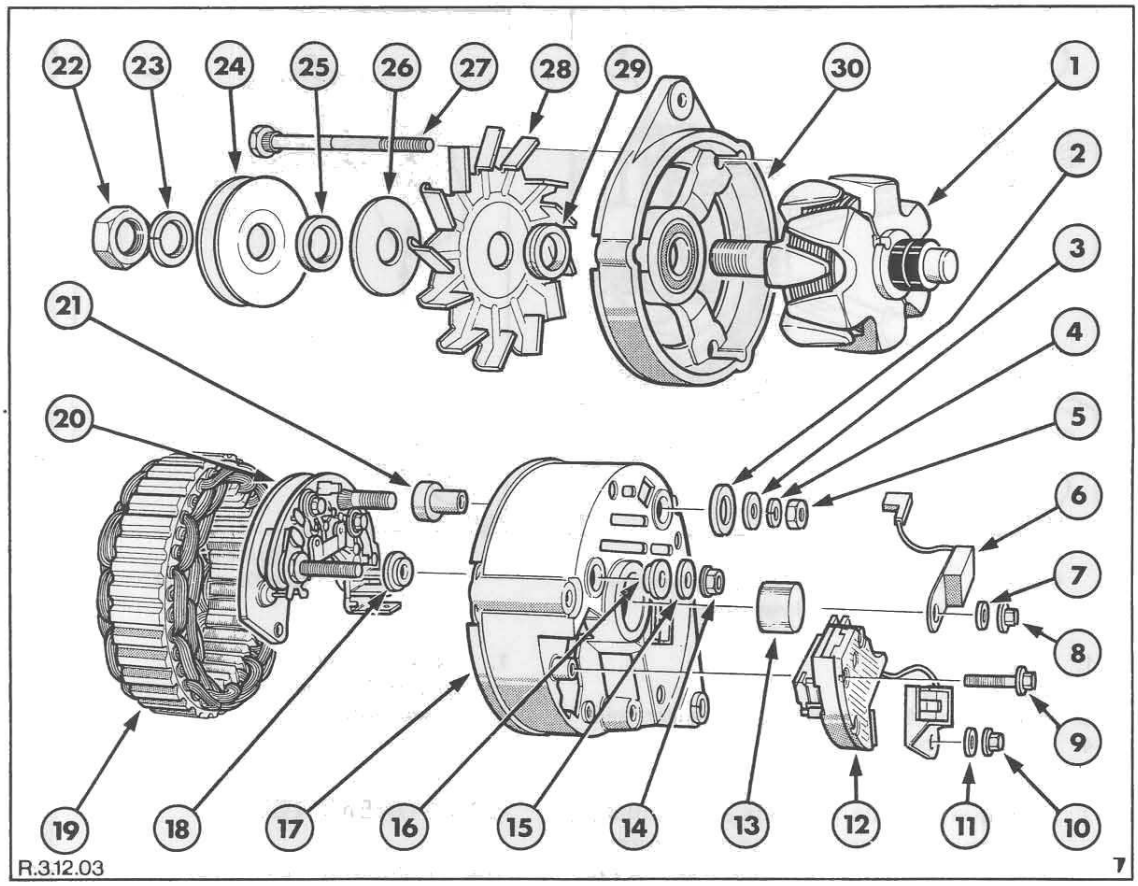


Figure 19
Alternator Components

1. Rotor
2. Insulator
3. Washer
4. Spring Washer
5. Nut
6. Suppressor (where fitted)
7. Washer
8. Nut
9. Bolt
10. Nut
11. Washer
12. Regulator/Brushbox
13. Bearing
14. Nut
15. Washer
16. Insulator
17. Rear End Bracket
18. Insulator
19. Stator
20. Rectifier
21. Insulator
22. Nut
23. Washer
24. Pulley
25. Spacer
26. Washer
27. Through Bolt
28. Fan
29. Double Spacer
30. End Bracket

DISASSEMBLY

With reference to Figure 19.

1. Remove the nut from the alternator throughbolt, allowing the radio interference suppressor (where fitted) to be disconnected and removed.
2. Remove the nut from the battery temperature sensor terminal.
3. Remove the three securing bolts and withdraw the regulator/brushbox assembly. Separate the wiring connection to the regulator.
4. Mark the alternator front end bracket, stator, and rear end bracket to ensure correct alignment on re-assembly.
5. Unscrew and remove the remaining three nuts from the alternator through bolts. With a soft mallet tap the threaded end of the through bolts to release the spline at hexagon head end.
6. Gently tap the rear face of the alternator front end bracket to separate the front end bracket and rotor assembly from the rear end bracket, stator and rectifier assembly.

CHARGING SYSTEM TROUBLE SHOOTING GUIDE

PROBLEM	POSSIBLE CAUSES
Battery Low in Charge	1. Poor Battery Condition will not accept or hold a charge, Electrolyte level low 2. Loose or worn alternator drive belt 3. Excessive resistance due to loose charging system connections 4. Defective temperature sensor 5. Defective alternator
Alternator Charging at High Rate (Battery Overheating)	1. Defective battery 2. Defective temperature sensor 3. Defective alternator
No Output from Alternator	1. Alternator drive belt broken 2. Loose connection or broken cable in charging system 3. Defective alternator
Intermittent or Low Alternator Output	1. Alternator drive belt slipping 2. Loose connections or broken cables in charging system 3. Defective temperature sensor 4. Defective alternator

ALTERNATOR TROUBLE SHOOTING GUIDE

PROBLEM	POSSIBLE CAUSES
Warning Light Dims and/or Battery Low	Faulty: 1. External charging circuit connections 2. Rotor slip rings or brushes
Warning Light Goes Out – Becomes Bright with Speed	1. External charging circuit connections 2. Rectifier
Warning Light Normal but Battery Boiling	1. Regulator 2. Battery temperature sensor
Warning Light Normal but Flat Battery	1. Regulator 2. Stator 3. Rectifier

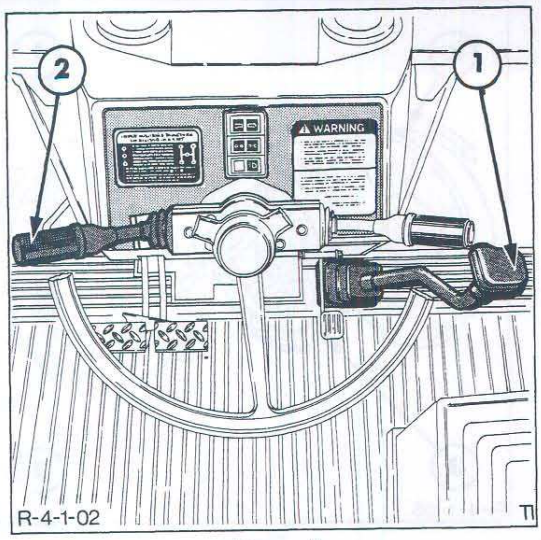


Figure 2
Transmission Shift Levers

1. Gearshift Lever
2. Power Reversing Lever

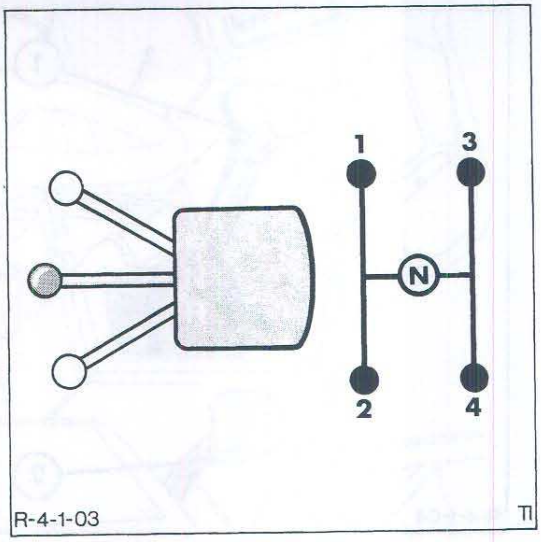


Figure 3
Gearshift Pattern

The gearbox receives power from the engine by means of oil reaction in the torque converter and hydraulic clutch assemblies.

The front clutch provides power for forward travel and the rear clutch power for reverse travel. Engagement of the front and rear clutch is controlled by the operator through the movement of the hand operated power reversing lever, shown in Figure 2.

The power reversing lever is linked to the modulating unit in the steering console by a wiring harness. A neutral lock is incorporated in the power reversing lever which prevents inadvertent engagement of the transmission and requires that the power reversing lever must be lifted upwards prior to selecting forward or reverse travel.

The gearshift lever, shown in Figure 2, is used to select any one of four synchronised gear ratios for forward or reverse travel. Figure 3 illustrates the gearshift pattern. In any gear ratio the operator need only move the power reversing lever to change direction of travel.

However, as a clutch is not used between the engine and the transmission, the power flow from the engine to the transmission must be interrupted to shift from one gear ratio to another. This is accomplished by using a transmission disconnect switch.

Two finger operated button type switches are provided, Figure 4, one on the gearshift lever knob, primarily to change gear ratios. The second on the loader control lever knob should be used during loader operations to divert full engine power to the backhoe/ loader hydraulic pump for faster loader operations.

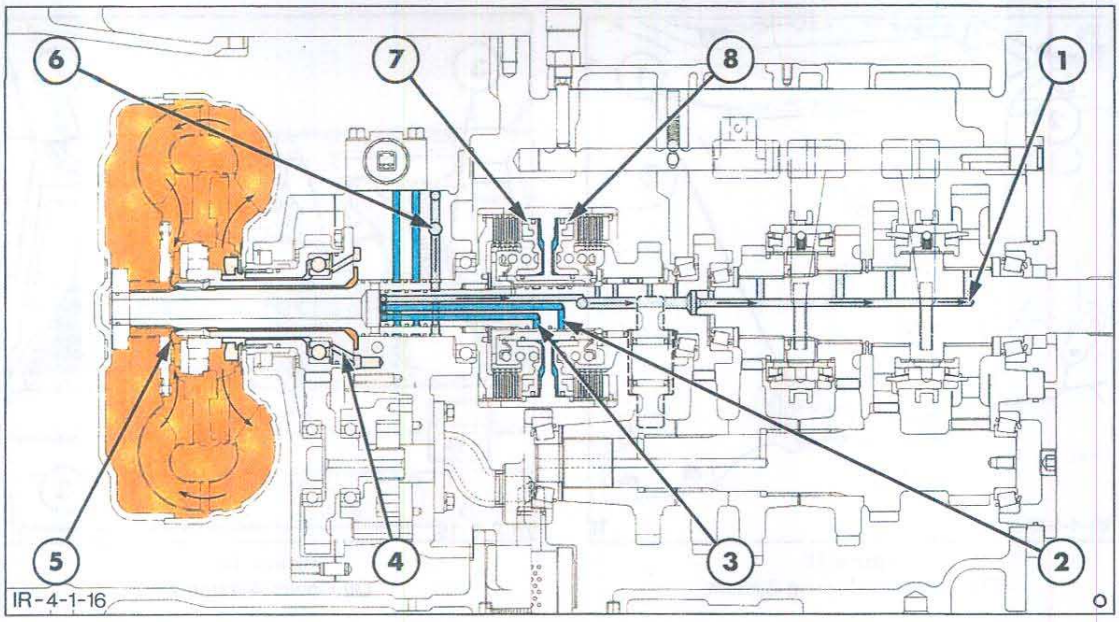


Figure 16
Transmission Lubrication Oil Flow

Torque Converter Pressure Oil
Torque Converter Return Oil
Lubrication Oil
Reservoir and Exhaust Oil

1. Lubrication Gallery
2. Reverse Clutch Gallery
3. Forward Clutch Gallery
4. Feed to Torque Converter
5. Return from Torque Converter
6. Return from Oil Cooler
7. Forward Clutch
8. Reverse Clutch

The lubrication passages, being smaller than the return tube, will act as an orifice and cause a pressure build-up. When the pressure reaches approximately 33 lbf/in² (2.26 bar) a bypass valve in the distributor housing will open allowing oil to return to sump.

OIL COOLER

The transmission cooling system, Figures 17 to 19, consists of a filter, a cooling unit and tubes and fittings. The oil is filtered after leaving the cooler. The filter incorporates a bypass valve that is st to open at 7 to 9 lbf/in² (0.5 to 0.6 bar) should the filter become clogged.

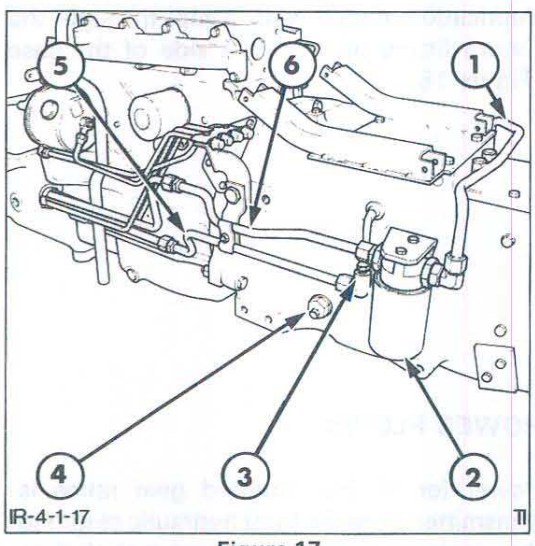


Figure 17
Transmission Cooling System

1. Filter Return Pipe
2. Filter
3. Temperature Switch
4. Pressure Test Point
5. Cooler Inlet Line
6. Cooler Outlet Line

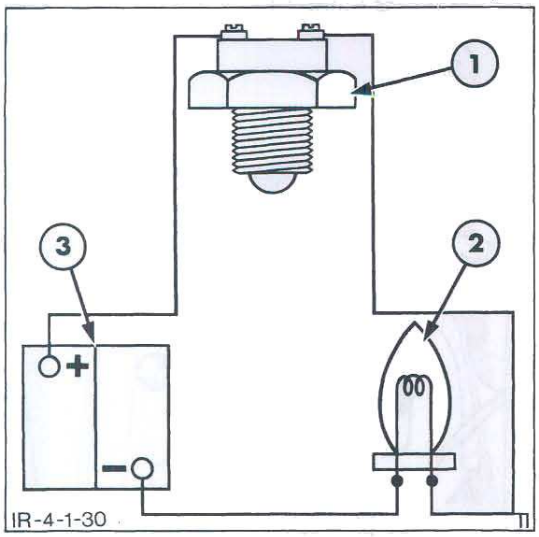


Figure 30
Safety Start Switch Test

1. Switch
2. Bulb
3. Battery

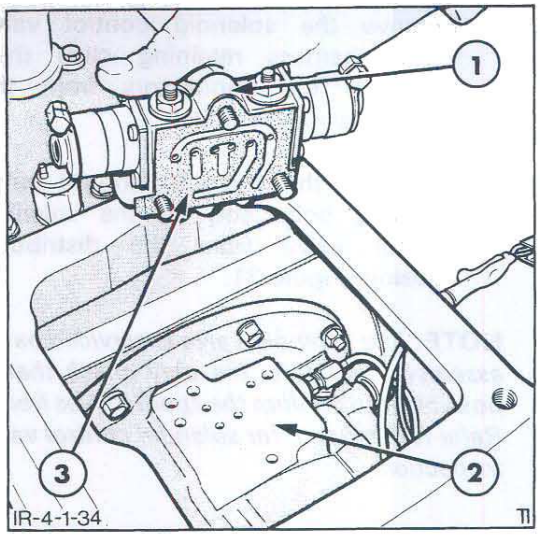


Figure 31
Solenoid Control Valve Removal

1. Solenoid Control Valve Assembly
2. Oil Distributor
3. Gasket

2. Remove the safety start switches from the transmission top cover, Figure 29, and then remove the switch plungers from the transmission housing.

INSPECTION

1. Inspect the conical ends of the switch plungers for nicks or burrs. If nicks or burrs exist that cannot be removed by polishing, install a new plunger.

2. Check the safety start switches for operation by connecting the switch to a suitable bulb and battery as illustrated in Figure 30.

3. Depress and then release the operating button. The switch is operating correctly if the light comes on when the button is depressed and goes out when the button is released. If the switch is faulty, install a new switch.

INSTALLATION

1. Install a new 'O' ring seal onto the safety start switches, then install into the transmission top cover and tighten to the specified torque – see "Specifications" – Chapter 3.

2. Install the fuel tank as described in Part 2 "Fuel Systems" – Chapter 1.

SOLENOID CONTROL VALVE

REMOVAL

1. Remove the fuel tank as described in Part 2 "Fuel Systems" – Chapter 1.

2. Remove the solenoid control valve access plate retaining bolts and lift the plate from the transmission.

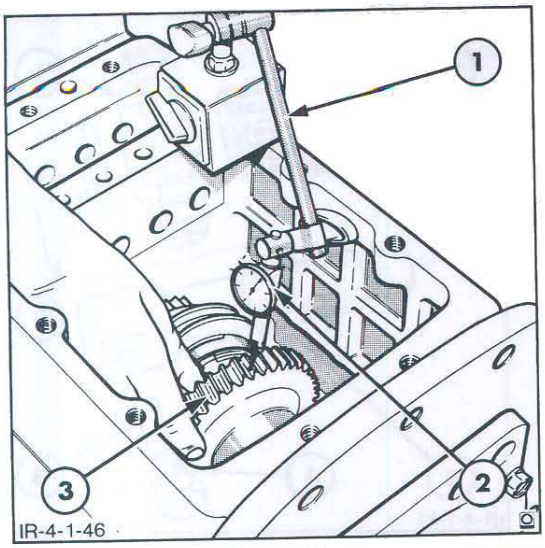


Figure 47
Gear Backlash Check

1. Gear Backlash Bracketry
2. Dial Indicator
3. Stylus

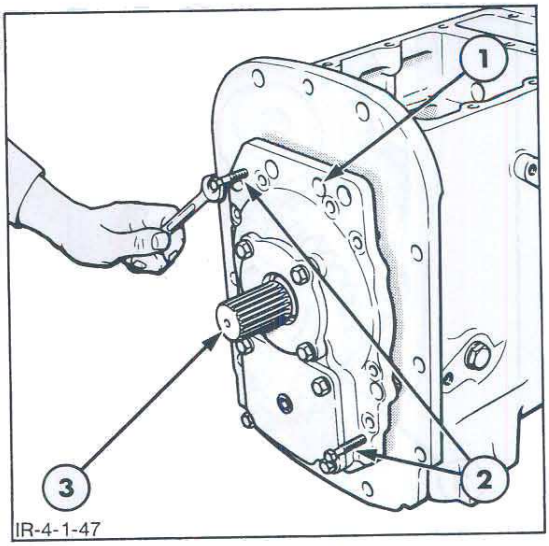


Figure 48
Rear Cover Plate Removal

1. Rear Cover
2. Jacking Bolts
3. Output Shaft

REAR COVER PLATE

1. If transmission gear wear is suspected then prior to removing the rear cover and output shaft bearing retainer check the gear backlash. Position a dial indicator gauge on the transmission casing as shown in Figure 47 and measure the backlash on output shaft gears.

2. Prior to removing the rear cover and output shaft bearing retainer tie the output shaft and countershaft together with a suitable length of cord.

3. Remove the rear cover retaining bolts then screw two jacking bolts into the rear cover as shown in Figure 48. Tighten the two jacking bolts equally until the rear cover is free of the transmission case. Remove the two jacking bolts and remove the rear cover assembly.

OUTPUT SHAFT AND COUNTERSHAFT GEAR ASSEMBLIES

1. Release the cord retaining the output shaft and countershaft assemblies together then lift the output shaft assembly rearwards from the transmission case as shown in Figure 49.

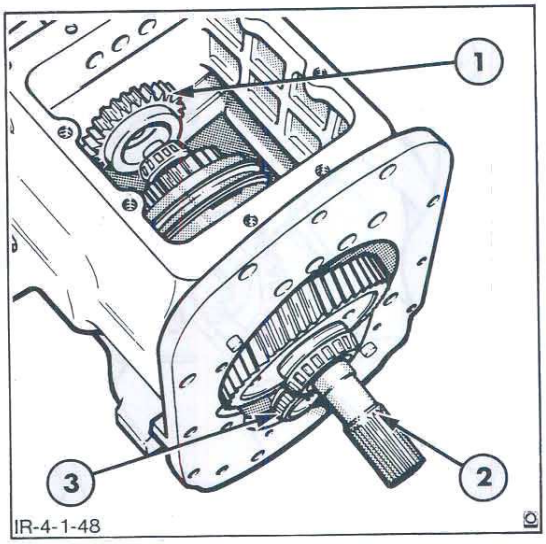


Figure 49
Output Shaft Removal

1. Rear Input Shaft
2. Output Shaft
3. Countershaft

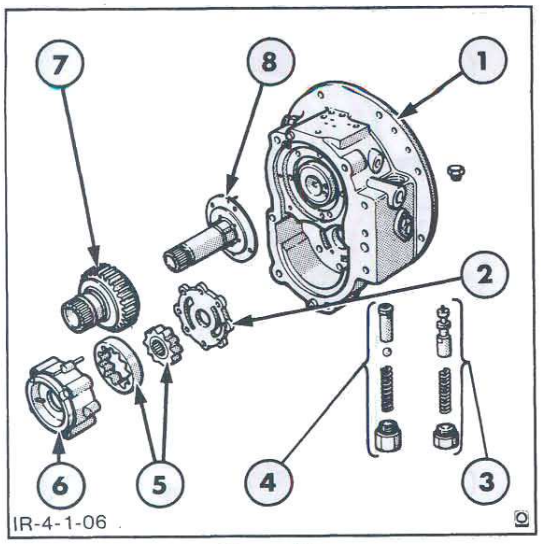


Figure 70
Oil Distributor Housing Components

1. Distributor Housing
2. Pump End Plate
3. Regulating Valve
4. By-Pass Valve
5. Pump Rotors
6. Pump Body
7. Pump Drive Gear
8. Stator Support

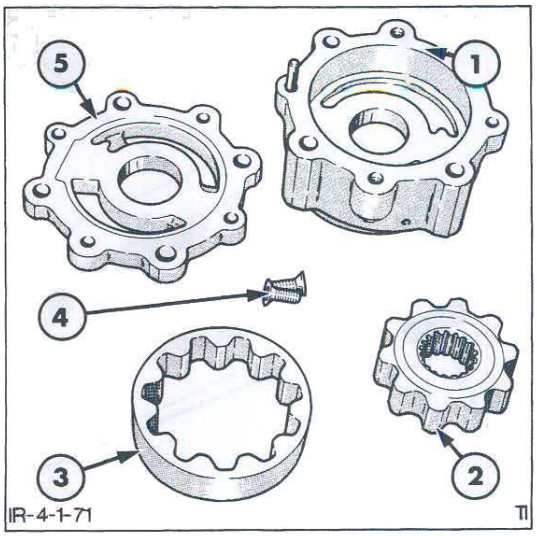


Figure 71
Transmission Pump Components

1. Pump Body
2. Inner Rotor
3. Outer Rotor
4. End Plate Screws
5. End Plate

4. Remove the hydraulic pump retaining bolts and lift the pump assembly from the distributor housing, Figure 70.

5. Remove the by-pass valve plug and extract the shim, spring ball and valve seat, Figure 70.

6. Remove the regulating valve plug and extract the spring, shim and spool.

7. Remove the 'O' ring seals from the valve plugs and discard. Install new 'O' rings on assembly.

INSPECTION

1. Thoroughly clean all the transmission hydraulic pump and oil distributor components with a suitable solvent and allow to dry. Use compressed air to clean the oil passages in the distributor housing.

2. Inspect the hydraulic pump driven gear and the bearings either side of the gear for wear or damage.

3. Inspect the front cover thrust washer for wear or scoring. If damaged, remove by prying the washer from the cover, do not remove if undamaged.

ASSEMBLY

With reference to Figure 86.

1. Install the 1st gear, thrust washer and rear bearing onto the shaft, then drive or press the bearing into place using a hammer or press, and a sleeve of the appropriate diameter and length.

2. Install the 1st/2nd gear synchroniser assembly over the front end of the shaft and locate onto the splines. Engage the tangs on the synchroniser ring to the 1st gear.

3. Install the 2nd gear, engage the gear with the synchroniser assembly, then install the thrust washer and retain with the appropriate snap ring.

4. Install the thrust washer and 3rd gear onto the shaft and retain in position with the appropriate snap ring.

5. Install the coupler onto the shaft and retain in position with the snap ring, then install the 3rd/4th gear synchroniser assembly onto the coupler.

6. Install the 4th gear onto the shaft followed by thrust washer and front bearing, then drive or press the bearing into place using a hammer or press, and a sleeve of appropriate diameter and convenient length.

7. Installation of the output shaft and gear assembly is covered in Section E.

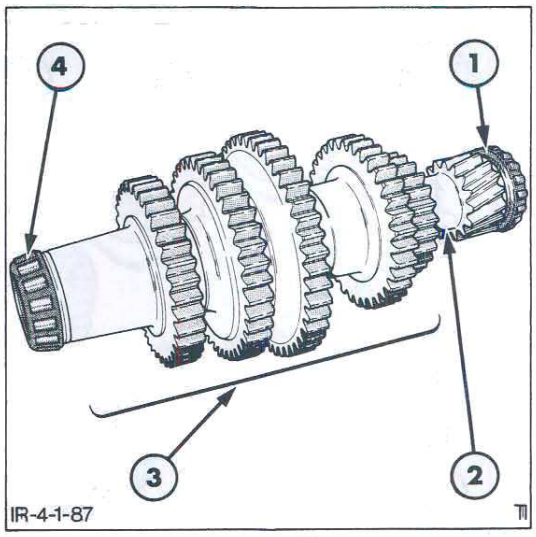


Figure 87
Countershaft Assembly

1. Rear Bearing
2. Shaft and Gear Assembly
3. Removal Gears
4. Front Bearing

COUNTERSHAFT AND GEAR ASSEMBLY

DISASSEMBLY

1. Remove the countershaft front bearing, thrust washer and gears, Figure 87, using a puller, Tool No. 1003 or 9516 with shaft protector Tool No. 625A or 9212 as shown in Figure 88.

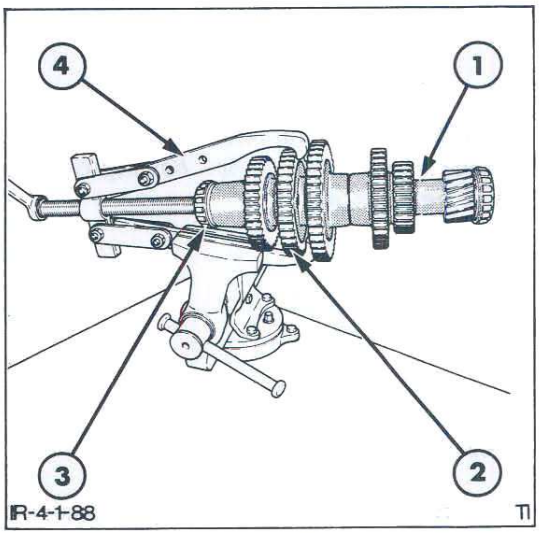


Figure 88
Countershaft Disassembly

1. Shaft
2. Forward Drive Gear
3. Front Bearing
4. Puller Tool No. 1003

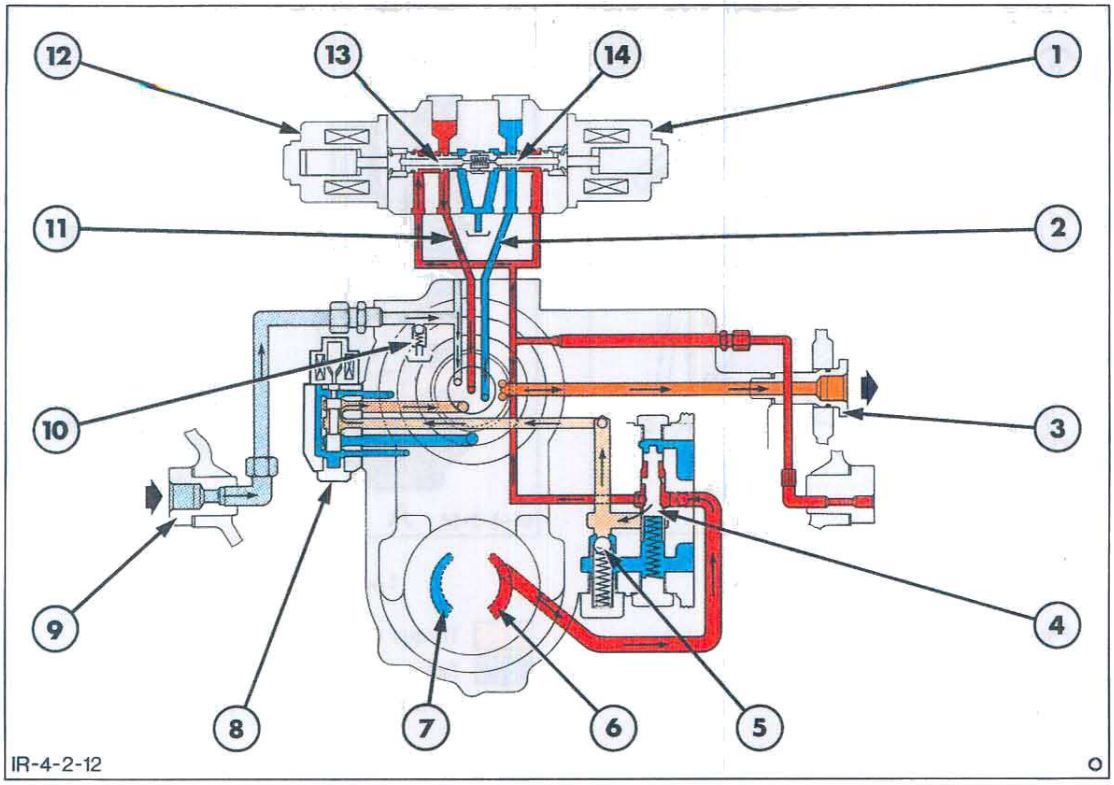


Figure 12
Oil Flow in Reverse

Pump Pressure Oil
Lubrication Oil
Torque Converter Pressure Oil
Reservoir and Exhaust Oil
Torque Converter Return Oil

1. Forward Solenoid
2. Forward Clutch Oil Gallery
3. Feed Port to Oil Cooler
4. Regulating Valve
5. Bypass Valve
6. Oil Pump Outlet
7. Oil Pump Inlet
8. Lock-Up Valve
9. Return Port from Oil Cooler
10. Cooler Bypass Valve
11. Reverse Clutch Oil Gallery
12. Reverse Solenoid
13. Reverse Spool
14. Forward Spool

Selecting reverse travel sends a signal from the modulating unit to the reverse solenoid of the control valve. The operation of the reverse section of the control valve is the same as the forward section, however, now the pressure regulated oil is directed to the reverse clutch pack, Figure 12, and power is delivered to the transmission gear box via the rear input gear (reverse clutch hub).

De-energised the forward solenoid moves back to the neutral position under spring pressure and the spool aligns the forward clutch pack oil gallery with the exhaust port.

LOCK-UP VALVE

The lock-up valve is mounted on the right-hand side of the distributor assembly, Figure 13, and consists of a solenoid, spool, return spring and a valve body.

The function of the lock-up valve is to direct oil from the by-pass valve to the torque converter.

With the lock-up valve solenoid de-energised the spool remains in the normal torque converter mode position with the return spring holding the spool as shown 'B' in Figure 14.

The inner cone is engaged to the sliding sleeve by the four (long) pins and rotates with the sleeve and outer cone as an assembly.

The synchroniser ring, engaged to the gear via the retainer, and the gear are free to rotate on the countershaft.

As the sliding sleeve is moved from neutral towards the gear to be selected the outer cone also moves and compresses the synchroniser ring between the outer and inner cones.

Further shift pressure causes the synchroniser ring and the inner and outer cones to rotate at the same speed. The synchroniser ring and gear now rotating in synchronisation with the sleeve permits the chamfered teeth on the internal circumference of the sleeve to engage the teeth on the gear.

Further shift pressure causes the outer cone to depress the balls and springs in the sliding sleeve and allow the sleeve to fully engage the gear.

The cone type synchroniser, Figure 25, for the 3rd/4th and the high/low range gears operate in an identical way to the 1st and 2nd gear synchroniser, however, as previously described the 3rd gear and the low range gear synchroniser rings are engaged directly to the gears and do not use a retainer as in the 1st and 2nd gear synchroniser.

POWER FLOWS

Power for all eight forward gear ratios is transmitted from the front hydraulic clutch to the rear input shaft. The rear input shaft then transmits power to the countershaft forward gear and the countershaft in turn transmits power to the output shaft. Figures 27 and 28 illustrate the power flows.

Power flow for all eight reverse gear ratios is the same as for all eight forward gear ratios except that the rear clutch is engaged to transmit power to the reverse idler gear. The reverse idler gear in turn transmits power to the reverse gear on the countershaft.

Because power is being transmitted through the reverse idler gear, the countershaft and output shaft will rotate in the opposite direction as for forward gear ratios. The rear input shaft will also rotate in the opposite direction.

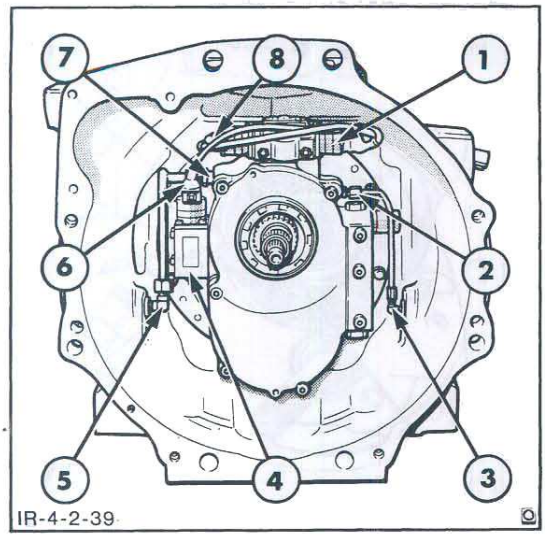


Figure 39
Front View of Transmission Case

1. Solenoid Connection
2. Test Port Line
3. Test Port Line
4. Lock-Up Valve
5. Return Line
6. Solenoid Connection
7. Return Line
8. Solenoid Connection

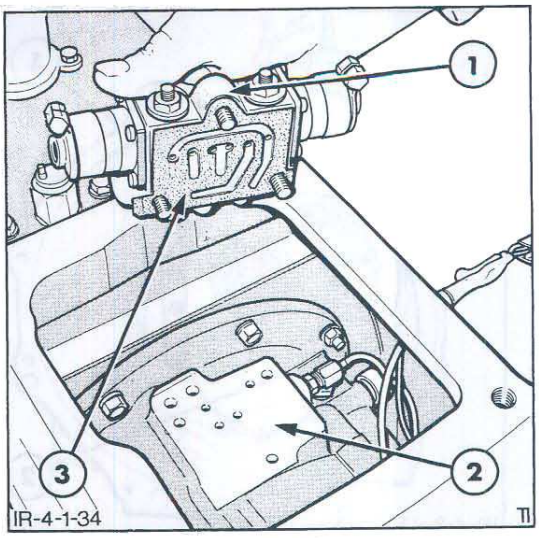


Figure 40
Solenoid Control Valve Removal

1. Solenoid Control Valve Assembly
2. Oil Distributor
3. Gasket

TRANSMISSION HYDRAULIC PUMP AND OIL DISTRIBUTOR HOUSING

1. Disconnect the oil cooler return pipe and elbow at the transmission case, Figure 39. Disconnect the return pipe at the oil distributor housing and remove the pipe from the transmission case.

2. Disconnect the pressure test port feed pipe and elbow at the transmission case. Disconnect the feed pipe at the oil distributor housing and remove the pipe from the transmission case, Figure 39.

3. Disconnect the wiring harness from the lock-up valve and the solenoid control valve and remove from the transmission case; note the colour and the position of the three connectors.

4. Remove the solenoid control valve securing bolts and remove the solenoid control valve from the distributor housing, Figure 40.

   Refer to Section F for the disassembly of the solenoid control valve assembly.

5. Remove the distributor housing retaining bolts. Obtain two M8 jacking bolts, approximately 30 mm (1.25 in.) long. Screw the bolts into the housing as shown in Figure 41, then continue to tighten until the distributor housing is freed from the transmission case. Lift the housing from the transmission and remove the jacking bolts.

NOTE: *The distributor housing is heavy, care should be exercised when removing the housing from the transmission case.*

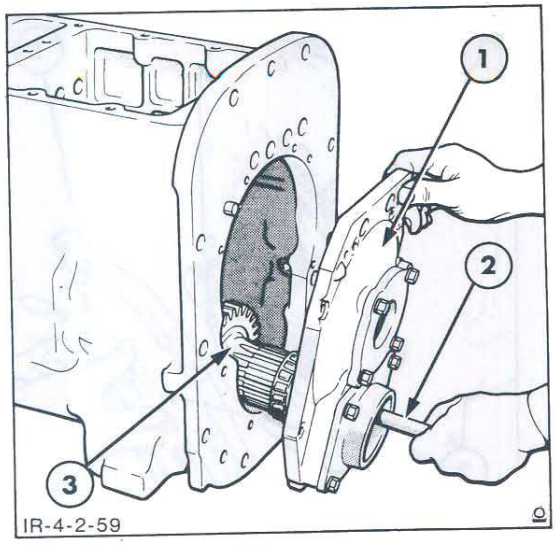


Figure 60
Countershaft Installation

1. Rear Cover
2. Rod
3. Point to Wrap Cord

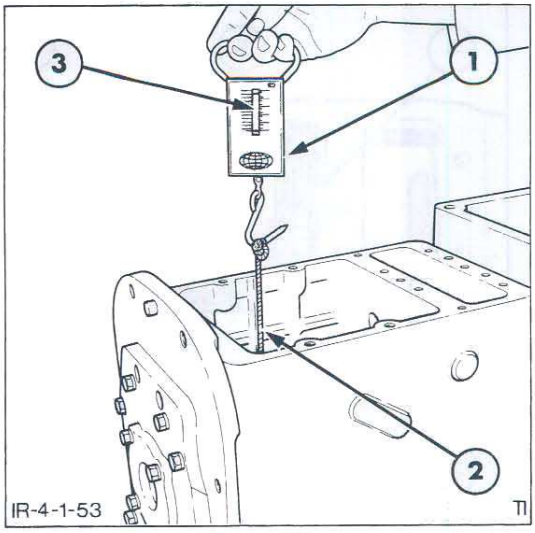


Figure 61
Countershaft Pre-Load Check

1. Pull Scale
2. Cord
3. Scale

4. Ensure the countershaft bearing cap attaching bolts are tightened to the specified torque, see "Specifications" – Chapter 3.

5. Insert a suitable rod through the bearing cap hole and into the countershaft assembly, Figure 60.

6. Position the rear cover to the transmission case while lifting the countershaft with the rod.

7. Secure the rear cover to the transmission case and tighten the retaining bolts to the specified torque, see "Specifications" – Chapter 3.

8. Rotate the countershaft assembly until the bearings run smoothly.

9. Using a suitable length of cord and a pull scale as shown in Figure 61, wrap the cord around the countershaft just ahead of the helical gear, Figure 60. Ensure that the cord does not overlap.

10. If the pull required to rotate the countershaft is outside the specified limits, see "Specifications" – Chapter 3, remove the rear cover and bearing cap and add or delete shims as required and repeat the procedure.

11. When the pre-load check is complete remove the rear cover.

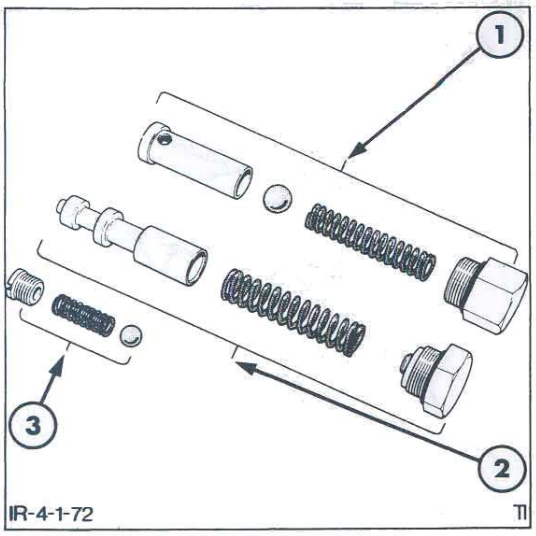


Figure 81
Transmission Hydraulic Valves

1. By-Pass Valve
2. Regulating Valve
3. Lubrication Valve

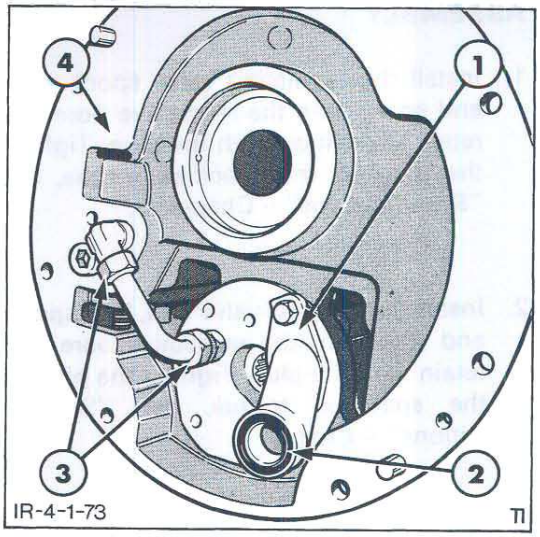


Figure 82
Transmission Pump Connections

1. Suction Tube
2. Seal
3. Pressure Tube Connections
4. Distributor Housing

4. Inspect the front cover torque convertor oil seal for damage. Do not remove the oil seal unless the seal is damaged. If damaged, remove the snap ring and drive the seal from the cover with a suitable punch and hammer.

5. Inspect the stator support gear and bearing for wear or damage. Check the seal rings for wear, nicks or other damage.

6. Disassemble the hydraulic pump, if not already disassembled, and inspect the inner and outer rotors for scratching and scoring or excessive wear.

7. Inspect the by-pass valve seat and ball for scratches and pitting, Figure 81. If scratch marks cannot be removed by polishing, install new parts during assembly. Check the spring and if suspect measure the spring, see "Specifications" – Chapter 3.

8. Inspect the regulating valve spool, Figure 81 for excess wear, grooves or scratches that may cause the spool to malfunction. If scratch marks cannot be removed by polishing, install new parts during assembly. Check the spring and if suspect, measure spring dimensions, see "Specifications" – Chapter 3.

9. Inspect the oil distributor housing for cracks and check the valve bores for wear or scoring. Check the pressure pipes connections are tight and renew the suction pipe seal on assembly, Figure 82.

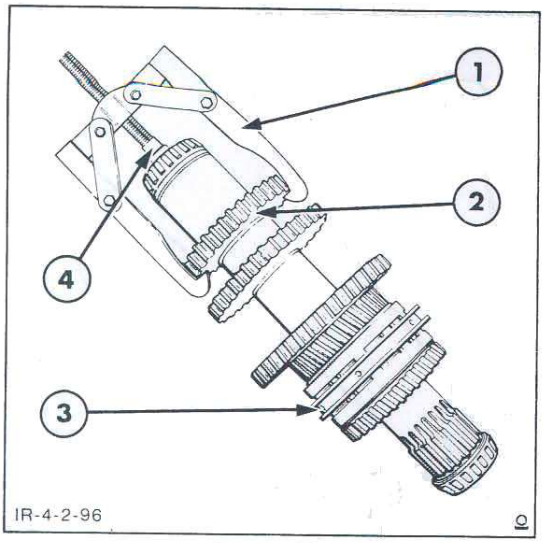


Figure 97
Countershaft Disassembly

1. Puller, Tool No. 1003 or 9516
2. Gear Cluster
3. 1st/2nd Synchroniser
4. Shaft Protector, Tool No. 625A or 9212

4. Remove the snap ring retaining the 1st/2nd gear coupler and remove the coupler thrust washers and 2nd gear from the gear cluster.

5. Normally, the countershaft rear bearing, Figure 98, need not be removed, however, if the bearing is worn or damaged it can be removed with a punch and hammer. If the bearing is removed, a new one must be installed as the cage will be damaged during removal.

NOTE: *If the countershaft rear bearing is replaced, the countershaft bearing cap must also be replaced.*

INSPECTION

1. Thoroughly clean the countershaft components, Figure 98, with suitable solvent, then blow dry with compressed air. Do not spin the bearings with compressed air.

2. Check the front and rear bearings for smooth rotation. If the bearings are worn, install new bearings during assembly.

3. Inspect the countershaft gears for cracks, burrs, or chipped teeth. Remove burrs with fine emery cloth or a fine stone. If the gears are chipped or cracked, new gears should be installed.

4. Place the gear on the countershaft and check for excessive play between the gear bushing and shaft. If the play feels excessive a new gear should be installed, as the bushing is not serviced separately.

5. Inspect the synchroniser assembly for scoring, cracks or excessive wear. Check the pins, springs and balls for wear or cracks. If any components of the synchroniser are damaged the complete assembly will require renewal as the components are not serviced separately.

B. SPECIFICATIONS

LUBRICANT

Capacity ..... 31.7 Imp. Pts. (18 litres) (38 U.S. Pts.)

For lubricant viscosity and type refer to the Ford Tractor Loader Backhoe Operators Manual.

SEALANT

Gasket Sealant ..... Ford Specification ESE – M4G234A1 (Loctite 515)

Thread Sealant ..... Ford Specification SJ-M4G9102A (Loctite 572)

GEAR RATIOS

Synchronised 4 × 4 Transmission

1st	4.2656:1	R1	4.2875:1
2nd	2.5:1	R2	2.508:1
3rd	1.2735:1	R3	1.28:1
4th	0.7281:1	R4	0.7318:1

Synchronised 8 × 8 Transmission

1st	7.9608:1	R1	8.0016:1
2nd	5.3724:1	R2	5.4000:1
3rd	3.5265:1	R3	3.5446:1
4th	2.4014:1	R4	2.4137:1
5th	2.2574:1	R5	2.2690:1
6th	1.5234:1	R6	1.5313:1
7th	1.0000:1	R7	1.0051:1
8th	0.6810:1	R8	0.6844:1

BY-PASS VALVE SPRING

Outside Diameter	0.543 in.	(13.8 mm)
Free Length (Approx)	2.610 in.	(66.3 mm)
Maximum Solid Height	1.205 in.	(30.6 mm)
Height Under Load 8.6 kg	1.811 in.	(46.0 mm)

REGULATING VALVE SPRING

Outside Diameter	0.610 in.	(15.5 mm)
Free Length (Approx)	2.717 in.	(69.0 mm)
Maximum Solid Height	1.181 in.	(30.0 mm)
Height Under Load 6.83 kg	2.205 in.	(56.0 mm)

CLUTCH PISTON SPRING

Outside Diameter	3.012 in.	(76.5 mm)
Free Length (Approx)	2.362 in.	(60.0 mm)
Maximum Solid Height	1.043 in.	(26.5 mm)
Height Under Load 114.6 kg	1.181 in.	(30.0 mm)

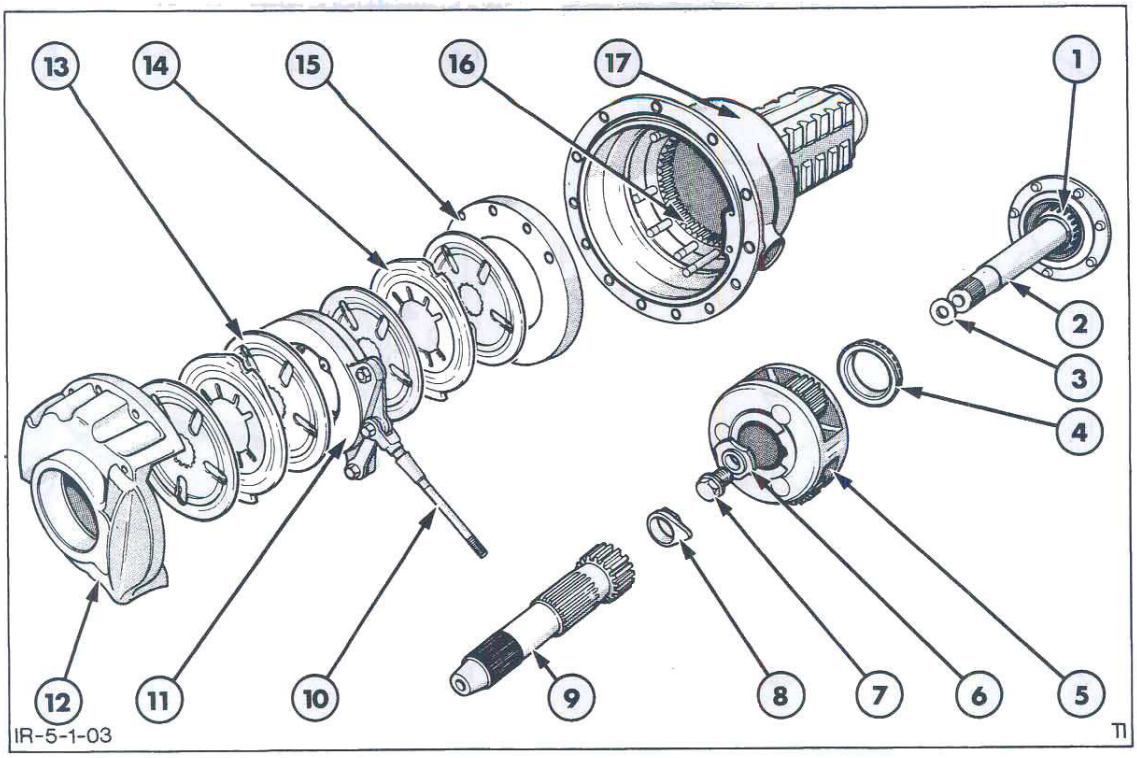


Figure 3
Axle Housing Assembly – Exploded View

1. Axle Shaft Outer Bearing
2. Axle Shaft
3. Spacer
4. Bearing
5. Planet Gear Carrier
6. Retaining Washer
7. Retaining Bolt
8. Lock Plate
9. Sun Gear and Shaft
10. Brake Actuating Rod
11. Brake Actuating Discs
12. Inner Brake Housing
13. Rotating Brake Discs
14. Fixed Brake Discs
15. Outer Brake Housing
16. Ring Gear
17. Axle Housing

DISASSEMBLY

1. Remove the large 'O' ring seal from the axle housing.

2. Left Hand Axle Housings – Remove the two bolts securing the differential ring gear thrust block to the axle housing and remove the thrust block.

   Right Hand Axle Housing – Remove the differential lock fork by loosening the differential lock fork screw and locknut Figure 4 and remove the differential lock lever shaft.

3. Remove the eight nuts that retain the inner disc brake housing assembly in the axle housing. Lift the brake housing out of the axle housing.

4. Remove the brake control rod fastener. Remove the brake rod seal if damaged. To remove the seal, place a sharp tool between the seal flange and the rear axle housing and pry the seal out. Remove the brake disc assemblies, intermediate discs, and actuating disc assembly.

INSPECTION AND REPAIR

1. Inspect the steel fixed plates for wear and warp. The inspection should include the inner and outer brake housings. Replace parts which are scored or warped.

2. Inspect the rotating discs for wear and warp. Replace the discs if the friction material has worn to the bottom of any grooves, or if the plates are warped more than maximum specified – see 'Specifications', Chapter 3.

3. Replace the actuating rod seal.

RE-ASSEMBLY

1. Place one actuating disc with the pockets uppermost on a flat surface and position a steel ball in each pocket.

2. Position the other actuating disc over the first with the pockets locating on the steel balls. The actuating lugs should be approximately 1 in. (25.4 mm) apart.

3. Install the four actuating disc return springs on the lugs on the inner edge of the actuating discs.

4. Install the actuating links and secure using the clevis pins, cotter pins and nuts.

INSTALLATION

1. Install the brake actuating assembly and disc assemblies as described in Section B.

2. Install the axle housing to the rear axle centre housing, and install the rear axle assembly as described in PART 10.

3. Reconnect the brake actuating linkage and adjust the brake linkage as described in PART 10.

E. DIFFERENTIAL AND DIFFERENTIAL LOCK ASSEMBLY – OVERHAUL

REMOVAL

1. Remove the left hand axle housing as described in Section B and lift out the differential assembly.

DISASSEMBLY

1. Remove the differential lock ring that secures the sliding coupling to the side gear. Remove the stop washer, sliding coupling, coupling spring and gear case adaptor, Figure 20.

2. Mark the two halves of the differential case so that the two halves may be reassembled in the same relative position.

3. Loosen the securing bolts and separate the two halves of the differential case as the bolts are loosened.

4. Remove the bolts which secure the differential ring gear to the differential case and separate the ring gear from the case.

INSPECTION AND REPAIR

1. Thoroughly clean and inspect all parts. Install new parts where worn or damaged.

NOTE: *If a new differential ring gear is installed a new drive pinion must also be fitted as outlined in Section F.*

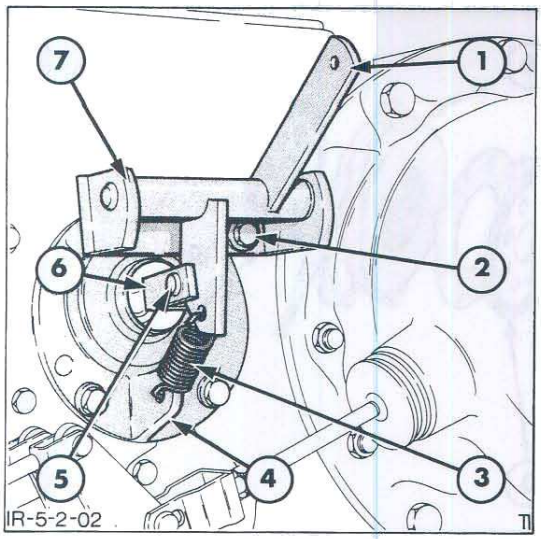


Figure 2
Bellcrank and Linkage

1. Bellcrank
2. Bracket Securing Bolts
3. Return Spring
4. Cover
5. Clevis Pin
6. Actuating Rod Clevis
7. Bellcrank Bracket

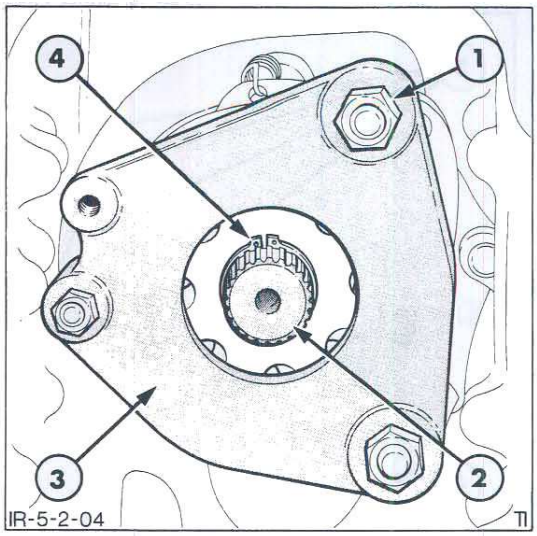


Figure 4
Front Reaction Plate

1. Securing Nut
2. Drive Pinion Shaft
3. Front Reaction Plate
4. Snap Ring

6. Remove the nuts that retain the front reaction plate, Figure 4. Disassemble the front reaction plate, brake discs and actuating plates from the drive pinion shaft after removing the snap ring.

7. Remove the rear reaction plate retainer bolts, Figure 5, and separate the rear reaction plate from the centre housing.

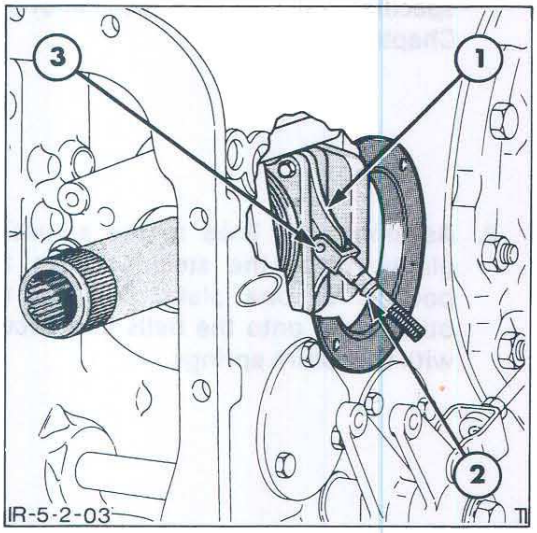


Figure 3
Handbrake Actuating Linkage

1. Actuating Link
2. Actuating Rod
3. Actuating Rod Clevis Pin

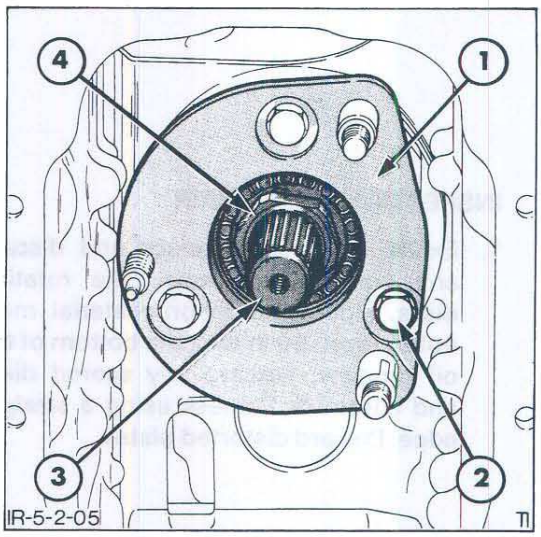


Figure 5
Rear Reaction Plate

1. Rear Reaction Plate
2. Securing Bolt
3. Drive Pinion Shaft
4. Bearing Pre-Load Adjuster

PART 6
POWER TAKE-OFF

Chapter 1
INDEPENDENT P.T.O. – FORD 455C

A. I.P.T.O. – DESCRIPTION AND OPERATION

The drive for the independent power take-off (I.P.T.O.) as featured for the Ford 455C Tractors with 8 × 8 transmission, is taken from transmission hydraulic pump driven gear, Figure 1.

A gear on the stator support, driven by the rear hub of the torque converter, drives the driven gear. The driven gear incorporates a splined centre for the I.P.T.O. counter shaft to engage.

The I.P.T.O. countershaft transmits the drive through the hollow transmission countershaft to the rear of the front transmission assembly. The I.P.T.O. countershaft is splined at the rear end to accept the hydraulic pump drive gear and the I.P.T.O. clutch input shaft.

The independent P.T.O. is controlled by an hydraulically operated clutch assembly located on and between the clutch input shaft and the rear shaft.

The clutch assembly comprises 7 internally splined sintered bronze drive plates, mounted on the clutch shaft hub, and sandwiched between these plates are 7 driven steel plates, which together with a pressure plate are externally splined to the clutch housing.

The I.P.T.O. rear shaft, which protrudes from the rear of the tractor, is splined into the rear of the clutch housing and is externally guarded by a screw-on cap. A piston, located within the clutch housing to the rear of the plates, is retained in the disengaged position by a spring, washer and snap ring.

Mounted on the rear of the I.P.T.O. clutch is a brake and support assembly. The brake is controlled by a double sided piston assembly. When the brake is applied a brake pad is forced against the I.P.T.O. clutch housing to stop the rotation of the P.T.O. shaft. When the I.P.T.O. clutch is engaged the brake is automatically released.

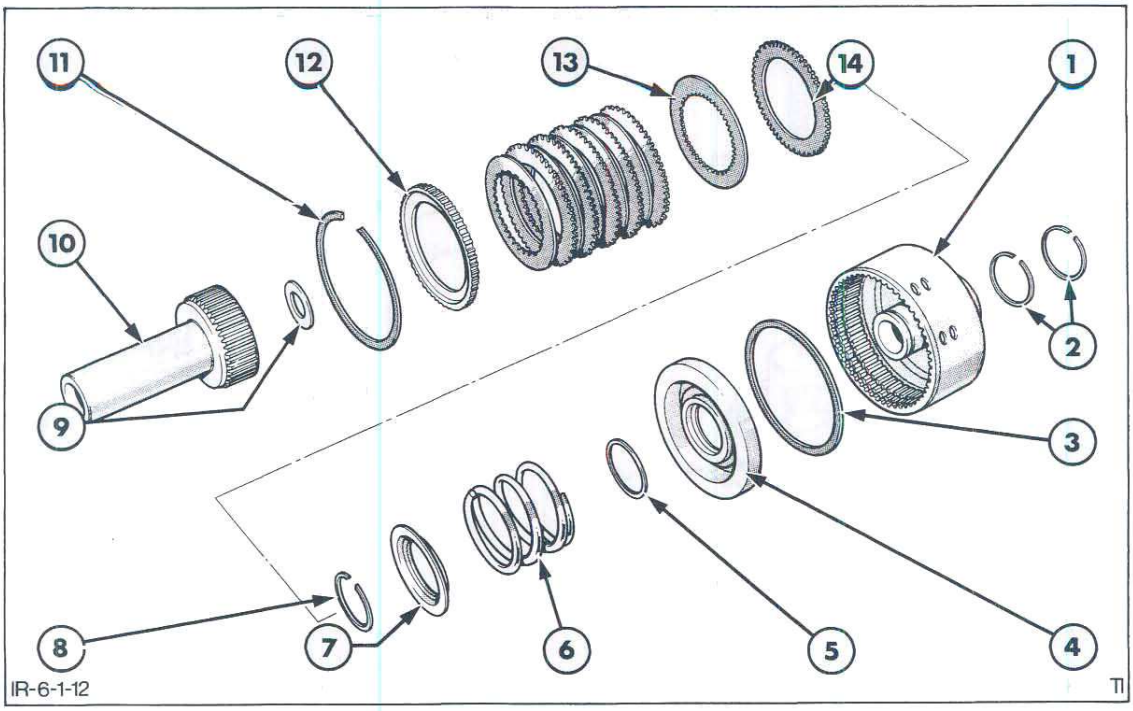


Figure 12
I.P.T.O. Clutch Assembly

1. Housing
2. Housing Sealing Rings
3. Outer Piston Sealing Ring
4. Piston
5. Inner Piston Sealing Ring
6. Piston Spring
7. Spring Retaining Washer
8. Snap Ring
9. Thrust Washer
10. Clutch Drive Coupling
11. Snap Ring
12. Pressure Plate
13. Drive Plate
14. Driven Plate

I.P.T.O. CLUTCH AND BRAKE ASSEMBLY

REMOVAL

1. Separate the tractor between the front and rear transmission assemblies, see "SEPARATING THE TRACTOR" – Part 10.

2. Remove the hydraulic pump, see Section H in this Chapter.

3. Remove the retaining bolts and withdraw the hydraulic pump inlet filter and tube assembly.

4. Extract the bolts and withdraw the I.P.T.O. shaft bearing and plate assembly and shaft from the rear of the tractor.

5. Withdraw the clutch drive coupling and disconnect the tube connection to the clutch support from the control valve. Disconnect from the pressure regulating valve the tube that is located under the clutch support connecting to the brake cylinder.

6. Remove the clutch pack and brake support as an assembly.

DISASSEMBLY

I.P.T.O. Clutch

With reference to Figure 12.

1. Separate the brake and support assembly from the clutch by pulling the support off the rear of the clutch.

2. Remove the snap ring which retains the pressure plate in the clutch housing then withdraw the drive and driven plates.

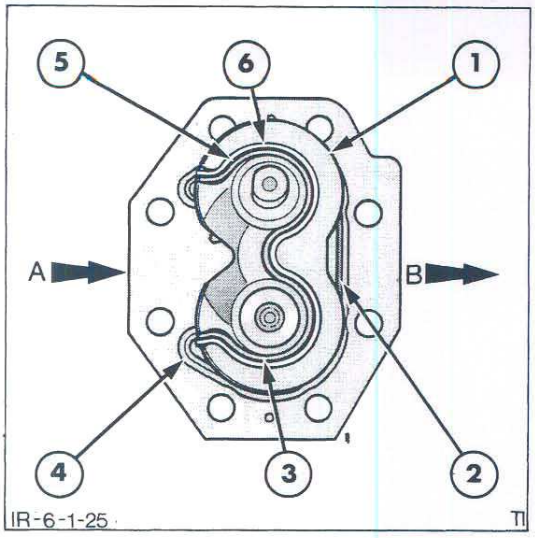


Figure 25
Position of Sealing Rings and Relationship of Bearings to Inlet Side of Body

A. Inlet B. Outlet

1. Relieved Radius on Outlet Side of Pump
2. Pressure Loading Seal
3. Back Up Strip
4. Seal Back Up Ring
5. Pressure Loading Strip
6. Back Up Strip

- Coat the seal lip with grease

- If the pump is not to be re-used immediately, the ports should be capped.

INSTALLATION

Installation of the transmission mounted gear type pumps follows the removal procedure in reverse.

IMPORTANT: *Prior to installation on the tractor, introduce hydraulic oil into the suction port and rotate the gears by hand.*

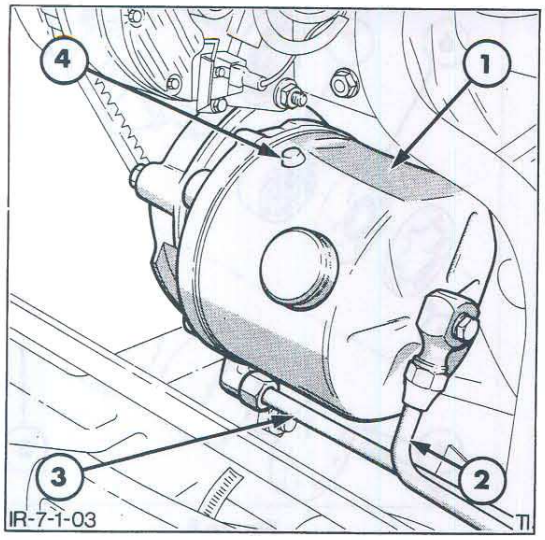


Figure 2
Steering Pump and Reservoir Installation

1. Reservoir
2. Inlet Tube – Low Pressure
3. Outlet Tube – Pressurised
4. Breather

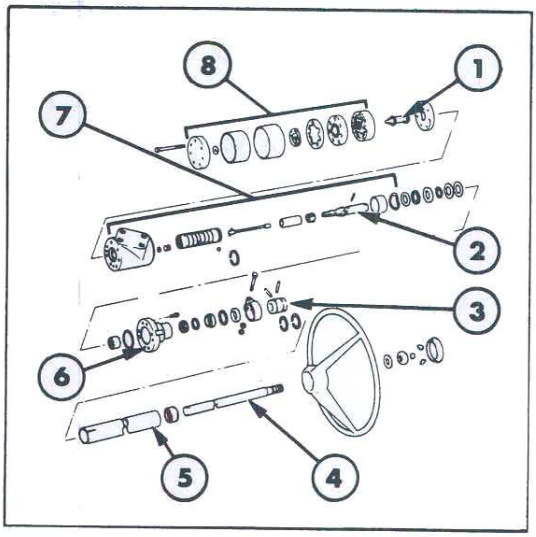


Figure 3
Steering Motor Assembly

1. Drive Link
2. Input Shaft
3. Coupling
4. Steering Column Shaft
5. Outer Tube
6. Top Cover
7. Linear Control Valve
8. Metering Valve

POWER STEERING PUMP AND RESERVOIR

The integral power steering pump and reservoir, Figure 2 are mounted on the engine front cover plate on the left hand side of the engine. The pump and reservoir are connected to the steering motor by two tubes.

The gear type pump is driven anti clock-wise by the camshaft gear. The pump driven gear is half the diameter of the camshaft drive gear, thus the pump is driven at engine speed. Pump output is 3.0 Imp. Gal. per minute (3.6 U.S. Gal. per minute) (13.65 litres per minute) at 1000 rev/min and a pump delivery pressure of 1525 lbf/in² (105 bar).

STEERING MOTOR

The hydrostatic steering motor, Figure 3 utilises a linear control valve to control the direction of the steered wheels and a metering unit to control the rate of turn. In the event of pump failure the wheels can be turned manually with the metering unit functioning as a hydraulic pump.

Port identification on the motor is cast in raised letters on the valve housing. The pressure port is identified 'IN' the return port 'OUT' the right turn port 'RT' and the left turn port 'LT'.

CONTROL VALVE SECTION

The control valve section, Figure 4, directs the hydraulic oil to and from the metering unit and steering cylinder, and regulates the pressure of the oil flowing to the steering cylinder. The lower end of the input shaft is bored to receive the top of the torsion bar. The torsion bar is pinned to the input shaft, extends through the spool and is linked with the drive link in the metering system. The drive link is splined to and turns the rotor in the stator assembly. Thus, the torsion bar is the principal link between the input shaft and the metering system.

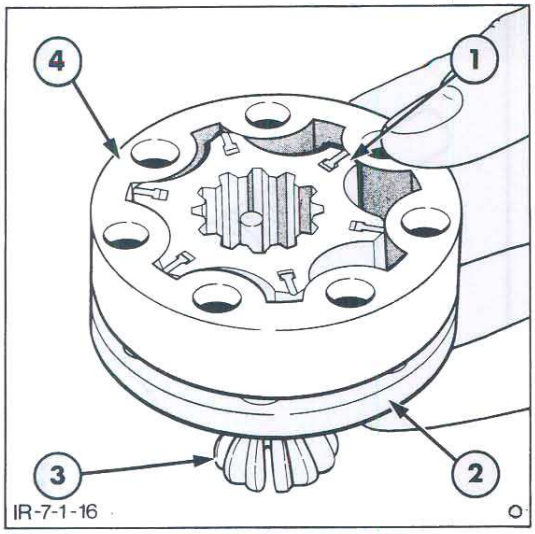


Figure 17
Metering Element

1. Rotor
2. Spacer
3. Drive Link
4. Stator

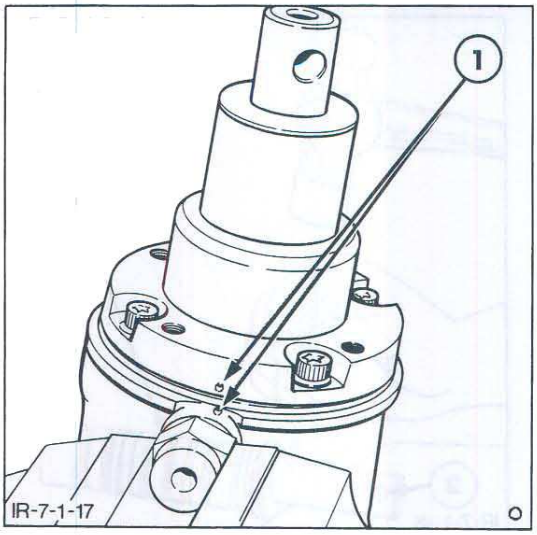


Figure 18
Steering Motor Input Shaft

1. Alignment Marks

8. Grasp the spacer then slide and lift the metering element, spacer and drive link as an assembly, from the valve housing, Figure 16.

9. Separate the drive link by sliding the metering element on the spacer and allowing the drive link teeth to clear the spacer hole. Remove the drive link and separate the metering element from the spacer. Use extreme caution to stop the vanes and springs from falling out. When handling the metering element, pressure should be applied to the rotor by gripping the metering element between the fingers and pressing the rotor into contact with the stator, Figure 17.

NOTE: *The rotor and stator must be kept in a matched set. Protect against damage to the side faces.*

10. Reverse the unit in the vice with the input shaft in a vertical position. To facilitate re-assembly, use a centre punch to mark the upper cover assembly and the port face of the housing, Figure 18.

11. Remove the four special cap screws with a $^{5}/_{16}$ inch 12-point socket.

12. Grasp the input shaft and, with a smooth upward motion, remove the input shaft, upper cover and spool assembly from the valve body.

NOTE: *Do not apply side forces to the spool which will cause binding of the closely fitted assembly. Never use excessive force to remove the spool from the body.*

13. Remove and discard the seal.

C. POWER STEERING PUMP AND RESERVOIR – OVERHAUL

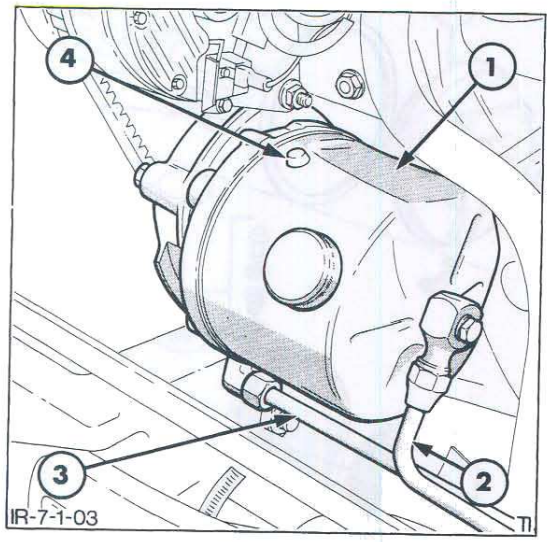


Figure 34
Steering Pump and Reservoir Installation

1. Reservoir Filler Cap
2. Inlet Tube – Low Pressure
3. Outlet Tube – Pressurised
4. Breather

REMOVAL

1. Support a suitable container under the pump and reservoir assembly.

2. Disconnect the pump pressure and return tube and allow the oil to drain. Refer to Figure 34.

3. Plug the disconnected tubes and ports to prevent the entry of dirt.

4. Extract the bolts retaining the pump in the timing gear casing.

5. Remove the pump from the Unit and drain the remaining oil from the reservoir.

DISASSEMBLY

Refer to Figure 35 for Component Identity.

1. Remove the reservoir retaining bolt and pull off the reservoir casing. Discard the large 'O' ring seal and filter element.

2. Straighten the tab on the lockwasher locating the drive gear retaining nut. Remove the nut, lockwasher and drive gear.

3. Remove the key from the drive gear shaft.

4. Withdraw the pressure relief valve from the pump body.

5. Remove the four bolts and separate the pump end cover and pump flange from the pump body.

6. Noting their positions relative to the pump body for re-assembly, remove the bearing blocks and pump gears.

7. Remove the snap ring retaining the drive shaft oil seal in the pump flange and extract the oil seal.

INSPECTION AND REPAIR

1. Clean all parts in a suitable solvent and air dry. Lightly oil machine surfaces. Keep disassembled parts in position to facilitate assembly.

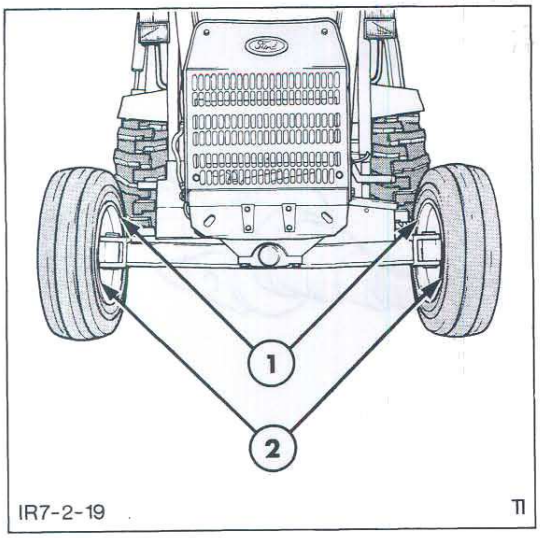


Figure 2
Front Wheel Toe-in Measurements

1. Rear Track Width (Dimension B)
2. Front Track Width (Dimension A)

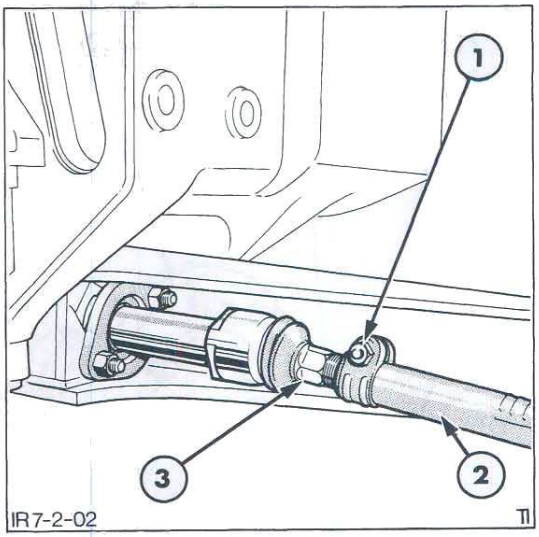


Figure 3
Track Control Rod Adjustment

1. Clamp Bolt
2. Track Control Rod
3. Hexagon Adjuster

5. Again measure and note the distance between the two marks, call this dimension B.

NOTE: *If dimension A is larger, then A-B gives the toe-out. If dimension B is larger, then B-A gives the toe-in.*

For specified toe-in see "Specifications" – Chapter 5.

To ensure accurate results it is recommended that the above procedure is completed three times with three different marks equally spaced around each wheel rim and the average dimension for toe-in calculated.

This method minimises any inaccuracy due to wheel rim run-out.

If the toe-in is not correct, make the adjustments outlined as follows:

1. Loosen the clamp bolt on each track control rod, Figure 3.

2. Rotate the hexagon adjuster in order to achieve the specified toe-in. Ensure that this adjustment is carried out equally on both track rods.

3. After the correct toe-in is obtained, tighten the clamp nuts.

4. Re-check the toe-in as outlined above and readjust if necessary.

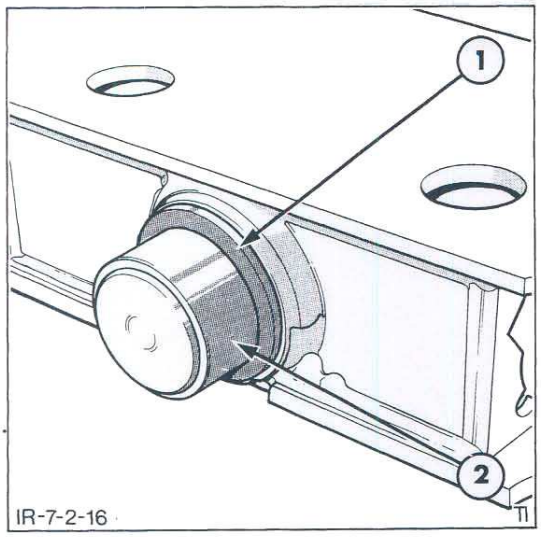


Figure 19
Trunnion Bush and Thrust Washer

1. Thrust Washer
2. Bush

3. Examine the oscillation bearing cap locating dowells for damage. During axle removal the dowells may remain in either the bearing cap or front support.

4. Inspect the front axle body for cracks or damage. If the axle structure is damaged it is necessary to install a new axle.

INSTALLATION

1. Position the thrust washers on both axle trunnions.

2. Locate the dowells in the front support.

3. Position the oscillation bearing caps onto the axle trunnions and using suitable lifting equipment locate the axle beneath the vehicle. Position the bearing caps onto the locating dowells in the front support and install the retaining bolts. Tighten the bolts to the correct torque, see "Specifications" – Chapter 5.

4. Reconnect the steering hoses using the removal procedure in reverse and tighten the joints to the correct torque.

5. Attach the wheel and tyre assemblies to the wheel spindles and tighten the nuts to the correct torque, see "Specifications" – Chapter 5.

6. Fill the power steering reservoir with the correct grade of oil, see "Specifications" – Chapter 5, and purge the air from the steering system as described in Chapter 1 Section F "BLEEDING THE STEERING SYSTEM".

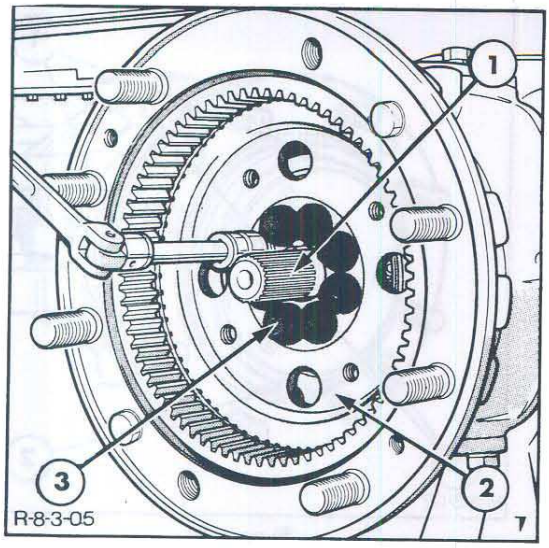


Figure 16
Tightening Ring Gear and Carrier Assembly Retaining Bolts

1. Axle Shaft
2. Ring Gear and Carrier
3. Retaining Bolts

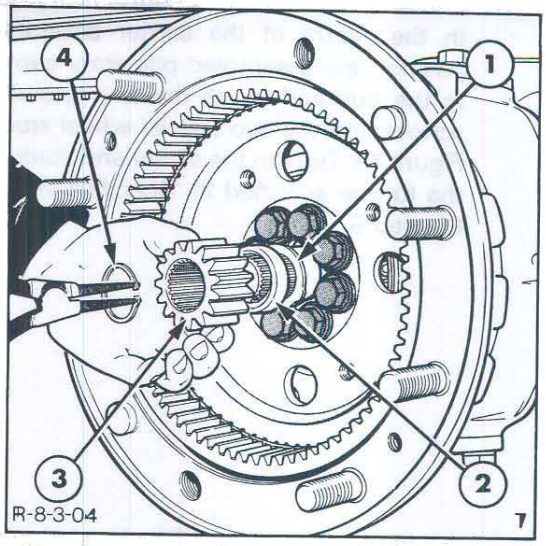


Figure 17
Installing Sun Gear Components

1. Thrust Washer
2. Spacer
3. Sun Gear
4. Snap Ring

2. Lubricate the oil seal journal area with grease, as specified in 'Specifications' – Chapter 5 and carefully assemble the hub to the swivel assembly.

3. Supporting the hub, slide in the outer bearing, maintain the hub in this position whilst fitting the ring gear and carrier.

NOTE: *The hub bearings and the machining of the hub housing and swivel stub are held to fine limits and bearing pre-load/rolling resistance adjustment is not necessary.*

4. Assemble the ring gear carrier to the ring gear with the wire type locking rings. Ensure that the rings have not been deformed or damaged during disassembly.

5. Bolt the ring gear and carrier assembly to the swivel casing, ensuring that the single large bushing is correctly positioned, Figure 16. Tighten the bolts, as specified, evenly in three stages, see 'Specifications' – Chapter 5.

6. Install the sun gear/axle shaft thrust washer, spacer and sun gear, Figure 17. Lock the sun gear to the axle shaft using a new snap ring.

7. Coat the mating surfaces of the planetary carrier and the hub with sealant as specified in 'Specifications' – Chapter 5.

7. Remove the swivel pins and the 1.00 mm (0.040 in) shim from the lower pin and install the calculated shim value to each swivel pin. Re-tighten to the specified torque, see 'Specifications' — Chapter 5.

8. Grease the swivel pins with grease as specified in 'Specifications' — Chapter 5.

9. Re-install the axle shaft thrust washer spacer and sun gear. Lock the sun gear to the axle shaft using a new snap ring and re-assemble the planetary gear carriage to the hub assembly following the removal procedure in reverse.

10. Fill the hub with the specified oil as detailed under the heading — "PLANETARY REDUCTION ASSEMBLY AND WHEEL HUBS".

11. Reconnect the track rod end to the steering arm and tighten the retaining bolt to the specified torque, see 'Specifications' — Chapter 5.

E. STEERING CYLINDER AND TRACK CONTROL ROD OVERHAUL

REMOVAL

1. Position the unit on a hard level surface.

2. Thoroughly clean the area around the cylinder to prevent contamination of the steering system during removal.

3. Disconnect the hydraulic steering connections to the cylinder, Figure 40 and cap the open ends of the connections. Remove the hose clip securing the tubes to the cylinder.

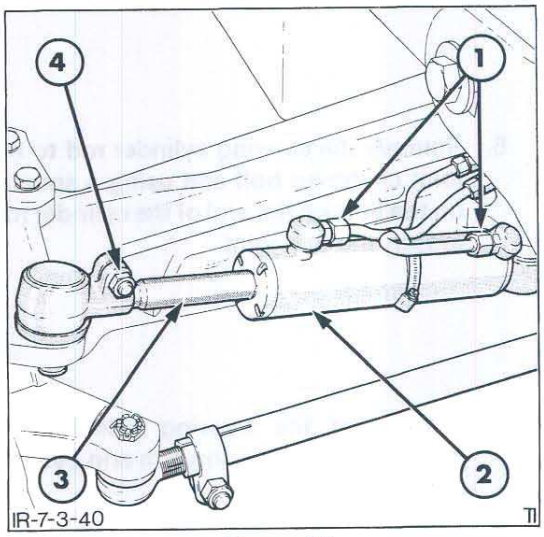


Figure 40
Steering Cylinder Installation

1. Hydraulic Steering Connections
2. Steering Cylinder
3. Cylinder Rod
4. Ball Joint Clamp Bolt

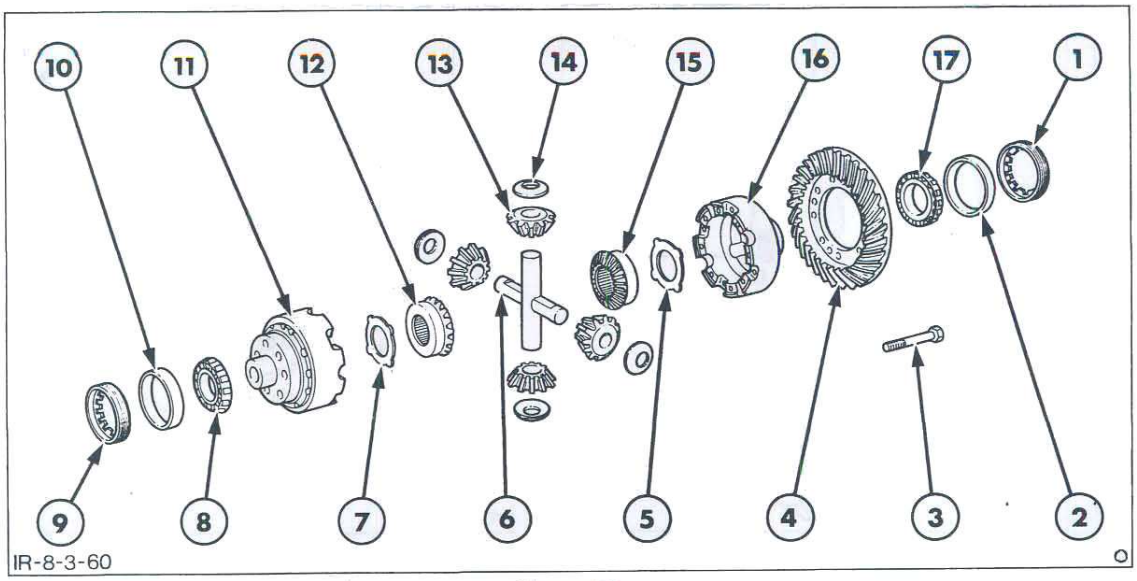


Figure 60
Differential and Crown Wheel Assembly — Exploded View

1. Adjuster Ring
2. Bearing Track
3. Bolt
4. Crown Wheel
5. Thrust Washer
6. Shaft
7. Thrust Washer
8. Bearing
9. Adjuster Ring
10. Bearing Track
11. Differential Housing
12. Side Gear
13. Bevel Gear
14. Thrust Washer
15. Side Gear
16. Differential Housing
17. Bearing

12. Prise the bevel gear shafts from the separated differential housing and collect the four bevel gears and thrust washers and two side gears and thrust washers.

13. Drive the pinion from the differential support housing and collect the collapsible spacer and outer bearing inner race Figure 61.

INSPECTION AND REPAIR

1. Clean all the components in a suitable solvent and allow to air dry.

2. Clean the differential support housing mounting face and the mating face of the axle casing, remove all traces of sealant.

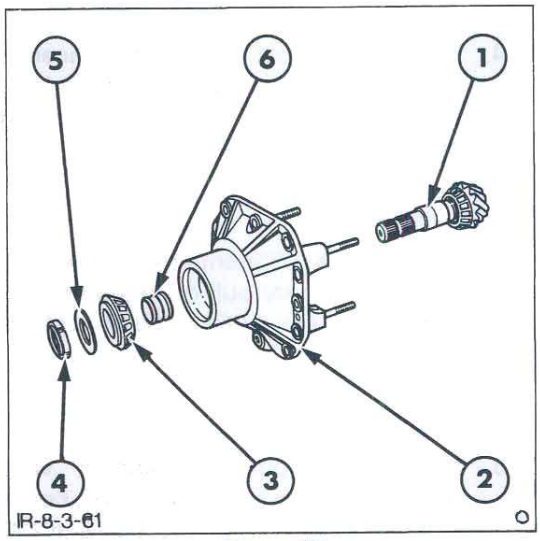


Figure 61
Drive Pinion Removed from Differential Support Housing

1. Pinion and Bearing
2. Support Housing
3. Outer Bearing
4. Retaining Nut
5. Tabbed Washer
6. Collapsible Spacer

PART 7
STEERING AND FRONT AXLE

Chapter 4
TRANSFER GEAR ASSEMBLY

A. TRANSFER GEAR ASSEMBLY — DESCRIPTION AND OPERATION

The front wheel drive on the Ford 455C, 555C and 655C tractors is taken via a transfer gear assembly housed in the transfer case located at the base of the rear axle centre housing, Figure 1.

The transfer gear assembly transmits the drive from the rear axle centre housing to the drive shaft which is located under the tractor and protected by a guard. The drive shaft connects directly to the pinion in the front axle.

A gear on the rear axle pinion drives the train of two gears inside the transfer case. The second gear in the train is connected to the transfer gear output shaft via a sliding dog clutch assembly, actuated by the spring loader selector lever mechanism.

The front wheel drive can be engaged and disengaged under all normal operating conditions using the selector lever located on the right-hand side of the operator on the side of the instrument console. The front wheel drive is engaged when the selector lever is in the up position and disengages when the lever is in the down position.

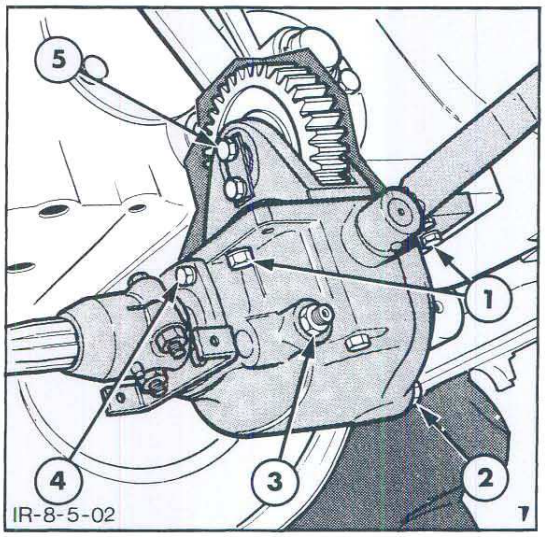
Moving the selector lever to engaged position (up) moves the selector fork operating the sliding coupling/dog clutch rearwards. Should a tooth to tooth situation occur on the dog clutch the rear springs in the sliding coupling will be loaded trying to force the shift gear half of the clutch rearwards. As the driving gear rotates the dog clutch teeth will move relative to one another and the springs will ensure full engagement takes place.

6. Position the selector lever in the disengaged, lower position. Ensure the transfer case actuating lever is in the disengaged position. Adjust the cable locknuts so that when the selector lever is operated the lever does not hit the console lower panel in either the engaged or disengaged position.

7. Tighten the locknuts to the specified torque, see "Specifications" – Chapter 5.

TORQUE SPECIFICATIONS
TRANSFER GEAR ASSEMBLY

Fig Ref.	Nm	Kgf.m	lbf.ft
1	48	4.9	35.5
2	60	6.0	44.0
3	87	8.8	64.0
4	24	2.4	17.5
5	24	2.4	17.5



E. SPECIAL TOOLS

Fixture – Crown Wheel and Pinion Bevel Setting	FT.3135	4775
Oil Seal Installer – Axle Shaft (Swivel Casing)	FT.3162	307972
Oil Seal Installer – Axle Shaft (Centre Casing)	FT.3162	307972
Oil Seal Installer – Differential Pinion	FT.3162	307972
Bushing Installer – Axle Shaft (Swivel Casing)	FT.3164	307974
Bushing Installer – Axle Shaft (Centre Casing)	FT.3165	307975
Wrench – Differential Pinion Bearing Nut	FT.3168	307978
Steering Cylinder 'C' Spanner	FT.8554	–
Driver Handle	550	–
Slide Hammer	943	9507
Slide Hammer Puller	943S	9567
Puller Attachment	951	9190
Slide Hammer	954C	9508
Puller	1003	9516

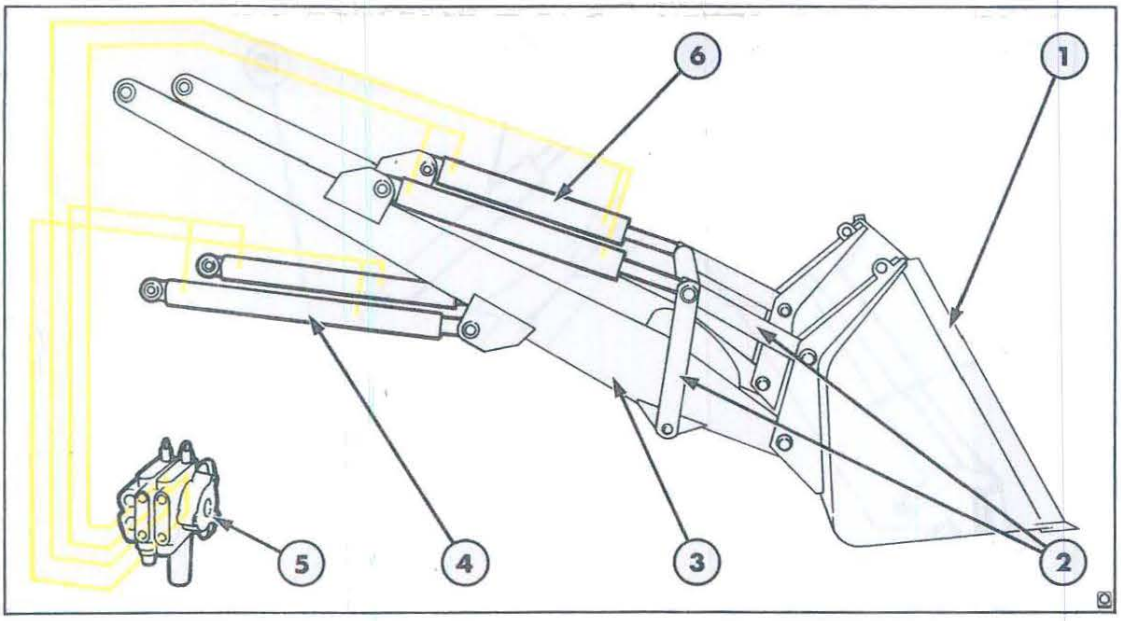


Figure 2
Loader Assembly and Hydraulic Circuit Schematic

Element Operating Oil

1. Loader Bucket
2. Idler and Bucket Attaching Links
3. Loader Frame
4. Loader Lift Cylinder
5. Loader Main Control Valve
6. Bucket Cylinder

Figure 3 shows the major components and backhoe digging and slewing circuits linked to the backhoe main control valve. Each of the numbered paragraphs that follow relate directly to the key numbers in the illustration.

1. The mainframe is bolted to the subframe and supports the backhoe digging elements. The illustration represents a side shift model and, as its name suggests, allows the digging elements, which on this model are attached to the mainframe through a movable carriage, to shift side to side to enable parallel digging to a wall or fence for example. A second type, termed the centre pivot, has a different mainframe and again as the name suggests, pivots about the centre only. The side shift design is not available on 455C loader/backhoe tractors.

2. The carriage, on the side shift models only, is hydraulically clamped to the mainframe by four single acting small cylinders. The carriage carrying the swing post and digging elements can be transported across the mainframe by releasing the clamp cylinders and actuating the digging elements at right angles to the mainframe.

3. The swing post, dependent on model design (side shift or centre pivot) is pinned to the carriage or in the vertical plane and carries the base of the boom horizontally pivoted at its lower level. At the upper level the lift cylinder is attached. The distance between each pivot provides sufficient mechanical advantage to raise and lower the boom at maximum and minimum travels.

- Fill the reservoir with the correct grade and quality of oil, see 'Specifications' – Chapter 11.

- Upon completion of the installation, start and idle the engine for several minutes. Examine hose and tube connections for hydraulic leaks.

- With the engine switched off, the loader resting on the ground and the backhoe in the transport position, check the oil level with the combined filler cap/dipstick, Figure 8. If necessary, add hydraulic oil as required.

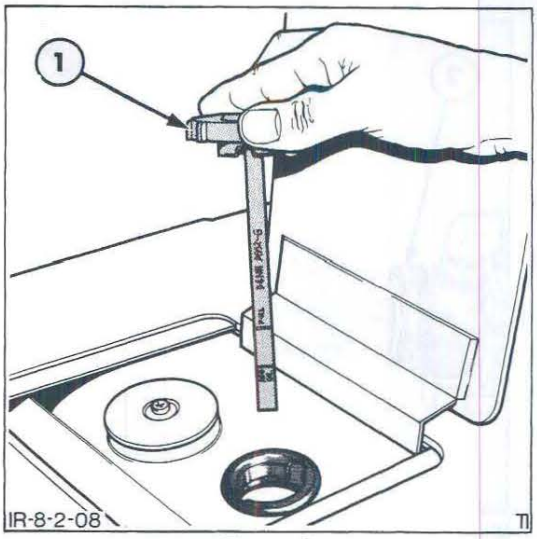


Figure 8
Reservoir Hydraulic Oil Dipstick

1. Dipstick

C. FILTER – OVERHAUL

WARNING: *Ensure the backhoe is supported in the transport position or resting on the ground and that the loader is resting on the ground or supported by the safety support prior to commencing overhaul.*

REMOVAL

NOTE: *The filter element can be removed with the filter body in situ on the unit.*

1. Run the engine until the hydraulic oil is warm.

2. Remove the cab step plate and disconnect the connector for the electrical pressure differential warning switch, Figure 9.

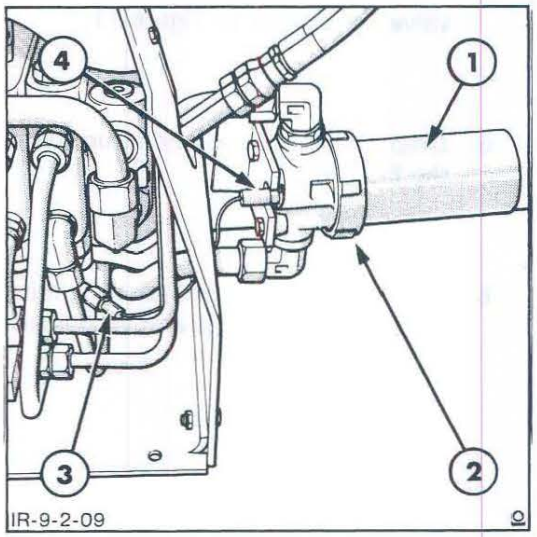


Figure 9
Hydraulic Oil Filter Installation

1. Filter Casing
2. Retaining Ring
3. Electrical Connector
4. Warning Switch

2. Examine the centre section for gear track wear. Light gear track wear is acceptable providing the efficiency of the overhauled pump is greater than 80%.

3. Inspect the bearing surfaces in the front and rear covers for wear.

4. Examine the gears for scored or worn side faces and journals, damaged teeth and surface cracks. Slight wear and scoring on the journals may be erased by mounting between lathe centres and polishing with 'O' grade emery paper lubricated with paraffin.

5. Examine the wear plates for excessive wear.

6. Inspect the pump body for external damage and cracks.

RE-ASSEMBLY

Re-assembly of the hydraulic pump follows the disassembly procedure in reverse.

On re-assembly, observe the following requirements:–

- Lubricate all parts with hydraulic oil.
- Install a new seal kit and coat the drive gear shaft seal with petroleum jelly to prevent damage by the shaft during re-assembly.
- Ensure that the pump body and original wear plates, if replaced, are re-assembled in the same orientation as removed.

INSTALLATION

Installation of the hydraulic pump follows the removal procedure in reverse.

During installation, observe the following requirements:–

- Tighten all bolts to the specified torque, see 'Specifications' – Chapter 11.
- Fill the reservoir with the specified grade and quantity of oil, see 'Specifications' – Chapter 11.
- If applicable, check the transmission oil level and replace any oil lost during oil cooler removal with the specified grade of oil. Refer to relevant section of the Operator's Manual.
- Upon completion of the installation, start and idle the engine for several minutes. Examine hose and tube connections for hydraulic leaks.
- Check the efficiency of the overhauled pump by conducting the pump performance test as described in Part 8, Chapter 10, Section E "Hydraulic Pump Performance Testing". If the efficiency of the overhauled pump is less than 80% then the pump must be replaced for a new unit.
- With the engine switched off, the loader resting on the ground and the backhoe in the tranport position, check the oil level in the reservoir with the combined filler cap/dipstick. If necessary, add hydraulic oil as required.

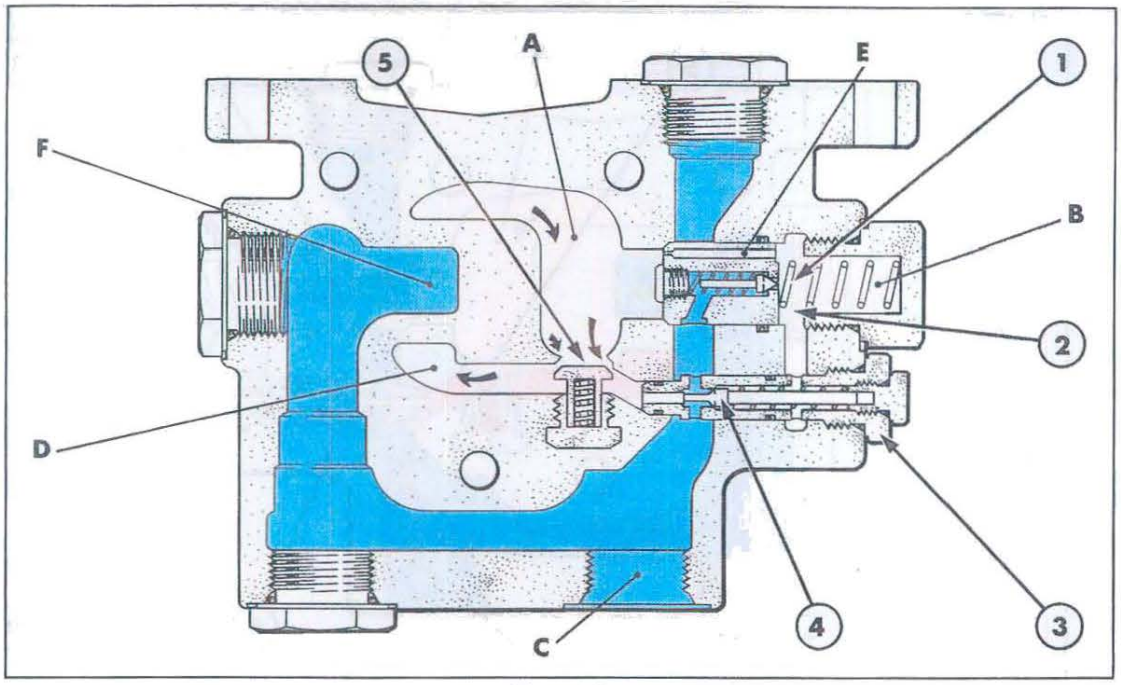


Figure 8
Regeneration Check Valve Operation

Cylinder Exhaust Oil | Cylinder Supply Oil | Return to Reservoir Oil

1. Backpressure Pilot Valve
2. Backpressure Valve
3. Backpressure Unload Valve Body
4. Backpressure Unload Valve
5. Regenerative Check Valve

A Control Valve Exhaust Gallery
B Backpressure Valve Gallery
C Return to Reservoir Port
D High Pressure Parallel Gallery
E Backpressure Valve Pressure Sensing Gallery
F Open Centre Gallery

In the "no load" or "light load" condition the backpressure valve provides backpressure of 250 lbf/in² (17.5 bar) in the exhaust gallery 'A', which is in addition to the natural backpressure in the return to reservoir line.

This backpressure complements the function of the regenerative check valve, provides more positive cylinder control and aids the anti-cavitation function on those circuit-relief valves incorporating the anti-cavitation feature. The operating sequence of the backpressure valve which is controlled by a pilot relief valve (backpressure relief valve) is as follows:

When a cylinder is operated the returning or cylinder exhaust oil passes from the control valve spool section to the exhaust gallery 'A'. Oil in gallery 'A' cannot pass unrestricted to the reservoir return port 'C' without opening the backpressure valve which requires 250 lbf/in² (17.5 bar) opening pressure and consequently creates the backpressure in gallery 'A'.

Exhaust oil in the gallery 'A' initially acts on the face of the backpressure valve which is held on its seat by a spring. Oil is bled through orifice 'E' in the backpressure valve to the rear of the valve and due to the similar surface areas, equalises the pressure differential with the spring maintaining the valve in the closed position.

Backpressure Valve

1. Inspect the seats for nicks or scratches. Minor nicks or scratches can be removed with a fine lapping compound. Care must be taken to prevent the lapping compound from entering and remaining in the outlet end cover.

2. Check the backpressure valve and its bore for scratches and wear or a groove worn by the 'O' ring located in the bore of the end cover. The inner relief valve components are not serviced separately, replace the valve assembly if necessary.

3. Check the spring for "setting" by visually comparing it to a new spring. Install a new spring if necessary.

4. Renew the end plug 'O' ring seal.

Backpressure Unload Valve

NOTE: *Individual parts, except for external 'O' rings and seals are not serviced. The valve is serviced as a pre-set assembly.*

1. Inspect the seats for nicks and scratches. Minor nicks and scratches can be removed with a fine lapping compound; however, care must be taken to prevent the lapping compound from entering and remaining in the outlet end cover.

2. Check the spring for "setting" by visually comparing it with a spring taken from a new "stock" valve. If spring is "set" renew the valve assembly.

3. Remove all 'O' rings and the back-up ring. Replace with new parts.

RE-ASSEMBLY

Pilot Operated With Anti-Cavitation Feature Circuit Relief Valves

NOTE: *Individual parts except for the two external 'O' rings are not serviced. The valves are serviced as pre-set assemblies.*

With reference to Figure 32.

1. Install new 'O' rings on the valve body and over the large threaded diameter of the housing.

2. Insert the piston into the poppet and place the small spring onto the end of the piston. The diameter of the spring is smaller at one end than the other and the smaller diameter must locate on the piston.

3. Slide the poppet assembly into the sleeve.

4. Position the large spring over the sleeve and insert the sleeve assembly into the valve body.

5. Assemble the housing to the body ensuring that both the piston and sleeve springs are correctly located in the housing. Tighten the body and housing thread to the specified torque, see "Specification" – Chapter 11.

6. Insert the pilot valve, spring, shims and adjusting plug, into the housing and retain with the locknut and adjusting cap.

7. Set the valve to the correct pressure setting as detailed in "Hydraulic Trouble Shooting and Pressure Testing" – Chapter 11.

NOTE: *The valve must not be set outside the specification stamped on the tag wrapped around the body of the valve.*

RE-ASSEMBLY AND INSTALLATION

Reassembly and installation of the valve assembly follows the removal and disassembly procedure in reverse. During reassembly observe the following requirements:

- Lubricate all components with hydraulic oil prior to re-assembly, see 'Specifications' – Chapter 11.

- Tighten the spool detent plug and check valve retaining plug to the specified torque, see 'Specifications' – Chapter 11.

CLAMPING CYLINDERS – REMOVAL

1. Park the Unit on a firm level surface, position the carriage in the centre of the frame with the dipstick parallel to the centre line of the Unit, retract the crowd cylinder and lower the dipstick to the ground.

2. Release the pressure on the clamping cylinders by pulling up the 'T' handle on the control console and retracting the stabiliser leg until the system relief valve operates.

3. Lower Clamping Cylinder Removal:

- Disconnect the feed hose to the cylinder being removed and cap the exposed ends.

- Remove the bolt securing the clamping cylinder bellcrank pivot pin. Withdraw the pin and remove the bellcrank. Refer to Figure 7.

- Using a suitable drift, drive the clamping cylinder from the backhoe carriage.

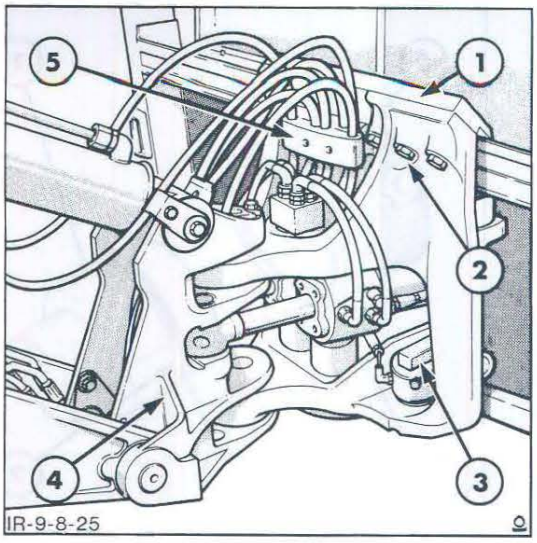


Figure 7
Carriage and Swing Post Assembly

1. Carriage Retaining Plate
2. Carriage Retaining Bolt (6 off)
3. Lower Clamp Cylinder Bellcrank
4. Swing Post
5. Carriage Hose Clamp

4. Upper Clamping Cylinder Removal:

- Support the carriage using a suitable sling and hoist.

- Remove the six carriage plate retaining bolts and remove the plate.

- Using the boom and dipstick operating elements carefully lower and tilt the carriage forwards to enable access to the upper clamp cylinders.

- Disconnect the feed hose to the cylinder being removed and cap the exposed end.

- Using a suitable drift, drive the clamping cylinder from the backhoe carriage.

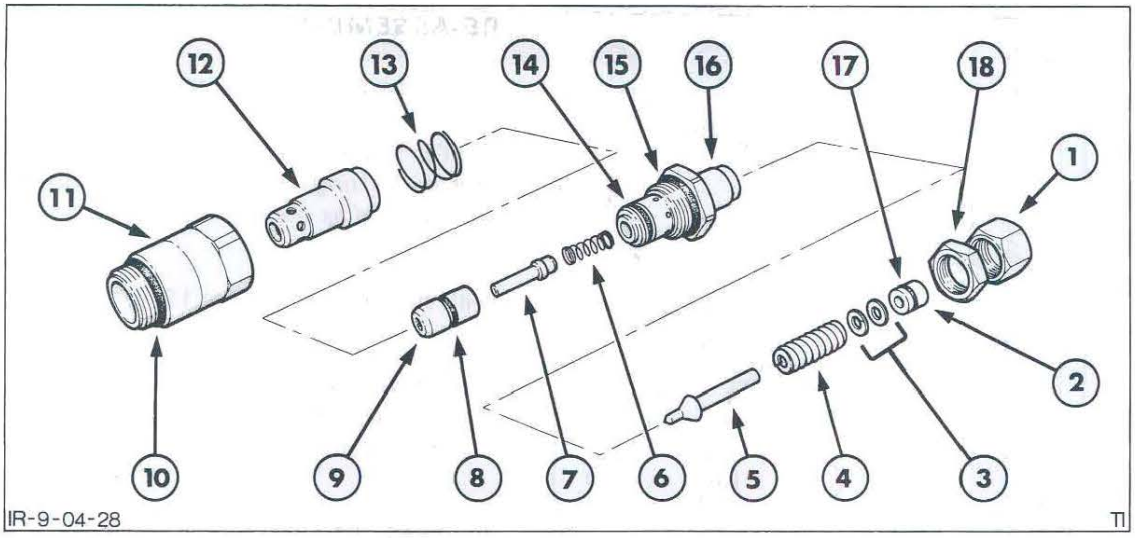


Figure 19
Pilot Operated with Anti-Cavitation Feature Circuit Relief Valve – Exploded View

1. Adjusting Cap
2. Adjusting Plug
3. Shim(s)
4. Spring
5. Pilot Valve
6. Spring
7. Piston
8. 'O' Ring and Back-up Rings
9. Poppet Valve
10. 'O' Ring
11. Body
12. Sleeve Poppet
13. Spring
14. 'O' Ring
15. 'O' Ring
16. Fitting
17. 'O' Ring
18. Locknut

SYSTEM RELIEF VALVE

With a small soft rod, depress the sleeve poppet fully into the body. When the rod is quickly removed, the sleeve poppet should snap back to the extended position. Repeat this procedure for the poppet and piston. If any of these items fail to snap back to the extended position disassemble the valve, Figure 19.

1. Check all 'O' rings and back-up rings for wear, damage or swelling. Mating parts must move freely with the 'O' rings and back-up rings installed.

2. Inspect the inside of the sleeve poppet for evidence of wear caused by the poppet 'O' ring and back-up ring. A slight groove may cause the poppet to stick open when operating under pressure, yet the poppet may move freely when depressed by hand.

3. Inspect the ground seating surface of the piston for nicks or excessive wear. The piston should be free of nicks and abrasion.

4. Inspect the pilot valve seat in the valve housing and the seat on the pilot valve. These seats should indicate a complete seating surface.

5. Visually inspect the springs for "setting" by comparing their lengths with a new stock item.

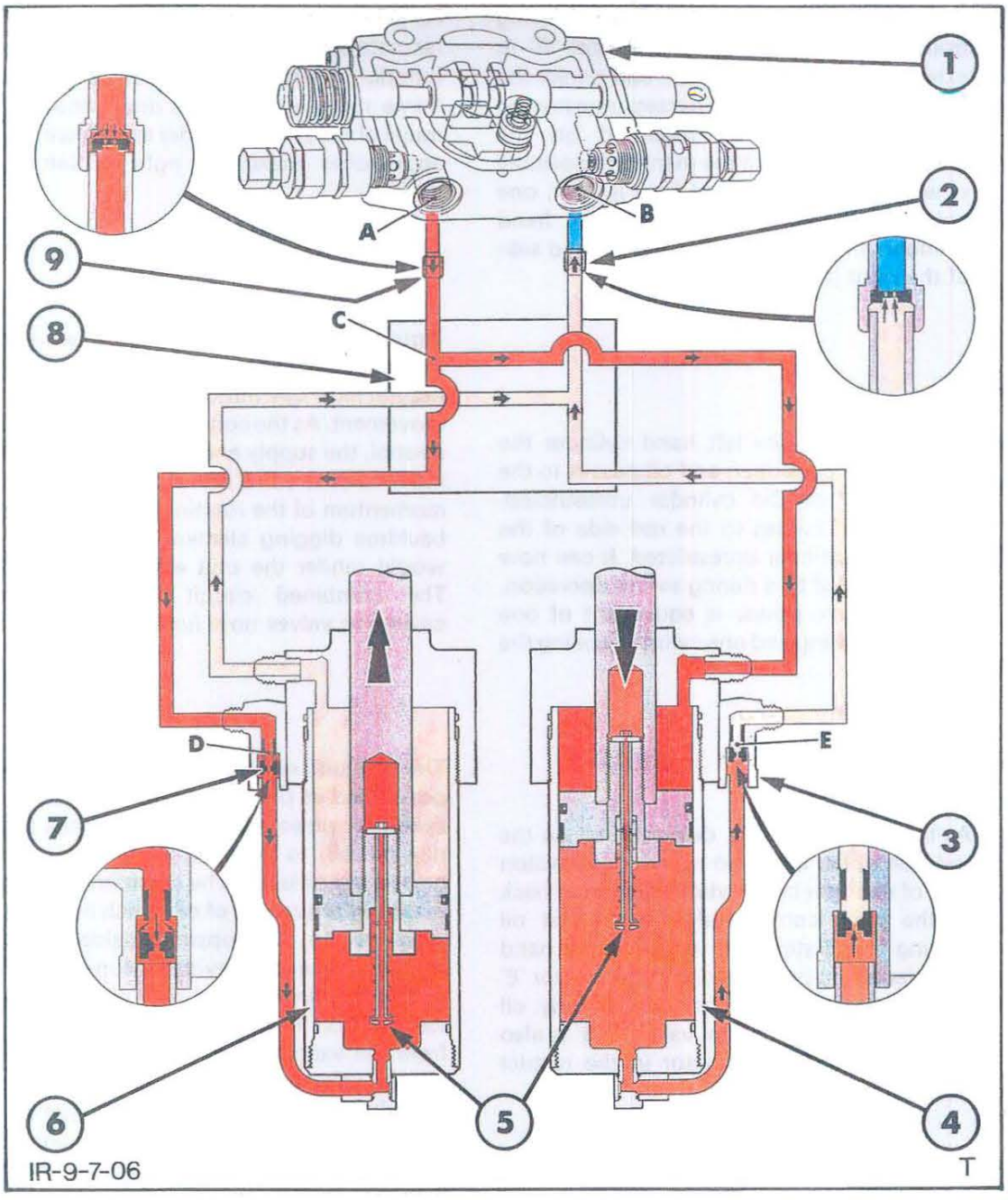


Figure 6
Swing Cylinders – Working Schematic Normal Swing (Sideshift shown)

Pump Pressure Oil

1st Stage Restricted Return Oil

2nd Stage Restricted Return Oil

Return to Reservoir Oil

1. Swing Section of Main Control Valve
2. Line Restrictor in Restrict Position
3. Cylinder Restrictor in Restrict Position
4. Cylinder Assembly
5. Sliding Internal Restrictors
6. Cylinder Assembly
7. Cylinder Restrictor in Open Position
8. Manifold Assembly
9. Line Restrictor in Open Position

APPLICATION	TYPES	TOOL NO. (VL CHURCHILL)
Lift Cylinder	Side shift and centre pivot backhoe with and without extendible dipstick	FT 8549 (Peg Wrench)
Crowd Cylinder	Side shift and centre pivot backhoe	FT 8549 (Peg Wrench)
Bucket Cylinder	Side shift and centre pivot backhoe	FT 8550 (Peg Wrench)
Extendible Dipstick	Side shift and centre pivot backhoe	FT 8553 ('C' Wrench)
Swing Cylinder	Side shift and centre pivot backhoe	FT 8552 (Peg Wrench)
Stabiliser Cylinder	Centre pivot backhoe	FT 8551 (Peg Wrench)
Stabiliser Cylinder	Side shift backhoe	FT 8554 ('C' Wrench)
Lift Cylinder	Loader	FT 8553 ('C' Wrench)
Bucket Cylinder	Loader	FT 8553 ('C' Wrench)
Multi-Purpose Bucket Cylinder	Loader	FT 8554 ('C' Wrench)

REMOVAL

Backhoe Lift, Crowd and Bucket Cylinders

1. Park the unit on a level, firm surface and place the backhoe elements in a suitable position to best enable the particular cylinder to be removed. Block or support the structural members so that they will be stable and safe to work around.

2. Using hydraulic pressure, relieve any loadings on the cylinder pins so that subsequent pin removal will be aided. Stop the engine and relieve all residual pressures.

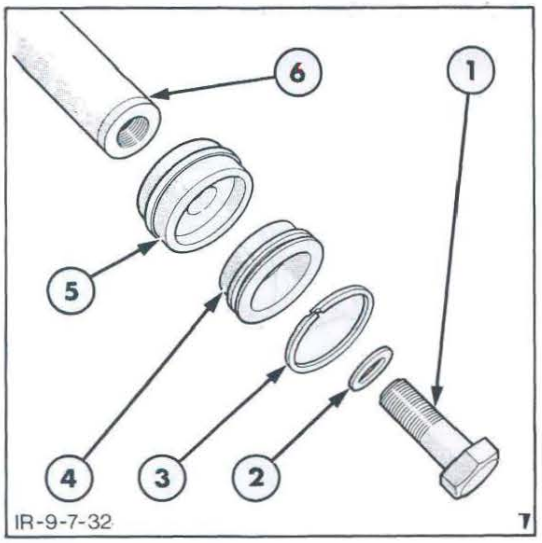


Figure 32
Piston Separated from Cylinder Rod – Ford 555C/ 655C Backhoe Lift Cylinder Shown

1. Retaining Bolt
2. Washer
3. Ring
4. Decelerometer
5. Piston Assembly
6. Cylinder Rod

6. Remove the gland from the rod, Figure 33.

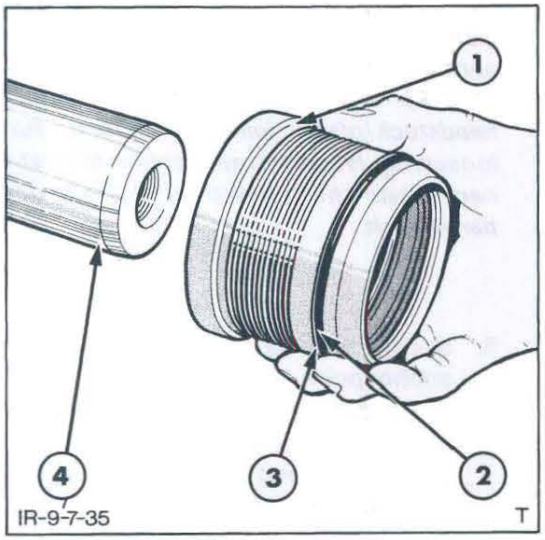


Figure 33
Removing Gland from Cylinder Rod

1. Gland
2. 'O' Ring Seal
3. Back-up Ring
4. Cylinder Rod

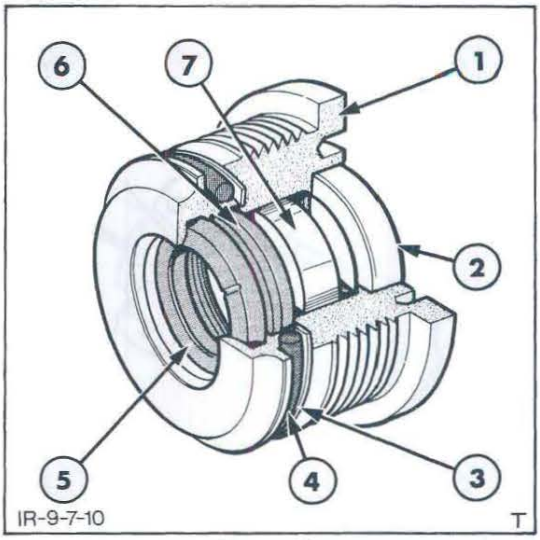


Figure 34
Threaded Type Gland Assembly – Section View

1. Gland
2. Wiper Seal
3. Back-up Ring
4. 'O' Ring Seal
5. Buffer Seal
6. 'U' Seal
7. Bearing Sleeve

NOTE: *That on the extendible dipstick cylinder a spacer is positioned on the rod between the piston and gland.*

7. Remove the 'O' ring and back-up ring from the outer diameter of the gland.

8. Remove the seals and nylon bearing from the gland taking care to note the orientation of the groove in the buffer seal, Figure 34.

Swing Cylinders – Side Shift and Centre Pivot

1. Drain the cylinder of all oil, re-cap the openings and thoroughly clean the exterior so that internal parts will not become contaminated.

2. When reconnecting the 'O' ring face seal (ORFS) fittings on hydraulic hoses replace the 'O' ring seal and tighten the fitting to the specified method and torque detailed in Chapter 11 of this Part. Incorrect tightening of ORFS fittings will result in leaks. Ensure that hoses are not twisted that they do not rub structural members and are neatly routed.

3. Lubricate all pins prior to installation and grease all pivots with the specified grade of grease.

4. Swing Cylinders — After replacing the headstock trunnion retainers, ensure the cylinder pivots in its headstock bushings freely before connecting the rod end to the swing frame.

5. Replenish any lost oil from the reservoir – see "Specifications" – Chapter 11, for oil specification.

6. Start engine, operate at low idle and cycle the replacement cylinder to purge all air from the circuit. Check for leaks and re-check the oil reservoir level.

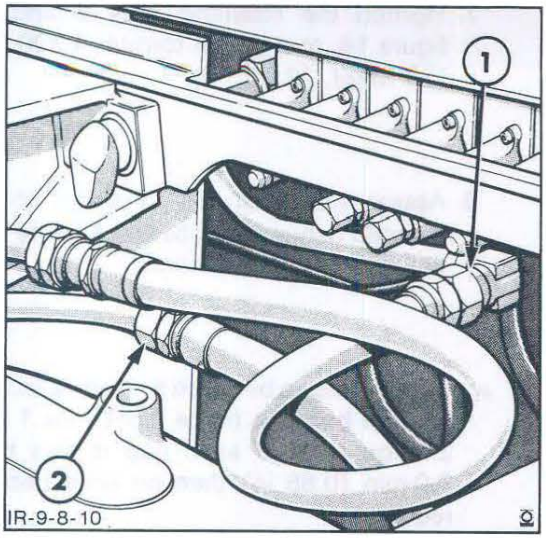


Figure 11
Unit to Backhoe Hose Connections

1. Backhoe Feed Hose Tube Connection
2. Return to Reservoir Hose Unit Connection

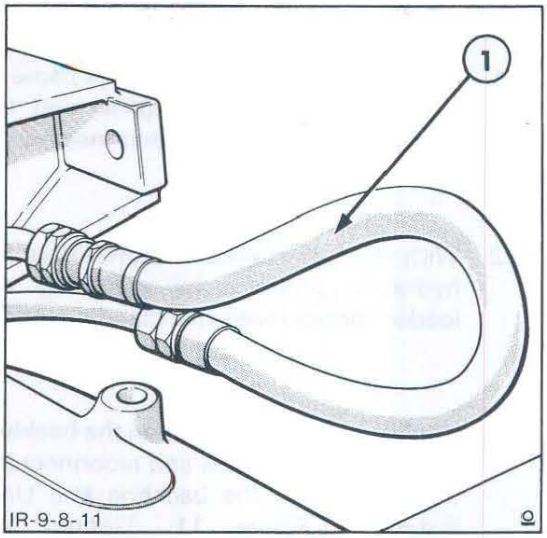


Figure 12
Unit Hose Connections – Backhoe Removed

1. Looped High Pressure Feed Hose

12. Disconnect the return to reservoir hose at the Unit fitting and the backhoe valve feed hose at the tube connection on the backhoe mainframe, Figure 11.

WARNING: *Do not start the Unit until the disconnected hoses have been connected as detailed above. Failure to comply will result in severe vehicle damage and possible personal injury.*

13. Connect each hose to the open fitting on the component to which that hose is fitted, Figures 12 and 13. This will complete the hydraulic circuits and prevent entrance of dirt and oil loss. Ensure the hoses are not twisted or kinked during installation.

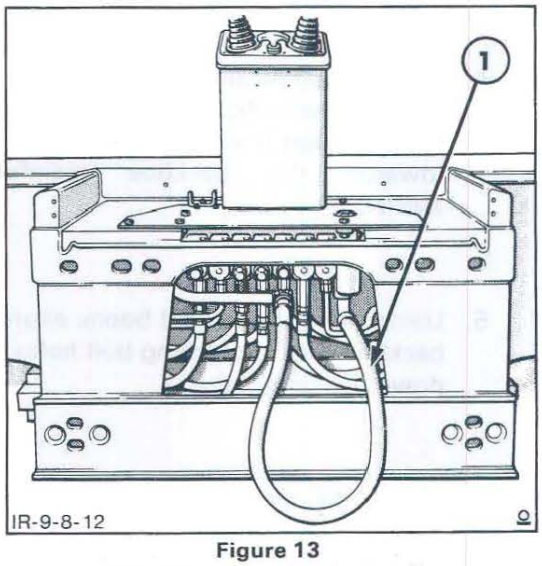


Figure 13
Backhoe Mainframe Hose Connections – Storage Position

1. Looped High Pressure Return Hose

14. The Unit may now be started and removed from the work area.

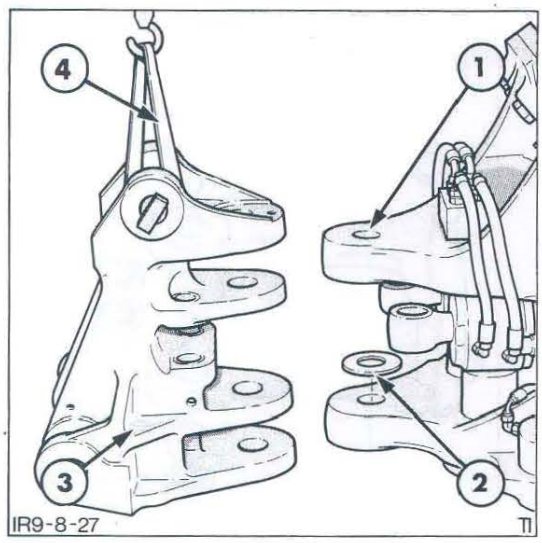


Figure 27
Swing Post Removal
Sideshift Shown

1. Carriage
2. Thrust Washer
3. Swing Post
4. Chain and Hoist

2. Examine the thrust washer for wear and replace if necessary.

3. Centre Pivot Units:

   Inspect the lift cylinder and extendible dipstick fittings on the sides of the swing post for damage and replace if necessary.

4. Inspect the two bushings and four seals in the mainframe/carriage on which the swing post pivots and replace if necessary. Figures 29 and 31. If worn pry out the seals and remove the bushings using a suitable step plate and driver.

INSTALLATION

1. Installation of the swing post follows the removal procedure in reverse.

During installation observe the following requirements:

- Ensure the thrust washer is positioned on top of the lower mainframe/carriage pivot point so that the thrust washer takes the wear and not the swing post or mainframe/carriage.
- Tighten all hose connections and pin retaining bolts to the specified torque, see 'Specifications' – Chapter 11.
- Check the hydraulic reservoir oil level and lubricate all grease fittings with the correct lubricant, see 'Specifications' – Chapter 11.
- Check all hose connections for hydraulic leaks.

BACKHOE CARRIAGE REMOVAL – SIDESHIFT UNITS

1. Park the Unit on a firm, level surface. Position the dipstick parallel to the centre line of the unit, retract the crowd cylinder and lower the dipstick to the ground.
2. Release the oil pressure on the clamping cylinders by pulling up the 'T' handle on the control console and retracting the stabiliser leg until the system relief valve operates.
3. With the engine switched off, move each control lever to relieve any pressure which may be in the system.
4. Remove the swing post as detailed earlier in this section.

NOTE: *Where overhaul of the carriage only is required the swing post may be removed with the boom in situ.*

J. HOSES AND TUBES – OVERHAUL

GENERAL

Figures 47 and 48 at the rear of this Chapter illustrate the hose routing at the mainframe and the main control valve for both sideshift and centre pivot Units manufactured for all countries except Sweden, Finland and Norway. On Units manufactured for Sweden, Finland and Norway the lift cylinder and crowd cylinder valve segments and hose routing are interchanged.

Overhaul of hoses and tubes is limited to replacement of 'O' rings on the hose and tubes where applicable and replacement of damaged hoses and tubes.

Repair all hydraulic oil leaks promptly to avoid loss of oil and possible damage and dirt entry into the system. When checking for hydraulic leaks, start and operate the engine at 1200-1500 rev./min.

Remove and install new hoses immediately, if they are severely damaged by a cut or scrape, swollen at the fittings or leaking. If leakage is observed, shut off the engine and relieve all hydraulic pressure.

The following points should be observed when removing hoses and tubes.

⚠ **WARNING:** *Never disconnect or tighten a hose or tube that is under pressure. If in doubt actuate the operating levers several times with the engine switched off prior to disconnecting a hose or tube.*

IMPORTANT: *Insure that when a hydraulic hose or tube is renewed/installed, all components are absolutely clean and free from dirt. Failure to ensure absolute cleanliness will result in the hose/tube leaking after installation or possible damage to other hydraulic system components.*

NOTE: *Use care in removal of hoses that will be re-installed. Be careful not to twist or kink a hose, doing so can damage the internal facing causing early hose failure.*

Before disconnecting any of the hoses or tubes from the control valves, tag and identify the hose, tube or connector.

Note the position of any hoses secured in clamps which will be loosened or removed and measure the length from the end of the hose or tube to the clamp so that re-installation will be correct.

NOTE: *Because of the close proximity of hose connections it may be necessary to remove more than one hose in order to service a particular hose. Loosening the hose at the connections away from the control valve will aid in gaining flexibility and hose movement within the mainframe.*

IMPORTANT: *On the swing cylinder hoses, make a note of the fitting position and routing of the hoses to ensure correct re-assembly and prevent early hose failure.*

Cap all hoses, connectors and ports to prevent entry of dirt into the system.

TRANSMISSION DUMP SWITCH

The transmission dump switches, Figure 8, located on the loader control lever and transmission gearshift lever knobs enable drive from the transmission to be engaged/disengaged without the need to move the power reversing lever to neutral. Either button will disengage the transmission when held in the depressed position.

The transmission dump switch feature allows full engine power to be available for operating the loader hydraulics. It is recommended that the loader control lever button is used to disengage the transmission at the point of bucket rollback and lift to increase loader productivity.

IMPORTANT: *To avoid possible damage to the transmission hydraulic clutches never use the dump switch control for inching the tractor forward. Inching the tractor forward with the dump switch will cause the clutches to slip excessively and overheat.*

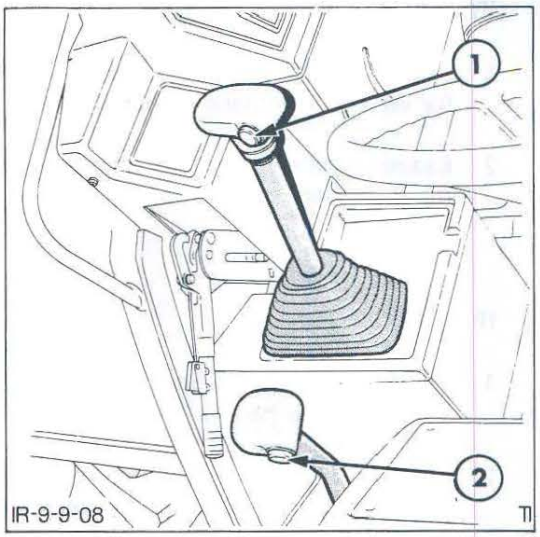


Figure 8
Transmission Dump Switches

1. Loader Control Lever Dump Switch
2. Gearshift Lever Dump Switch

B. LOADER BUCKET, LIFT ARMS AND SUBFRAMES – OVERHAUL

LOADER BUCKET – REMOVAL

1. Position the bucket on the ground with the open side down (full dump position), Figure 9.

2. Remove the bucket pivot pin securing bolts and using a brass drift and hammer, drive out the bucket link pivot pins.

3. Retract the bucket cylinder rods and drive out the lift arm to bucket pivot pins.

NOTE: *On Units with a multi-purpose bucket installed it is necessary to disconnect and plug the hydraulic hoses prior to loader bucket removal.*

WARNING: *To avoid personal injury, shut off the engine and relieve all hydraulic pressure by operating the control levers in all directions before any hydraulic connection is disconnected.*

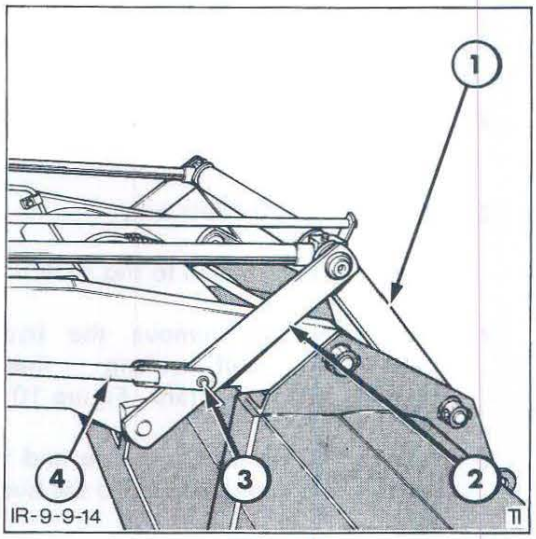


Figure 9
Loader Bucket Pivot Pins

1. Bucket Tipping Link
2. Bucket Pivot Pins
3. Bucket Idler Link

4. Using two suitable wrenches, tighten the fitting to the specified torque, Figure 26. See "Specifications" – Chapter 11.

NOTE: *To ensure a leak free joint is obtained, it is important that the fittings are not over or under torqued.*

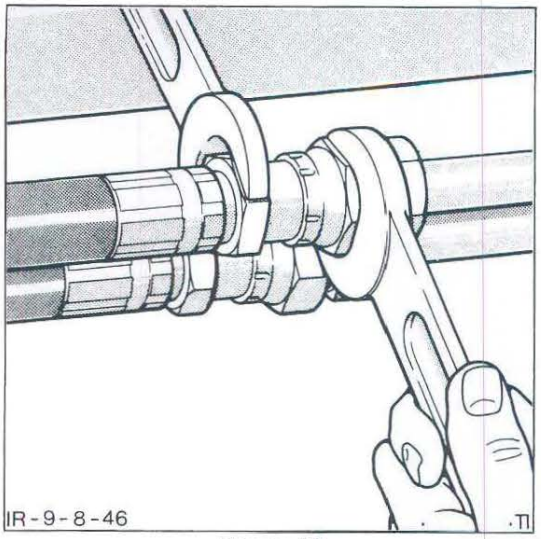


Figure 26
Tightening the O.R.F.S. Fitting

5. Bleed the air from the system any time a hydraulic hose is removed, a tube disconnected, or the system is opened to atmosphere. This is accomplished by running the engine at 1200-1500 rev/min., and actuating the loader or backhoe control levers (no load in the bucket) for approximately 15 minutes or until all air is expelled from the system.

6. After bleeding the system, position the loader bucket flat on the ground, put the backhoe into the transport position, and shut off the engine. Then check the hydraulic system oil level and add oil if necessary.

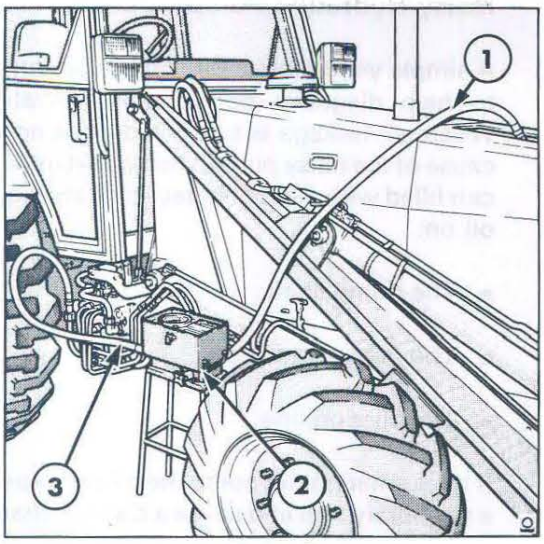


Figure 2
Hydraulic Tester Installation

1. Return Hose to Reservoir
2. Hydraulic Tester MS 820-A
3. Input Hose to Hydraulic Tester

Hydraulic Pump – Test Procedure

Cavitation

1. Re-check that the tester load valve is fully open.

2. Start the engine and operate at approximately 2200 rev/min. Where a tachometer is not installed in the vehicle use a suitable stroboscope to measure the engine speed. A suitable point for measuring the engine speed is the hydraulic pump driveshaft which attaches directly to the engine crankshaft pulley.

3. Gradually close the tester load valve. Until a pressure of approximately 1500 lbf/in² (100 bar) is shown on the pressure gauge and allow the hydraulic oil to warm to a temperature of 165°F (75°C).

4. Remove the load by fully opening the load valve and reset the engine speed to 2200 rev/min. Record the indicated flow.

5. Reduce the engine speed to 1100 rev/min and again record the flow.

ANALYSIS – since the pump is a fixed displacement type, the volume of oil flow recorded at 2200 rev/min should be twice the no-load volume at 1100 rev/min. If the volume is not doubled then a restriction in the pump supply tubing is indicated. The higher demand for oil made by the pump at 2200 rev/min indicates this restriction. Investigate and correct before progressing to the next test.

Efficiency

1. Re-run the preceding cavitation test.

2. Set the engine speed to 2200 rev/min and record the flow with no load applied.

3. Gradually apply load until 2500 lbf/in² (172 bar) is displayed on the pressure gauge. Re-adjust the now reduced engine speed back to 2200 rev/min. Record the indicated flow rate.

ANALYSIS – having ensured that both readings were conducted at 2200 rev/min – this must be kept constant – determine the pump efficiency or "State of Health" by dividing the no-load volume into the with-load volume.

Example:

$$\frac{\text{25 galls (or litres) at 2500 lbf/in}^2\text{ (172 bar)}}{\text{28 galls (or litres) at 0 lbf/in}^2\text{ (0 bar)}}$$

= 0.9 or 90% efficient

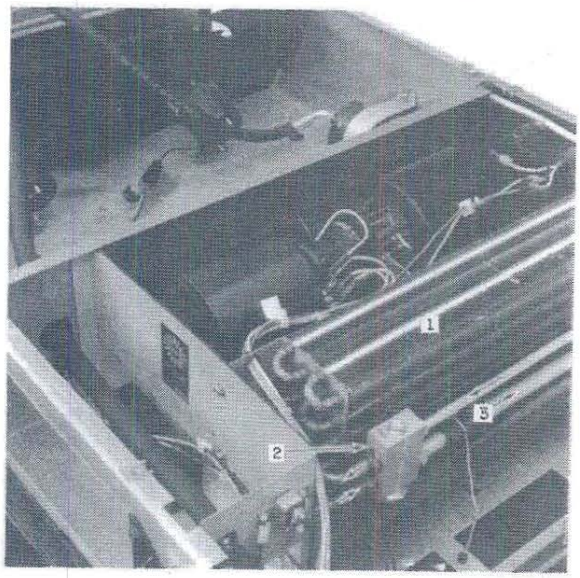


FIGURE 9-18

Air Conditioning Expansion Valve

1 Evaporator core
2 Expansion valve
3 To compressor

EXPANSION VALVE

The expansion valve, Figure 9-18, is located on the pressure line leading from the dehydrator and receiver into the evaporator and performs the following functions:

1. METERING ACTION - A metered orifice changes the liquid refrigerant from a high to a low pressure.
2. MODULATING ACTION - A thermostatically controlled valve within the expansion valve body controls the volume of liquid refrigerant passing through the orifice and makes sure the refrigerant is fully vaporized within the evaporator. Liquid refrigerant would damage the compressor reed valves or freeze the pistons.
3. CONTROLLING ACTION - The valve responds to changes in the cooling requirements. When increased cooling is required, the valve opens to increase the refrigerant flow and when less cooling is required (or increased compressor volume due to increased engine speed) the valve closes and decreases the refrigerant flow.

EXPANSION VALVE - OPERATION

All of the needed temperature sensing and pressure sensing functions are consolidated into this basic unit and no external tubes are required for these purposes.

The block or "H" type expansion valve gets its name from its construction, Figure 9-19.

There are two refrigerant passages which form the legs of the "H." One passage is in the refrigerant line from the condenser to the evaporator and contains the ball and spring valve. The other passage is in the refrigerant line from the evaporator to the compressor and contains the valve's temperature sensing element.

The thermal element is part of the push-rod mechanism.

Liquid refrigerant flow is controlled by the push-rod forcing the ball off its seat and the valve spring exerting pressure on the ball to keep it on its seat.

During stabilized (vehicle shutdown) conditions, the pressure on the bottom of the expansion valve diaphragm rises above the pressure on the top of the diaphragm allowing the valve spring to close the valve.

When the system is started, the pressure on the bottom of the diaphragm drops rapidly, allowing the valve to open and meter liquid refrigerant to the lower evaporator tubes where it begins to vaporize.

The compressor suction draws the vaporized refrigerant out of the top of the evaporator at the top tube where it passes the temperature sensor.

Pressure in the temperature sensor drops when cooled and the expansion valve starts to close. Its pressure rises with evaporator superheat and opens the expansion valve, allowing more refrigerant to flow.

PROBLEM	POSSIBLE CAUSES	CORRECTION
Insufficient Cooling (Cont'd)	9. Faulty blower fans.	Visual inspection of fan rotor and fastening to motor shaft. Repair or replace.
	10. Plugged or restricted receiver/drier.	Perform system tests - replace if needed.
	11. Moisture in the system.	Perform system tests - evacuate and recharge.
	12. Faulty compressor.	Perform system tests - overhaul if needed.
Noisy System	1. Loose panel in cab plenum.	Visual inspection.
	2. Faulty compressor clutch.	Overhaul.
	3. Noise in compressor.	Overhaul.
	4. Excessive charge in system.	Perform system test and adjust charge.

MANIFOLD GAUGE READINGS AND INTERPRETATIONS

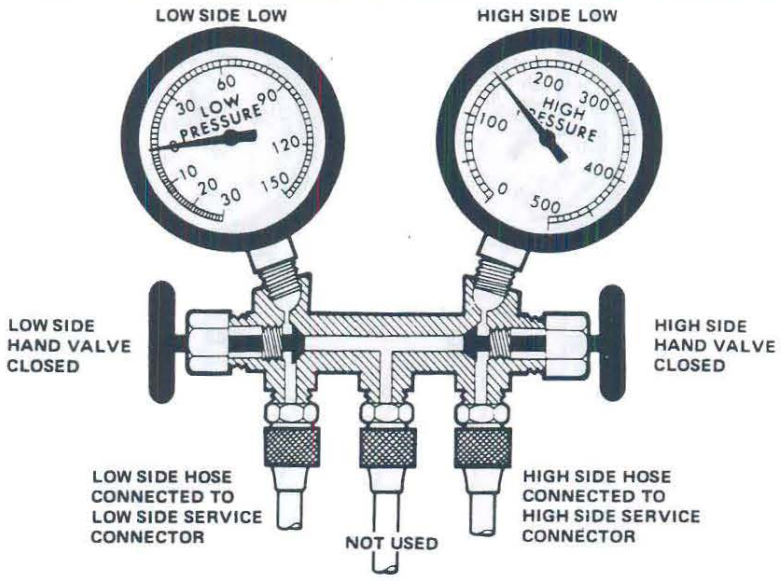
Normal manifold gauge readings on the low side gauge are 15 to 30 psi. The high pressure gauge readings used in the gauge reading examples that follow are for an ambient temperature of 95° F (35° C). However, as outside air temperature increases of decreases, so will the pressure readings. Refer to the Pressure-Temperature Relationship chart below for equivalent readings.

Test Conditions:

1. Tractor engine speed set at 1000-1200 RPM.
2. System fully charged.

NOTE: Ambient air temperature readings are taken 2″ (50 mm) in front of the condenser.

PRESSURE-TEMPERATURE RELATIONSHIP		
Condenser Temperature	**High Pressure Gauge Reading**	
Degrees F	**lbf/in²**	**kgf/cm²**
60° (15.6° C)	95-115	6.7-7.9
65° (18.3° C)	105-125	7.4-8.8
70° (21.1° C)	116-135	8.2-9.5
75° (23.9° C)	130-150	9.1-10.6
80° (26.7° C)	150-170	10.6-12.0
85° (29.4° C)	165-185	11.6-13.0
90° (32.2° C)	175-195	12.3-13.7
95° (35.0° C)	185-205	13.0-14.4
100° (37.8° C)	210-230	14.8-16.2
105° (40.6° C)	230-250	16.2-17.6
110° (43.3° C)	250-270	17.6-19.0
115° (46.1° C)	265-285	18.6-20.0
120° (48.9° C)	280-310	19.7-21.8



GAUGE READINGS AND INTERPRETATIONS

EXAMPLE 9

PROBLEM:

Insufficient cooling.

CAUSE:

Improper operation of thermostatic expansion valve (stuck closed).

CONDITIONS*

1. Low side pressure too low (0 psi or vacuum). Gauge should read 15-30 psi.
2. High side pressure low. Gauge should read 185-205 psi.
3. Evaporator air cool, but not sufficiently cold.
4. Evaporator valve inlet pipe surface shows considerable moisture or frost.

CORRECTIVE PROCEDURES

1. Place finger on expansion valve inlet. If too cold to touch, proceed as follows:
   a. Operate the system at maximum cooling.
   b. Check the low side gauge. The pressure should drop slowly.
2. If the expansion valve inlet surface shows frost or heavy moisture, proceed as follows:
   a. Discharge and recover the refrigerant from the system.
   b. Disconnect the inlet line from the expansion valve and inspect the screen.
   c. Clean the screen, replace it, and reconnect the inlet line to the valve.
4. If the corrective procedure outlined in Step 1 shows that the expansion valve is defective, proceed as follows:
   a. Evacuate the system.
   b. Charge the system.
   c. Performance test the system.

DIAGNOSIS: Expansion valve is not permitting a sufficient flow of refrigerant. May be caused by valve stuck in restricted or closed position, clogged valve screen, or insufficient amount of refrigerant in temperature sensing bulb.

***NOTE: Test procedure based upon ambient temperature of 95° F. For proper high side gauge reading for other ambient temperatures, refer to the pressure-temperature chart.**

AIR CONDITIONING CONDENSER, RECEIVER/DRIER, HIGH AND LOW PRESSURE CUT-OUT SWITCHES, EXPANSION VALVE AND EVAPORATOR - OVERHAUL.

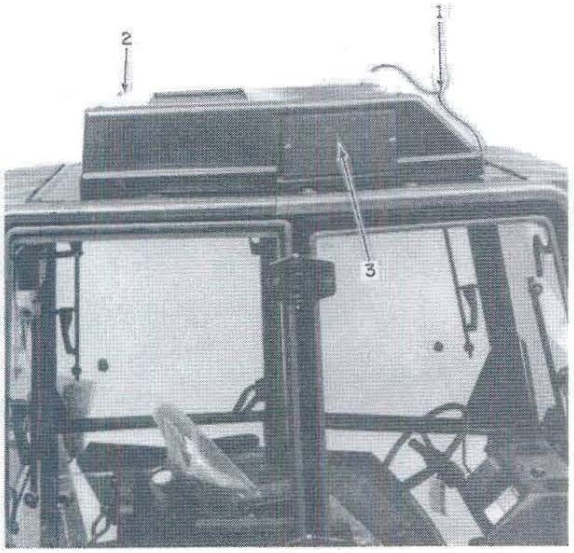


FIGURE 9-32

Air Conditioning Unit

1 Air conditioning unit
2 Air conditioning outer cover
3 Air intake grille

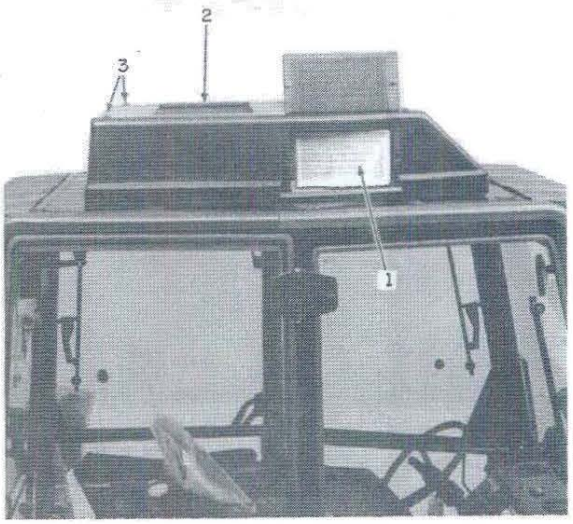


FIGURE 9-33

Air Conditioning Filter

1 Air conditioning filter
2 Air conditioning unit
3 Outer cover bolts

These components are located in the air conditioning unit mounted on the roof. Figure 9-32.

NOTE: These components can only be removed after the entire system has been discharged using an appropriate recovery system.

Component Removal

1. Completely discharge and recover the freon in the system.
2. Remove the air conditioning screen and filter, Figure 9-33.
3. Remove the air conditioning pod cover, Figure 9-32.
4. Remove the 7 condenser cover retaining bolts and tilt the cover up so that it rests on the cab roof as in Figure 9-34.

NOTE: The condenser will still be attached to the cover, so be sure it does not drop, damaging the condenser.

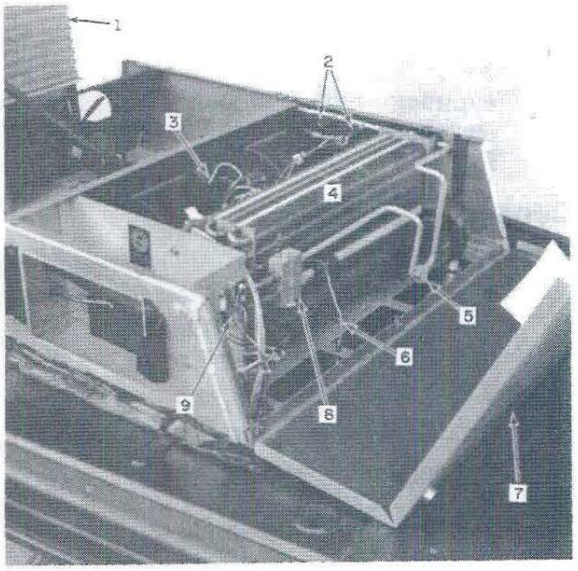
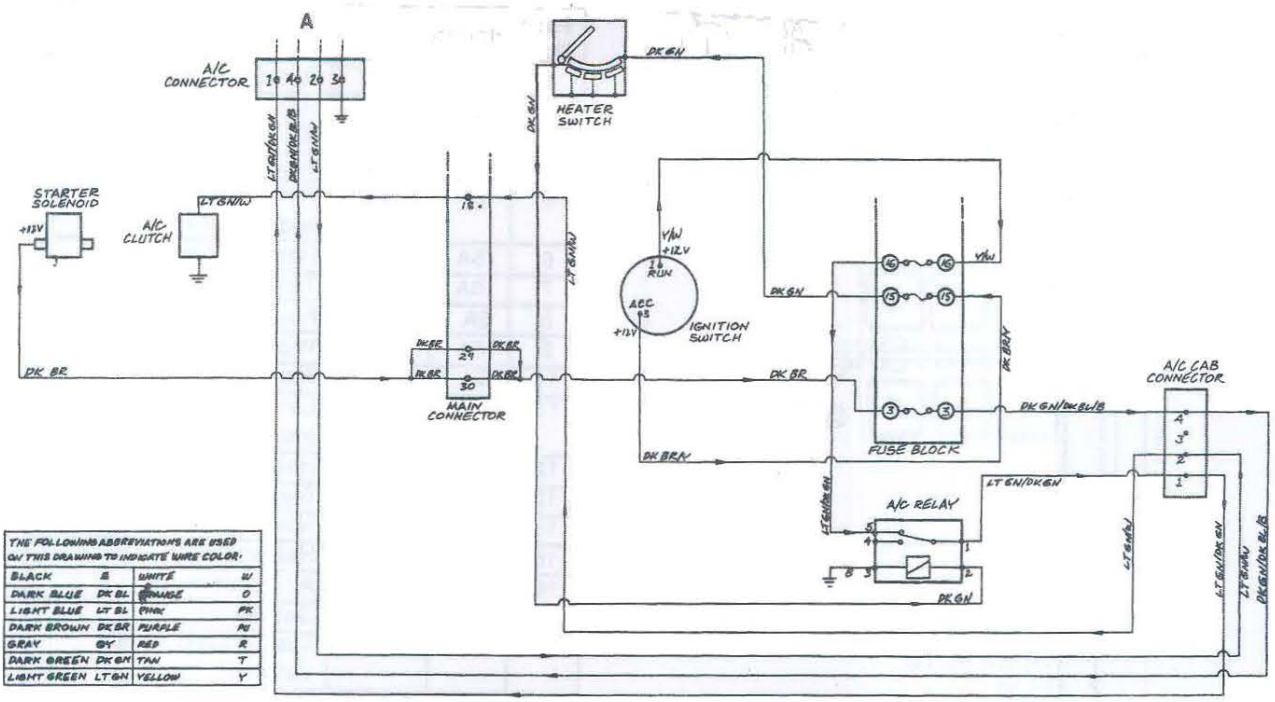


FIGURE 9-34

Air Conditioning Component Removal

1 Condenser
2 Pressure cut-out switches
3 Blower motor assembly
4 Evaporator
5 Sight glass
6 Capillary tube
7 Evaporator cover
8 Expansion valve
9 Air conditioning electrical components



Air Conditioner Wiring Diagram - Tractor Electrical System

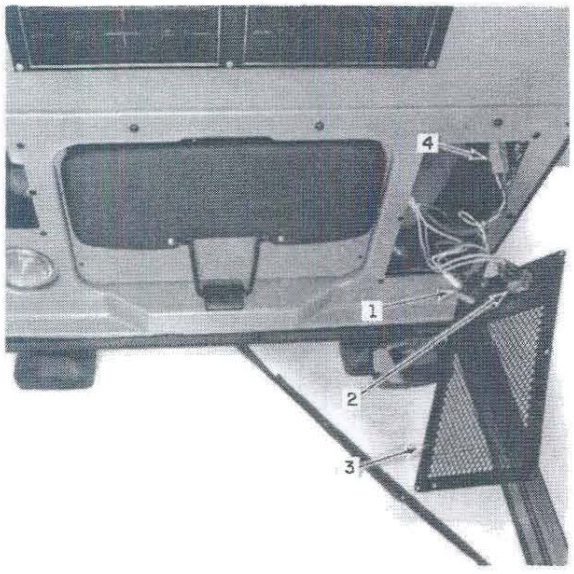


FIGURE 9-48

Air Conditioning Control Switches

1 Thermostat switch
2 Fan speed switch
3 Switch panel
4 Gray electrical connector

The air conditioning unit has two power feeds coming from the tractor electrical system. The power leads are connected through the gray connector above the thermostat and blower switch panel, Figures 9-48.

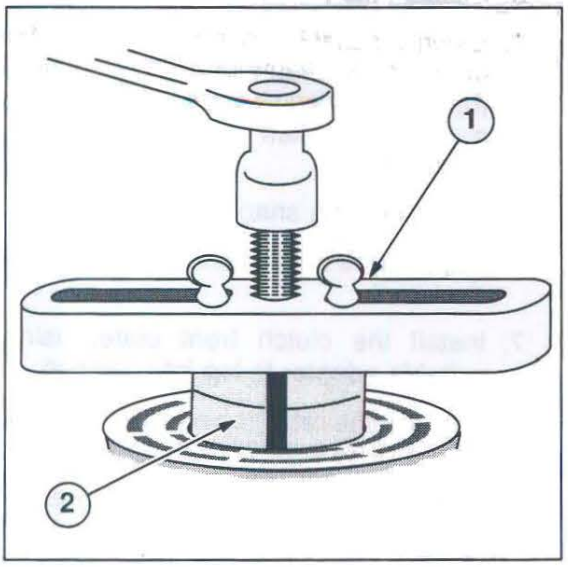


FIGURE 9-58

Pulley Removal

1 Puller
2 Adaptor

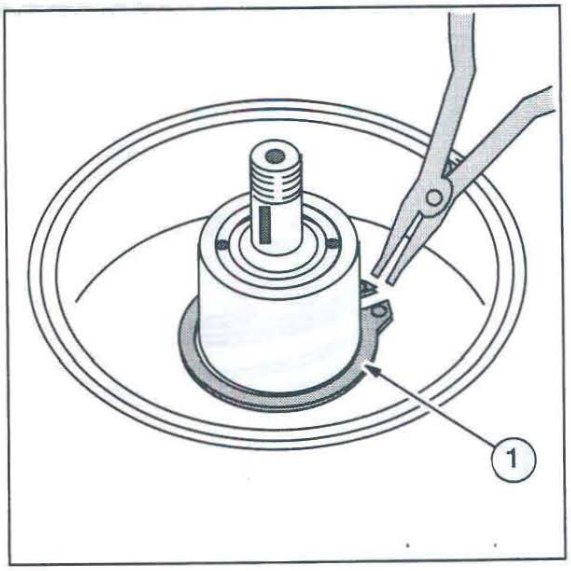


FIGURE 9-59

Field Coil Removal

1 Snap-ring

7. Remove the pulley, using a universal puller as shown. Ensure the lip on the adaptor jaws are located in the groove on the internal diameter of the pulley, Figure 9-58.
8. Remove the field coil retaining snap ring and field coil, Figure 9-59.
9. Loosen the cable clip on the compressor housing, Figure 9-60.

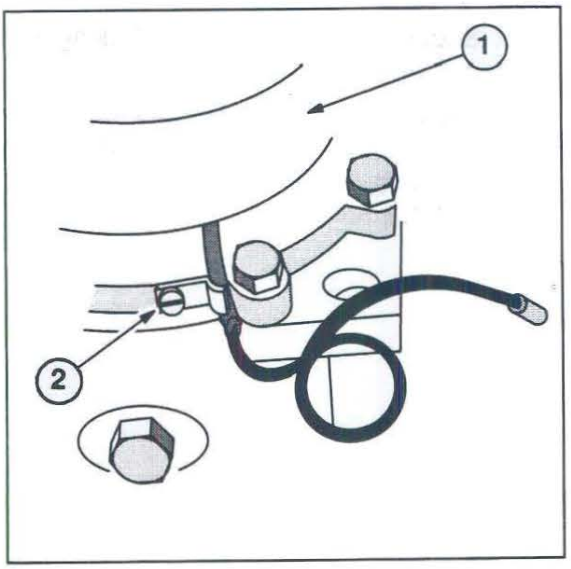


FIGURE 9-60

Field Coil Installation

1 Field coil
2 Cable clip

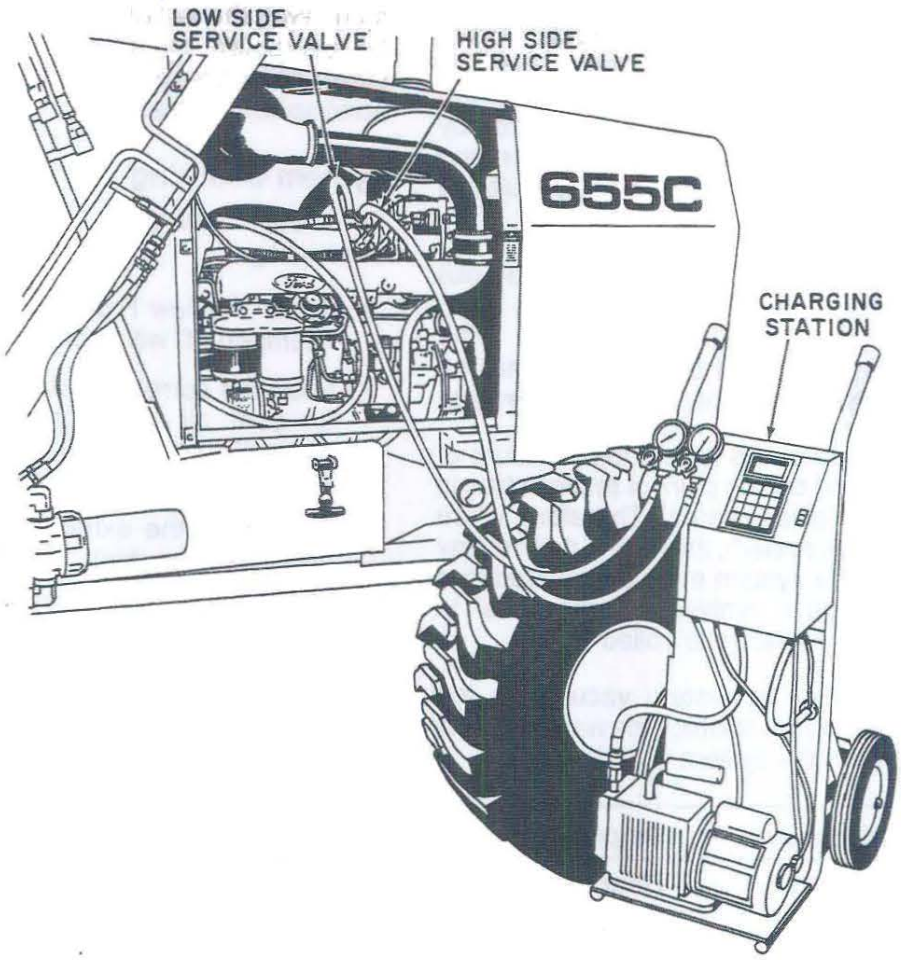


FIGURE 9-31

CHARGING THE SYSTEM - CHARGING STATION

Refer to Figure 9-31.

Whenever the air conditioning system is exposed to air and moisture for any period of time, you will need to evacuate and recharge the system. OTC's Smart Cart Charging Station, Figure 9-31, is recommended to save both time and increasingly expensive freon.

The Smart Cart features a keypad and liquid crystal display for programming the carts operation. Besure to read an follow all the manufacturers instruction for operating the charging station. The following is a summary of the steps for operating the unit.

1. Connect the Smart Cart's hoses to the air conditioning system and turn it on following the manufacturer's instructions.
2. Make sure "Program" and "Vacuum" appear on the display.
3. Press the appropriate number keys to enter the desired vacuum time, then press "Enter".

The system should be evacuated for a minimum of twenty minutes after obtaining maximum vacuum to remove all traces of moisture.

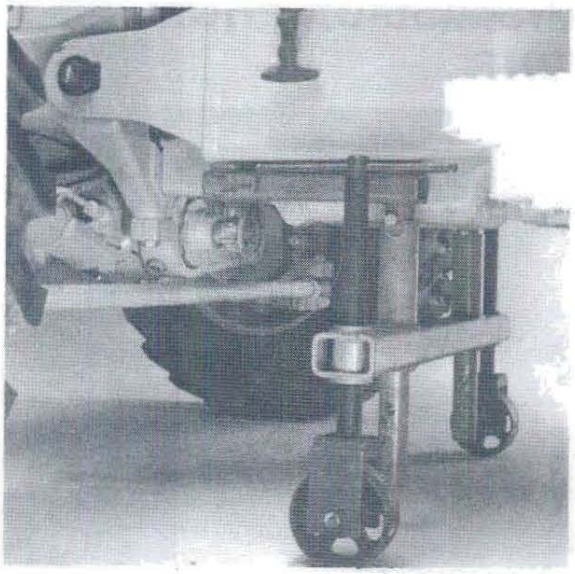


FIGURE 10-27

Engine Splitting Stand

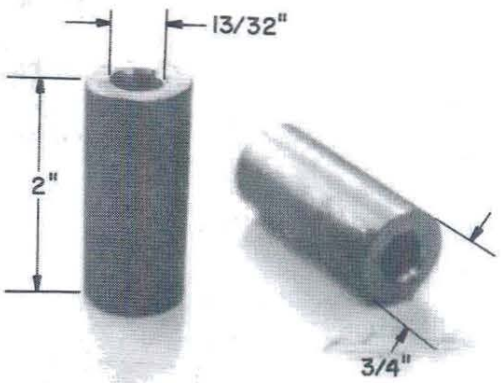


FIGURE 10-28

Splitting Stand Mounting Spacers

7. Install an engine splitting stand (Part #F50817) under the engine, Figure 10-27.
8. Install jack stands under each loader subframe and the center of the transmission housing.

   NOTE: To get clearance with the loader subframe, you will need to use 2″ spacers, Figure 10-28, and 3-1/2″ bolts to mount the stand to the oil pan.

9. Install wedges, Figure 10-29, between the axle and the front support.
10. Remove the loader subframe to engine support bolts.
11. Remove the screw on the flywheel inspection cover, Figure 10-22.

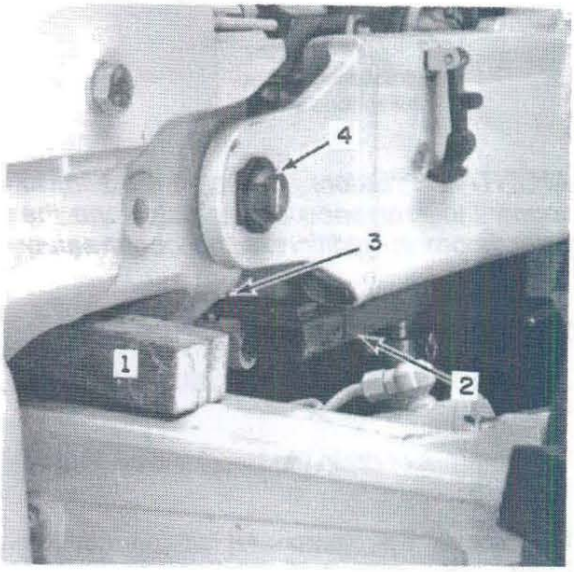


FIGURE 10-29

Supporting Engine and Front Axle

1 Wooden wedge block
2 Engine splitting stand
3 Mounting spacers
4 Loader subframe to front support bolts