REPAIR MANUAL

FORDSON MAJOR

and

Power FORDSON MAJOR

Issued by
FORD TRACTOR AND IMPLEMENT DIVISION
FORD MOTOR COMPANY

FOREWORD

The 4 cylinder O.H.V. Fordson Major Tractor introduced in 1952 has undergone a process of gradual development culminating in the current Power Major Tractor.

Apart from modifications in styling the changes have been in detail only, the main concentration being on the Diesel engine which has been steadily improved in efficiency and power.

From a service point of view the basic principles laid down in the Fordson Major Repair Manual will apply and the purpose of this Supplement is to provide a summary, under one cover, of the important differences which may be encountered on these models together with detailed information on features such as "Live" P.T.O., Vacuum Brakes, etc., which have been developed.

To obviate unnecessary repetition it is intended that this Supplement is used in conjunction with the existing Repair Manual.

The tool numbers quoted are in line with the new tool numbering system which was introduced in August 1957 and, as many of these tools will have already been supplied under the previous numbering system, a conversion list is included at the end covering all tools quoted in the Supplement.

As the Supplement has been produced in a loose leaf form additional sheets will be issued as and when future items of interest arise and Service Bulletins, as such, will therefore no longer be issued on the Major Tractor.

Ford Policy is one of continuous improvement and the right to change prices, specification and equipment without notice is reserved.

Issued by:—
Service Department,
Tractor Division,
Ford Motor Company Limited,
Dagenham, England

INDEX - 1962 SERVICE BULLETINS
FORD TRACTORS

SUBJECT	TRACTOR BULLETIN NO.	BULLETIN DATE
Tractor - General Information		
Service Information - Series 2000 and 4000 LCG Tractors	1199	2-12-62
6000 Series Tractor Modification-Phase I	1203	3-6-62 6000 Dealers Only
Industrial Tractor Radius Rod to Transmission Case Interference	1207	4-24-62
Swinging Drawbar - 701-901 Series Tractor	1209	4-11-62
Service Parts Stock Disposition - Service Bulletin 1203, dated 3-6-62	1212	6-1-62 6000 Dealers Only
Supplement to Service Bulletin 1203	1213	5-24-62 6000 Dealers Only
6000 Series Tractor Modification - Phase II	1215	9-25-62 6000 Dealers Only
6000 Series Tractor Service Information	1218	5-16-62 6000 Dealers Only
Campaign Deadline - Service Bulletin 1203	1224	6-18-62 6000 Dealers Only
Supplement to Service Bulletin 1215, Dated 9-25-62	1228	8-31-62 6000 Dealers Only
SAR Deadline - 6000 Series Tractor Modification - Phase I and II	1232	8-31-62 6000 Dealers Only
Service Information - Series 601 Through 4040 Tractors	1240	11-2-62
Service Inforatmion - 1962 Ford Four-Cylinder Tractors	1242	11-19-62
Supplement to Service Bulletin 1236	1239	10-8-62
Clutch and Clutch Controls		
Pressure Lubricated Clutch Release Bearing for Industrial Tractors	1198	1-25-62
Clutch Release Bearing Change	1216	5-14-62
Pressure Lubricated Clutch Release Bearing Lubricant	1216	5-14-62
Electrical System		
Water Protected Starter Motor Assemblies	1205	3-28-62
6-Volt to 12-Volt Electrical System Field Conversion	1219	6-5-62
Correction to Service Bulletin 1205, Dated 3-28-62.	1225	6-27-62

SUBJECT	TRACTOR BULLETIN NO.	BULLETIN DATE
Engine and Related Parts		
New Cylinder Blocks for Four-Cylinder Engines	1200	5-21-62
Dynamic Balancer Repair and Improvement Procedure	1202	2-28-62
Cylinder Sleeves for Ford Tractors	1206	3-27-62
Connecting Rod Lock Nuts Deleted	1217	5-16-62
Diesel Engine Pistons	1221	6-18-62
Dynamic Balancer Repair - Set Screw Staking	1221	6-18-62
Deletion of Undersize Crankshaft Bearing Liners	1226	7-10-62
Tractor - 703 Loader Pump Drive Hub Production Change	1234	8-21-62
Correction to Service Bulletin 1226, Dated 7-10-62	Unnumbered	8-24-62
Front Suspension and Steering System		
Series 2030 and 4030 Front Axle Bushings	1207	4-24-62
Power Steering Service Information for Series 601-801 Tractors	1237	9-21-62
Power Steering Cylinder Seal Kits - for Series 601-801 Tractors	1237	9-21-62
HydraulicPressure Gauge Fitting - Series 601, 801, 2030 and 4030 Tractors	1237	9-21-62
Steering Gear Housing Lubricant - Series 601, 801, 2030 and 4030 Tractors	1237	9-21-62
Series 1801 and 4040 Tractors Power Steering	1238	9-18-62
Binding of Control Cables	1238	9-18-62
Power Steering Return Hose Clamps	1238	9-18-62
Power Steering Reservoir Filter Element	1238	9-18-62
Fuel and Exhaust Systems		
Pilot Tube for Roosa-Master Pumps	1217	5-16-62
Fuel Tank Standpipe Improvement	1217	5-16-62
New Fuel Injection Tubes	1217	5-16-62
Improvement to Roosa-Master Fuel Injection Pumps	1236	8-28-62
Correction to Service Bulletin 1236 Dated 8-28-62	Unnumbered	10-8-62
Fuel Shut-Off Assembly for Gasoline Tractors	1241	11-4-62
Hydraulic System		
CONN-881-A Bearing Assembly Pump Gear Housing	1207	4-24-62

INDEX - 1962 SERVICE BULLETINS
IMPLEMENT INFORMATION

Subject	Implement Bulletin No.	Bulletin Date
IMPLEMENT - GENERAL INFORMATION		
Fordson Super Major Tractor Subframe Kit, Component No. 19-275 Front Axle Trunnion	2278	7-31-62
Fordson Super Major Tractor Subframe Component No. 19-275 - Interference	2291	11-19-62
COMBINE		
Series 611 Self-Propelled Combine Improvement Program of 1961 Field Inventory Units	2271	6-4-62
Series 611 Self-Propelled Combine - New Service Parts - Installation Instructions	2279	8-31-62
Series 611 Self-Propelled Combine	2280	8-31-62
CULTIVATORS		
All Cultivators - Slippage of Model 13-197 Clamps	2255	2-28-62
HARROWS, TILLERS AND ONE WAY PLOWS		
Series 204 and 207 Wheel-Type Harrows	2292	11-41-62
FORAGE HARVESTER		
Cut Free Guards, Part No. 241057	2254	4-24-62
Series 605 Forage Harvester - Shorter Length of Cut Sprocket	2256	3-16-62
HAY BALER		
Ford 250 Hay Baler - Conversion to Roller Plunger	2260	3-28-62
Ford 250 Hay Baler - Self-Aligning Connecting Rod Bearing Service Kit, Part No. 241392	2260	3-28-62
LOADERS AND FORK LIFTS		
19-181 Super Duty Loader Diagonal Brace to 19-275 Subframe Kit Side Frame Member - Service Information	2244	1-16-62
Series 711 Farm Loader Production Improvements	2245	2-12-62
Series 712 Super Duty Loader, Model 19-181 - Production Improvement	2246	3-14-62
Series 712 Super Duty Loader Control Valve Improvements	2252	3-28-62
Series 703 Loader Control Valve - Lift Spool "Float" Position	2253	3-15-62
Series 4000 Fork Lift Mast Channel - Wear Pad Replacement	2258	7-20-62

Subject	Implement Bulletin No.	Bulletin Date
LOADERS AND FORK LIFTS CONT'D		
Series 712 Super Duty Loader - Production Changes	2262	9-10-62
Fordson Super Major Tractor Subframe and Hydraulic Kit, Model 19-275 Pump Drive Line Production Change	2263	10-8-62
Ford Loader and Industrial Crane Service Information and Production Changes	2265	5-4-62
Sherman F9 Backhoe, Mounted on Series 2000 and 4000 Tractors	2267	5-14-62
Series 720 Industrial Loader and Model 19-314 Ford Backhoe Hydraulic Attaching Kit - Production Change	2268	5-16-62
Series 722 Heavy Duty and 711 Farm Loader Service Information	2276	7-27-62
Fordson Super Major Tractor Subframe Kit, Component No. 19-275 Front Axle Trunnion	2278	7-31-62
Series 722 Loader Pump Installation	2283	8-28-62
Series 712 Loaders - Component Nos. 19-332 and 19-131 - Installation Information	2289	10-31-62
Series 703 and 720 Loader Hydraulic Line Change	2290	11-29-62
Fordson Super Major Tractor Subframe, Component No. 19-275 - Interference	2291	11-19-62
Series 703 and 720 Loader Hydraulic Line Change - Effective Serial Number Correction to Service Bulletin 2290	Unnumbered	11-29-62
MOWERS		
Series 502 Side Mounted Mower - Extension Lever U-Bolt	2257	3-13-62
Series 907 - Ford Flail Mower Service Procedures	2270	6-5-62
Series 907 - Flail Mower - Production Changes - Service Information	2273	10-17-62
PLOWS AND SUBSOILERS		
Series 108 Subsoilers	2259	3-27-62
Economy Bottoms - All Plow Series	2293	11-21-62
ROTARY CUTTERS		
Series 906, 84" Rotary Cutter - Improvements	2261	4-24-62
Rotary Cutter Production Improvements	2272	10-17-62
Series 906 Rotary Cutter 84" - Production Change	2287	10-31-62

Subject	Implement Bulletin No.	Bulletin Date
PLANTERS		
Series 310 Unit Planters	2247	2-28-62
Series 311 Planters Operation	2249	3-15-62
BACKHOES		
Boom Improvement Program - Series 713 Backhoes	2248	2-6-62
Ford Backhoe, Series 723	2251	3-28-62
Fordson Super Major Tractor Subframe and Hydraulic Kit, Model 19-275 Pump Drive Line Production Change	2263	10-8-62
Series 720 Industrial Loader and Model 19-314 Ford Backhoe Hydraulic Attaching Kit - Production Change	2268	5-14-62
Series 723 Backhoe - Improved Cylinders	2269	6-5-62
Series 723 Backhoe Lift and Crowd Cylinder Hose to Tube Proeuction Change	2274	6-20-62
Fordson Super Major Tractor Subframe Kit, Component No. 19-275 Front Axle Trunnion	2278	7-31-62
Installation of Ford Backhoe Buckets on Sherman F9 Diggers	2282	8-28-62
Series 723 Backhoe - Correction to Operating Instruction Manual, SE 08678	2284	10-8-62
Series 713 Backhoe Boom Improvement Program - Supplement to Service Bulletin No. 2248	2286	10-8-62
Fordson Super Major Tractor Subframe, Component No. 19-275 Interference	2291	11-19-62
PICKER-HARVESTER, CORN		
Corn Picker and Harvester	2264	5-21-62
Series 601, One Row Corn Pickers and Harvesters Mounting on 800 Series Ford Tractors Equipped with 14.9 Tires	2277	7-31-62
16-120 Two-Row Snapping Units Installation on Ford 901 Tractors	2285	10-8-62

INDEX - 1962 SERVICING BULLETINS
FORDSON TRACTORS

Subject	Fordson Bulletin No.	Bulletin Date
TRANSMISSIONS		
Front Transmission Housing - FSM	93	3-16-62
Front Transmission Housing Breather Bolt - FSM	93	3-16-62
Main Gear Shift Assembly - FSM	93	3-16-62
Fordson Super Major Primary Transmission Lower Shifter Shaft	94	3-28-62
Transmission Parts Interchangeability - Dexta	97	6-20-62
Secondary Gear Shift Lever - Dexta	97	6-20-62
Improved Main Gear Shift Lever - FSM	97	6-20-62
Main Gear Change Spring and Plungers - FSM	97	6-20-62
Fordson Super Major Service Information	99	8-16-62
P.T.O.		
Power Take-Off Idler Gear Bearings-FSM	93	3-16-62
Raised Power Take-Off - FSM	93	3-16-62
P.T.O. Guard - Dexta	97	6-20-62
PROOF-METER		
Proof-Meter Cables and Conduits (Dexta)	96	5-25-62
REAR AXLE		
Rear Axle Shafts (FSM)	96	5-25-62

Hydraulic System		
6000 Series Tractor Accumulator Hydraulic System	1208	6-4-62 6000 Dealers Only
6000 Series Tractor Service Information	1229	7027062 6000 Dealers Only
New Heavy Duty Hydraulic Lift Housing Cover for Service - 601 Through 4040 Series Ford Tractors	1230	7-19-62
Hydraulic Pump Drive Gear	1231	7-31-62
Hydraulic Lift Check Valve Ball	1235	10-8-62
Oil Seal - Drawbar Control Arm to Lift Housing	1235	10-8-62
P.T.O.		
Lubrication Information Utility Model Tractors with PTO	1207	4-24-62
Rear Axle, Center Housing and Drive		
Rear Axle Stud Change - Series 501, 601, 701, 801 and 901 Tractors	1207	4-24-62
M2C53B Differential and Wet Brake Lubricant - 6000 Series Tractors	1210	4-11-62 6000 Dealers Only
Rear Axle to Center Housing Bolt, 376420-S36	1233	8-16-62
Transmissions		
M-2C-41 Oil Usage	1201	2-12-62
Servicing Select-O-Speed Transmission Bushings - All Transmissions	1211	6-18-62
Series 40501 Fork Lift Tractor - Transmission Gear Shift Lever	1223	6-20-62
Select-O-Speed Transmission Production Improvements for Four-Cylinder Tractors	1227	7-16-62

SPECIFICATION AND REPAIR DATA

	ENGINES FROM Eng. No. 1217101 to Eng. No. 1425096	*FROM Eng. No. 1425097 to Eng. No. 1481090*	*FROM Eng. No. 1481091 Onwards*
Type of Engine	Vertical in-line 4 stroke	Vertical in-line 4 stroke	Vertical in-line 4 stroke
No. of Cylinders	4	4	4
Stroke	4.524 – 4.528 ins. (114.91 – 115.011 mm.)	4.524 – 4.528 ins. (114.91 – 115.011 mm.)	4.524 – 4.528 ins. (114.91 – 115.011 mm.)
Bore	3.937 – 3.938 ins. (100 – 100.023 mm.)	3.937 – 3.938 ins. (100 – 100.023 mm.)	3.937 – 3.938 ins. (100 – 100.023 mm.)
Cubic Capacity	220.35 cu. ins. (3611 ccs.)	220.35 cu. ins. (3611 ccs.)	220.35 cu. ins. (3611 ccs.)
Max. B.H.P.	40.5 @ 1600 r.p.m. (with accessories less fan)	44 @ 1600 r.p.m. (with accessories less fan)	51.8 @ 1600 r.p.m. (less ancilliaries)
Max. Torque	140 llbs. ft. (19.348 kg.m.) @ 1150 r.p.m. (with accessories less fan)	148 lbs. ft (20.45 kg.m.) @ 1150 r.p.m. (with accessories less fan)	171 lbs. ft. (23.63 kg.m.) @ 1200 r.p.m. (bare engine)
Compression Ratio	16 : 1	16 : 1	16 : 1
Firing Order	1 - 2 - 4 - 3	1 - 2 - 4 - 3	1 - 2 - 4 - 3
Camshaft			
Cam Lift	.258 ins. (6.55 mm.)	.305 ins. (7.75 mm.)	.258 ins. (6.55 mm.)
Camshaft Identification No. cast between No. I and II Cams	EIADKN 6250 – F (obsolete, replaced by EIADDN – 6250)	500E 6250 – B (obsolete, replaced by 528E – 6250)	EIADKN 6250 – F or EIADDN 6250
Camshaft end float	.003 - .008 ins. (.076 – .203 mm.)	.003 - .008 ins. (.076 – .203 mm.)	.003 – .008 ins. (.076 – .203 mm.)
Cylinder liners	Replaceable wet type retained by pressure of cylinder head through gasket	Replaceable wet type retained by pressure of cylinder head through gasket	Replaceable wet type retained by pressure of cylinder head through gasket
Liner Protrusion (above top face of block)	.002 ins. – .004 ins. (.051 – .102 mm.)	.002 ins. – .004 ins. (.051 – .102 mm.)	.002 ins. – .004 ins. (.051 – .102 mm.)
Pistons	Solid skirt aluminium alloy 100 mm. dia. combustion chamber machined in piston crown 1.250 ins. (31.75 mm.) dia. piston pin bore	Solid skirt aluminium alloy 100 mm. dia. combustion chamber machined off-set in piston crown 1.375 ins. (34.9 mm.) dia. piston pin bore	Solid skirt aluminium alloy 100 mm. dia. combustion chamber machined off-set in piston crown 1.375 ins. (34.9 mm.) dia. piston pin bore
Oversizes	.0025 ins. (.0635 mm.)	.0025 ins. (.0635 mm.)	.0025 ins. (.0635 mm.)
Piston Pin Type	From Eng. No. 1362380 Solid pin fully floating retained by end circlips	Hollow pin fully floating retained by end circlips	Hollow pin fully floating retained by end circlips

	ENGINES FROM Eng. No. 1217101 to Eng. No. 1425096	*FROM Eng. No. 1425097 to Eng. No. 1481090*	*FROM Eng. No. 1481091 Onwards*
Outside diameter	1.2496 – 1.2499 ins. (31.74 – 31.8747 mm.)	1.3747 – 1.375 ins. (34.917 – 34.925 mm.)	1.3747 – 1.375 ins. (34.917 – 34.925 mm.)
Piston Rings			
Ring Gap Compression	.011 – .016 ins. (.279 – .406 mm.)	.011 – .016 ins. (.279 – .406 mm.)	.011 – .016 ins. (.279 – .406 mm.)
Oil Control	.011 – .016 ins. (.279 – .406 mm.)	.011 – .016 ins. (.279 – .406 mm.)	.011 – .016 ins. (.279 – .406 mm.)
No. Compression Rings	3	3	3
No. Oil rings	2	2	2
Width of Piston rings.			
Compression mean	.0933 ins. (2.370 mm.)	.0933 ins. (2.370 mm.)	.0933 ins. (2.370 mm.)
Oil control mean	.187 ins. (4.75 mm.)	.187 ins. (4.75 mm.)	.187 ins. (4.75 mm.)
Ring to groove Clearance			
Compression	.0014 – .0034 ins. (.036 – .086 mm.)	.0014 – .0034 ins. (.035 – .086 mm.)	.0014 – .0034 ins. (.035 – .086 mm.)
Oil Control	.0015 – .0035 ins. (.0381 – .0889 mm.)	.0015 – .0035 ins. (.0381 – .0889 mm.)	.0015 – .0035 ins. (.0381 – .0889 mm.)
Valves			
Valve Clearance			
Inlet hot	.015 ins. (.381 mm.)	.015 ins. (.381 mm.)	.015 ins. (.381 mm.)
Exhaust	.015 ins. (.381 mm.)		
Exhaust w/Rotator cap	.012 ins. (.305 mm.)	.012 ins. (.305 mm.)	.012 ins. (.305 mm.)
Valve Head Angle	29° – 30'	29° – 30'	29° – 15' / 29° – 30'
Angle of Valve Seat in Head	30°	30°	30° – 0' / 30° – 30'
Valve Springs			
No. of Coils	8.8 (7 free)	8.8 (7 free)	8.8 (7 free)
Free Length	2.48 ins. (62.99 mm.)	2.48 ins. (62.99 mm.)	2.48 ins. (62.99 mm.)
Compressed Length and Load	1.98 ins. @ 45–50 lbs. (50.3 mm. @ 20.4 – 22.7 kg.)	1.98 ins. @ 45–50 lbs. (50.3 mm. @ 20.4 – 22.7 kg.)	1.98 ins. @ 45–50 lbs. (50.3 mm. @ 20.4 – 22.7 kg.)
Push Rod Length	11.9 ins. (302.26 mm.)	11.8 ins. (299.72 mm.)	11.8 ins. (299.72 mm.)
Crankshaft			
End float	.002 – .010 ins. (.051 – .254 mm.)	.002 – .010 ins. (.051 – .254 mm.)	.002 – .010 ins. (.051 – .254 mm.)
Connecting Rod			
Journal Diameter	2.4997 – 2.5005 ins.	2.4997 – 2.5005 ins.	2.4997 – 2.5005 ins.
Wear Limit Taper	0.001 ins.	0.001 ins.	0.001 ins.
Out of Round	0.0015 ins.	0.0015 ins.	0.0015 ins.
Main Bearing			
Journal Diameter	3.0002 – 3.0010 ins.	3.0002 – 3.0010 ins.	3.0002 – 3.0010 ins.
Wear Limit Taper	0.001 ins.	0.001 ins.	0.001 ins.
Out of Round	0.0015 ins.	0.0015 ins.	0.0015 ins.
Maximum run out at flywheel clutch face	.005 ins. T.I.R. (.127 mm.)	.005 ins. T.I.R. (.127 mm.)	.005 ins. T.I.R. (.127 mm.)

THE DIESEL ENGINE

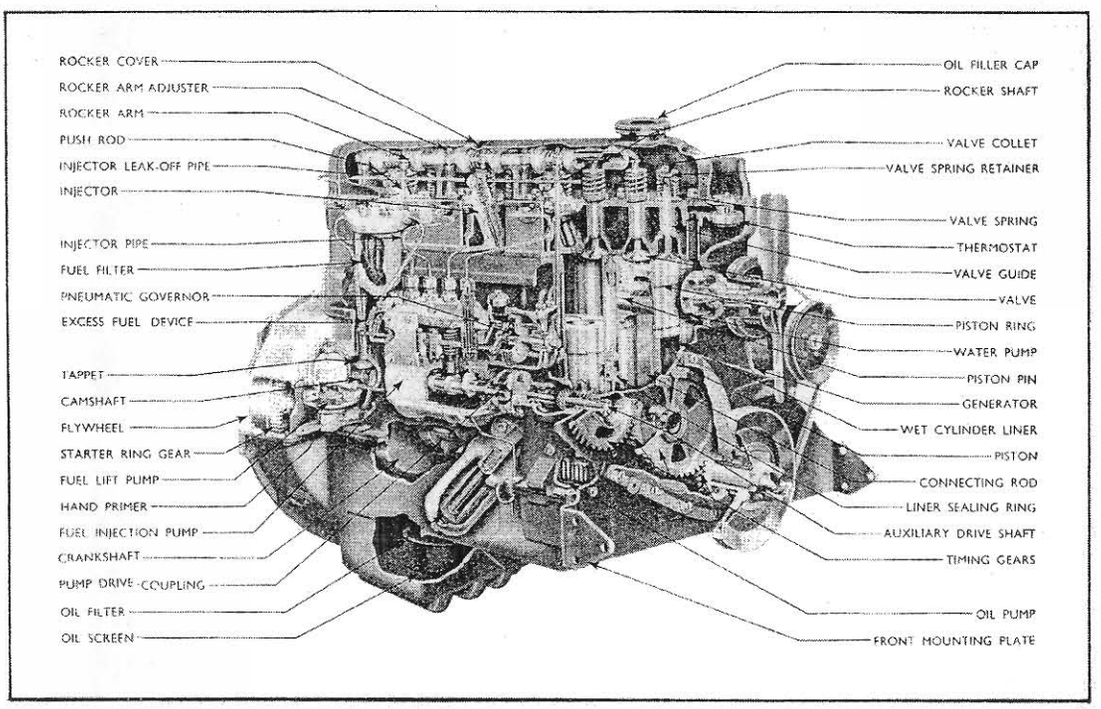


Fig. 1.
Sectioned View of Diesel Engine.

INTRODUCTION

The design of the four cylinder O.H.V. diesel engine used on Fordson Tractors has remained basically unchanged since it was introduced in 1952.

This supplement will cover the complete dismantling and reassembly procedure for Power Major engines including where necessary any differences which exist between the current and previous type units.

For clarity of description, reference will be made to Mk. I engines (Engine Nos. from 1217101 to 1425096), Mk. II engines (from Engine No. 1425097 to 1481090) and Mk. III (from Engine No. 1481091 onwards, i.e. Power Major).

TO DISMANTLE THE ENGINE

To Remove the Engine from the Tractor

To prevent the possibility of damage and to facilitate the fitting of the engine stand bracket, the method of removing the engine as described below includes the removal of all external assemblies.

1. Drain the cooling system through the taps on the radiator and cylinder block.
2. Remove the sump drain plug and drain off the engine oil.
3. Remove the primary air cleaner (and vertical exhaust if fitted). Extract the two screws and lockwashers retaining the rear clip of the bonnet hinge and remove the bonnet.

4. Disconnect the battery leads and remove the batteries (*prior to Engine No. 1408399 a single 12 volt battery was fitted, subsequent to this number two 6-volt batteries giving the same total capacity were fitted to facilitate handling*). Check battery condition and put them on charge if necessary.

5. Remove the tool box which is bolted to the engine rear mounting pad (L.H. side).

6. If a downswept exhaust system is fitted, disconnect it at the outer manifold flange, remove the two brackets, one on the rear axle housing and one to the side channel supporting the tail pipe and silencer, then remove the pipe and silencer complete.

7. Remove the air cleaner to inlet manifold hose.

8. Remove the air cleaner to rocker cover breather pipe (Mk. II and III engines). *The Mk. I breather pipe is fitted between the inlet manifold and the side of the rocker cover.*

9. Disconnect the starter motor actuating rod at the starter switch clevis.

10. Disconnect the wiring from the starter motor (including heavy duty cable) generator, oil pressure switch, and L.H. headlight snap connectors and coil up the wiring loom so that it does not become damaged (Mk. III engines only).

    The wiring loom on the Mk. I and II engines is located in clips attached to the tappet cover extension studs on the R.H. side of the cylinder block extensions from the main loom crossing at the rear of the cylinder block to the starter motor, and across the front of the block to the generator.

    Disconnect the wiring from the starter motor and generator on Mk. I and II engines, release the loom retaining clips, pull the extension wires from the starter motor and generator through to the R.H. side of the engine, disconnect the headlamp snap connectors and coil back the wiring loom.

11. Remove the starter motor and generator.

12. Disconnect the water temperature gauge bulb from its location in the cylinder head, release the clips holding the capilliary tube to the radiator tie bar and carefully coil back the capilliary tube clear of the engine.

    The capilliary tube is located in the wiring loom clips on the R.H. side of the Mk. I and II engines.

13. Remove the oil pressure warning light switch (Mk. III only). *Disconnect the oil pressure gauge pipe to cylinder block union (Mk. I and II engines).*

14. Remove the vertical operating rod to the throttle butterfly arm.

    The lower end of this rod on Mk. I engines is connected to the arm of a linkage rod carried in a through cross drilling in the cylinder block, between No. 1 and 2 cylinder bores. On Mk. II and III engines the connection is to a relay lever and the linkage passes across the rear of the cylinder block.

15. Disconnect the governor suction pipe unions from the inlet manifold venturi and remove the inlet and exhaust manifolds.

16. Remove the throttle swivel linkage from the cylinder block (Mk. II and III engines only).

17. Disconnect the radiator tie bar at the water outlet connection.

18. Remove the top and bottom radiator hoses.

19. Disconnect the proof-meter drive and remove the driving gear assembly from the auxiliary drive shaft location.

20. Loosen the pinch bolt on the stop control lever of the fuel injection pump and remove the stop control cable.

21. Turn off the fuel tap, disconnect the fuel lift pump inlet and outlet pipes at the lift pump, extract the two retaining screws and remove the fuel lift pump.

22. Disconnect the fuel filter to injection pump pipe at the pump.

23. Remove the two screws securing the fuel filter to the cylinder head and detach the filter and pipes.

24. Remove the two screws securing the oil filter to the cylinder block and detach the filter. The injection pump leak-off pipe is retained by a clip located under the head of the lower filter securing screw.

25. Remove the injection pump to injector high pressure pipes and governor suction pipes (the latter are retained by a clip under the head of the R.H. side water outlet connection retaining screw).

26. Extract the four retaining screws and remove the fuel injection pump (suitably seal all openings against dust).

27. Disconnect the throttle operating rod at the point where the horizontal rod from the hand operating lever connects with the cross linkage at the rear of the cylinder block (Mk. II and III engines).

    On Mk. I engines disconnect the horizontal rod where it connects with the cross rod link on the R.H. side of the cylinder block.

28. Disconnect the fuel leak-off pipe banjo connection at the rear of the cylinder head.

29. Disconnect the steering drag link from the spindle steering arm by removing the split pin and unscrewing the drag link front ball plug.

30. Support the engine and transmission using the tractor dismantling stand (Tool No. Tr.NMD27). Lay the two rail sections under the tractor, place the engine and gearbox trolleys in position and suitably adjust them to support these units during splitting.

31. Place the front axle wedge (Tool No. T.3007) in position between the front crossmember and the stops on the front axle to prevent movement between the engine and front axle assemblies.

32. Remove the four bolts on each side retaining the side channels to the gearbox, and the bolts retaining the engine to the gearbox. Do not forget the two bolts behind the side channels.

33. Withdraw the engine, radiator and front axle assembly, moving the assembly forward until the engine is clear of the gearbox.

34. Fit the two engine lifting plates (Tool No. CT.6003) one to the fuel filter boss at the rear of the cylinder head on the R.H. side of the tractor, and the other under the two front L.H. side cylinder head bolts. Take the weight of the engine on a hoist or gantry.

35. Remove the front axle radius rod rear pin after removing the split pin.

36. Remove the four bolts from the front of the side channel on the L.H. side, and the radiator shell bolt.

37. Remove the bolts from the engine front mounting to each side channel, and remove the side channel from the L.H. side.

38. Remove the engine by lifting it slightly and pushing it carefully towards the L.H. side so that the radius rod slides sideways out of its sump location, and the front mounting plate clears the R.H. side channel. Lift the engine a little higher, then wheel away the front axle and radiator assembly.

39. Mount the engine on the engine stand (Tool No. 200A), using the special mounting bracket (Tool No. CT.6006) or, if already in the Dealer's possession, Tool No. CT.6005. The bracket is fitted to the L.H. side of the engine and is secured by two bolts locating in tapped holes provided at the lower forward position on the cylinder block, two bolts at the throttle bracket location behind the exhaust manifold, and four bolts at the engine rear side channel location.

40. Remove the clutch assembly from the flywheel taking care to slacken the clutch cover to flywheel bolts evenly.

41. Remove the two engine lifting plates.

To Dismantle the Engine

1. Remove the six screws securing the flange of the valve rocker cover to the cylinder head (*two screws into the intermediate rocker shaft brackets on Mk. I engines*) and remove the cover and gasket.

If a decompressor is fitted and it is of the type which has the operating lever at the front of the engine, it will be necessary to extract the retaining screw and detach the lever before the rocker cover can be removed (*prior to Engine No.* 1290291 *the lever was located in the rear R.H. side of the cylinder head*).

An oil seal is fitted where the tongued boss of the lever enters the cover and this may be removed, if necessary, and a new seal tapped into position until the flange of the seal is flush with the outside face of the cover.

2. Remove the two screws retaining the water outlet connection to the cylinder head and remove the outlet connection and the thermostat.

3. Remove the screws retaining the leak-off pipe to the injectors, unscrew the union nut at the rear of the cylinder head and detach the forward portion of the leak-off pipe, then remove the injector retaining screws and extract the injectors from their housings followed by the copper washers from the injector locating bores in the cylinder head.

4. Slide the valve rocker levers sideways to enable the ball ends of the tappet adjusting screws to disengage from the cup ends of the push rods, and remove the push rods keeping them in their correct sequence. It will be necessary to turn the engine using the engine turning bar (Tool No. CT.6071) to take the load off any rocker lever which may be holding a valve open.

5. Knock down the tab washers, unscrew the rocker shaft support bracket retaining screws evenly and lift off the rocker shaft assembly, then remove the rotator caps from the exhaust valves and keep them in their correct sequence.

To Dismantle the Rocker Shaft Assembly

Three distinct rocker shaft assemblies may be encountered i.e. without decompressor, with decompressor operating lever at rear of assembly (prior to Engine No. 1290291*) and with decompressor operating mechanism at the front of the assembly.*

Where the decompressor lever is located at the front of the valve rocker cover, a special retaining plate incorporating a locking ball and spring is pinned to the rocker shaft in place of the standard front end plug, the pin hole being offset in the rocker shaft so that it can only be fitted in one position (see Fig. 2).

Where the decompressor is operated by a lever acting through a boss at the rear of the cylinder head the control plate is pinned to the rear end of the rocker shaft (see Fig. 3).

The rocker arms are " handed " i.e. the valve ends of the levers are offset to the right or left of the centre line of the arm when viewed from the push rod end. Identical right- and left-hand arms are used on Mk. I and II engines but those fitted to Mk. III engines are shorter from the centre of the adjusting screw to the centre of the rocker shaft than those fitted to the earlier engines.

Similarly, special decompressor sleeves, identified by an indentation in the surface of the sleeve between the two holes are used on Mk. III engines (see Fig. 2).

Mk. III arms and sleeves are not interchangeable with those used previously.

i Stand the rocker shaft assembly on end with the rocker arms for No. 1 cylinder uppermost.

ii Pull down on the front support bracket until the pin securing the end plug or decompressor locking plate is uncovered.

iii Push out the pin and remove the end plug (or locking plate spring and ball where a front operated decompressor is fitted).

iv Remove the adjacent rocker support bracket, two rocker arms and spacer springs. If a decompressor is fitted, remove the first eccentric sleeve and woodruff key.

v Remove the screw securing the intermediate support bracket to the shaft and remove the support bracket. (If a decompressor is fitted, these support brackets are not secured to the shaft as it is then necessary to rotate the shaft to effect decompression.)

vi Further dismantle the assembly, following a similar sequence, until after removal of the rear support bracket the rear end plug pin (operating plate retaining pin when a rear operated decompressor is fitted) is exposed. This pin may then be pushed out and the end plug removed.

To Reassemble the Rocker Shaft

i Replace the rear end plug or decompressor operating plate and pin.

ii Replace the rear support bracket.

iii Fit a left-hand rocker arm, i.e. one on which the valve end is " set " away from the rear support. If a decompressor is fitted, assemble a woodruff key to the rear keyway in the shaft and fit an eccentric sleeve.

iv Fit a spacing spring and a right-hand rocker arm, i.e. one on which the valve end is " set " towards the rear bracket.

v Fit an intermediate support bracket and secure it to the shaft with a set screw. (No screw if decompressor is fitted.)

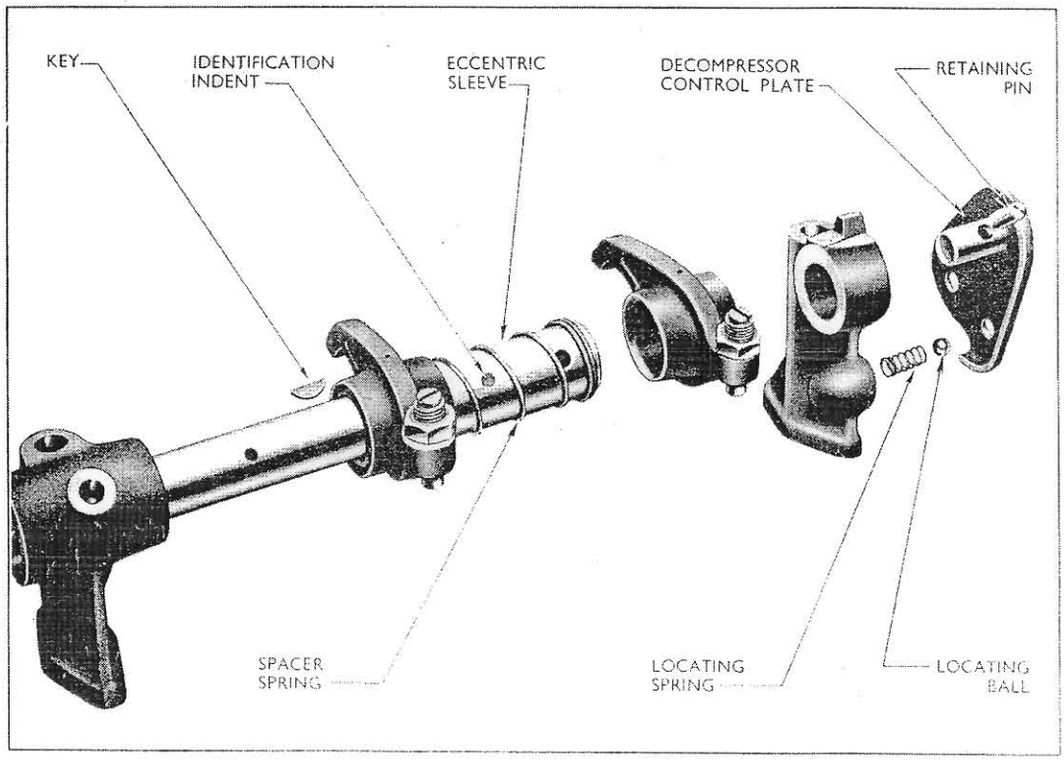


Fig. 2.
Rocker Shaft with Front Operated Decompressor.

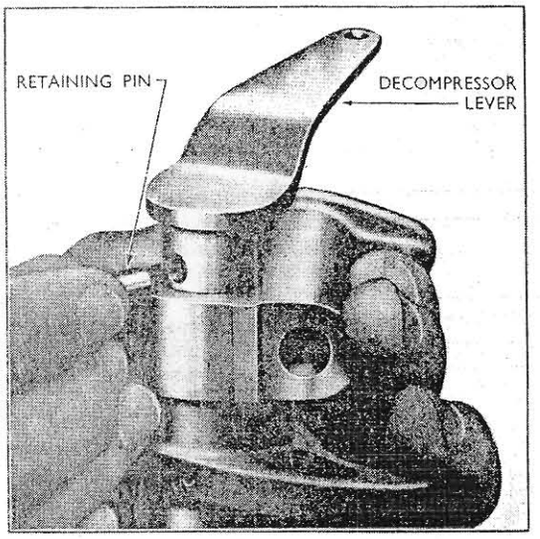


Fig. 3.
Rear Operated Decompressor.

vi *Continue building up the rocker shaft, springs, sleeves and brackets until the front support bracket is in position.*

vii *Fit the front end plug, pull down on the support bracket and fit the plug securing pin.*

When a front operated decompressor is fitted, locate the boss of the control locking plate in the end of the rocker shaft, pull down the front support bracket and fit the securing pin through the shaft and plate boss (see Fig. 4). Hold the front support bracket down and fit the decompressor plate locating spring into the blind hole in the front of the bracket. Position the control ball in one of the locating holes in the control plate, and release the support bracket so that it abuts the plate with the ball locating in the end of the spring.

Until the rocker shaft is replaced on the engine and the support brackets are bolted down, care should be taken to ensure that the control plate spring and ball do not become detached and lost.

6. Remove the retaining screws and detach the fan pulley and fan blades from the water pump hub.

7. Remove the four water pump retaining screws and detach the pump and gasket from the cylinder block.

The water pump body used on the Mk. II and III engines incorporates an enlarged water by-pass port, which also necessitates a different gasket from that used on the Mk. I engine.

To Overhaul the Water Pump

Throughout the following operation the water pump overhaul main tool (Tool No. CPT.8000) is used in conjunction with the appropriate adaptors (Tool Nos. CPT.8000–2 and CPT.8000–3).

When overhauling a water pump from a tractor fitted with Power Assisted Steering it will also be necessary to use main tool (T.7000) and adaptors (Tool No. T.7000–17/a and T.7000–17/b) to remove the pulley and hub assembly.

i *Clamp the main tool (Tool No. CPT.8000) in a vice, pass the hub of the water pump assembly through the base of the tool from the underside and position the split adaptors (Tool No. CPT.8000–2/a) under the hub flange. Attach the centre screw extension (Tool No. CPT. 8000–3/d) to the main tool centre screw and wind down the centre screw, applying sufficient pressure to remove the hub from the pump shaft.*

A similar procedure should be adopted when removing the hub from the special pump assembly which is fitted when tractors are equipped with Power Assisted Steering. In this case, however, the fan pulley is of different design being flange located on the pump side of the hub, and is retained by four bolts which also secure the fan blades to the hub flange.

These bolts should be removed and the pump assembly located in the main tool (Tool No. T.7000) as before with the split adaptors (Tool No. T.7000–17/a) under the flange of the pulley and hub assembly. Using the centre screw extension (Tool No. T.7000–17/b) press the pump shaft through the hub as far as possible. Due to the length of the hub boss it will then be necessary to insert a suitable distance piece between the centre screw extension and the end of the shaft to complete the operation.

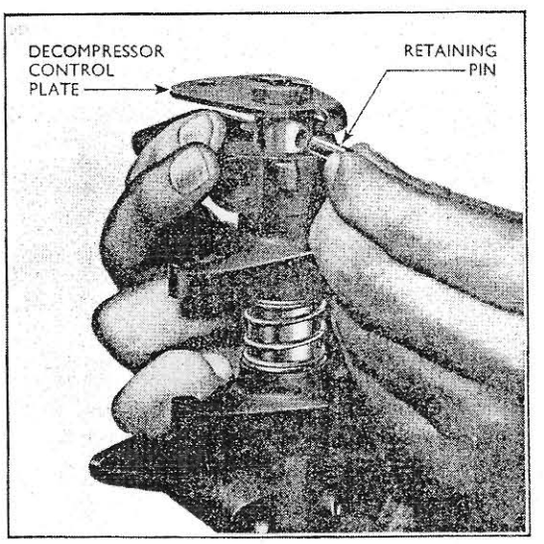


Fig. 4.
Front Operated Decompressor.

The pulley is a light press fit on the hub boss and may be removed if necessary by suitably supporting the pulley and tapping out the hub with a copper or hide-faced hammer.

ii *Lever the bearing retainer clip out of the slot in the housing.*

iii *Locate the pump mounting flange in the adaptor ring (Tool No. CPT.8000–2/d) and, using the hollow thrust block (Tool No. CPT.8000–3/b), press the impeller, seal, slinger, shaft and bearing assembly out of the housing.*

iv *Support the impeller in the adaptor ring (Tool No. CPT.8000–2/b) with the pump shaft downwards and press the shaft out of its location, using the centre screw extension (Tool No. CPT.8000–3/d).*

v *Remove the pump seal from the shaft, carefully split the slinger bush with a chisel and detach it from the shaft.*

To Reassemble the Water Pump

i *Using ring adaptor (Tool No. CPT.8000–2/d) and the hollow thrust block (Tool No. CPT. 8000–3/b), press the shaft and bearing assembly into the housing (short end of the shaft to the front of the housing) until the groove in the shaft is in line with the groove inside the housing.*

ii *Refit the bearing retainer clip in the groove of the bearing and the housing.*

iii *Using the ring adaptor (Tool No. CPT. 8000–2/a), press the pump pulley hub onto the front end of the shaft until the end of the shaft is flush with the end of the hub bore.*

In the case of a Power Assisted Steering water pump it is necessary to use the main tool (Tool No. T.7000) and it is therefore preferable to leave this operation until last.

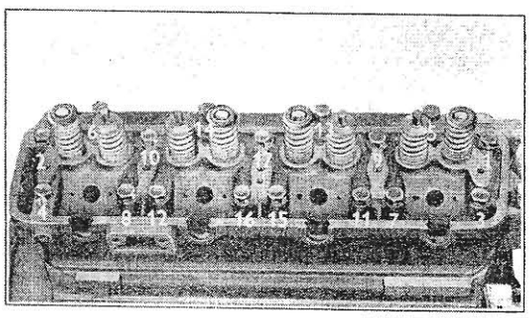


Fig. 5.
Correct Sequence for Loosening Cylinder Head Screws.

iv *Using the driver adaptor (Tool No. CPT. 8000–3/a) replace the slinger bush (flanged end first) on the rear end of the shaft, and refit the pump seal on the slinger bush with the carbon thrust face towards the impeller.*

v *Using the adaptor (Tool No. 8000–2/b), press the impeller onto the shaft until a clearance of .030 ins. (.762 mm.) is obtained between the impeller blades and the housing face.*

On Power Assisted Steering pumps replace the pulley on the hub and, using the main tool (Tool No. T.7000) and adaptors (Tool No. T.7000–17/a and T.7000–17/b), press the shaft into the pulley hub until the end of the shaft is 1.406 ins. (10.312 mm.) from the machined face of the boss at the front of the hub.

vi *Replace the fan blades and four retaining bolts.*

8. Remove the 17 cylinder head retaining screws using the sequence shown in Fig. 5 and remove the cylinder head and gasket, and followed by the small rubber washer fitted under the gasket at the rocker oil feed drilling, mid-way along the block.

Note.—If further work is to be carried out on the cylinder assembly necessitating inversions of the unit a suitable screw and large flat washer should be fitted between each pair of cylinder liners to prevent them falling out.

To Dismantle the Cylinder Head Assembly

i *Position the valve spring compressor (Tool No. CT.6074) over the valve to be removed locating the tool with a rocker support bracket retaining screw.*

ii *Compress the valve spring and extract the split collets.*

iii *Remove the valve spring compressor, spring retainers, spring, rubber sealing ring or cup (also the spring spacer if an exhaust valve is being removed).*

iv *Extract the valve from its location in the cylinder head.*

v *Repeat the above operation on the remaining valves. Keep the valve assemblies in their correct order.*

Note.

It is possible to change a valve spring without removing the cylinder head providing the piston of the associated cylinder is brought to top dead centre position (see Fig. 6).

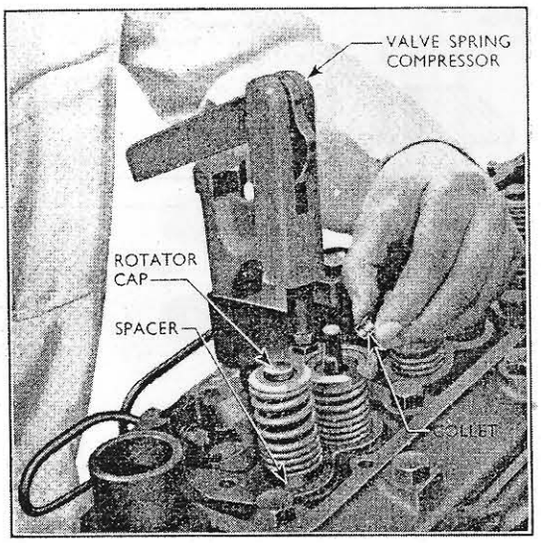


Fig. 6.
Valve Spring Compressor.

vi Pass the rod of the valve guide remover and replacer tool (Tool No. CT.6073) through the valve guide so that the angled face of the body abuts the valve seat in the cylinder head.

vii Fit the spacer and knurled retainer to the rod, and turn the wing nut of the tool to remove the valve guide from the head.

viii Repeat the above operation on the remaining valve guides.

To Reassemble the Cylinder Head

Prior to Engine No. 1458447 (apart from a few very early engines) the exhaust valve guides were shorter than the inlet guides. A common guide is now used (original inlet type) at both inlet and exhaust locations but at different protrusions (see Fig. 7 and 8) and should it be necessary to renew an exhaust valve guide on any Fordson Major Diesel Engine only the current valve guide should be fitted, using the adaptor (Tool No. CT.6073–1/h V.O. and Pet.) to ensure that it is pulled in to the correct depth in the cylinder head.

If the valve seats in the cylinder head are burnt or pitted they may be reconditioned by using suitable propriery valve seat grinding equipment with the stone cutter set at 30°.

If necessary the valves should be ground on a valve refacing machine set to 29½°. The valves should be hand lapped to the valve seats in the normal manner making certain on completion that all traces of the lapping compound are removed.

From approximate Engine No. 1425097 the rotator caps and collets were increased in diameter and the spring retainer was modified to accommodate them. Only the latest parts will be serviced and they must be fitted in sets, i.e. caps, collets, and spring retainers.

i Place an inlet valve guide into its location with the sharp chamfer towards the top of the cylinder head.

ii Pass the spindle of the special replacer (Tool No. CT.6073) up through the cylinder head and inlet guide.

iii Position the replacer adaptor (Tool No. CT.6073–1/g Diesel Inlet) over the spindle of the main tool and secure in position with the knurled nut.

iv Pull the guide into position by winding on the wing nut of the main tool (see Fig. 9). The

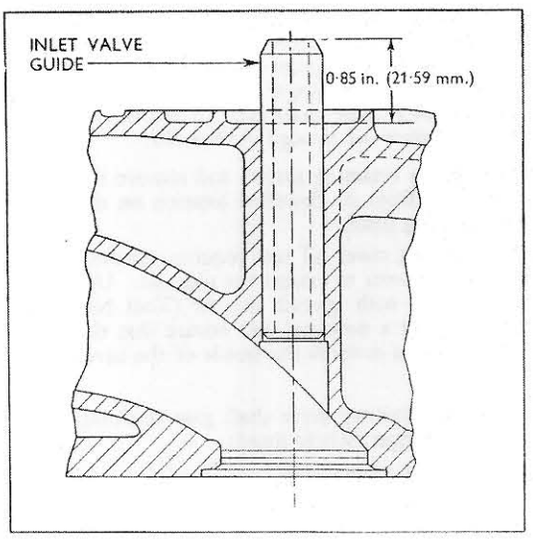


Fig. 7.
Inlet Valve Guide Protrusion.

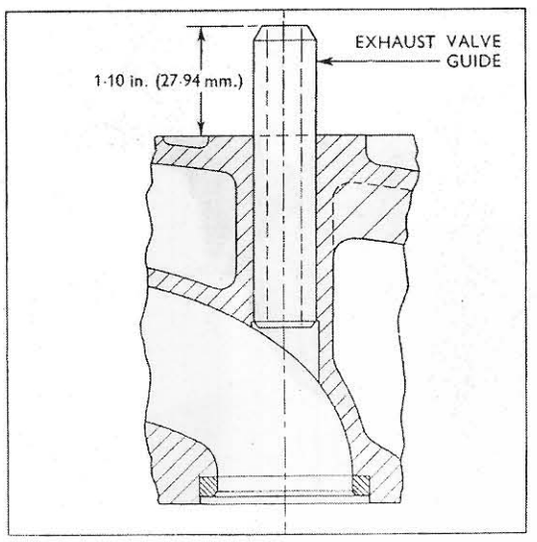


Fig. 8.
Exhaust Valve Guide Protrusion.

adaptor ensures correct depth of the guide in the cylinder head.

v *Fit the remaining inlet valve guides in the same sequence as above.*

vi *Place an exhaust valve guide in position and, using the replacer (Tool No. CT.6073) with the adaptor (CT.6073-1/h V.O. and Pet.) pull the exhaust valve into position.*

vii *Lightly lubricate the valve stems and fit the valves into their respective locations.*

viii *Lay the cylinder head face down, on a clean bench.*

ix *Position the exhaust valve spring spacers over the exhaust valve guides and fit the current type oil seal cups to both inlet and exhaust valve stems. (Prior to Engine No. 1458447 rubber ring seals were fitted to a groove machined in the inlet valve stems only. Discard these ring seals and use the cup type seal on all valves irrespective of whether or not a groove is machined in the valve stem.)*

x *Assemble the inlet and exhaust valve springs with the close wound coils of the spring towards the cylinder head.*

xi *Place the valve spring retainers in position, compress the springs, using the spring compressor (Tool No. CT.6074) and locate the spring retaining collets. Parallel sided collets are used on exhaust valves, and tapered collets on inlet valves.*

xii *Ensure the collets are seating correctly, fit the rotator caps to the exhaust valves, and ensure that there is a clearance of .001 in. (.025 mm.) to .003 in. (.076 mm.) between the end of the valve stems and the inner face of the cap (see Fig. 10).*

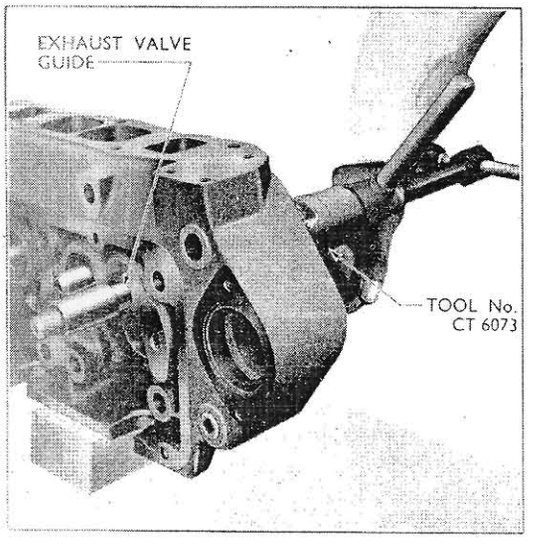


Fig. 9.
Replacing a Valve Guide.

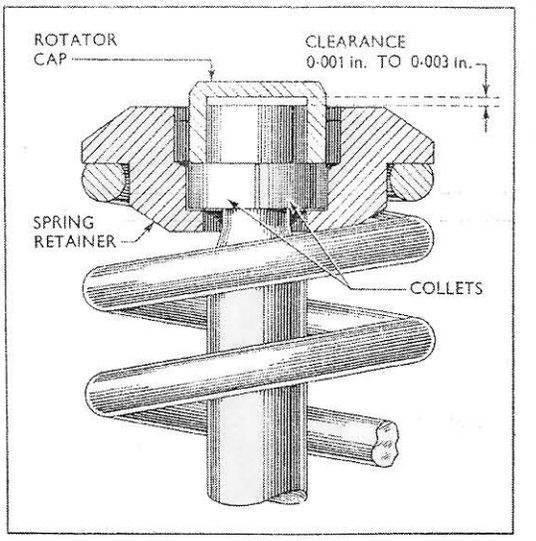


Fig. 10.
Valve Rotator Cap Clearance.

9. Remove the crankshaft ratchet nut and washer, using the special spanner (Tool No. CT.6071).

10. With the screws of extractor tool (Tool No. CT. 6070) located in the three tapped holes in the crankshaft pulley boss, tighten the centre screw of the tool and draw the pulley from the crankshaft. (Early Mk.I pulleys incorporated two puller holes, the same tool however may be used to remove this type of pulley).

11. Remove the oil bath air breather (where fitted) from the front timing cover.

Note.—*Mk. I engines used a closed circuit breathing system but on Mk. II and III engines an open circuit breathing system is used with an air breather mounted on the front timing cover. With the latter system an oil slinger is fitted to the front of the auxiliary drive shaft gear to prevent oil from being thrown out through the breather.*

12. Extract the 14 retaining screws and remove the timing cover from its dowelled location on the front mounting plate.

If the timing cover oil seal requires renewal, use a suitable lever to extract the old seal. Use Tool No. 550 with special adaptor (Tool No. CT.6072) to fit a new seal and ensure that the lip of the seal is towards the inside of the cover (see Fig. 11).

13. Remove the auxiliary drive shaft gear retaining nut and oil slinger (where fitted).

14. Knock back the tab washers and remove the three screws holding the camshaft inner and outer gears to the camshaft flange. Remove the inner and outer gears from the camshaft spigot and dowel.

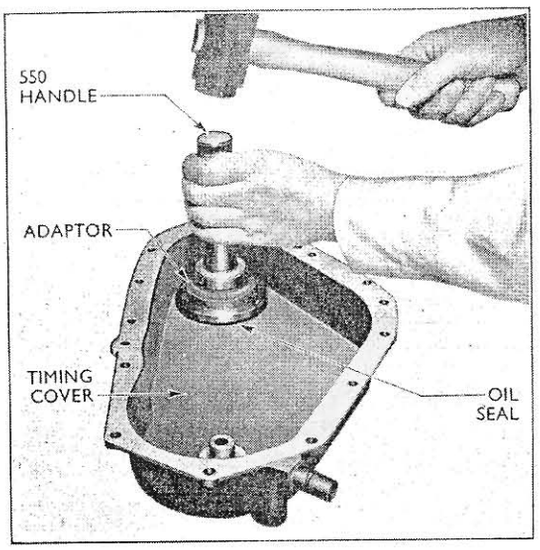


Fig. 11.
Fitting Crankshaft Oil Seal in Timing Cover.

15. Withdraw the auxiliary drive shaft gear from its location on the auxiliary drive shaft.

Note.—When the timing gears have been removed, do not turn the crankshaft again until the camshaft has been withdrawn, otherwise if the camshaft moves, the fuel lift pump drive eccentric on the camshaft may foul No. 4 connecting rod big end with resultant damage.

16. If necessary, remove the crankshaft gear, using the special remover (Tool No. CPT.6040) as shown in Fig. 12.

Note.—It is not necessary to remove the crankshaft gear in order to remove the engine mounting plate.

17. Unlock the front mounting plate screw locking tab washers, and remove the retaining screws, mounting plate and gasket from the cylinder block face.

18. Invert the engine, taking care that the camshaft does not drop out, then extract the sump retaining screws and remove the sump and gaskets.

19. Remove the oil pump filter screen, (see Fig. 13) straighten the tabs on the suction pipe union locking plate and unscrew the union nut. Remove the suction pipe support bracket screw which is located in the centre main bearing cap, and detach the pipe from the pump.

20. Remove the two screws securing the oil pump to the cylinder block and withdraw the pump.

21. Remove the clamp bolt from the fuel injection pump drive coupling and tap the coupling rearwards off the shaft.

22. Remove the woodruff keys from the auxiliary drive shaft and tap the shaft complete with bearings forward out of its location in the cylinder block.

23. Remove the auxiliary drive shaft oil seal by driving it rearwards from its location in the cylinder block.

Note.—This seal may be replaced without removing the shaft, by using a suitable lever to remove the old seal, and a special replacer (Tool No. CT.6086) to ensure correct positioning without damage to the new seal.

To Dismantle the Auxiliary Drive Shaft

i *Clamp the main tool (Tool No. CT.6085) in a vice.*

ii *Use the split ring adaptors (Tool No. CT. 6085–3/a) and remove the small bearing.*

iii *Use the split ring adaptors and the thrust pad (Tool No. CT.6085–3/d) to remove the large bearing.*

To Reassemble the Auxiliary Drive Shaft

i *Place the split ring adaptor (Tool No. CT. 6085–3/a) in position in the main tool with the large bearing positioned in the recess of the ring.*

ii *Enter the threaded end of the auxiliary drive shaft into the bearing and press the shaft through the bearing until the shoulder on the shaft abuts the inner face of the bearing.*

iii *Place adaptor ring (Tool No. CT.6085–3/b) within the split ring adaptor (Tool No. CT.6085–3/a) and position the small bearing in the recess of the ring.*

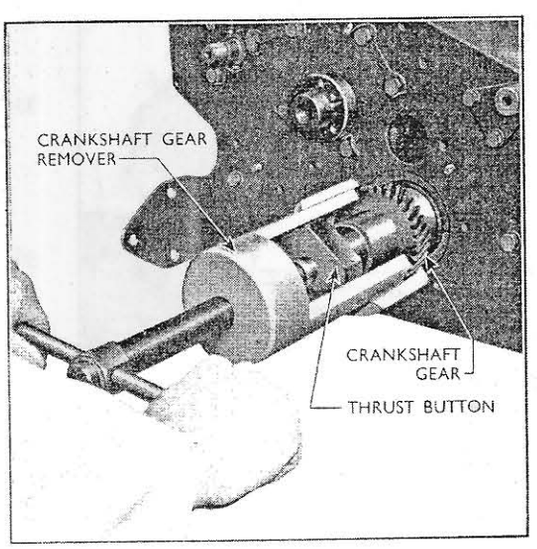


Fig. 12.
Removing Crankshaft Gear.

iv *Reverse the auxiliary drive shaft and enter the plain end of the shaft into the bearing.*

v *Using the thrust pad press the shaft through the bearing until the bearing abuts the shoulder on the shaft.*

24. Pull the camshaft forward and extract the thrust washer (see Fig. 14).

25. Carefully remove the camshaft, taking care not to damage the cams and journals, then lift the tappets from their bores in the cylinder block and retain them in their correct sequence.

26. Rotate the crankshaft so that the piston to be removed is at bottom dead centre.

27. Remove the two self-locking nuts from the connecting rod bolts, and remove the connecting rod cap and lower bearing liner.

28. Push the piston and connecting rod out through the cylinder bore, and assemble the cap and bearing liner to the rod to retain them in their correct position and order.

29. Repeat on remaining pistons and connecting rod assemblies.

30. Remove the piston rings by using two or three lengths of feeler strip inserted between the rings and the pistons. Slide the rings over the feeler strip and off the pistons.

31. If it is required to replace the piston pins, remove the end circlips from the pistons and push out the pins. This operation may be facilitated by first immersing the piston in hot water.

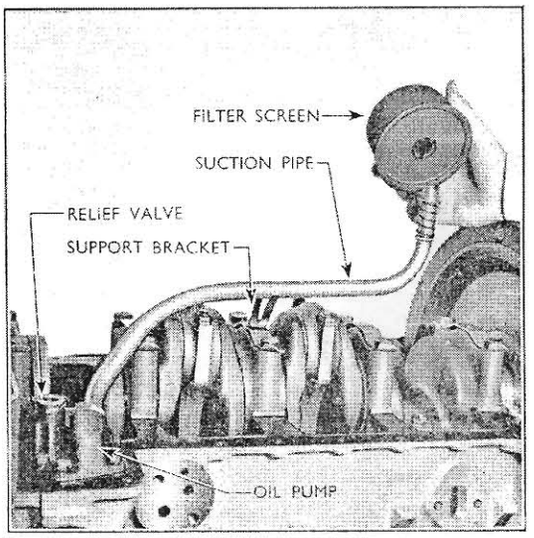


Fig. 13.
Removing Sump Oil Filter Screen.

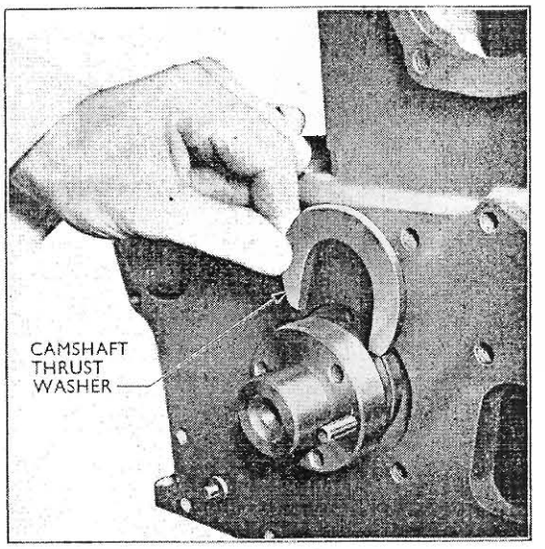


Fig. 14.
Camshaft Thrust Washer.

32. Straighten the locking tabs, unscrew the flywheel retaining screws and remove the flywheel. The flywheel is located on two dowels in the crankshaft flange and removal may be facilitated by using two puller bolts screwed into the tapped holes provided in the flywheel.

33. To remove the clutch pilot bearing, withdraw it from the flywheel, using Tool No. 7600 and adaptor (Tool No. CPT.7600-3). Fit the new pilot bearing into position, using clutch pilot bearing replacer tool (Tool No. CPT.7061 and 550 handle).

34. To remove the flywheel ring gear, remove the six countersunk screws securing the gear to the flywheel, and tap the gear off its register (see Fig. 15).

35. Mark the main bearing caps so that they may be replaced in their original positions. Straighten the main bearing cap screw locking tabs, remove the main bearing cap screws, and remove the caps together with the lower halves of the bearing liners and thrust washers.

36. Carefully lift the crankshaft clear of the cylinder block, taking care to ensure that the upper halves of the bearing liners do not adhere to the crankshaft.

37. Remove the upper halves of the bearing liners—unless they are to be renewed they should be kept with their respective caps. Under no circumstances should the caps be interchanged as the main bearings are line bored in production with the caps in their correct locations.

38. Remove the upper half of the main bearing oil seal then, if necessary, extract the three dowel screws and remove the oil seal housing. Normally the latter should not require removal.

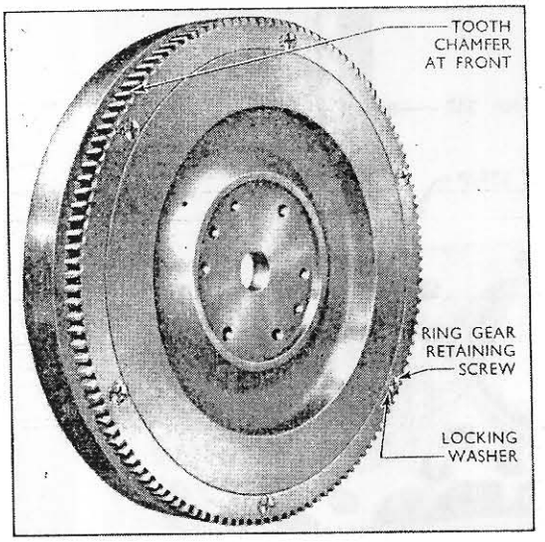


Fig. 15
Flywheel Ring Gear Retaining Screws

39. Revolve the cylinder block on the stand to bring the cylinder head face upwards, remove the temporary screws and washers fitted to retain the cylinder liners in position and withdraw the liners, using the special tool (Tool No. CT.6075). If the original liners are to be refitted, they should be numbered and marked for angular position to ensure that they are replaced in their original positions.

40. Remove the liner sealing rings from their recesses in the cylinder block.

To Reassemble the Engine

At the time of going to print, a new cylinder head gasket is being released together with locating dowels for the gasket in the cylinder block, modified cylinder liners and new pistons.

These changes involve revised fitting procedures for these items and the following instructions have been written on the assumption that these changes are in effect.

1. Thoroughly clean and inspect the parts.

   Threaded sealing plugs are fitted to the cylinder block at each end of the main oil gallery, and these can be removed so that the oil gallery can be thoroughly cleaned out.

   Check the cylinder block top face for flatness and remove any local high spots or burrs by light draw-filing. Check the cylinder liner seat and the liner seal groove in the block and ensure that they are undamaged and free from dirt or foreign matter.

   Where cylinder head gasket locating dowels are fitted to the top face of the cylinder block, ensure that they are undamaged, and replace if necessary.

   When reassembling, all normal fitting instructions regarding cleanliness and lubrication of parts should be strictly adhered to.

2. Discard the cylinder liner rubber sealing rings and fit one of the liners without a sealing ring to the cylinder block. Clamp it down at five locations, using suitable screws and washers as shown in Fig. 16, and tighten the screws to a torque of 20 lbs. ft. (2.764 kg.m.).

   Make a check between each pair of clamping screws that the liner protrusion above the face of the block is within the specified limit .002 to 004 in. (.05 to .10 mm.).

   If these figures cannot be obtained, loosen the clamping screws and rotate the liner through a series of short arcs retightening the screws and checking to establish the best protrusion position for the liner.

   If the protrusion is consistently below .002 in. (.05 mm.) install not more than two of the .003 in. (08 mm.) thick steel shims, which are supplied through service for this purpose, under the flange of the liner and again check the protrusion

   Note.—There is no necessity to disturb the liners if a cylinder head gasket only is being changed, providing that there is a genuine protrusion of not less than .001 in. (.025 mm.) at any point and that the current type gasket is fitted in the approved manner. (See Operation 47.)

3. Mark the liner and block to ensure that the same relative position is maintained on final assembly then remove the liner and repeat the protrusion checks on the remaining liners.

4. Before finally fitting each liner lightly apply a small quantity of Wellworthy Wellseal, or approved equivalent, under the liner flange, also each side of any shim which is being

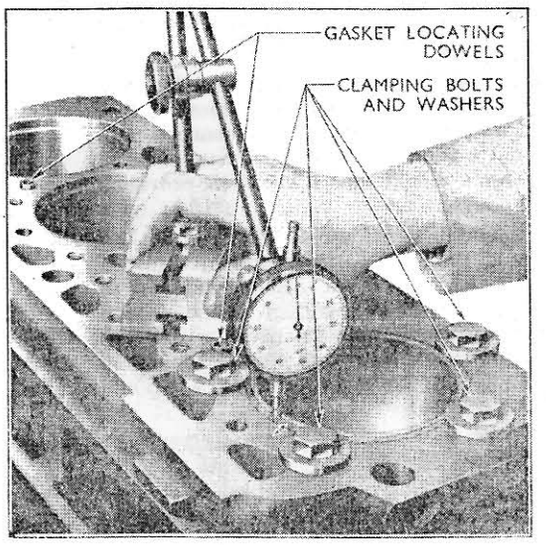


Fig. 16
Cylinder Liner Clamping Screws

used. Only a thin film of sealer should be applied and care must be taken that the sealer does not enter the cylinder bores, the water passages or on to the rubber sealing ring location at the lower end of the liner.

5. Select a new set of sealing rings, lubricate them with soft soap and fit them into their recesses in the cylinder block.

   Replace the cylinder liners and press them into position, ensuring they are fitted in the same bore and in the same angular position as when checked. Retain each pair of liners with screws and washers as before to prevent movement during subsequent assembly operations.

   The current type cylinder liner has a spigot formed on the top flange which locates inside the cylinder bore hole in the cylinder head gasket. This liner may be used on any Fordson Major 4 cylinder O.H.V. diesel engine.

6. Invert the engine on the stand and fit the upper halves of the main bearing liners to the cylinder block. If the crankshaft rear oil seal packing requires replacement, the new packing should be first soaked in engine oil for at least one hour before fitting. When fitted, the ends of the packing should protrude 1/32 in. (.794 mm.) above the oil seal housing face.

7. Fit the crankshaft thrust washer upper halves on either side of the centre main bearing web in the cylinder block, with the oilways in the washers facing outwards.

8. Install the crankshaft in the cylinder block. (See Appendix 2.)

9. Fit the lower halves of the bearing liners to the caps and install the caps in their correct locations in the cylinder block.

   NOTE.—Main bearing caps are line bored in production and it is not recommended that caps from one engine are interchanged with those from another engine. Semi-finished caps are available for use in service providing facilities exist for line boring to .015 in. (.381 mm.) oversize. (See Appendix 3.)

   No. 2 and No. 4 (intermediate) caps are identical and care must therefore be taken to replace them in their correct locations. For identification a single number or letter is stamped on No. 2 cap and block location and a double letter or number on No. 4 cap and block location.

   Nos. 2, 3, 4 and 5 caps are marked with the word "Rear" and this should face the rear of the engine when assembled. The front cap must be fitted with the machined face to the front of the engine and this face must be lined up with the front face of the block otherwise oil leakage may occur across the front mounting plate gasket.

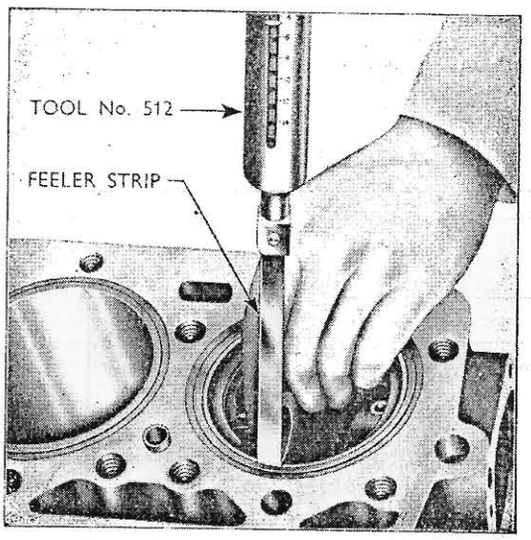


Fig. 17
Checking Piston Fit in Bore

Effective from Engine No. 1425097, *the oil return holes in the front main bearing cap were reduced from* $\frac{5}{16}$ *in.* (15.87 *mm.*) *to* $\frac{5}{16}$ *in.* (7.94 *mm.*), *these caps should only be used on engines fitted with the current type oil pump, i.e., where the oil pressure relief valve is incorporated in the pump cover.*

10. Fit new locking plates to the main bearing bolts and tighten them to a torque of 70 to 75 lbs. ft. (9.674 to 10.365 kg.m.).

11. Check that the crankshaft is free to rotate, and that the end-float is between .002 in. and .010 in. (.051 and .254 mm.) measured between the thrust washers on the centre main bearing and the crankshaft, oversize washers are available to obtain this end-float (see Appendix 3). When the end-float is correct and the main bearing bolts have been tightened to the correct torque, bend up the tabs on the locking plates to secure the bolts.

12. Fit the flywheel ring gear to the flywheel with the chamfered edge of the teeth facing towards the front of the flywheel.

    Replace the chamfered retaining screws and countersunk lockwashers, and tighten the screws evenly and securely.

13. Install the flywheel on the crankshaft flange, having first ensured that the flange is clean and free from burrs. The flywheel can only be fitted in one position on the two different diameter locating dowels. Fit new tab washers to the flywheel securing screws and tighten the screws evenly to the correct torque of 80 to 90 lbs. ft. (11.056 to 12.438 kg.m.).

    Note.—A special flywheel is required when a double clutch is fitted

Check the flywheel run-out which should not exceed .005 in. (.127 mm.) maximum total indicated reading on either the periphery or the clutch driving face and bend up the tab washers to secure the screws.

14. Reverse the engine on the engine stand, and if new pistons are being fitted, select the piston to suit the bore by using the poundage pull gauge (Tool No. 512) with a feeler strip 9 ins. (228.6 mm.) in length, .004 in. (.102 mm.) thick and .5 in. (12.7 mm.) wide. (See Fig. 17.)

The piston should be positioned in the bore with the valve recesses on the head of the piston away from the camshaft side of the engine and the feeler strip between the piston and the cylinder bore on the camshaft side. The pull required to remove the abovementioned feeler strip should be between 4 and 7 lbs. (1.814 to 3.175 kg.) with the piston fully inserted in the bore.

Note.—*Prior to Engine No.* 1425097 *the combustion chamber was centrally disposed in the piston crown and the piston pin bore was approximately* 1.25 *ins.* (31.8 *mm.*) *diameter, but subsequent to this engine number a new piston was introduced on which the combustion chamber was placed offset to the centre of the piston crown, the piston height* (*pin to crown*) *was decreased by* .012 *in.* (.305 *mm.*) *approximately to suit a crimped steel cylinder head gasket and the pin bore diameter was increased to approximately* 1.375 *ins.* (34.9 *mm.*) *to suit the increased diameter piston pin which was also introduced at this time.*

Pistons with 1.375 *ins.* (34.9 *mm.*) *piston pin bores must not be used on engines prior to Engine No.* 1425097 (*i.e. with the original copper asbestos cylinder head gasket*) *unless a service cylinder assembly has been fitted* (*see Appendix* 5). *A special piston, having the off-set combustion chamber but with the original piston height and* 1.25 *in.* (31.8 *mm.*) *diameter piston pin bore is now serviced to replace the original pistons on engines prior to Engine No.* 1425097. (*See Figs.* 18 *and* 19.)

It should be noted that a further piston .010 *in.* (.25 *mm.*) *higher* (*piston pin to crown*) *than that used with the crimped steel cylinder head gasket will shortly be introduced for use with an improved copper/asbestos cylinder head gasket* (*with steel reinforcement around the cylinder bore holes*). *This piston must not be used with a crimped steel cylinder head gasket* (*see Operation* 47) *nor on engines fitted with a decompressor if the cylinder block has been refaced. It is not, however, essential to change the pistons when fitting the current type copper/asbestos cylinder head gasket as a replacement for a crimped steel type gasket.*

Piston usage may be summarized as shown in Figs. 18 *and* 19.

15. Before fitting the piston rings to the pistons, check the ring gaps by inserting each ring in turn in the particular bore to which it is to be

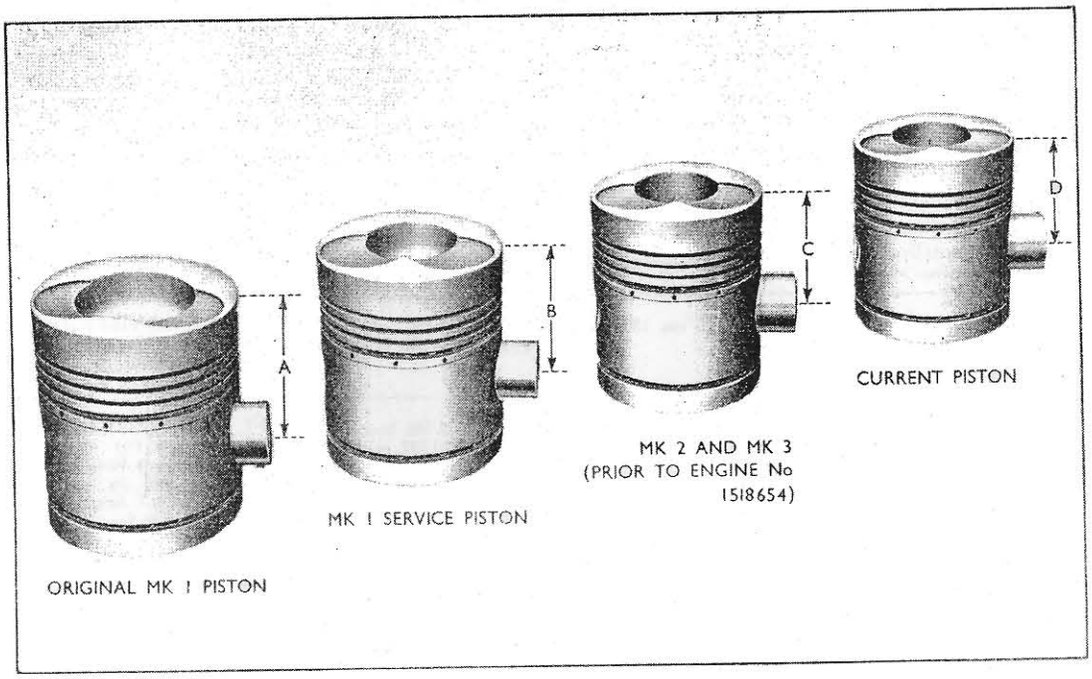


Fig. 18
Piston Identification

fitted, make the check at the lower end of the ring travel in the bore. Adjust the gap if necessary to between .011 and .016 in. (.28 and .406 mm.).

16. Check the ring to groove clearance in the piston which should be between .002 and .004 in. (.051 and .102 mm.), then assemble the rings to the pistons. The top compression ring is marked " H & T TOP " denoting it is hardened and tempered and this marking must face towards the top of the piston when assembled.
The second and third compression rings are tapered and marked " TOP " on one face, and must be fitted this way up in the piston ring groove.
The oil control rings are interchangeable and reversible.

17. Check the connecting rods for alignment on the connecting rod aligning jig (Tool No. 335), using the multi-purpose arbor (Tool No. 336) and adaptor.
Bolt the connecting rod, minus bearing liners to the arbor adaptor and mount the checking gauge on the piston pin. The connecting rod can be checked for bend or twist by positioning the gauge so that either the vertical or horizontal gauge pins are adjacent to the vertical surface plate.
With the gauge in the horizontal position, clearance at either of the two pins indicates a twisted rod, and in the vertical position clearance indicates a bent rod. When checking, ensure that the piston pin is a good fit in the small end bush.

Note.—*The following changes have been made to piston pins: Prior to Engine No.* 1362380 *the piston pin was hollow and of approximately* 1.25 *ins.* (31.75 *mm.*) *diameter.*

Between Engine No. 1362380 *and* 1425097, *the pin was solid but the diameter was unchanged.*

Subsequent to Engine No. 1425097 *a hollow pin was again introduced but the diameter was increased to approximately* 1.375 *ins.* (34.9 *mm.*).

The solid pin should be used (in sets of four) when fitted as replacement for original hollow type on any engine prior to Engine No. 1425097.

18. To ensure the correct assembly of the piston to connecting rod, fit the piston so that the recesses for the valve head in the piston crown are on the same side as the machined slots in the big end bore (for the locating tongue of the bearing liner).
With the small end of the connecting rod positioned between the piston pin bosses, press the piston pin into position and retain it with end circlips. Assembly may be facilitated by warming the piston in hot water.
Position the piston ring gaps equally around the pistons, ensuring that no gaps are directly above the piston pin ends.

19. Check that the connecting rod liners are the correct type for the crankshaft being used (see Appendix 2) and fit the upper liner to the connecting rod.

20. Replace the piston and connecting rod assemblies in their correct bores with the arrow and the word " FRONT " on the piston crown towards the front of the engine. (In some instances the word FRONT is omitted, being replaced by an arrow head only.)

Pistons Ref. Fig. 18	*Identification*	*Piston Pin Hole Diameter*	*Height, Piston Pin to Piston Crown*	*Piston Usage*
(a)	Centrally disposed combustion chamber.	1.25 ins. (31.8 mm).	2.795—2.797 ins. (70.997—71.048 mm.).	No longer serviced.
(b)	Offset combustion chamber, and diameter of piston pin hole.	1.25 ins. (31.8 mm.).	2.795—2.797 ins. (70.997—71.048 mm.).	Use in sets of 4 with solid piston pins when replacing original pistons having central combustion chamber (i.e., type *(a)*).
(c)	Offset combustion chamber; piston pin height, and piston pin hole diameter. Also: Standard—Part No. E1ADDN—6110E cast inside skirt. .0025 in. O/S — Letter F stamped on top of piston.	1.375 ins. (34.93 mm.).	2.783—2.785 ins. (70.686—70.737 mm.).	Use only for individual piston replacement or on any engine after 1425097 which is fitted with a decompressor and on which .010 in. (.254 mm.) has been removed from the top face of the block. Where all 4 pistons are to be changed used piston *(d)*.
(d)	Offset combustion chamber; piston pin height, and piston pin hole diameter. Also: Standard—Letter L stamped on top of piston. .0025 in. O/S—Letter M stamped on top of piston.	1.375 ins. (34.93 mm.).	2.793—2.795 ins. (70.946—70.997 mm).	Use on current production engines fitted with latest type copper/asbestos cylinder head gasket, or in sets of 4 as in *(c)* above.

Fig. 19 **Piston Usage Chart**

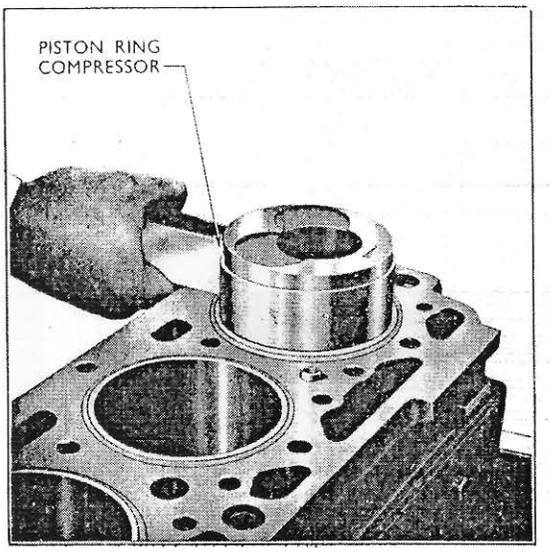


Fig. 20.
Piston Ring Compressor.

With the corresponding crank pin on the crankshaft at bottom dead centre, insert the pistons from the top of the block, use the piston ring compressing tool (Tool No. CT.6024) to compress the rings (see Fig. 20) and press the piston down the bore through the compressor until the connecting rod big end and liner registers above the crank pin.

22. Ensure that the upper bearing liner and connecting rod bolts are located correctly, then fit the appropriate cap and lower bearing liner to the rod with the mating marks together. Fit new self-locking nuts and tighten to a torque of 55 to 60 lbs. ft. (7.601 to 8.292 kg.m.).

Note.—*Two types of connecting rod bolts may be encountered in service and these may be identified by their overall length, i.e.* 2.87 *ins.* (72.9 *mm.*) *on engines prior to Engine No.* 1509598 and 2.99 *ins.* (75.9 *mm.*) *on engines subsequent to this number* (*the engine number quoted is approximate as the change was gradually brought into production*).

Nuts for use with the shorter bolt should have a thickness of .462 *in.* (11.7 *mm.*) *and a width across flats of* .618 *in.* (15.7 *mm.*) *whereas those for use with the longer bolt have a thickness of* .530 *in.* (13.5 *mm.*) *and a width across flats of* .684 *in.* (17.3 *mm.*).

It is permissible to use the longer bolt with connecting rods originally fitted with a shorter type bolt but essential that when so doing the smaller nut only is used as the spot-face on the cap will not allow the larger type nut to seat correctly.

The shorter bolt must not be used where the connecting rod was originally fitted with the longer bolt. In an emergency it is permissible to use the smaller nut with the longer bolt.

23. After all the connecting rods and pistons have been fitted, check that the engine is free to rotate and the end-float on the connecting rod big end is from .003 to .009 in. (.076 to .229 mm.).

24. Fit the tappets into their bores in the cylinder block, ensuring that if the original tappets are to be used they are replaced in their original positions. Ensure that they are all pushed right home in their housings.

Note.—*Effective from Engine No.* 1358273 *chilled cast tappets were fitted. These may be identified by the thickness of the tappet foot* (*approximately* 1½ *times greater than the previous type*) *and the fact that the radius between foot and stem is rough cast whereas the original type were machined at this location* (see Fig. 21). *Only the current type parts should be used as replacements and when fitting to engines prior to Engine No.* 1358273 *it is advisable to check that in the position of maximum lift the foot of the tappet does not foul the cylinder block.*

At the same time mechanical chilling of the cams on the camshaft was introduced. Under no circumstances should these camshafts be used with non-chilled tappets (*see note following Operation* 26).

25. Before fitting the camshaft a check should be made that the camshaft thrust washer protrusion forward of the front face of the cylinder block is between the specified limits of .002 to .005 in. (.05 to .13 mm.) see Fig. 22. This may be established by placing the thrust washer in the recess in the block, without the camshaft, and by means of a straight edge across its front face, measuring the protrusion with suitable feeler gauges.

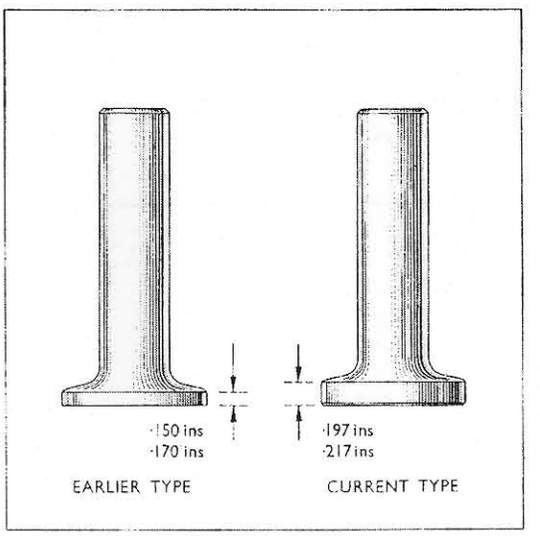


Fig. 21.
Tappet Comparison.

If the protrusion is less than that specified, one or more steel shims available through service in thickness of .003 and .005 in. (.07 and .13 mm.) may be placed behind the thrust washer.

Note.—*Prior to Engine No.* 1445056 *the camshaft thrust washer consisted of two semi-circular sections; between this engine number and Engine No.* 1511488 *a horseshoe-shaped washer with rounded ends to the jaws was used, after which a redimensioned horseshoe type (identified by flat ends to the jaws, see Fig.* 23*) was introduced. The current horseshoe-type washer can be used with any camshaft, but the previous types although interchangeable may need easing out on the inside diameter and on the internal edges in order to seat them fully into the groove in the current type camshaft.*

26. Having checked the protrusion and established which, if any, shims are required, turn the crankshaft until No. 1 piston is at top dead centre and enter the camshaft into its location in the cylinder block, taking care not to damage the cams or journals. The crankshaft must not be moved from this position until all the timing gears have been refitted, otherwise the fuel lift pump drive eccentric may foul No. 4 connecting rod.

Where a new camshaft is to be installed in an engine in which white metal camshaft liners have been fitted it is important that the phosphate coating on the camshaft journals is removed by lapping prior to installation.

Note.—*A number of minor changes have taken place on the camshaft, but from a service point of view, three camshafts only require identification and these must be used as indicated* in the table on page 17.

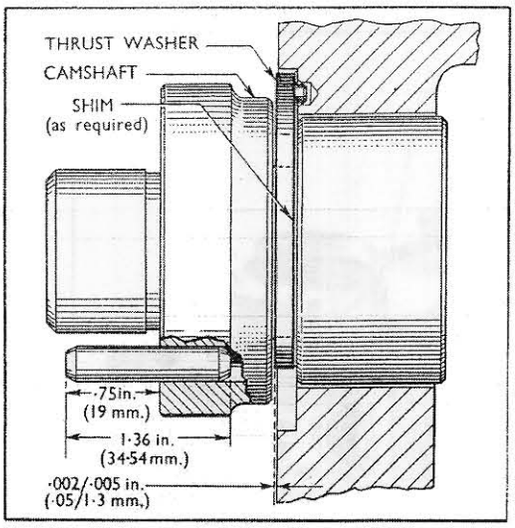


Fig. 22.
Camshaft Thrust Washer Protrusion.

It should be noted that these camshafts supersede all other types, and in particular it is important that when fitting to engines prior to Engine No. 1358273. *as replacements for an original camshaft the tappets must also be changed to the current type (see Operation* 24*). A few early type E1ADDN–6250 camshafts were marked E1ADKN–6250–F but also carried a red paint spot at the same location.*

The camshaft gear dowel pin used with the E1ADDN–6250 camshaft is 1.36 *ins.* (34.54 *mm.*)

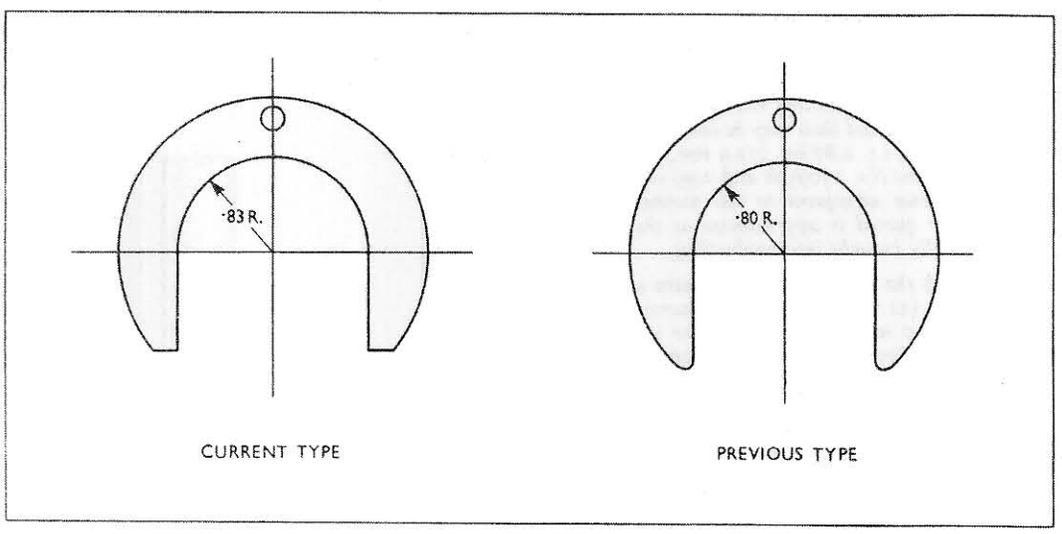


Fig. 23.
Camshaft Thrust Washers.

in length as compared to 1.18 *ins.* (29.97 *mm.*) *on previous camshaft dowel pins but the protrusion forward of the front face of the camshaft boss remains at* .75 *in.* (.19 *mm.*)—*the locating hole in the camshaft being deepened accordingly.*

Engine No. Range	*Use Camshaft Marked (between Nos.* 1 *and* 2 *cams)*
Prior to 1425097 *and between* 1481097 *and* 1511487	*E1ADKN*–6250–F *or* *E1ADDN*–6250
Between 1425097 *and* 1481096	500*E*–6250-*B* *or* 528–6250
After 1511487	*E1ADDN*–6250

27. Fit the camshaft thrust washer in position before the camshaft is fully entered, taking care to locate the dowel on the thrust washer with its corresponding hole in the recess at the front of the cylinder block.

28. Install the auxiliary drive shaft assembly into its location in the cylinder block, making the assembly from the front of the block and pressing it into position so that the front bearing seats on the step in the bore.

29. Screw the guide part of the seal replacer tool (Tool No. CT.6086) into the rear end of the shaft, to protect the seal from damage as it is pressed into position, then fit a new oil seal into the auxiliary drive shaft bore in the cylinder block, using special replacer (Tool No. CT.6086). The seal should be pressed in, lip facing inwards, until the seal case contacts the locating circlip.

30. Fit a new gasket to the front face of the cylinder block and replace the front mounting plate on its two dowels. Replace the front mounting plate screws and new tab washers. Tighten the screws using the sequence shown in Fig. 24 to the correct torque :—

$\frac{5}{16}$ in. bolts—12 to 15 lbs. ft. (1.658 to 2.073 kg.m.)
$\frac{3}{8}$ in. bolts—17 to 22 lbs. ft. (2.349 to 3.04 kg.m.)

and bend the tab washers up against the screw heads.

Screws numbered 1 to 9 must be tightened prior to the assembly of the front cover and those numbered 10 to 18 after the cover is assembled. The sequence for the remaining screws is not important.

Prior to Engine No. 1425097 *the mounting plate was secured by* $\frac{5}{16}$ *in.* (7.937 *mm.*) *diameter screws but subsequent to this number a new plate was introduced, (see Fig.* 25*) secured by* $\frac{3}{8}$ *in.* (9.525 *mm.*) *diameter screws (with the exception of the one used in the lower left-hand corner which remains at* $\frac{5}{16}$ *in.* (7.937 *mm.*)). *A new gasket and locking tabs to suit the increased size of screw were also fitted. At*

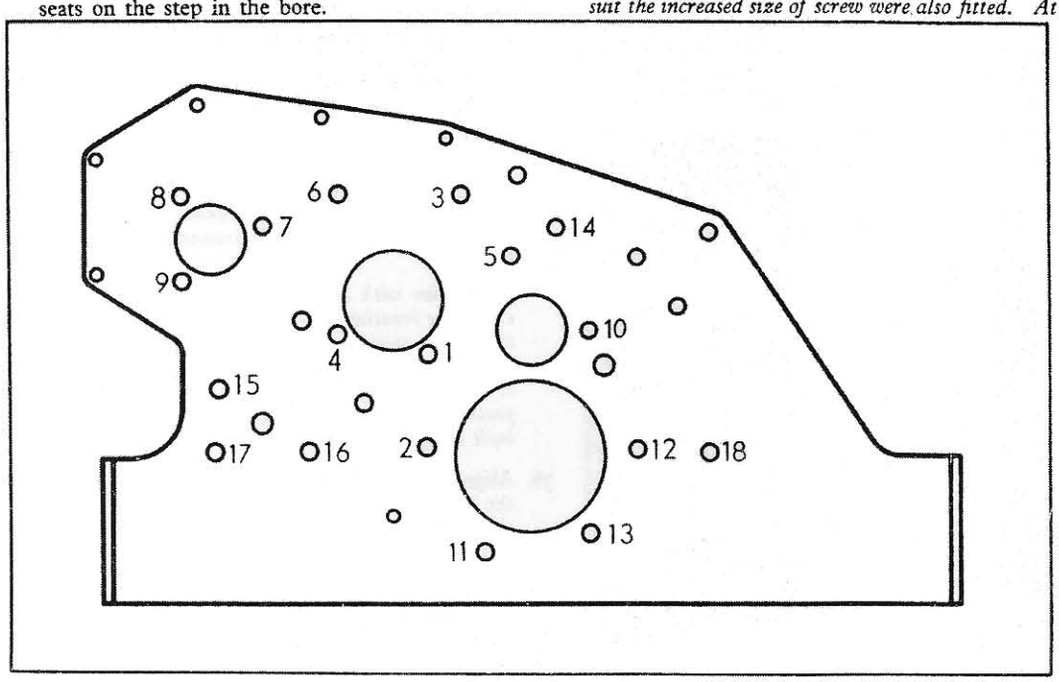


Fig. 24.
Front Mounting Plate Bolt Tightening Sequence.

the same time the threaded hole for the oil pressure relief valve was deleted from the plate (a valve of new design being incorporated in the oil pump) and a $\frac{1}{16}$ in. (1.6 mm.) diameter hole being substituted to retain an oil feed to the front timing gears. (See also Appendix 4.)

31. If the crankshaft gear has been removed, replace it, using the crankshaft gear replacer (Tool No. CT.6069).

32. Fit the woodruff key in the front of the auxiliary drive shaft, and replace the auxiliary drive shaft gear, oil slinger (Mk. II and III engines), spring washer and retaining nut. Do not tighten the retaining nut fully until all the timing gears have been replaced.

33. Fit the camshaft inner gear onto the camshaft spigot, so that the timing mark on the gear lines up with the timing mark on the auxiliary drive shaft gear.

34. Replace the camshaft outer gear on the camshaft spigot so that the timing mark on this gear and the crankshaft gear coincide. Secure the camshaft gears in position with three screws and a three holed locking plate, the tabs of which should be bent up against the screw heads after they have been tightened fully. With all the gears in position tighten the auxiliary drive shaft gear retaining nut to a torque of 60 to 70 lbs. ft. (8.292 to 9.674 kg.m.) (see Fig. 26).

35. Fit a new timing cover gasket, and replace the timing cover on the two dowels in the engine mounting plate. Secure in position with the appropriate screws and spring washers, and tighten to a torque of 12 to 15 lbs. ft. (1.658 to 2.073 kg.m.) tightening first the screws numbered 10 to 18 in Fig. 24, in the sequence shown.

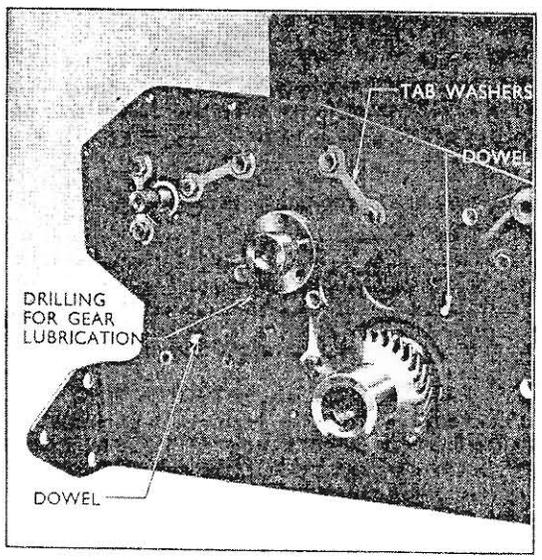


Fig. 25.
Modified Engine Mounting Plate.

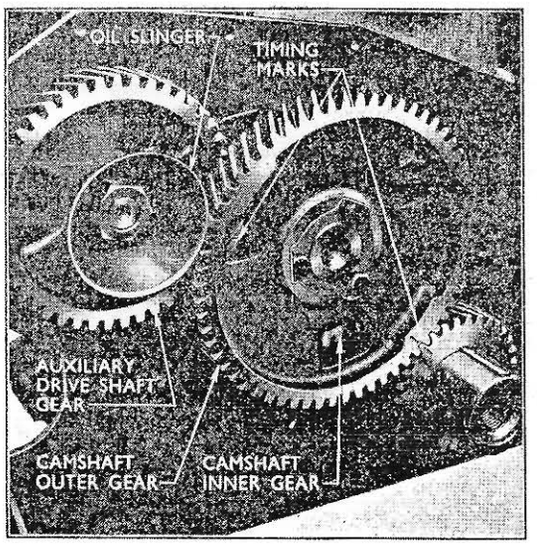


Fig. 26.
Timing Gears.

The long coarse threaded screws pass through clearance holes in the cover and mounting plate and screw into the cylinder block, whilst the shorter fine threaded screws locate directly into tapped holes in the mounting plate.

Effective with Engine No. 1308977 the crankshaft pulley hub diameter was changed from 2.5 ins. (63.5 mm.) to 2.625 ins. (66.67 mm.) and in consequence a change was also made to the oil seal in the front cover. Seals for use with the 2.625 ins. diameter hubs should have an approximate sealing diameter (internal) of 2.56 ins. (65.02 mm.) as against 2.44 ins. (61.98 mm.) for the 2.5 ins. diameter hub.

NOTE.—If a new seal is to be installed in the front cover plate it must be soaked in light engine oil for at least 15 minutes immediately prior to fitting.

Effective with Engine No. 1425097 an oil bath crankcase breather was fitted to the front cover and it will be necessary to suitably seal off the short inlet pipe (supporting the breather) if this cover is to be fitted to tractors prior to this change. The previous cover is not suitable for use on engines built subsequent to the change.

36. Align the keyway in the crankshaft pulley with the key in the crankshaft, and replace the crankshaft pulley taking care not to damage the oil seal in the timing cover.

37. Replace the crankshaft ratchet nut and flat washer and tighten the ratchet nut, using the special spanner (Tool No. CT.6071).

38. Fit the generator bracket to the mounting plate, and secure it in position with two screws and spring washers.

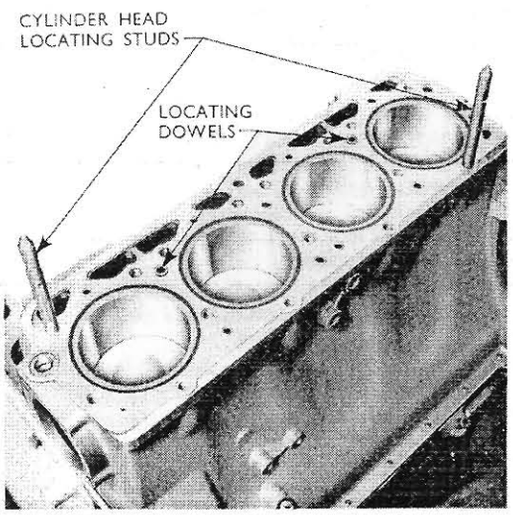


Fig. 27.
Cylinder Head Locating Studs.

39. Invert the engine on the stand and fit the lubricating oil pump into its location in the cylinder block securing it in position with two screws and spring washers. (See also " Lubrication ").

40. Fit the oil pump suction pipe securing the union nut into the inlet connection of the pump, and the suction pipe support bracket to the centre main bearing cap. Bend the union nut locking plate so that it is locked against the pump cover and the union nut.

It should be noted that prior to Engine No. 1425097 *the sump incorporated a detachable plate which afforded access to the oil pump filter screen, the latter being bowl-shaped and retained inside a pressed steel cover. Subsequent to this engine number the filter screen was changed to a cylindrical type whilst the pressed steel cover and access plate in the sump were deleted. Only the current type sump is now serviced for all tractor engines of this type and when fitting this type of sump as a replacement for a previous type a small modification is necessary on the filter screen cover as outlined in Appendix* 1.

41. Where no access plate is fitted to the sump, position the oil pump filter screen on the suction pipe and rotate it through 90° to retain it in position. If an access plate is fitted the filter screen may be installed after the sump is assembled.

42. Fit the two sump side gaskets ensuring that the front ends of the gaskets fit into the grooves in the front main bearing cap and insert the cork strip into the circumferential groove of the cap so that it laps over the front ends of the gaskets.

43. Fit a new rear oil seal packing in the groove at the rear of the sump. The packing should be soaked in engine oil for at least one hour before fitting, and when finally assembled the ends of the packing should protrude $\frac{1}{32}$ in. (.79 mm.) above the sump face.

44. Refit the sump taking care not to damage the gaskets and tighten the retaining screws evenly and securely.

45. Reverse the engine on the stand and remove the cylinder liner retaining screws and washers.

46. Install cylinder head locating studs (Tool No. CT.6076) to diagonally opposite bolt holes at either end of the cylinder block (see Fig. 27) and fit a new rubber seal in the recess at the rocker shaft oil feed drilling in the cylinder block top face.

47. Apply a thin coating of Wellworthy Wellseal or approved equivalent to both sides of the gasket but only in the shaded areas indicated in Fig. 28.

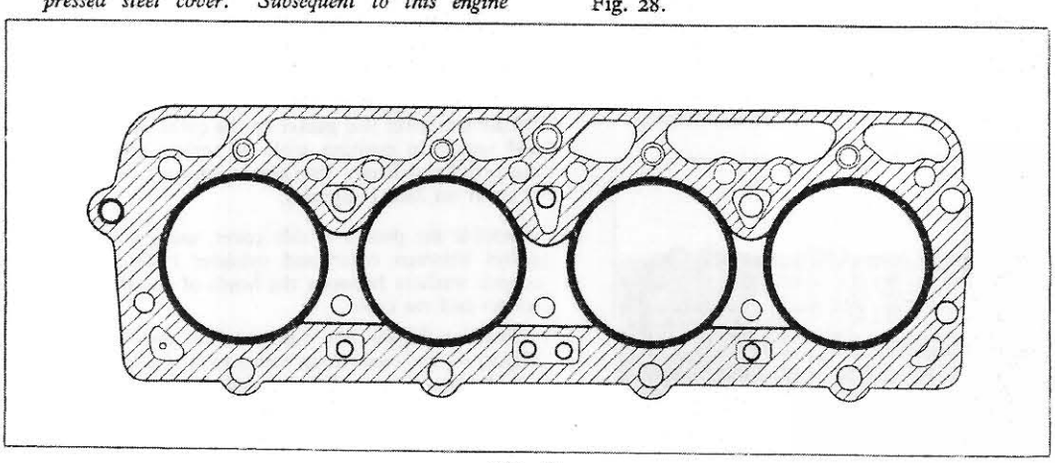


Fig. 28.
Current Cylinder Head Gasket.

The sealer must not be allowed to enter the cylinder bores or the water passages. THIS IS MOST IMPORTANT.

Note.—The above instructions apply to the current copper/asbestos cylinder head gasket. The crimped steel gasket previously fitted in production is no longer serviced and should not be used.

Apply a thin film of grease to the tops of the liner flanges and assemble the cylinder head gasket ensuring that the gasket locates correctly on the dowels (where fitted) in the cylinder block top face.

48. Assemble the cylinder head, remove the locating studs and fit the cylinder head screws. Tighten the screws evenly to a torque of 85 to 90 lbs. ft. (11.747 to 12.438 kg.m.) in the correct sequence as shown in Fig. 29.

Effective with Engine No. 1425097 a new cylinder head was specified on which the exhaust and inlet ports were brought into line horizontally whereas previously they were offset to each other (see Fig 30).

With the introduction of the Power Major, changes made to the valve rocker arms altered the operating angularity of the push rods. This in turn makes it necessary to check, when fitting any head held in stock prior to August 1958 to a Power Major, that clearance exists at the points where the push rods pass through the cylinder head. Dealer's stocks of cylinder heads received after this date will have such clearance and they may therefore be used on any engine subsequent to Engine No. 1425097.

49. Replace the rocker shaft assembly on the cylinder head, refit the retaining screws with new tab washers, and tighten the screws evenly and securely.

50. Insert the lower ends of the push rods in their original positions in the tappets, slide the rocker levers sideways off the valve stems or caps, and engage the cup ends of the push rods with the ball ends of the tappet adjusting screws. The crankshaft will require turning slightly to allow all the push rods to be entered in this manner.

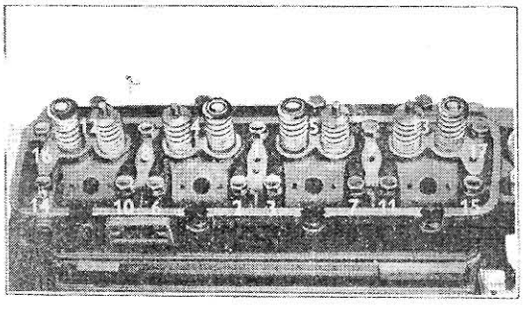


Fig. 29.
Cylinder Head Bolt Tightening Sequence.

Effective with Engine No. 1425097 the push rods were reduced in length from approximately 11.9 ins. (302.3 mm.) to 11.8 ins. (299.7 mm.). The longer rods are still serviced for engines built prior to the change.

51. Check the valve clearances by turning the crankshaft to bring each valve to the fully closed position, and then inserting feeler blades between the valve stem or rotator cap and the end of the rocker lever. Adjust the clearances to roughly .012 in. (.305 mm.) for exhaust valves and .015 in. (.381 mm.) for inlet valves.

Note.—*Early Mk. I engine exhaust valves were not fitted with rotator caps in which case the gap should be set at .015 in. (.381 mm.).*

After final assembly it is important that the engine is run up to a temperature of 180°F (80°C) when the cylinder head screws should be re-tightened to the correct torque, and the valve clearances re-adjusted.

52. Fit the copper sealing washers to the injector bores in the cylinder head, place the rubber seals on the inlet adaptors of the injectors and assemble the injectors to the head locating the rubber seals in the recesses in the side of the cylinder head.

Injectors used on Mk. I and Mk. III engines are identical but a different injector was used on Mk. II engines (i.e. between Engine Nos. 1425097 and 1481090) see "Fuel Injection System." Where service replacements are required similar type injectors to those originally fitted should be installed but in an emergency it is permissible to use either type, preferably in sets of four.

53. Insert the retaining screws and tighten to a torque of 15 lbs. ft. (2.073 kg.m.). Note that these screws are marked 'HT' on the head and are fitted without lockwashers.

54. Remove the protective covering from the injector cap nuts and assemble the injector leak-off pipe securing the banjo connections with the appropriate screws which are of a special slotted type.

55. Fit a new gasket to the valve rocker cover. Locate the cover and gasket on the cylinder head and secure in position with six screws around the peripheral flange (two screws through centre of cover on Mk. I engines).

56. Assemble the push rod side cover, using a new gasket between cover and cylinder block and copper washers between the heads of the fixing screws and the cover.

Prior to Engine No. 1481091 (i.e. pre-Power Major) the two outer fixing screws were of a special type having an extended threaded portion on the outside of the head to provide fixing points for the main wiring loom clips. Subsequent to this engine number the wiring loom was re-routed on the opposite side of the engine and the special screws are not therefore required.

57. Replace the fuel injection pump mounting bracket, if removed, and fit the coupling flange onto the rear end of the auxiliary drive shaft, the flange is keyed and secured by a screw which clamps it to the shaft.

58. Swing the plate on the R.H. side of the flywheel bell housing to one side and turn the engine until the appropriate degree marking (B.T.D.C.) on the flywheel is opposite the V notch on the housing with No. 1 piston on the compression stroke.

Mk. I Engines (prior to Engine No. 1425097) are timed at 26° B.T.D.C.

Mk. II Engines (Between Engine Nos. 1425097 and 1481090) were timed at 19° B.T.D.C. and should now be timed at 23° B.T.D.C., when the current type copper asbestos gasket is fitted

Mk. III Engines (After Engine No. 1481091) are timed at 23° B.T.D.C.

59. Fit the injection pump to the mounting bracket with the pump timing mark on the pump timing plate and the mark on the adjacent coupling in line.

If necessary, loosen the two claw bolts on the engine half of the coupling and turn the coupling to bring the marks in line then tighten the claw bolts securely.

60. Replace the water pump, using a new gasket between pump body and cylinder block, then fit the water pump pulley and fan.

A 17 in. two-bladed fan is fitted to Mk. III engines as standard equipment but an additional two blades may be fitted where climatic conditions warrant their use.

Mk. I and II engines are fitted with a 15 in. two-bladed fan as standard equipment but 18 in. two- and four-blade fans are available as optional fittings.

61. Fit the thermostat to the cylinder head (see Appendix 6). The current shrouded by-pass type may be used on all Major engines but the previous type must not be fitted to Mk. II and III engines. Check that the thermostat flange protrudes .005 to .028 in. (.13 to .71 mm.) above the cylinder head (see Fig. 31).

This protrusion will ensure a satisfactory pinch, and seal, between the recessed seat in the head and the water outlet casting. If this protrusion cannot be obtained, shims of .018 to .021 in. (.457 to .533 mm.) should be fitted between the thermostat flange and its seat in the cylinder head until this specified limit is attained.

62. Replace the cylinder head water outlet connection and gasket, securing it in position with two screws and spring washers.

Note. *On Mk. II and III engines the governor pipe bracket fits under the head of the right-hand screw.*

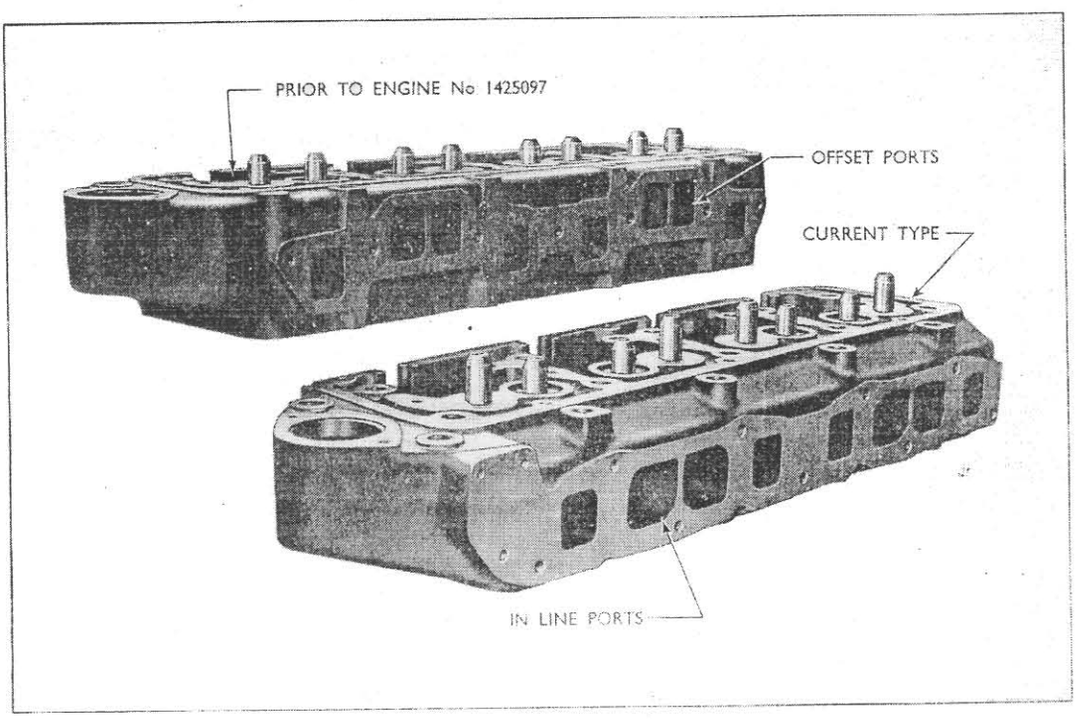


Fig. 30.
Cylinder Heads.

To Replace the Engine in the Tractor

1. Lightly pack the recess behind the flywheel spigot bearing with high melting point grease and if a single clutch is to be fitted, place the clutch disc on the flywheel (longest spline boss to the outside) using locator (Tool No. T.7024) (see Fig. 32). Fit the pressure plate assembly over the clutch disc and retain this in position with six screws and spring washers. Tighten the screws evenly to a torque of 12 to 15 lbs. ft. (1.658 to 2.073 kg.m.) and remove the clutch disc locating tool.

   If a double clutch is to be fitted locate the clutch assembly on the special flywheel, insert the nine retaining screws and shakeproof lock-washers and tighten securely.

2. Refit the engine lifting brackets and, using slings and a hoist, remove the engine from the stand and position it in the front axle assembly so that the front mounting plate seats in the right-hand side channel, and the lugs on the sump locate on either side of the radius rod tongue.

3. Fit the radius rod pin and split pin, and three bolts, nuts and spring washers to secure the front mounting plate to the side channel.

4. Fit the left-hand side channel and install the trolley of Dismantling stand (Tool No. Tr/NMD. 27).

5. Fit the engine and front axle assembly to the front transmission engaging the splines of the gearbox main shaft (and " Live " P.T.O. input shaft where fitted) with the clutch disc splines, and install the engine to gearbox, and the side channel, retaining bolts.

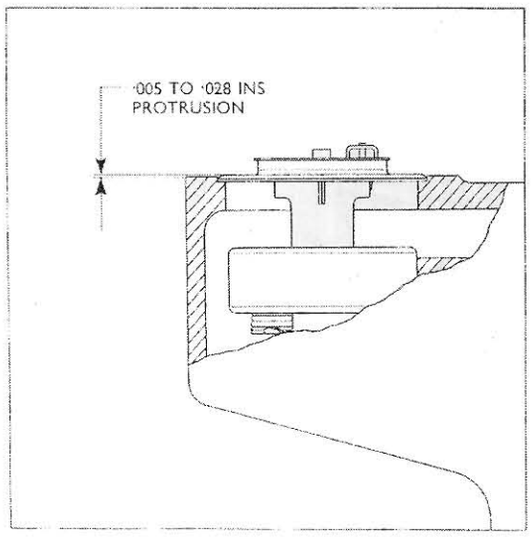


Fig. 31.
Thermostat Protrusion.

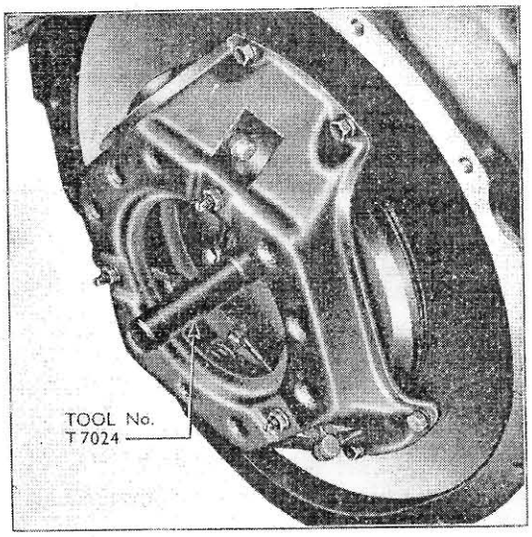


Fig. 32.
Clutch Disc Locator.

6. Connect the steering drag link to the spindle steering arm and screw in the ball plug until it is tight against the steering arm ball, then back off the plug half to one turn until the retaining split pin can be inserted. (The plug should not be backed off more than one complete turn.)

7. Remove the front axle wedges, engine lifting brackets and dismantling stand.

8. Refit the throttle control bracket to the left-hand side of the engine (Mk. II and III only).

9. Fit the inlet and exhaust manifolds, using new gaskets as required, between manifolds and head.

   Effective with Engine No. 1425097 *the exhaust manifold was redesigned to suit the new cylinder head which was introduced, and on which the inlet and exhaust ports were brought into line horizontally.*

9. If the exhaust silencer is of the horizontal type, connect the pipe to the exhaust manifold—if vertical install the adaptor elbow.

10. Refit the generator and fan belt and adjust to give the correct fan belt tension of ½ in. (12.7 mm.) free movement measured midway between the generator and fan pulleys (see Fig. 33).

    Effective with Engine No. 1308977 *a narrower fan belt was introduced and at the same time the crankshaft pulley diameter was reduced from approximately* 9 *ins.* (228.6 *mm.*) *to* 7·5 *ins.*

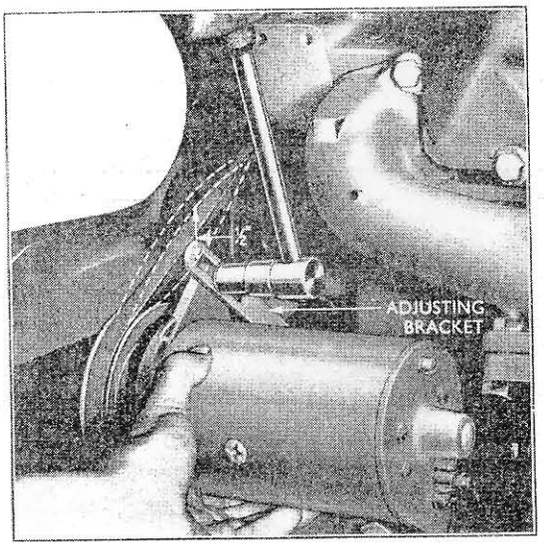


Fig. 33.
Adjusting Fan Belt Tension.

(190.5 *mm.*) *and the water pump and generator pulley diameters from* 5.27 *ins.* (133.85 *mm.*) *to* 4.5 *ins.* (114.3 *mm.*). *The crankshaft pulley hub and front cover oil seal were changed (see operation* 35 *of assembly instructions) and the timing pointer was deleted in favour of flywheel timing.*

The correct combination of pulleys, belt and oil seal must be used with engines before and after the above number.

11. Refit the oil pressure warning light switch (Mk. III) or the oil pressure pipe (Mk. I and II) whichever is required.

12. Replace the starter motor, connect up the wiring loom to starter motor, generator, oil pressure warning light switch, and headlamp and connect the starter motor actuating rod to the starter switch.

13. Fit the water temperature gauge bulb to the cylinder head and locate the capilliary tube in the appropriate clips. Care should be taken to prevent damage to the capilliary tube which runs along the R.H.side of the Mk. I and II engines, and on the L.H. side of the Mk. III engines.

14. Refit the governor control pipes, the pipe from the outer governor connection going to the upper manifold union, the remaining pipe fitting in the inner governor connection and the lower manifold union. Both pipes are held in a clip attached to the R.H. water outlet connection bolt.

15. Refit the hose between the inlet manifold and the air cleaner and the breather pipe between the valve rocker cover and air cleaner on the Mk. II and III engines. (*A short pipe was fitted between the inlet manifold and rocker cover on Mk. I engines*).

16. Refit the water pump to radiator, and radiator to water outlet connection hoses and secure the radiator tie bar to the clip under the head of the L.H. water outlet connection retaining bolt.

17. Refit the fuel lift pump, and injector high pressure pipes. The injector pipes used on the Mk. II and III engines are of equal length and are looped and clipped in pairs.

18. Fit a new element and rubber sealing ring to the fuel filter and assemble the filter to the engine. Install the feed pipe between filter and injection pump and connect the inlet pipe from the lift pump.

19. Connect up the fuel leak-off pipe (to the tank) at the R.H. side rear adaptor in the cylinder head.

20. Replace the proofmeter drive gear assembly and secure with the two screws and spring washers, then reconnect the drive cable.

21. Replace the batteries and connect up the battery leads.

22. Reconnect the throttle linkage and stop control cable, ensuring that a $\frac{1}{4}$ in. of free movement is allowed at the control knob.

23. Fit the oil bath breather to the inlet pipe on the front timing cover, ensuring that the oil sealing ring is installed between pipe and breather (Mk. II and III engines only) then fill the breather to the correct level with engine oil.

24. Before refitting the oil filter remove and clean the interior of the shell, fit a new element, and a new rubber sealing ring between filter head and shell.

    Assemble the filter unit to the engine retaining it with two screws, the lower one of which should also secure the leak-off pipe from the fuel injection pump cambox.

25. Fill the sump to the correct level with an approved grade of lubricating oil.

26. Fill the radiator with water (fill slowly to avoid an air lock) and run the engine until its normal working temperature is reached.

27. Remove the valve rocker cover, tighten down the cylinder head bolts to the correct torque and re-adjust the valve clearances.

28. Check for oil and water leaks. Refit the valve rocker cover.

29. Replace the bonnet, primary air cleaner, vertical exhaust silencer if fitted and tool box.

LUBRICATION SYSTEM

The engine lubrication system has received only slight modification since the introduction of the engine, the major change taking place with Engine No. 1425097 when the oil pressure relief valve previously fitted in the front mounting plate was deleted and a redesigned oil pump cover incorporating a spring loaded plunger type relief valve was introduced.

At the same time the inlet and outlet ports in the pump body were increased in diameter (current type bodies may be identified by measuring the outlet port diameter which is $\frac{7}{16}$ in. (11.1 mm.) as against $\frac{11}{32}$ in. (8.7 mm.) on the previous type) and a larger diameter pick-up pipe was introduced together with a cylindrical type sump filter screen instead of the bowl type screen and separate cover previously used.

A number of changes have been made to the main oil filter and three proprietary designs have been used at one time or another. Certain of the filter elements are interchangeable as shown in the table on page 27 the current type being identical with those used on the Fordson Dexta.

Effective with the introduction of the Power Major an oil pressure indicator switch has been fitted on the left-hand side of the cylinder block in a branch passage from the main oil gallery.

Connected to this switch is an oil pressure warning light fitted to the instrument panel which comes into operation when the engine oil pressure drops below 5 to 7 lbs./sq. in. (.3515 to .4921 kg./sq. cm.). The warning light and switch replaces the oil pressure gauge and pipe leading from the same location on previous Major tractors.

Oil Pump

Procedure for carrying out repairs on oil pumps fitted to engines prior to Engine No. 1425097 are fully covered in the original Fordson Major Repair Manual and it is therefore proposed to only deal with the current type pump in this supplement.

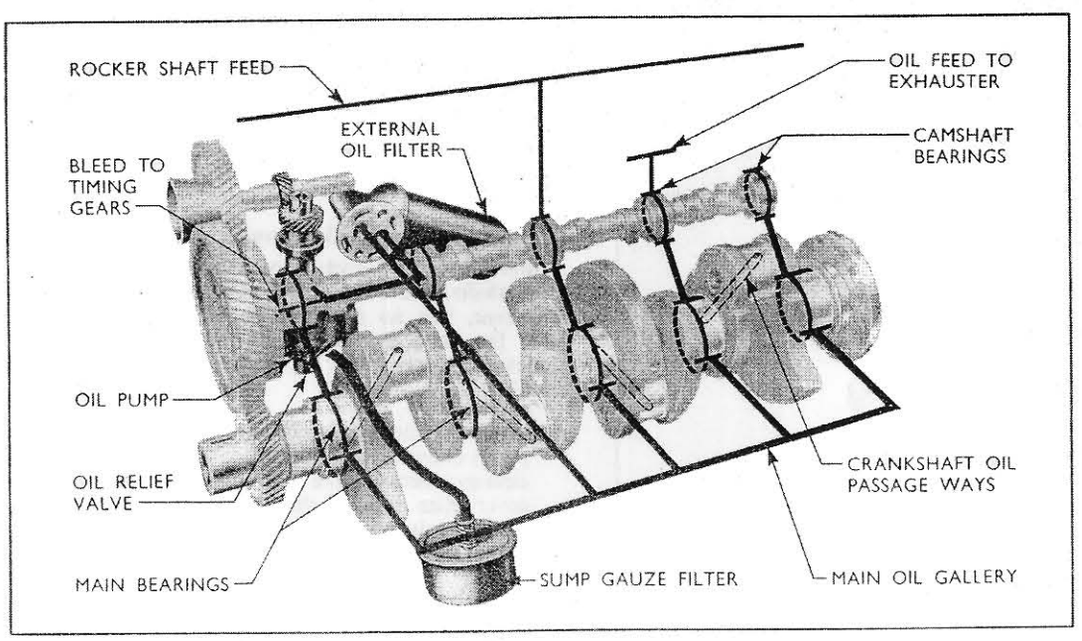


Fig. 34.

To Remove the Oil Pump

1. Remove the sump plug and drain off the engine oil.
2. Suitably chock the front wheels to prevent movement and remove the bolts retaining the radius rods to the front axle.
3. Remove the pin retaining the rear end of the radius rod to the sump.
4. Tap the radius rod sideways on the axle beam until the rear end is clear of the sump then remove the radius rods.
5. Disconnect the track rod on the left-hand side of the tractor.
6. Suitably support the sump, remove the sump screws and lower the sump squarely away from the engine.
7. Extract the bolt retaining the oil pump suction pipe to the centre main bearing cap then remove the suction pipe from the pump.
8. Extract the two screws retaining the pump to the cylinder block and withdraw the pump.

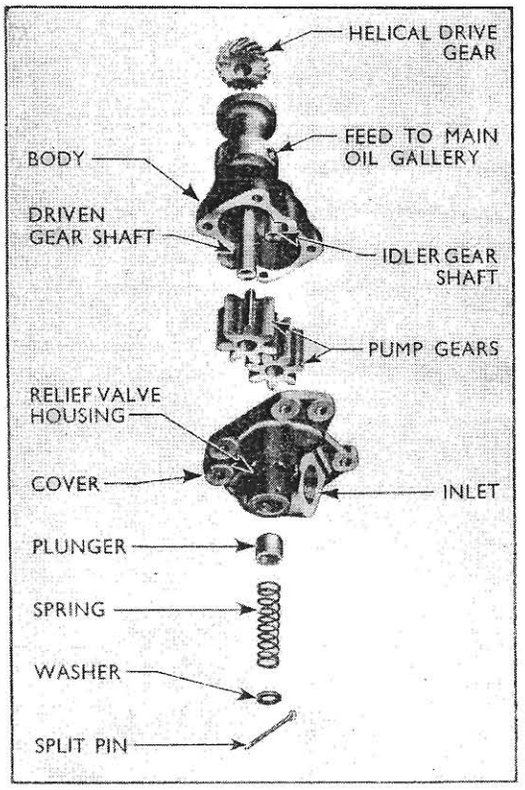


Fig. 35.
Oil Pump.

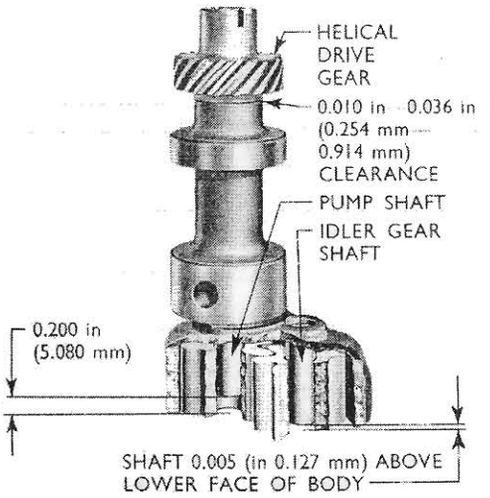


Fig. 36.
Fitting Shafts and Gears.

To Dismantle the Oil Pump

1. Remove the four set screws and spring washers securing the pump cover plate to the pump body.
2. Remove the cover plate and if necessary withdraw the split pin retaining the pressure relief valve, and extract the washer, spring and plunger.
3. Withdraw the idler gear from its shaft.
4. Press the helical drive gear from its location, and remove the pump driven gear and shaft complete from the pump body.
5. If necessary press the pump driven gear from its shaft.

To Reassemble the Oil Pump

Note.—Check all parts, especially the two pump gears, shafts, and body to ensure no excessive wear is present, that no distortion exists on the pump cover face, and that the oil pressure relief valve plunger and spring are in good condition. (See Specification.)

1. Press the idler gear shaft (if removed) into the pump body so that there is .005 in. (.127 mm.) clearance between the end of the shaft and the cover plate face of the pump body, using a straight edge and feeler gauge to check this clearance.
2. Press the pump driven gear onto the pump shaft, so that the end of the shaft is .20 in. (5.08 mm.) below the face of the gear, (see Fig. 36). A suitable distance piece .20 in. (5.08 mm.) thick and approximately .40 in. (10.16 mm.) diameter can be used for this purpose.

3. Enter the gear and shaft into the pump body and stand the assembly on a flat surface, insert the same distance piece in the centre of the gear to maintain a clearance between the shaft and the top face of the gear.
4. Press the helical drive gear onto the shaft until a clearance of .010 in. to .036 in. (.254 to .914 mm.) between the gear hub and pump body is obtained.
5. Replace the pump idler gear.
6. Reassemble the relief valve plunger, spring, washer and split pin in the pump cover.
7. Replace the cover and secure with four set screws and spring washers.

To Replace the Oil Pump

1. Enter the pump assembly into its location in the cylinder block meshing the helical driving gear with the corresponding gear on the auxiliary drive shaft.
2. Insert the two retaining bolts and spring washers and tighten securely.
3. Locate a tab washer on the suction pipe, assemble the pipe to the pump and insert the suction pipe securing bolt through the pipe bracket and into the centre main bearing cap.
4. Tighten the suction pipe to pump union nut and turn over the tab washer to secure it in position.
5. Thoroughly wash the sump filter screen in petrol and assemble the screen to the suction pipe, ensuring that washer and spring are in position on the pipe and above the screen and that they are undamaged and operating. Turn the screen through 90° so that it is retained on the pipe.
6. Using new gaskets between sump and block, assemble the sump and retain with the appropriate screws and lockwashers. A new cork strip should also be fitted to the front main bearing cap and asbestos seals to the rear oil seal housing in the sump and in the groove in the block if necessary.

Temperature Range	*S.A.E. H.D. Grade*
From 0°F to 20°F (-18°C to -7°C)	10 *or* 10*W*
From 20°F to 90°F (-7°C to 32°C)	20 *or* 20*W*
Over 90° F (over 32°C)	30

7. Replace the front axle radius rod and secure to the front axle with two bolts, castellated nuts and split pins and to the sump with a plain pin, retaining it with a split pin through the drilled hole in the rear lug of the sump.
8. Reconnect the track rod to the spindle steering arm.
9. Replace the sump drain plug and fill the engine with the requisite quantity of H.D. oil.

Type	*Year Range*	*Manufacturer*	*Identification*	*Interchangeability of Elements*
1	1952–55	Fram.	Manufacturers name on filter head.	Not interchangeable.
2	1952–June 56.	A C Delco	Manufacturers name on filter head and element approx. 5½ ins. (139.7 mm.) in length.	Interchangeable with types 3 and 4.
3	June 56–Jan. 59	A C Delco	Manufacturers name on filter head element approx. 5½ ins. (139.7 mm.) in length and in addition a hexagonal plug in head retaining a detachable relief valve.	Interchangeable with types 2 and 4.
4	Jan. 56–Jan. 59	Tecalemit	Manufacturers name on filter head and element approx. 5½ ins. (139.7 mm.) in length.	Interchangeable with types 2 and 3.
5	Jan. 59 onwards.	A C Delco	Manufacturers name on filter head and element approx. 4½ ins. (114.3 mm.) in length.	Interchangeable with type 6 and those fitted to Fordson Dexta.
6	Jan. 59 onwards.	Tecalemit	Manufacturers name on filter head and element approx. 4½ ins. (114.3 mm.) in length.	Interchangeable with type 5 and those fitted to Fordson Dexta.

Table Showing Filter Identification.

APPENDIX

APPENDIX 1

Engine Sump

As Engine Sump E1ADKN-6675-F is no longer serviced, in future all demands for this item will be met by the modified sump E1ADKN-6675-G which has no inspection cover on the underside. When using this sump on engines prior to Engine No. 1425097 the sump screen assembly will require modification in order to be able to fit the sump and to prevent oil starvation.

It should also be noted that a new sump drain plug, EB-6730, and washer EB-6734 are required when using this sump as a replacement for a previous type.

The modification consists of cutting .38 in. (9.65 mm.) from the bottom of the cover, opening up the cut-away portion to 2.5 ins. (63.5 mm.) and cutting two .5 in. (12.7 mm.) holes as shown in Fig. 37.

A retaining clip, E120-Z-9, is used to hold the screen assembly in position while fitting the sump. This means that when assembling the screen the cover must first be fitted to the pipe, the circlip fixed around the pipe so that it supports the cover, and finally the gauze screen and spring assembled to the cover.

It is absolutely essential that the screen assembly is fitted with the retaining spring along the length of the engine as shown in Fig. 38, otherwise the cover will foul the bevelled face of the sump.

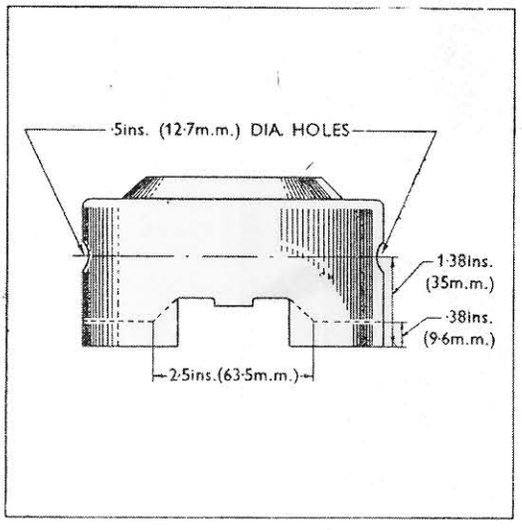


Fig. 37.
Sump Screen Cover.

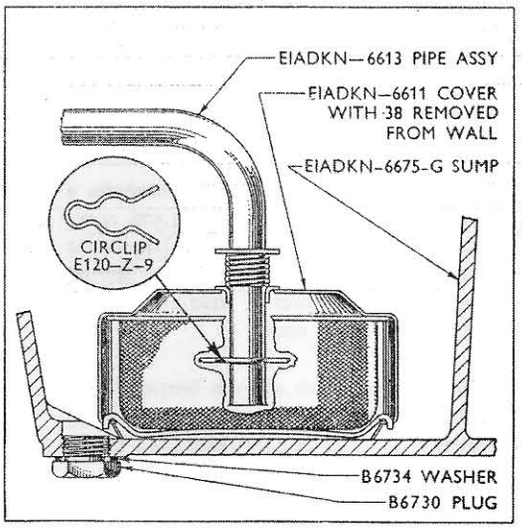


Fig. 38.
Sump Screen Assembly.

APPENDIX 2

Crankshaft, Bearing Liners and Thrust Washers

Effective with Engine No. 1483140 crankshafts fitted to Power Major engines were modified by increasing the fillet radius between the crankshaft webs and the journals. Providing the correct bearing liners are used, this crankshaft may be fitted to engines built prior to Engine No. 1483140 and there is therefore no change in part number.

To accommodate the change to the crankshaft the overall width of the connecting rod and main bearing liners was reduced by .080 in. (1.93 mm.) and the internal diameter of the crankshaft thrust washers increased by .1 in. (2.54 mm.).

Normally, where a previous type crankshaft is fitted the original (wide) liners and smaller diameter thrust washers should be used for replacement purposes but these should not be used with the current type crankshaft. To obviate the fitting of incorrect liners and thrust washers it is advisable therefore to note the width of the liners removed and use liners of similar width and corresponding thrust washers as replacements.

If, however, any doubt exists as to the type of crankshaft fitted, or when installing a new crankshaft, only the current (narrow width) liners and larger internal diameter thrust washers should be used.

Fig. 39 indicates the dimensional differences between the current and previous type liners and thrust washers. The part number is stamped on the outer

surface of the current type liner, but unless this number carries a E1ADDN prefix it should not be used as a means of identification between current and previous type parts as a quantity of current type liners were at one time marked with the part number of the previous type liners. Where the stamped number carries a E1ADKN prefix, identification can only be established by physical measurement of the width.

To facilitate the use of reground crankshafts a series of .010 in. (.254 mm.), .020 in. (.508 mm.) .030 in. (.762 mm.) and .040 in. (1.016 mm.) undersize internal diameter liners are available. Similar considerations apply in respect of wide and narrow liners as with the standard ones.

In addition a similar series of main bearing liners ranging from standard to .040 in. (1.016 mm.) undersize internal diameter **but .015 ins. (.381 mm.) oversize on the outside diameter** are available for use with replacement bearing caps (see Appendix 3).

There are, however, two distinct types of liner serviced for each bearing size and these must be used in pairs, i.e. the top and bottom halves of any one bearing must be of the same type. Identification as to type is most easily established by the manufacturers trade marking on the outer surface of the liner. The letters V.P. entwined and enclosed in a circle indicates one type—the letter G enclosed in a square indicates the alternative type.

Similar considerations apply to the crankshaft thrust washers which must also be used in pairs. In addition to standard thickness thrust washers a series of .0025 in. (.063 mm.), .005 in. (.127 mm.), .0075 in. (.190 mm.), .010 in. (.254 mm.), .015 in. (.381 mm.) and .020 in. (.508 mm.) oversize thickness washers are available for service (see Appendix 3).

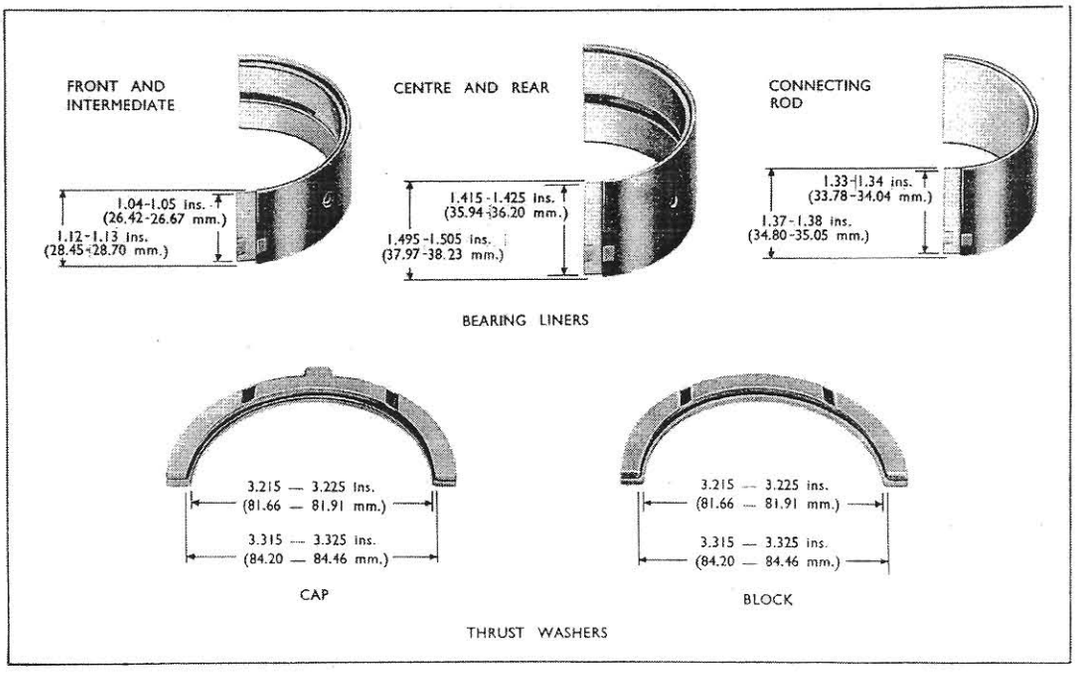


Fig. 39.
Main Bearing Liners and Thrust Washers.

APPENDIX 3

Main Bearing Caps for Service

Semi-finished main bearing caps suitable for line boring .015 in. (.38 mm.) oversize, also bearing liners and thrust washers to be used with these caps, are available for Service.

The semi-finished caps include three types of front bearing cap for use on the three types of cylinder block encountered in Service on these tractors. In each case the correct front cap must be fitted to the cylinder block. These parts are identified in the table on page 32.

Finishing Operations—Main Bearing Caps and Blocks

When replacing one or more main bearing caps it is essential to line bore the block .015 in. (.38 mm.) oversize, with all caps assembled to 3.1815 ins. to 3.1820 ins. (80.81 mm. to 80.82 mm.) diameter. If any attempt is made to bore only one new cap, misalignment and crankshaft failure will be likely. If the centre bearing cap is replaced, the recess in the block and cap thrust faces must be machined to produce a continuous bearing surface within the limiting dimensions shown below and in Fig. 40. Before line boring and machining the thrust faces, mount and secure the cap on the block so that one of its thrust faces is in line with the corresponding face on the block within .005 in. (.13 mm.).

The recesses should be machined square with the centre line of the bearing bore within .002 in. (.05 mm.) total indicator reading and the recess bore concentric with the bearing bore within .006 in. (.15 mm.) total indicator reading. An equal amount should be machined from each face to give an overall distance between thrust faces of 1.589 ins. to 1.591 ins. (40.36 mm. to 40.41 mm.). File back the slots in the cap, which locate the tabs on the thrust washers, to enable the washers to seat on the thrust faces of the cap.

Main Bearing Liners

For use with these caps there is a complete range of main bearing liners .015 in. (.38 mm.) oversize outside diameter available from standard to .040 in. (1.015 mm.) undersize inside diameter. Each liner is available in two materials, one a copper lead bearing and the other a lead bronze bearing. It is essential that the upper and lower liners of a pair are of the same material.

Thrust Washers

Crankshaft upper and lower thrust washers although not normally required on engines which have not been fitted with service caps are available in .010 in. (.25 mm.), .015 in. (.38 mm.) and .020 in. (.51 mm.) oversize thicknesses to suit the machining detailed above.

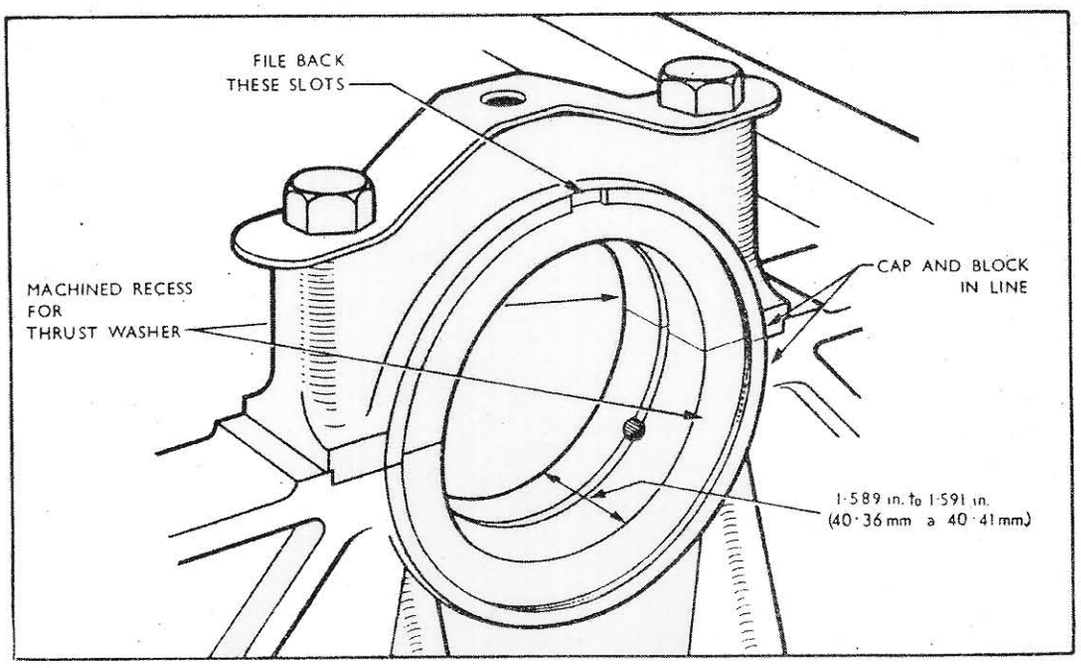


Fig. 40.
Centre Main Bearing.

Front Main Bearing Caps for Line-boring .015 in. (.38 mm.) oversize

Model	*Identification*
" Fordson Major " Tractors with original 4 cyl. O.H.V. engines built prior to Engine No. 1425097.	Letter "A" stamped on cap and $\frac{5}{8}$ in. (15.9 mm.) diameter oil drain holes.
" Fordson Major " and " Power Major " Tractors with 4 cyl. O.H.V. engine built after Engine No. 1425097, and service cylinder assemblies and blocks for above tractors, i.e. where the cylinder block has six tapped holes in the mounting pads on each side of the flywheel housing but no cross-drilling for the throttle linkage.	Letter " B " stamped on cap and $\frac{5}{16}$ in. (7.9 mm.) diameter oil drain holes.
" Fordson Major " Tractors with 4 cyl. O.H.V. engine built prior to Engine No. 1425097 fitted with interim cylinders assembly or block supplied for service only, i.e. where the cylinder block has a cross drilling for the throttle linkage as well as six tapped holes in the mounting pads on each side of the flywheel housing.	Letter " C " stamped on cap and $\frac{5}{8}$ in. (15.9 mm.) diameter oil drain holes.

APPENDIX 4

Cylinder Block Assembly for Service

In view of the changes to the cylinder block effective with Engine No. 1425097 a special cylinder block has been released for service on diesel engines produced prior to the above number.

This block incorporates the cross drilling for the throttle linkage and the oil return holes in the front main bearing cap are of $\frac{5}{8}$ in. (15.88 mm.) as the oil relief valve will still be located on the front mounting plate.

When fitting this block to an early engine the following points must be taken into account:—

(a) **Engine Front Mounting Plate**

The holes shown shaded in Fig. 41 should be drilled out to $\frac{13}{32}$ in. (10.3 mm.) diameter to accommodate the $\frac{3}{8}$ in. (9.5 mm.) diameter retaining bolts. New locking plates for the larger bolts and oil pressure relief valve will be required.

Note.—If the mounting plate is of the very early type without the dowel holes shown at D - D in Fig. 41, it will also be necessary to drill hole "A" (Fig. 41) $\frac{11}{32}$ in. (8.73 mm. diameter to provide for the additional $\frac{5}{16}$ (7.94 mm.) bolt.

(b) **Engine Front Mounting Plate Gasket**

Either a new gasket with larger bolt hole diameters will be required or the previous type gasket can be suitably modified.

(c) **Water Pump Assembly**

As the by-pass port in the cylinder block has been enlarged the early type water pump assembly cannot be fitted. All internal components are however identical with those used on current type water pump assemblies and may be used providing the water pump housing is changed to the current type and that the current type gasket is then used.

APPENDIX 5

Service Cylinder Assemblies

With the introduction of the Mk. II (Engine No. 1425097) a special service cylinder assembly was released for replacement purposes on Mk. I engines which incorporated Mk. II pistons, connecting rods and piston pins and enabled a crimped steel cylinder head gasket to be used.

(This gasket has now been obsoleted, only the current type copper/asbestos gasket must be used.) When fitting such an assembly the current type water pump body and gasket must also be

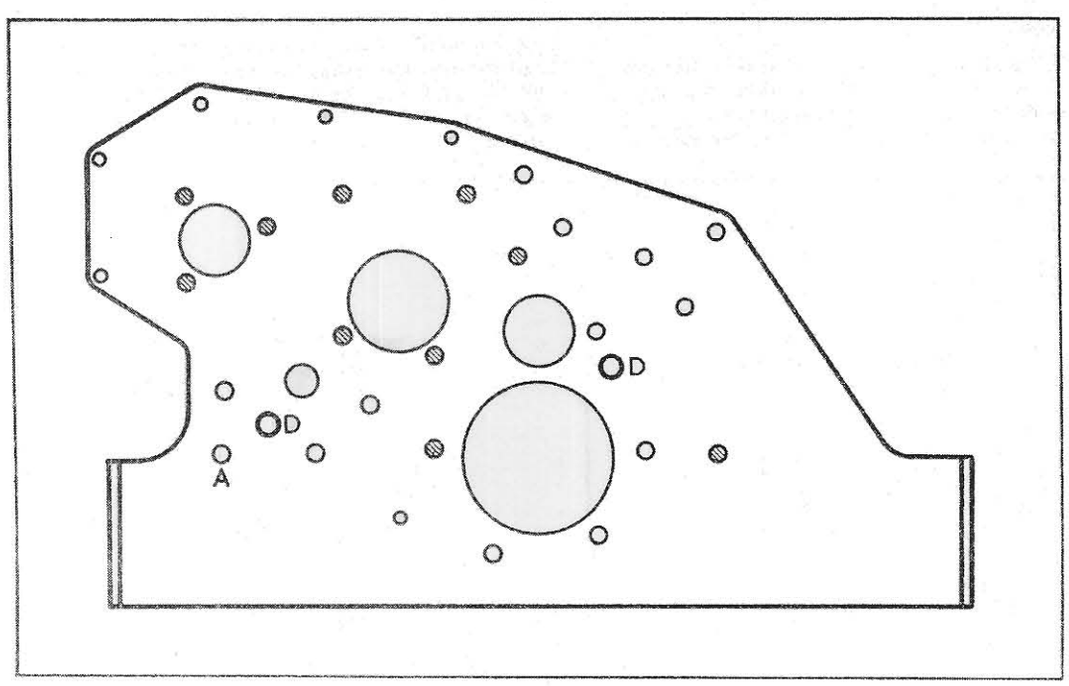


Fig. 41
Front Mounting Plate

fitted. The internal components of the water pump are however unchanged.

Two further service cylinder assemblies are also available, one for Mk. II engines (between Engine Nos. 1425097 and 1481090), the other for Mk. III engines (after Engine No. 1481090).

To identify the three type of assemblies the combination of oil hole diameter in the front main bearing cap and the camshaft in use should be observed as indicated below:—

Under no circumstances should the Mk. III rocker levers be used in conjunction with the Mk. II cylinder assembly which incorporates a high lift camshaft as under such conditions there would be a danger of a foul condition between valves and pistons.

Service Cylinder Assemblies Used on Engines:	*Diameter of Oil Holes in Cap*	*Number Cast on Camshaft*
Prior to No. 1425097 (Mk. I)	$\frac{5}{8}$ ins. (15.88 mm.)	E1ADKN—6250—F or E1ADDN—6250
Between Nos. 1425097 & 1481090 (Mk. II)	$\frac{5}{16}$ ins. (7.94 mm.)	500E—6250—B or 528E—6250
After No. 1481090 (Mk. III)	$\frac{5}{16}$ ins. (7.94 mm.)	E1ADKN—6250—F or E1ADDN—6250

APPENDIX 6

Cooling System

Effective with Mk. II engines (from Engine No. 1425097) a by-pass cooling system controlled by a shrouded thermostat (see Fig. 42) was introduced.

With the thermostat valve closed (i.e. with cold engine) the coolant is circulated within the engine by thermosyphon action, the closed valve preventing loss of warmed coolant back to the radiator.

When the temperature rises to approximately 170°—179° F. (77°—82° C.) the thermostat commences to open and the shroud which is attached to the bellows rises and gradually seals off the by-pass tube located at the front of the cylinder head.

A restricted flow of hot coolant is then circulated through the radiator until at approximately 199° F. (93° C.) the thermostat is fully open, when an unrestricted thermosyphon impeller assisted flow is attained.

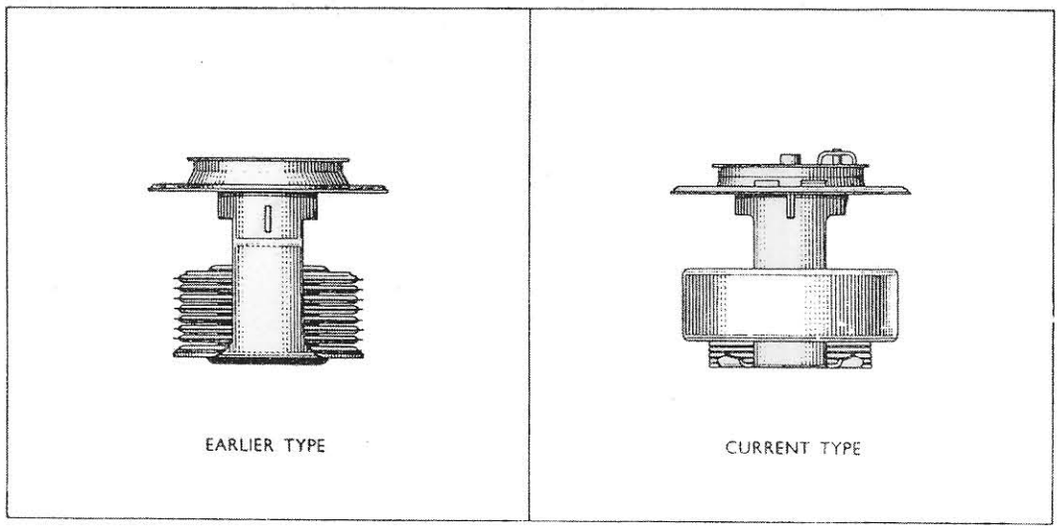


Fig. 42
Thermostat Comparison

Prior to Engine No. 1425097 the coolant temperature was controlled by a non-shrouded thermostat, no by-pass tube being fitted.

Note.—Although it is permissible to fit a shrouded thermostat to any engine, a non-shrouded type must not be fitted to a by-pass system, i.e. after Engine No. 1425097.

Water Pump

Effective with Engine No. 1425097 changes were made to the water ports in the pump body. Pump bodies supplied prior to this change should not be fitted to engines incorporating a by-pass cooling system.

Radiator

Subsequent to Engine 1420356 a new radiator with a core built up of five fins per inch was fitted in production, and at the same time the radiator shutters fitted to engines prior to this number were deleted.

Fan Blades

Prior to Engine No. 1481091 (pre-Power Major) a two blade 15 ins. (38.10 cm.) diameter fan was fitted to Fordson Major engines working in ambient temperatures up to 90° F. (32° C.). For engines working continuously above this temperature a two blade 18 ins. (45.72 cm.) diameter fan was fitted.

For engines subsequent to Engine No. 1481091 a two blade 17 ins. (43.18 cm.) diameter fan is specified as standard equipment for ambient temperatures up to 90° F. (32° C.). For engines working continuously in ambient temperatures of over 90° F. (32° C.) additional fan blades are attached to the standard two blade fan, converting to a 17 ins. (43.2 cm.) four bladed unit.

Temperature Gauge

The coolant temperature gauge fitted to Mk. III engines is combined in one instrument with the warning lights for oil pressure and generator.

To Remove the Water Temperature Gauge (Mk. III)

1. Disconnect the temperature gauge bulb from its location at the front left-hand side of the cylinder head.

2. Release the capillary tube from the retaining clips attached to the radiator tie bar and main wiring loom.

3. Remove the steering wheel and the throttle operating lever.

4. Remove the three screws retaining the instrument panel and raise the panel sufficiently to detach the knurled nuts retaining the gauge. (It will be necessary to remove a grease nipple located on the steering column, to allow the panel to be raised sufficiently.)

5. Remove the generator, oil pressure warning and water gauge illumination bulbs complete with holders from the rear of the gauge.

6. Remove the gauge, feeding the capillary tube and bulb carefully up through the steering column bore in the fuel tank.

To Replace the Water Temperature Gauge (Mk. III)

1. Feed the capillary tube and bulb down through the steering column bore in the fuel tank and locate the gauge in the instrument panel.

2. Replace the bulb holders in their correct locations, i.e. holder with violet covered wire to oil side of gauge, holder with yellow and white covered wire to generator side, and holder with yellow and red wire to central, or gauge illumination position.

3. Refit the knurled nuts to retain the gauge in position.

4. Refit the three panel retaining screws, throttle control lever, grease nipple and steering wheel.

5. Refit the temperature gauge bulb in the cylinder head and retain the capillary tube in its appropriate clips.

SPECIFICATION AND REPAIR DATA

	ENGINES FROM Eng. No. 1217101 to Eng. No. 1425096	*FROM Eng. No. 1425097 to Eng. No. 1481090*	*FROM Eng. No. 1481091 Onwards*
Type of Engine	Vertical in-line 4 stroke	Vertical in-line 4 stroke	Vertical in-line 4 stroke
No. of Cylinders	4	4	4
Stroke	4.524 – 4.528 ins. (114.91 – 115.011 mm.)	4.524 – 4.528 ins. (114.91 – 115.011 mm.)	4.524 – 4.528 ins. (114.91 – 115.011 mm.)
Bore	3.937 – 3.938 ins. (100 – 100.023 mm.)	3.937 – 3.938 ins. (100 – 100.023 mm.)	3.937 – 3.938 ins. (100 – 100.023 mm.)
Cubic Capacity	220.35 cu. ins. (3611 ccs.)	220.35 cu. ins. (3611 ccs.)	220.35 cu. ins. (3611 ccs.)
Max. B.H.P.	40.5 @ 1600 r.p.m. (with accessories less fan)	44 @ 1600 r.p.m. (with accessories less fan)	51.8 @ 1600 r.p.m. (less ancilliaries)
Max. Torque	140 llbs. ft. (19.348 kg.m.) @ 1150 r.p.m. (with accessories less fan)	148 lbs. ft (20.45 kg.m.) @ 1150 r.p.m. (with accessories less fan)	171 lbs. ft. (23.63 kg.m.) @ 1200 r.p.m. (bare engine)
Compression Ratio	16 : 1	16 : 1	16 : 1
Firing Order	1 - 2 - 4 - 3	1 - 2 - 4 - 3	1 - 2 - 4 - 3
Camshaft			
Cam Lift	.258 ins. (6.55 mm.)	.305 ins. (7.75 mm.)	.258 ins. (6.55 mm.)
Camshaft Identification No. cast between No. I and II Cams	EIADKN 6250 – F (obsolete, replaced by EIADDN – 6250)	500E 6250 – B (obsolete, replaced by 528E – 6250)	EIADKN 6250 – F or EIADDN 6250
Camshaft end float	.003 – .008 ins. (.076 – .203 mm.)	.003 – .008 ins. (.076 – .203 mm.)	.003 – .008 ins. (.076 – .203 mm.)
Cylinder liners	Replaceable wet type retained by pressure of cylinder head through gasket	Replaceable wet type retained by pressure of cylinder head through gasket	Replaceable wet type retained by pressure of cylinder head through gasket
Liner Protrusion (above top face of block)	.002 ins. – .004 ins. (.051 – .102 mm.)	.002 ins. – .004 ins. (.051 – .102 mm.)	.002 ins. – .004 ins. (.051 – .102 mm.)
Pistons	Solid skirt aluminium alloy 100 mm. dia. combustion chamber machined in piston crown 1.250 ins. (31.75 mm.) dia. piston pin bore	Solid skirt aluminium alloy 100 mm. dia. combustion chamber machined off-set in piston crown 1.375 ins. (34.9 mm.) dia. piston pin bore	Solid skirt aluminium alloy 100 mm. dia. combustion chamber machined off-set in piston crown 1.375 ins. (34.9 mm.) dia. piston pin bore
Oversizes	.0025 ins. (.0635 mm.)	.0025 ins. (.0635 mm.)	.0025 ins. (.0635 mm.)
Piston Pin Type	From Eng. No. 1362380 Solid pin fully floating retained by end circlips	Hollow pin fully floating retained by end circlips	Hollow pin fully floating retained by end circlips

	ENGINES FROM Eng. No. 1217101 to Eng. No. 1425096	*FROM Eng. No. 1425097 to Eng. No. 1481090*	*FROM Eng. No. 1481091 Onwards*
Outside diameter	1.2496 – 1.2499 ins. (31.74 – 31.8747 mm.)	1.3747 – 1.375 ins. (34.917 – 34.925 mm.)	1.3747 – 1.375 ins. (34.917 – 34.925 mm.)
Piston Rings			
Ring Gap Compression	.011 – .016 ins. (.279 – .406 mm.)	.011 – .016 ins. (.279 – .406 mm.)	.011 – .016 ins. (.279 – .406 mm.)
Oil Control	.011 – .016 ins. (.279 – .406 mm.)	.011 – .016 ins. (.279 – .406 mm.)	.011 – .016 ins. (.279 – .406 mm.)
No. of Compression rings	3	3	3
No. of Oil Control rings	2	2	2
Width of Piston rings. Compression mean	.0933 ins. (2.370 mm.)	.0933 ins. (2.370 mm.)	.0933 ins. (2.370 mm.)
Oil control mean	.187 ins. (4.75 mm.)	.187 ins. (4.75 mm.)	.187 ins. (4.75 mm.)
Ring to groove Clearance			
Compression	.0014 – .0034 ins. (.036 – .086mm.)	.0014 – .0034 ins. (.035 – .086 mm.)	.0014 – .0034 ins. (.035 – .086 mm.)
Oil Control	.0015 – .0035 ins. (.0381 – .0889 mm.)	.0015 – .0035 ins. (.0381 – .0889 mm.)	.0015 – .0035 ins. (.0381 – .0889 mm.)
Valves			
Valve Clearance Inlet hot Exhaust	.015 ins. (.381 mm.) .015 ins. (.381 mm.)	.015 ins. (.381 mm.)	.015 ins. (.381 mm.)
Exhaust with Rotator cap.	.012 ins. (.305 mm.)	.012 ins. (.305 mm.)	.012 ins. (.305 mm.)
Angle of Valve Head	29° – 30′	29° – 30′	29° – 15′ / 29° – 30′
Angle of Valve Seat in Head	30°	30°	30° – 0′ / 30° – 30′
Valve Springs No. of Coils	8.8 (7 free)	8.8 (7 free)	8.8 (7 free)
Free Length	2.48 ins. (62.99 mm.)	2.48 ins. (62.99 mm.)	2.48 ins. (62.99 mm.)
Compressed Length and Load	1.98 ins. @ 45–50 lbs. (50.3 mm. @ 20.4 – 22.7 kg.)	1.98 ins. @ 45–50 lbs. (50.3 mm. @ 20.4 – 22.7 kg.)	1.98 ins. @ 45–50 lbs. (50.3 mm. @ 20.4 – 22.7 kg.)
Push Rod Length	11.9 ins. (302.26 mm.)	11.8 ins. (299.72 mm.)	11.8 ins. (299.72 mm.)
Crankshaft			
End float	.002 – .010 ins. (.051 – .254 mm.)	.002 – .010 ins. (.051 – .254 mm.)	.002 – .010 ins. (.051 – .254 mm.)
Max. run out at fly-wheel clutch face	.005 ins. T.I.R. (.127 mm.)	.005 ins. T.I.R. (.127 mm.)	.005 ins. T.I.R. (.127 mm.)

	ENGINES FROM Eng. No. 1217101 to Eng. No. 1425096	*FROM Eng. No. 1425097 to Eng. No. 1481090*	*FROM Eng. No. 1481091 Onwards*
Cooling System			
Water pump	Belt drive vane type centrifugal pump	Belt drive vane type centrifugal pump	Belt drive vane type centrifugal pump
Thermostat	Non-shrouded bellows type	Shrouded by-pass bellows type	Shrouded by-pass bellows type
Fan 90° and below	2 blade 15 ins. dia. (38.10 cm.)	2 blade 15 ins. dia. (38.10 cm.)	2 blade 17 ins. dia. (43.18 cm.)
Fan above 90° F.	2 blade 18 ins. dia. (45.72 cm.)	2 blade 18 ins. dia. (45.72 cm.)	4 blade 17 ins. dia. (43.18 cm.)
Lubrication System			
Sump Capacity	13 Imp. pints	12.5 Imp. pints	12.5 Imp. pints
Oil Filter (dry)	1¼ Imp. pints (approx)	1 Imp. pint (approx.)	1 Imp. pint (approx.)
Oil pump type	Spur gear submerged (pressure relief valve in engine mounting plate location)	Spur gear submerged (pressure relief valve in pump cover)	Spur gear submerged (pressure relief valve in pump cover)
Relief valve spring free length.	(Serviced as a	1.44 ins. (36.58 mm.)	1.44 ins. (36.58 mm.)
Relief valve spring length under load	valve assembly)	.75 ins. at 9.8 – 10.8 lbs. (19.05 mm. at 4.45 – 5.39 kg.)	.75 ins. at 9.8 – 10.8 lbs. (19.05 mm. at 4.45 – 5.39 kg.)
Oil pump pressures	30 – 40 lbs./sq. in. (2812 – 3516 gm./sq. cm.)	30 – 40 lbs./sq. in. (2109 – 2812 gm./sq. cm.)	30 – 40 lbs./sq. in. (2109 – 2813 gm./sq. cm.)

Grade of lubricant

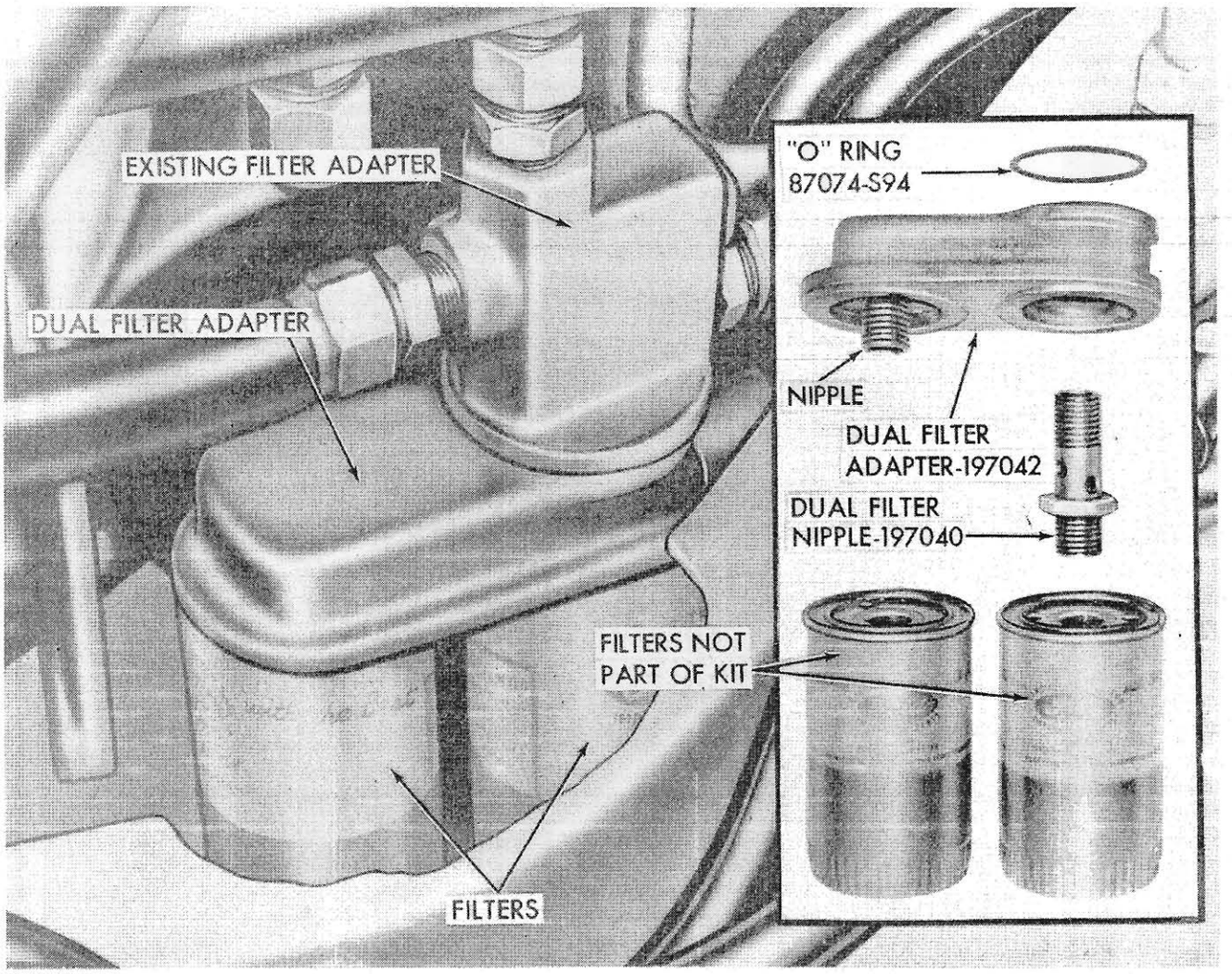
Temperature Range	Grade of lubricant
From 0° to 20° F. (– 18°C. to – 7° C.)	S.A.E. 10 H.D. or S.A.E. 10 W H.D.
From 20° to 90° F. (– 7° to – 32° C.)	S.A.E. 20 H.D. or S.A.E. 20 W H.D.
Over 90° F. (over 32° C.)	S.A.E. 30 H.D.

Touque Tightening Figures

Main bearing cap screws	70 – 75 lb. ft. (9.674 – 10.365 kg.m.)
Connecting rod nuts	55 – 60 lb. ft. (7.601 – 8.292 kg.m.)
Cylinder head screws	85 – 90 lb. ft. (11.747 – 12.439 kg.m.)
Flywheel to crankshaft screws	80 – 90 lb. ft. (11.056 – 12.438 kg.m.)
Rocker cover screws	3 – 4 lb. ft. (.415 – .553 kg.m.)
Auxiliary drive shaft gear retaining nut ...	60 – 70 lb. ft. (8.292 – 9.674 kg.m.)
Front mounting plate screws and all ⅜ in. screws unless otherwise specified	17 – 22 lb. ft. (2.349 – 3.040 kg.m.)
Front mounting plate schews and all ⅜ in. screws unless otherwise specified	12 – 15 lb. ft. (1.658 – 2.073 kg.m.)
Camshaft gear screws Mk. III	18 – 21 lb. ft. (2.487 – 2.902 kg.m.)
Mk. I oil pressure relief valve assay	20 – 25 lb. ft. (2.764 – 3.455 kg.m.)

HYDRAULIC FILTER ADAPTER KIT

PART NO. 197039



The Dual Filter Adapter Kit, Part No. 197039, consists of the following parts:

Part No.	Description	Quantity
197042	Adapter, Dual Filter	1
107393	Nipple	1
197040	Nipple, Dual Filter	1
87074-S94	"O" Ring	1

Install the Dual Filter Adapter Kit as follows:

1. Place a drain pan under the hydraulic system filter.
2. Remove the existing filter from the filter adapter and discard the filter.
3. Remove the existing nipple from the adapter and discard the nipple.
4. Dip the new "O" ring, as shown, in hydraulic oil and install it in the groove provided in the top of the dual filter adapter.
5. Position the dual filter adapter on the existing adapter as shown, and secure in place with the dual filter nipple.
6. Thread the other new nipple (provided in the kit) into the second filter return port of the dual filter adapter.
7. Install two new filters, as shown, and hand tighten as described by the instructions on the filter cans.
8. Replenish the oil in the hydraulic system to bring the oil level to the full mark on the reservoir dipstick.

Prepared by

TRACTOR AND IMPLEMENT DIVISION

FORD MOTOR COMPANY

SE 8296 9606.5

PRINTED IN U.S.A.

FUEL SYSTEM

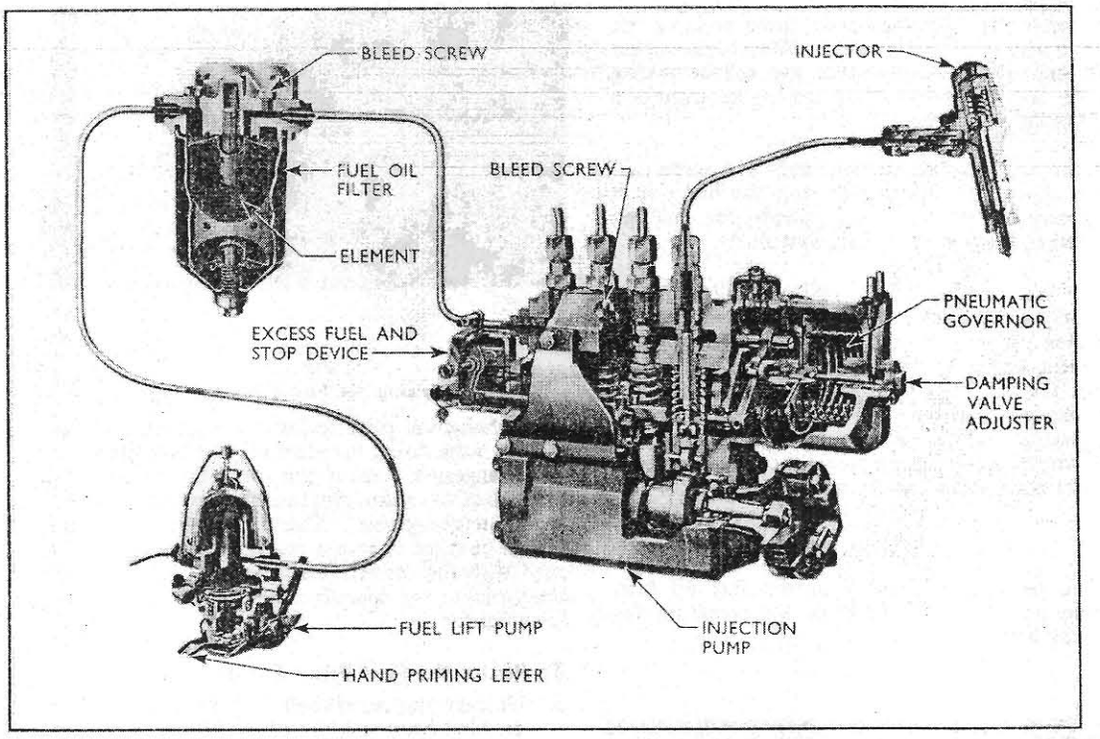


Fig. 1.
Fuel Injection System.

The fuel system used on all Fordson Major and Power Major Diesel Tractors has remained basically unchanged since the inception of the model in 1952.

Modifications have been made to produce changed engine characteristics required by the Mark II engine (from engine No. 1425097 to 1481090) and Mark III engines (1481091 onwards, i.e. all Power Major Engines) such as injection pump timing, the use of larger bore injection pump elements, different type delivery valve assemblies, larger bore injector nozzle holes, changed injection rate and pneumatic governor assemblies.

These changes, and modifications made prior to the introduction of the Mark II engine will be detailed as and when applicable under their appropriate section headings in this bulletin.

A description of the operation of the fuel injection system is not included in this bulletin as it is considered that it has been covered sufficiently in the past in the Fordson Major Repair Manual and previous issues of Tractor Service Bulletins.

ROUTINE SERVICING OF THE FUEL SYSTEM

FUEL LIFT PUMP FILTER

The fuel lift pump located on the right-hand side of the cylinder block is provided with a gauze filter screen fitted beneath a glass sediment bulb (see Fig. 2). Any accumulation of dirt or water is visible through the glass bulb, and when dirt or water is apparent the bulb and filter screen should be removed for cleaning by unscrewing the clamp securing the bulb to the fuel lift pump body. When replacing the bulb and screen, ensure that the rubber sealing washer is in good condition (on earlier tractors a cork gasket was used).

After cleaning the sediment bulb and screen, all traces of air must be removed from the fuel system as described on this page, under the heading "Bleeding Air from the Fuel System."

On tractors fitted with exhausters (industrial tractors) the fuel lift pump is mounted on the fuel injection pump cambox and does not incorporate a sediment bulb. A filter screen is fitted, however, under the top cover plate and may be removed for cleaning by unscrewing the centre bolt and lifting off the plate and screen. When replacing the cover plate and screen ensure that the gasket is in good condition and do not overtighten the centre bolt.

FUEL FILTER

The replaceable element in the fuel oil filter should be renewed at intervals not exceeding 600 working hours.

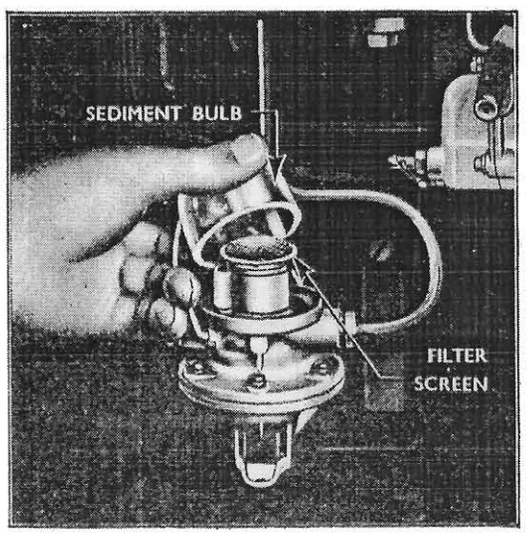


Fig. 2.
Fuel Lift Pump Filter Screen.

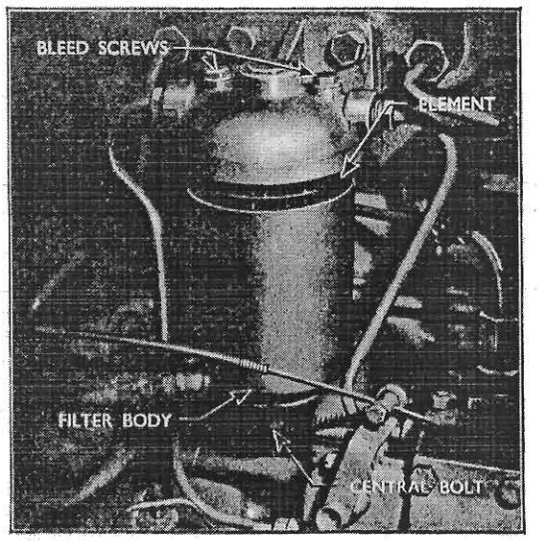


Fig. 3.
Changing the Fuel Filter Element.

In production prior to January 1956, three types of filter were fitted, the elements of which were not interchangeable. After this date the number of filters used was reduced to two, the elements of which were interchangeable. Therefore, in service, care should be taken to ensure that the correct element is used with the correct filter. In all cases the filter head carries the manufacturer's name for ease of identification.

To Renew the Fuel Filter Element

1. Unscrew the central bolt from the filter, remove the filter body and discard the filter element (see Fig. 3). Using a brush and clean fuel oil, thoroughly clean the interior of the filter body. *On no account should rag be used for this operation.*
2. Fit a new element to the filter body and a new sealing ring to the groove in the filter head. Tighten the central bolt to a torque of 10 lbs. ft. (1.38 kg.m.).

BLEEDING AIR FROM THE FUEL SYSTEM

If the fuel system has been disconnected at any point or air has entered the system due to fuel shortage it will be necessary to remove all air before satisfactory engine performance can be attained.

1. Ensure that there is sufficient fuel in the fuel tank and that all fuel pipe connections are tight.
2. Remove the bleed screw (see Fig. 3) on the outlet side of the fuel filter head (the one nearest the fuel injection pump) and operate the priming lever on the fuel lift pump. Continue pumping until a stream of fuel, free from air bubbles, issues from the filter. Replace and tighten the bleed screw.

Fig. 4.
Removing the Air Cleaner Base.

3. Unscrew the bleed screw in the centre of the injection pump body approximately 2 to 3 turns, operate the lift pump priming lever as before, tightening the bleed screw when an air-free flow of fuel emerges from the bleed hole.

4. Wipe all surplus fuel from the exterior of the fuel filter and the fuel injection pump.

FUEL INJECTORS

The injectors should normally be removed for testing and servicing, at intervals not exceeding 600 working hours. For details of servicing refer to page 16.

AIR CLEANER

The air cleaner consists of a primary cleaner mounted on top of the main oil bath air cleaner, the whole assembly being bolted to the left-hand side of the battery carrier and the battery heat baffle, and connected by a rubber hose to the inlet manifold.

The primary cleaner should be kept free of obstruction and the filter base and the removable gauze element removed, washed thoroughly and replaced, with the filter base filled to the correct level with clean engine oil, after every 50 working hours, or more often when working in dusty conditions (see Fig. 4).

After 600 working hours the complete air cleaner assembly should be removed, dismantled and the fixed and removable gauze elements thoroughly cleaned. At the same time the oil in the base should be replaced with clean engine oil.

Prior to January 1955 the air cleaners fitted in production did not have a removable gauze element, and with this type of cleaner it is necessary to remove the complete assembly at least once a month (or every 200 hours) and clean the fixed element thoroughly.

With the advent of the Mark II engine and the change to the engine crankcase breathing system the main body of the air cleaner was changed by adding a small diameter pipe at right angles to the inlet pipe at the top of the air cleaner. This small pipe was connected by means of a tube and rubber pipes to the engine valve rocker cover, engine fumes being drawn from the valve rocker cover into the air cleaner and subsequently burnt in the engine.

The air cleaner for the Mark III engine is similar to that for the Mark II but has a bracket on it to which the voltage control regulator fits.

PNEUMATIC GOVERNOR AIR FILTER CAPSULE

To ensure satisfactory operation of the governor, the air filter capsule, fitted under the small plate on the top of the rear half of the governor case (see Fig. 10) should be inspected, and removed and cleaned if deemed necessary every 200 working hours. The filter capsule should be lightly oiled with clean engine oil before replacement.

INJECTION PUMP TIMING

The injection pump timing will vary depending on the type of engine, i.e. Mark I engines prior to engine No. 1308977—29° B.T.D.C. (indicated by lining up the notch on the crankshaft pulley with the fixed pointer on the engine front cover) and Mark I engines after engine No. 1308978—26° B.T.D.C., Mark II engines—19° B.T.D.C. (when fitted with steel cylinder head gasket) and 23° B.T.D.C. (when fitted with copper-Permanite-rubber asbestos cylinder head gasket). and Mark III engines—23° B.T.D.C.

All engines after approximate engine No. 1308978 have graduated marks on the flywheel that can be lined up with a notch in the sump aperture to give the correct degree markings for injection pump timing (see Fig. 5).

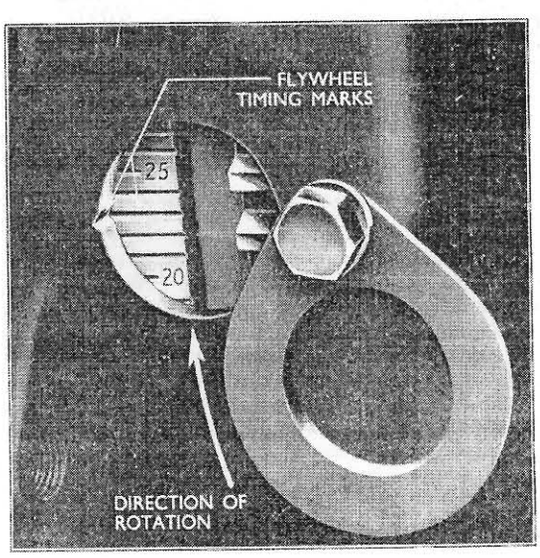


Fig. 5.
Flywheel Timing Marks.

Checking and Adjusting Injection Pump Timing

1. Move the inspection cover on the right-hand side of the sump flywheel housing to one side and turn the engine until with No. 1 piston on its compression stroke (this can be checked by removing the oil filler cap and observing the operation of the valves), the correct degree marking for the type of engine is in line with the index notch on the side of the inspection aperture (see Fig. 5).

2. If correctly timed the injection pump driven coupling timing mark should be in line with the timing plate fitted to the front of the pump (see Fig. 6). If this is not so, slacken the two claw bolts on the driving coupling and move the driven coupling until the timing marks coincide. Tighten the claw bolts securely.

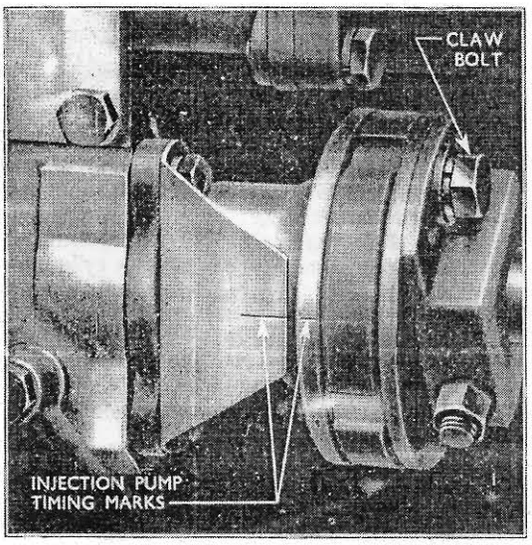


Fig. 6.
Fuel Injection Pump Timing Marks.

PNEUMATIC GOVERNOR

Prior to May 1954 (approximate pump No. 37476) the governor link was secured to the end of the control rod by a castellated or self-locking nut. After this date a modified governor link was fitted secured to the control rod by a tapered screw located in a hole in the rod and locked by a nut. The links are not interchangeable owing to the change in the control rods and if the latest link is to be fitted to an early pump the control rod, excess fuel and stop control lever assembly, stop control inner and outer case assembly and maximum fuel stop screw must also be changed.

At the same time as the above changes the tappings in the outer half of the governor housing for the vacuum and air bleed pipes were increased in size from $\frac{1}{4}$ inch 20 N.F.2 to $\frac{5}{16}$ inch 18 U.N.F. with consequent changes to the ferrules and nuts on the pipes.

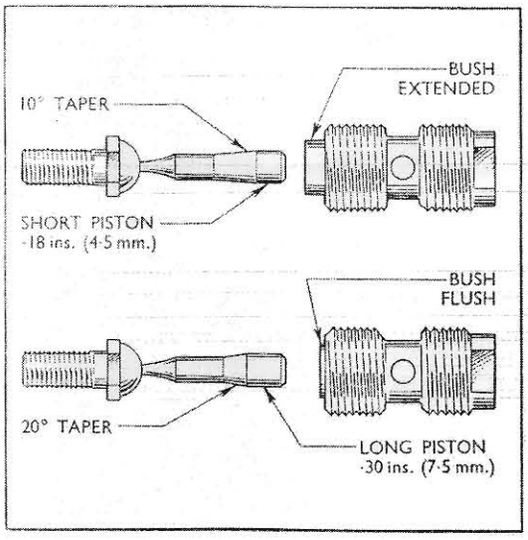


Fig. 7.
Governor Damping Valves and Guides.

When replacing early type governor outer housings it will be necessary to convert the original governor vacuum and air bleed pipes at the governor ends by using two of the latest type ferrules and nuts. The ferrules should be located up to, but not exceeding .030 inch (.762 mm.) from the end of each pipe and the ferrule seating must be free of solder.

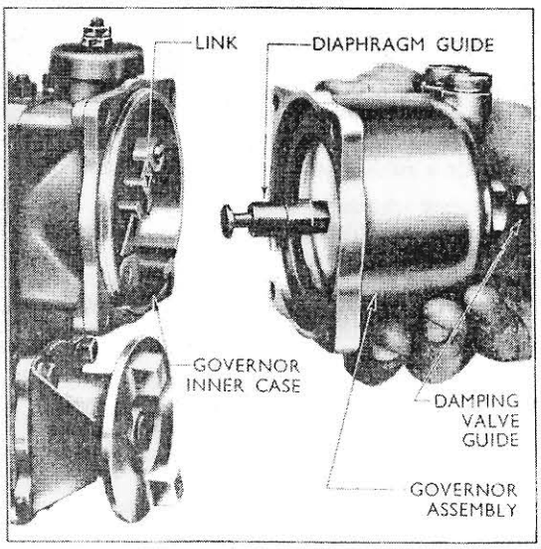


Fig. 8.
Removing the Governor Assembly.

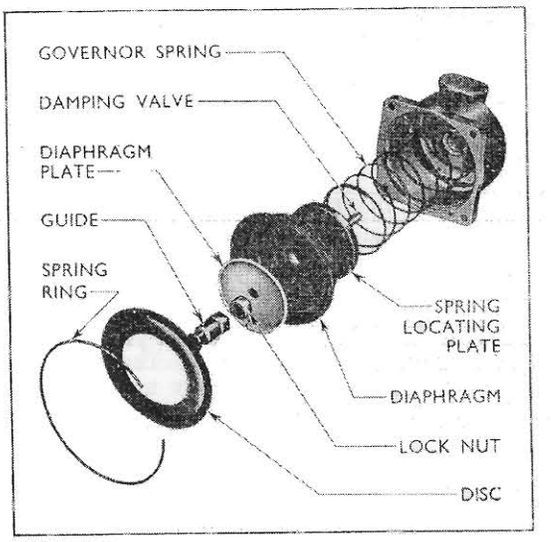


Fig. 9.
Pneumatic Governor—Exploded.

Effective with approximate pump No. 176929 a change to the governor spring rate resulted in the free length being changed from 7.16 ins. (182 mm.) to 6 ins. (152.5 mm.)—identified by a blue paint band along the length of the spring. At the same time the outside diameter of the spring locating plate was reduced and the indentations on the plate for locating the spring were deleted. The internal diameter of the large diaphragm disc was reduced in line with the change to the locating plate from 2.48 ins. (63 mm.) to 2.09 ins. (53 mm.). The plates should only be replaced in pairs and under no circumstances should one of the latest type plates be used with one of the previous type or vice versa.

Two types of governor damping valve and valve guide assembly have been used in service (see Fig. 7) and it is important that these are only used in pairs as shown in the illustration.

To Renew the Governor Diaphragm or Spring

1. Disconnect the two governor pipes from the governor assembly.
2. Unscrew the four bolts securing the governor assembly to the injection pump and lift the diaphragm guide from the governor link (see Fig. 8).
3. Remove the spring ring and disc retaining the diaphragm, from the governor housing. The diaphragm is lightly spring-loaded and care is necessary to prevent damage.
4. Remove the diaphragm from the assembly by first unscrewing the diaphragm guide, then the locknut and remove the diaphragm plate and diaphragm.
5. Fit the new diaphragm and plate and screw on the locknut and guide. Ensure that all the parts comprising the diaphragm assembly are fitted in the correct order (see Fig. 9) and the damping valve ball joint is lightly oiled.
6. Fit the governor spring and diaphragm assembly into the housing, ensuring that the damping valve enters its guide. Fit the diaphragm, disc and spring ring. The diaphragm disc must be fitted with the offset centre portion away from the diaphragm, and the spring ring with the gap in the ring adjacent to the ejector recess in the governor housing.
7. Fit the governor assembly to the injection pump ensuring that the guide enters the governor link.
8. Reconnect the two governor pipes, ensuring that the outer pipe connects with the upper port on the inlet manifold.

ENGINE SPEED

Idling Setting

Engine idling speed is adjusted by means of the idling screw on the inlet manifold and the damping valve located on the front end of the governor diaphragm unit (see Fig. 10). This latter adjustment is used to eliminate surging.

To adjust the idling speed, ensure that the engine is thoroughly warm and adjust the idling screw to give an idling speed of 540 to 560 r.p.m. If the engine is surging, slacken the damping valve locknut and screw the valve guide in or out, as necessary, to obtain a steady idling speed. Finally, recheck the idling speed and adjust the idling screw if necessary to ensure that the speed is between 540 and 560 r.p.m.

Maximum " No Load " Speed

With the engine at its normal operating temperature the maximum " No Load " speed should be 1,900 r.p.m. and can be adjusted at the maximum speed screw on the inlet manifold (see Fig. 10).

The engine speed can only be accurately checked and adjusted with the aid of a tachometer capable of being driven from the end of the belt pulley shaft or from the periphery of the engine fan belt.

When checking the engine speed from the belt pulley shaft the primary gear lever must be in the " high " position.

To calculate the engine speed from the reading obtained when the tachometer is driven from the periphery of the engine fan belt, divide the effective diameter of the crankshaft pulley (8.80 ins. (22.35 cm.) for wide type fan belt and 7.52 ins. (19.10 cm.) for narrow type fan belt) by the diameter of the tachometer adaptor wheel. Then divide the tachometer reading by the figure thus obtained to get the equivalent engine speed.

TO RENEW A DELIVERY VALVE AND GUIDE ASSEMBLY

The replacement of the delivery valve and guide assembly and or spring should only be done in an emergency, as the characteristics of the new parts may slightly alter the delivery of that particular element. The pump calibration should therefore be checked and adjusted at the first opportunity.

The delivery valve and guide are a matched assembly and must always be replaced as a pair.

1. Remove the injector pipe from the delivery valve holder and injector of the element concerned and fit blanking plugs.
2. Unscrew the delivery valve holder, using Tool No. CT.9008, and extract the valve complete with spring and volume reducer (see Fig. 15).
3. With the respective plunger at the bottom of its stroke, insert the expanding end of the delivery valve guide extractor (Tool No. CT.9022) into the valve guide bore, until the projecting lips of the tool locate against the underside of the valve guide. Turn the engine slowly, and the guide, with its washer, will be pushed out of the pump body.
4. Thoroughly rinse the new delivery valve guide and washer, and press the guide and washer into the bore until it touches the top of the plunger barrel.
5. Thoroughly clean the delivery valve, spring and volume reducer and fit them to the valve guide.
6. Replace the delivery valve holder and tighten to a torque of 30 lbs. ft. (4.15 kg.m.).
7. Replace the injector pipe, ensuring that it is clean and that the olives on the end of the pipe seat correctly before tightening the union nuts.

FUEL INJECTION PUMP

Injection pumps fitted to engines manufactured prior to July 1954 (Pump No. 61994), have 7 mm. (.276 in.) diameter plungers with the helix machined at 45 degrees. Pumps manufactured between this date and April 1957 have 7 mm. diameter plungers with the helix machined at 50 degrees. These are easily identified by means of a groove machined around the lower portion of the barrel (see Fig. 11).

With the advent of the Mark II engine (April 1957—Engine No. 1425097) the plungers were increased in size to 7.5 mm. (.295 in.) diameter with the helix machined at 50 degrees but without any identification mark on the barrel. The cam followers were altered to allow wider rollers to be fitted. These may be used on earlier pumps and consequently are the only followers serviced.

The two types of fuel injection pump are identified by the following numbers stamped on the inspection cover :—

Pumps incorporating 7.0 mm. diameter elements, type No. SPE.4A.70S.

Pumps incorporating 7.5 mm. diameter elements, type No. SPE.4A.75S.

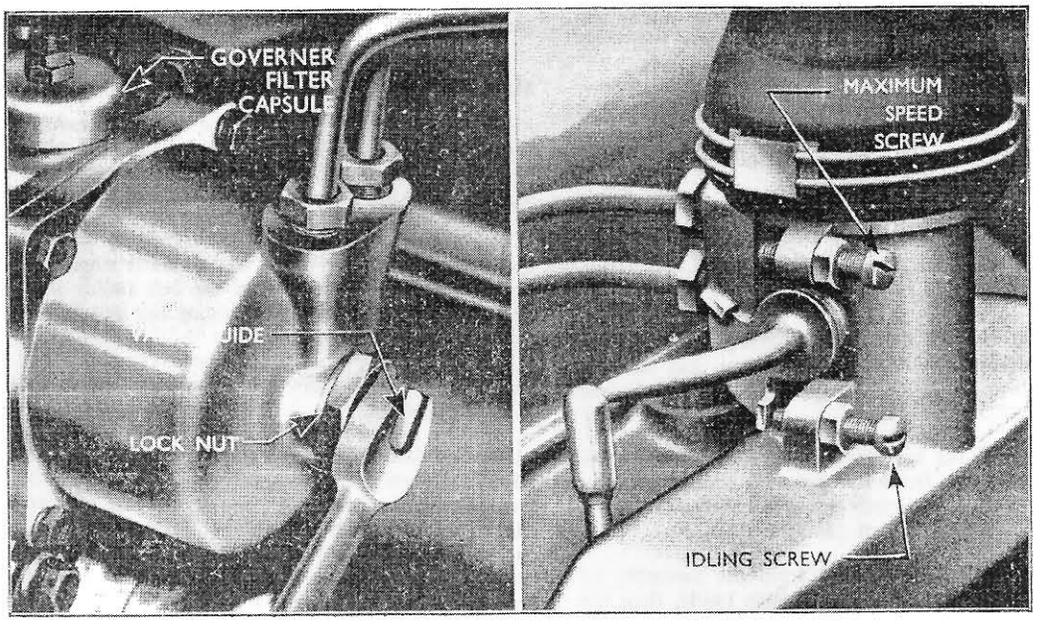


Fig. 10.
Engine Idling and "No Load" Speed Adjustment.

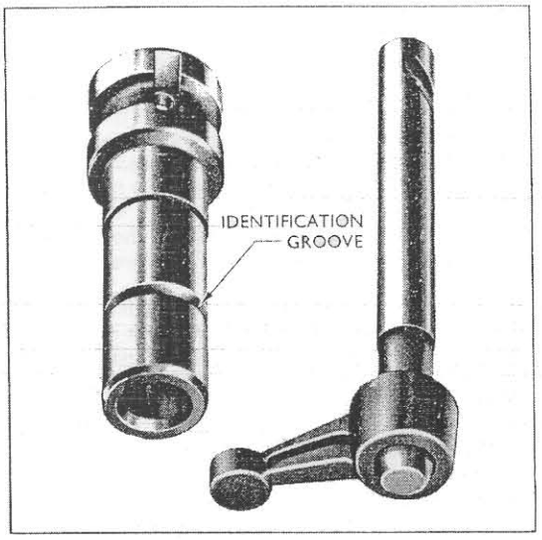


Fig. 11.
Injection Pump Element.

As the injection pump housing will accommodate either diameter element, it is possible to convert the previous pump to the current type if required. If this action is necessary it is essential that the inspection cover is inscribed with the appropriate type number identification, and when refitted to the engine the correct injection pump timing angle is used.

On the Mark III pump the effective inlet stroke of the plunger was increased by reducing the thickness of the tappet spacers. This necessitated changes to the floor of the tappet chamber on the cambox and the fitting of thicker plunger spring upper discs, i.e. .16 in. (4 mm.) thick, fully machined disc as against .036 in. (.9 mm.) thick, pressed steel disc. The latest type discs may be used on any pump but the previous type should not be used on the Mark III pump.

The cambox is fully interchangeable providing clearance exists for the plunger arms at the bottom of the stroke when it is used on the Mark III. In order to utilise previous design camboxes it may therefore be necessary to remove metal from the floor of the tappet chamber to obtain this clearance. If necessary, material should be removed as indicated in Fig. 12 to ensure clearance for the plunger arms and forks throughout the control rod movement.

The delivery valves were changed at the introduction of the Mark III engine, the piston portion immediately below the conical seat of the latest valves is parallel faced instead of taper faced (see Fig. 13). Only delivery valves with parallel faced piston portions should be used on Mark III engines.

During 1954 the following minor modifications were also introduced in production on the Mark I engine fuel injection pump.

1. **Inspection cover**—to improve the dust proofing qualities of the pump the cover was changed from a four bolt to an eight bolt fixing (effective with Pump No. 34624). Previous type pump bodies and camboxes with only four tapped holes at the inspection cover location may be suitably modified by fitting one of the latest covers and drilling four extra holes, $\frac{3}{16}$ in. (5.3 mm.) diameter and $\frac{13}{16}$ in. (17 mm.) deep (measured from the bolt head spot-facing on the cover), using the new cover as a guide during the

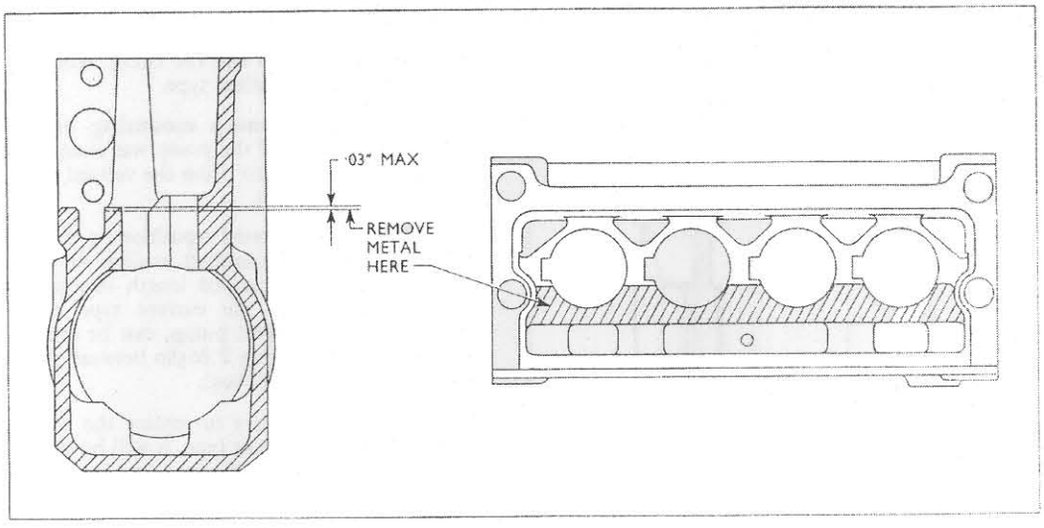


Fig. 12.
Injection Pump Cambox Modification.

drilling operation. Tap the holes ¼ in. U.N.C. 20 T.P.I. Great care should be taken during the operation to ensure that all openings on the pump are fully blanked off and that all swarf is removed before the pump is returned to service.

2. Excess fuel and stop control lever assembly and housing, control rod and governor link—to ensure correct alignment between the stop control inner housing and the cambox the number of retaining screws was increased from one to two (effective with Pump No. 37476) with a consequential increase in the number of tapped holes in the cambox. The number of outer housing to inner housing retaining screws was increased from two to four and a seal was fitted to the stop lever assembly to prevent the ingress of dirt.

A control rod, round in section at both ends was also introduced at the same time, the bore in the stop control inner housing being changed from square section to round section in consequence. The method of retaining the governor link to the control rod was changed from a locknut at the end of the rod to a tapered bolt in the governor link locating in a hole in the control rod and locked by a nut.

When any one of the following parts of early design are renewed it will be necessary to fit a complete set of parts of the latest design, i.e. governor link, stop control inner and outer housings, stop control and excess fuel lever assembly, control rod and maximum fuel stop screw.

3. Inner half of governor housing—to ensure correct alignment a countersunk screw and lockwasher were added to supplement the two screws previously used (effective with Pump No. 37476). This also involved the addition of a tapped hole in the cambox.

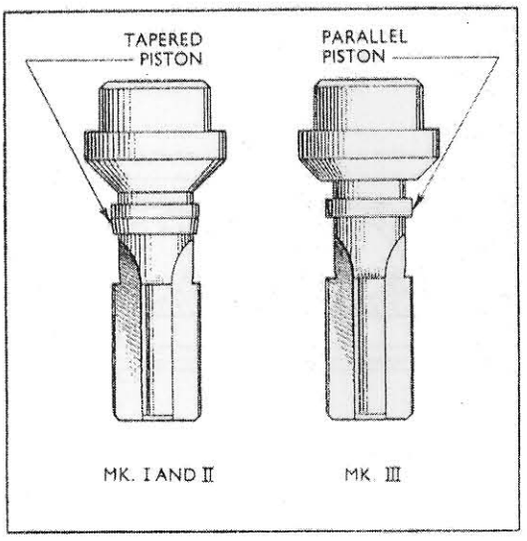


Fig. 13
Delivery Valve Assemblies.

When a new cambox is fitted and the remainder of the original parts re-used, the tapped holes in the cambox—the lower hole of the three at the governor housing end and the one below the control rod hole at the stop control end—must be sealed to prevent the ingress of dirt. For this purpose use two headless screws (Part No. 89406-S) smeared with sealing compound, ensuring that the ends of the screws are flush or below the outer faces of the cambox.

4. Injection pump pre-filter.—the fuel pre-filter located in an extension of the injection pump body adjacent to the stop control housing assembly was deleted (effective with pump No. 39001) as was the filter housing portion of the injection pump body.

When fitting later design inner stop control housings to pumps incorporating the pre-filter it will be necessary to fit a later type pump body due to the stop control housing fouling the pre-filter housing.

Alternatively, the existing body may be modified by suitably machining to remove the pre-filter housing and then tapping a 19 mm. × 1.5 mm. pitch thread (S.I. form) to a depth of .55 in. (14 mm.) into the fuel gallery to accommodate the inlet connection. Ensure that the bore of the thread is perfectly square with the pump body face and thoroughly wash the body to remove all traces of swarf, also make certain that the threads are clean.

If a tap of the size mentioned above is not available, the inlet adaptor can be reworked to a suitable thread size and the fuel gallery tapped accordingly.

5. Tappet bodies, spacers and circlips—the tappet spacers were changed from flat faced to step faced (effective with Pump No. 40268). The thickness of the outside diameter is now constant for all spacers, the variation in thickness being obtained on the stepped centre portion. The tappet body was also changed and the circlip was changed from a flat type to a dished type.

6. Fuel injection pump mounting bracket—the installation angle of the pump was changed from vertical to an angle of 10° from the vertical (effective with pump No. 52205).

This change necessitated repositioning the keyway in the injection pump camshaft to allow for injection pump timing, and increased length injector pipes. The identification of the current type camshaft, fitted to the 10° inclined pump, can be established by means of the marking P.86580 between the cams (early type marking P.84695).

Should it be necessary to replace the early type camshaft with the current type, it will be found that there is sufficient range of adjustment on the engine half of the fuel injection pump coupling to accommodate the 10° change in the location of the keyway.

If the early type mounting bracket is replaced by the current type bracket the fuel injector pipes must be replaced by later type pipes.

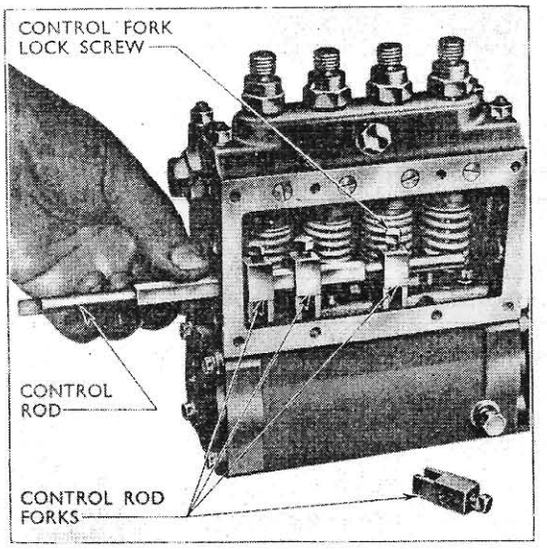


Fig. 14.
Removing the Control Rod and Forks.

7. Push button excess fuel device—a modified design excess fuel and stop control lever assembly, introduced at the end of 1954, is operated by pushing the control knob in towards the pump as against pulling the stop lever out on previous pumps. The parts of this latest assembly—excess fuel and stop control lever assembly, maximum fuel stop screw and the stop control inner and outer housings are not interchangeable individually with previous parts, only collectively.

TO DISMANTLE THE FUEL INJECTION PUMP

1. Remove the injection pump from the tractor, fit sealing caps to the delivery valve holders, inlet connection and governor connections, and clean off all dirt and paint from the outside of the pump body.
2. Remove the four screws securing the governor assembly to the governor inner case, and lift the diaphragm guide clear of the governor link to remove the assembly (see Fig. 8).
3. Remove the governor link by unscrewing the locknut and tapered bolt securing the link to the end of the control rod. (Early Mark I control rods had a threaded end which was located through the governor link and secured by a self-locking or castellated nut.)
4. Remove the governor inner case by unscrewing the two bolts and one countersunk screw securing it to the pump cambox. (One bolt and one countersunk screw were used on early Mark I pumps.)
5. Remove the four screws from the stop control outer housing and lift out the excess fuel and stop control lever assembly. (Two screws on early Mark I units.)
6. Remove the eight screws securing the pump inspection cover and remove the cover and gasket (Four screws on early Mark I pumps).
7. Remove the stop control inner housing which is retained by two screws (One screw on early Mark I pumps).
8. Loosen the screws which lock the control forks to the control rod and withdraw the rod from the rear of the pump (see Fig. 14.)

   Both ends of the control rod are of round section, which prevents the possibility of sluggish movement or binding that occurred with early Mark I pumps when the rear end of the control rod was of square section and operated through a square hole in the stop control inner housing.
9. Before dismantling further, loosen the delivery valve holders, then remove the four pump housing to cambox retaining nuts evenly. Lay the pump on its side, and lift the housing complete with plungers and springs from the cambox, ensuring that the plungers do not drop out and become damaged. (Elastic bands fitted over the delivery valve holders and down to the plunger arms will prevent this happening.)
10. Remove the plungers, springs and spring seats from the barrels (see Fig. 23).

    Note.—The plungers and barrels are a lapped fit to one another. They should be kept as paired assemblies and under no circumstances should they be interchanged.
11. Remove the delivery valve holders, and lift out the volume reducers, springs, and delivery valves (see Fig. 15). The delivery valves and guides are matched assemblies and must not be interchanged.

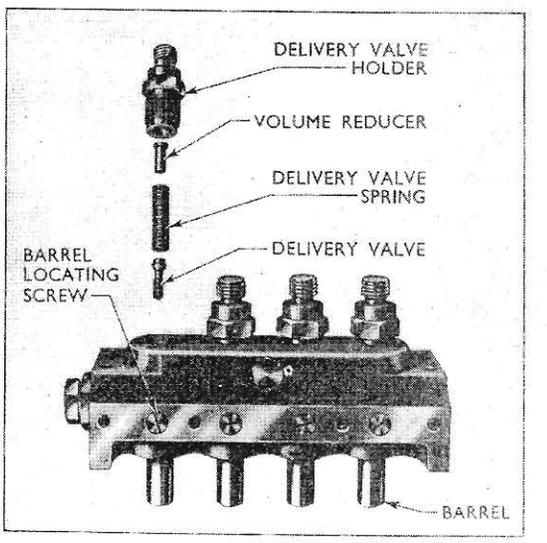


Fig. 15.
Delivery Valve, Spring and Volume Reducer.

12. Remove the barrel locating screws (see Fig. 15) and push the barrels upwards to remove the delivery valve guides and washers. The delivery valves should be kept with their respective guides, and the barrels with their plungers.

13. Remove the roller tappets from their location in the cambox and retain them in their correct sequence. The rollers may be removed by extracting the retaining pins from the tappet bodies.

14. Remove the camshaft drive coupling using the slotted flange wrench (Tool No. CT.9015) to prevent rotation while the coupling retaining nut is removed, and use the wrench in conjunction with the flange remover (Tool No. CT.9004) to remove the coupling (see Fig. 16).

    It is advisable to check the camshaft end-float at this stage with the special gauge (Tool No. CT.9017) and adaptor (Tool No. CT.9017–1) as shown in Fig. 17. The end-float should be between 0.002 and 0.006 in. (0.05 to 0.15 mm.) and should adjustment be necessary it can be made when reassembling the camshaft.

15. Remove the four screws retaining the bearing housings to the cambox at each end of the pump. (The pump timing plate is retained by two of the screws at the front bearing housing.) Remove the Woodruff key from the camshaft and tap the shaft towards the rear of the pump to remove the rear bearing housing, and then towards the drive end of the pump to remove the front bearing housing. Withdraw the camshaft from the cambox.

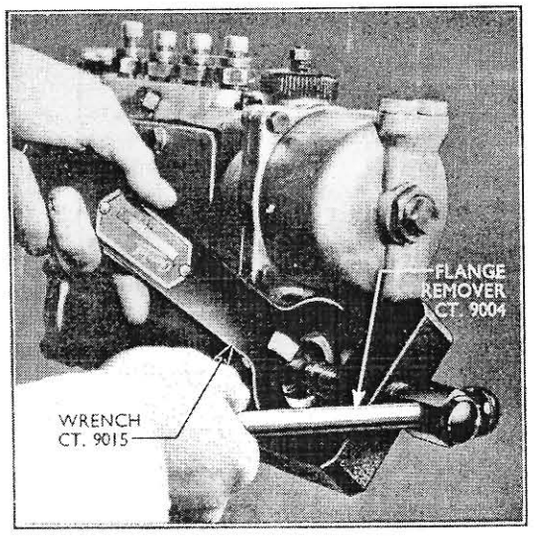


Fig. 16.
Removing the Pump Drive Coupling.

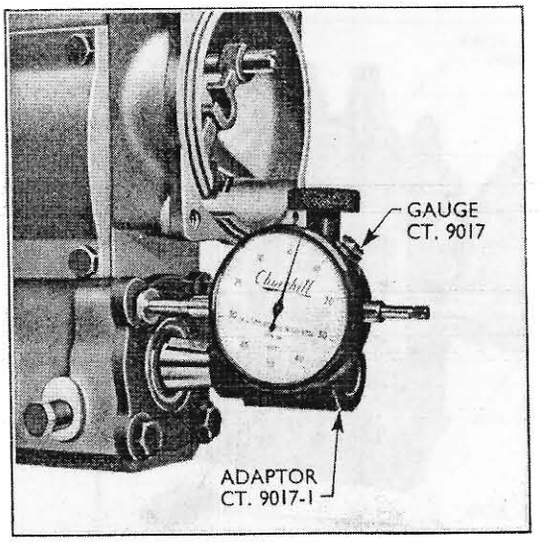


Fig. 17.
Checking Camshaft End-float.

16. Remove the ball bearing cages from each end of the camshaft, these are easily pulled off by hand, then use the special puller (Tool No. CT.6085) and adaptors (Tool No. CT.6085–1) to remove the inner races (see Fig. 18).

    The shims which govern the camshaft end-float fit behind the inner bearing races. Take care not to lose these shims.

17. Remove the camshaft outer races from both bearing housings, using the puller (Tool No. CT.9018) as shown in Fig. 19. Ensure that the lips of the threaded jaws are located under the bearing outer race.

18. Lift out the baffle washer from the coupling end bearing housing and remove the oil seal which is a light press fit in the housing.

    All parts of the pump should be thoroughly washed in clean fuel or substitute oil, inspected for wear and new parts fitted where necessary (do not use cloth when cleaning, if necessary, use a chamois leather).

TO REASSEMBLE THE INJECTION PUMP

1. Fit a new oil seal to the coupling end bearing housing.

2. Fit the oil baffle washer with the inner step towards the oil seal and fit the front bearing outer race, using the driver (Tool No. CT.9019 and the 550 handle). Use the same tools to fit the outer bearing race to the rear bearing housing.

3. Replace the original shims on the camshaft. If it was previously found that adjustment was necessary make the adjustment using 0.004 in. or 0.008 in. shims (0.10 or 0.20 mm.), ensuring that the shimming is equally divided between

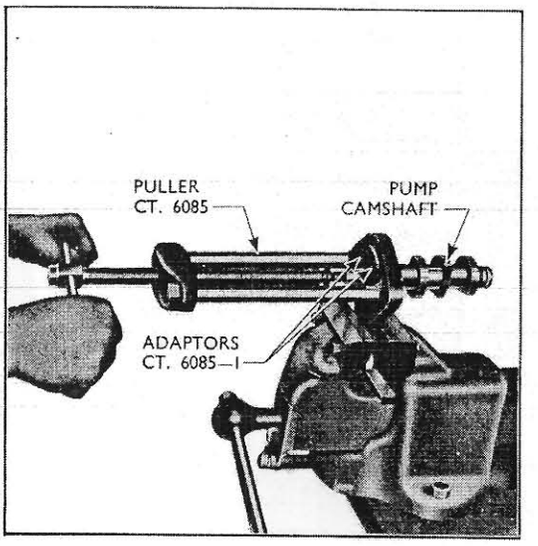


Fig. 18.
Removing the Camshaft Bearing Inner Races.

each end of the camshaft. Replace the camshaft inner bearing races, using the adaptors (CT. 6085–1) in the puller tool (CT.6085) to hold the race, and press the camshaft down into position. Press the ball bearing cages onto the inner races by hand.

4. Position the camshaft in the cambox, pack the bearings with high melting point grease, apply a thin coating of jointing compound to the bearing housing flanges and gently tap the housings into position. Replace the housing retaining screws (the pump timing plate fits under the two outside screws retaining the coupling end bearing housing) and spring washers, and re-check the camshaft end-float (see Fig. 17) which should be between .002 to .006 in. (.05 to to .15 mm.).

   Remove the checking gauge and replace the Woodruff key in the drive end of the camshaft.

   When fitting a new camshaft to an early type cambox it may be necessary to remove the surplus metal from the mounting bolt bosses as outlined on page 83 of the Fordson Major Repair Manual.

5. Replace the drive coupling, fit the retaining nut and spring washer, and using the special wrench (Tool No. CT.9015) to hold the coupling, tighten the nut to a torque of 45 lbs. ft. (6.22 kg.m.).

6. Replace the rollers in the tappet bodies, fit the roller retaining pins and fit the tappet assemblies in their original positions in the cambox.

   NOTE.—Rollers with a wider bearing contact surface are fitted to Mark II and III pumps.

   If the phasing spacers are not worn they may be refitted providing the original plunger and barrel assemblies are to be used. The pump phasing must still be checked later. If new plunger and barrel assemblies are necessary, fit an intermediate thickness spacer to each tappet (see chart on page 13), ensuring that the convex side of the retaining circlip is towards the spacer.

   The range of phasing spacers was increased with the advent of the Mark II and Mark III engines with consequent changes to the grading number stamped on the edge of the spacers.

   The chart on page 13 shows the complete range of renumbered spacers and also the previous markings.

   Unless new spacers are carefully stored under their appropriate part numbers there is the possibility of confusing the previous range with the current numbers and, therefore, it is advisable to measure each one. The chart also specifies the spacer to be used as a basis for initial phasing.

7. Rinse each plunger and barrel assembly in clean fuel or substitute oil and fit the barrels to the pump housing. Fit the barrel screws using new fibre washers and ensure that when they are tight a slight up and down movement of the barrel is possible.

8. Rinse the delivery valves and guides in clean fuel or substitute oil and refit them, using a new sealing washer, into their original locations.

   The unloading collar or piston portion of the delivery valves used in the Mark III pump is parallel where previous to this they were tapered (see Fig. 13).

9. Replace the delivery valve springs and volume reducers. Refit the delivery valve holders and tighten them until they are finger-tight (see Fig. 15).

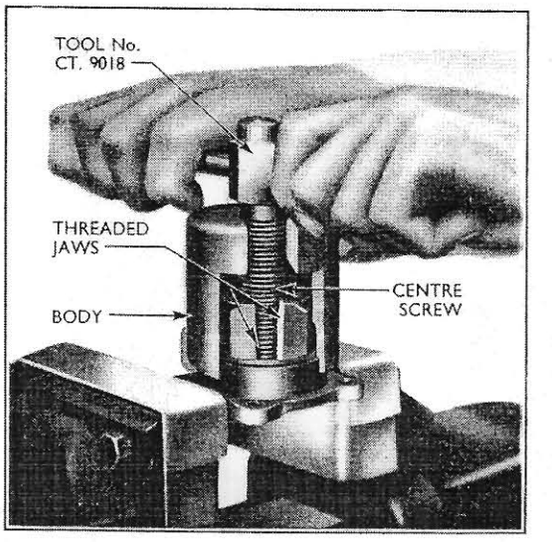


Fig. 19.
Removing Camshaft Bearing Outer Races.

10. Rinse the plungers and fit them to their respective barrels. Check that they are perfectly free. At this stage omit fitting the plunger springs and spring seats as it is easier to phase the pump without them.

    Fit the pump housing to the cambox and secure in position with four nuts and spring washers.

11. Mount the pump on the calibrating machine and engage the pump coupling with the calibrating machine driving pad. Secure the pump to the machine with the two clamp screws, and connect up the fuel feed pipe to the pump inlet connection. Turn on the fuel supply, bleed the fuel system then turn off the fuel supply.

12. Remove the delivery valve, spring and volume reducer from No. 1 element. Replace the delivery valve holder, tighten all holders to a torque of 30 lbs. ft. (4.15 kg.m.) and fit the spill pipe (Tool No. CT.9023) to No.1 delivery valve holder (see Fig.20).

13. Ensure that the driving belt of the calibrating machine is fitted to the 200 r.p.m. pulleys (see Fig. 21). Then open the belt pulley cover at right-angles so that the brake mounted behind the lower pulleys is operating against them.

14. Set the arms at the lower end of the plungers fully to the left, the maximum fuel delivery position, and No. 1 plunger at the bottom of its stroke (see Fig. 20).

15. Turn on the fuel supply and rotate the pump camshaft slowly clockwise, by means of the pulley on the motor shaft and as the plunger in No. 1 element begins to rise, fuel will flow freely from the spill pipe until such time as the plunger covers the ports. Stop rotating the camshaft as soon as the fuel flow from the spill pipe ceases and set the phasing ring on the end of the lower pulleys so that one of the graduation lines marked "4C" is in line with the fixed pointer.

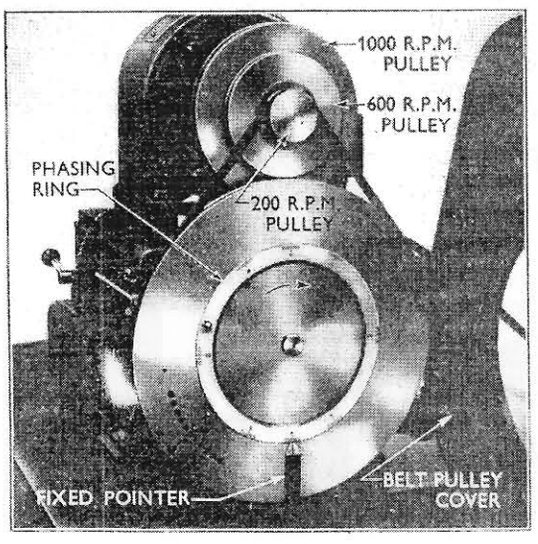


Fig. 20.
Checking No. 1. Element Spill Point.

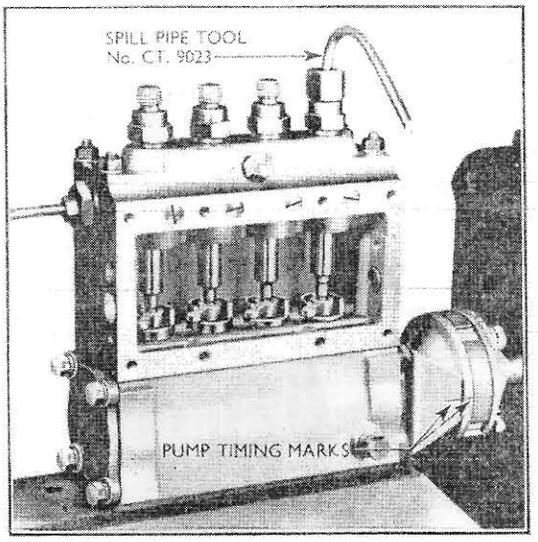


Fig. 21.
Checking Pump Phasing.

It is advisable to repeat the above procedure to check that the phasing ring has been set accurately.

16. Check that when No. 1 element is at the spill cut-off position, the timing marks on the coupling and timing plate coincide (see Fig. 20). If not, re-mark the coupling or adjust the timing plate as necessary.

    Note.—During phasing the spill cut-off point must always be ascertained when the plunger is rising.

17. Turn off the fuel, remove the spill pipe and fit the delivery valve, spring and volume reducer to No. 1 element. Tighten the holder to a torque of 30 lbs. ft. (4.15 kg.m.).

18. Remove the delivery valve, spring and volume reducer from No. 2 element. Refit the delivery valve holder and spill pipe. Turn on the fuel and rotate the camshaft slowly clockwise as before, until the spill cut-off point is reached on No. 2 element. The phasing ring should now have revolved through 90°, and the next graduation line marked "4C" should be in line with the fixed pointer. A limit of 1° either side of the "4C" mark is permitted.

    If the phasing is outside this limit, it will be necessary to change the phasing spacer of the element which is phased incorrectly. It is advisable, however, to note the extent of the phasing inaccuracy, as each remaining element is phased, working to the "4C" marks, throughout

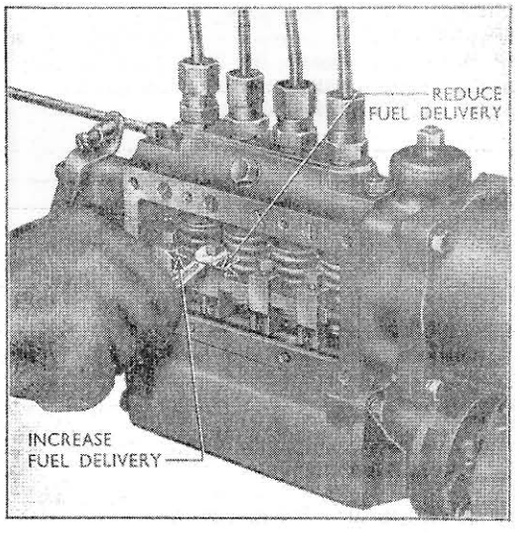


Fig. 25.
Adjusting Control Rod Forks.

(11.8-12.4 c.cs. for Power Major) with a maximum variation of .2 c.c. between all elements.

On fuel injection pumps fitted to engines prior to the Power Major (engine No. 1481090) a good average is 11.6 c.cs. but on pumps fitted to Power Major engines the average should preferably be as close as possible to 12 c.cs.

Adjust the control rod forks where necessary to obtain these figures (see Fig. 25).

Note.—At altitudes over 3,000 feet (900 metres) it is advisable to reduce the calibration figures by three per cent for every 1,000 feet (300 metres).

When calibrating, disregard the first set of readings from either bank of test tubes, and adjust the elements so that they all deliver exactly the same amount of fuel for the average of four readings.

The fuel readings should always be taken from the bottom of the curve of the fuel surface (i.e. meniscus).

30. Run the pump at 200 r.p.m. and check the delivery for 200 injections. Delivery at this speed should not be more than 2.5 c.cs. below the delivery at 600 r.p.m. If the drop is more than 2.5 c.cs. it indicates worn pump elements.

If the delivery is higher at 200 r.p.m. than it was at 600 r.p.m., fit new delivery valve assemblies to the elements affected, re-calibrate at 600 r.p.m. and re-check at 200 r.p.m.

Run the pump at 600 r.p.m. with the excess fuel device in operation when each element should deliver at least 19 c.cs. of fuel for 200 injections.

Finally check that all elements cease delivery just before the control rod reaches the end of its travel, when the pump is running at 200 r.p.m.

31. Replace the pump inspection cover and gasket. Wire and seal the maximum fuel stop screw.

Injection Pump Storage

If, after overhaul, an injection pump is being stored for a period exceeding 30 days, it should be left filled with substitute oil and all connections sealed with special plugs and caps.

MAINTENANCE OF MASTER INJECTORS ON CALIBRATING MACHINE

To ensure that fuel injection pumps are calibrated accurately, it is essential that the master injectors fitted to the calibrating machine are maintained as an accurately balanced set. The master injectors must be checked regularly for balance. To carry out this test, mount an injection pump on the calibrating machine, connect all pipes and run the machine for at least 10 minutes, to allow everything to reach normal operating temperature. It is essential that this is strictly observed when carrying out this test.

Adjust one pump element to deliver 15 c.cs. for the mean of three readings, running at 600 r.p.m. for 300 injections of fuel. Connect this pump element to each master injector in turn using the same pipe throughout this test. Running at 600 r.p.m., collect 300 injections of fuel, allowing 10 seconds after delivery has ceased for the fuel to settle before taking the readings and 10 seconds for the tube to drain when emptying.

Take the mean of the three readings from each injector in turn and the variation between the highest and lowest readings should not exceed 0.3 c.cs. If the variation exceeds this figure a fresh set of master injectors should be fitted.

No attempt should be made to balance master injectors by cleaning or pressure adjustment.

Periodically the fuel tank of the calibrating machine should be drained and thoroughly cleaned before refilling it with clean fuel. Renew the fuel filter element after 200 pumps have been calibrated.

REPLACING AND TIMING THE FUEL INJECTION PUMP

1. Turn the engine until the correct timing mark on the outer face of the flywheel is in line with the " V " notch on the side of the sump aperture, with No. 1 piston on its compression stroke (see Fig. 5).

The timing setting will vary depending on the type of engine, i.e. Mark I, Mark II or Mark III, and the correct settings for all these engines are detailed on page 3 under the heading " Injection Pump Timing "

2. Turn the injection pump coupling until the marks on the pump timing plate and the coupling are in line (see Fig. 6).

Fit the pump to the mounting bracket and engage the fibre drive pad between the pump and the auxiliary drive shaft couplings. It may be necessary to move the pump coupling slightly to allow engagement.

3. Before tightening the pump mounting bolts fit the fuel inlet pipe, governor control pipes and injector high pressure pipes. The injector pipes used on the Mark II and III engines are of equal length and are looped and clipped in pairs, and from approximately engine No. 1458430 the width across the flats of the pipe nuts was decreased from $\frac{3}{4}$ in. (19.05 mm.) to $\frac{5}{8}$ in. (15.88 mm.).

4. Tighten the injection pump to mounting bracket screws ensuring that there is a 0.010 in. (0.254 mm.) clearance between the fibre disc and the pump coupling.

5. Check the pump timing marks, if they do not coincide loosen the two claw bolts on the auxiliary drive shaft coupling, and turn the coupling to bring the marks in line. Tighten the claw bolts securely.

6. Operate the excess fuel device and reconnect the stop control wire ensuring that there is approximately $\frac{1}{4}$ in. (6.4 mm.) free movement of the stop control knob at the dash panel.

7. Bleed the fuel system (see page 2), and run the engine until its normal operating temperature is reached. Check the engine idling and " No Load " speeds as described on page 5.

INJECTORS

The injectors used on Mark I and III engines are identical, having spray holes .25 mm. (.010 in.) in diameter as against the .27 mm. (.011 in.) diameter spray holes used on injectors fitted to the Mark II engine. The injectors used on the Mark II may be identified by the red paint mark on the body (reconditioned injectors—blue paint mark) and the nozzle number NL141 stamped on the larger diameter shank of the nozzle, the Mark I and III injectors have green paint spots (yellow for reconditioned) and the inscription NL123.

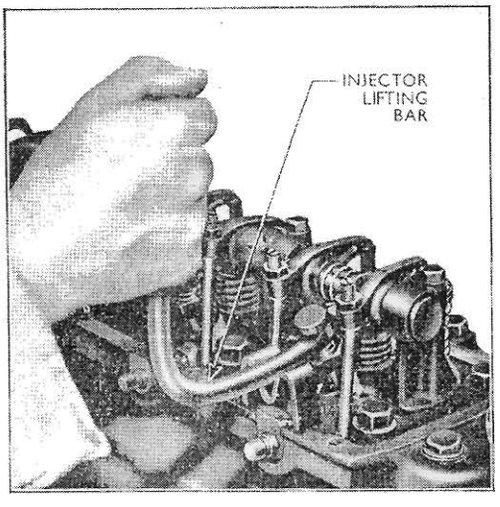


Fig. 26.
Removing an Injector.

The injectors should be kept to their respective type of engine as specified, although in an emergency they may be interchanged providing that when they are used in engines for which they are not strictly specified, they are used in sets of four.

Removing an Injector

1. Remove the valve rocker cover and gasket.

2. Remove the fuel injector pipe by unscrewing the union nuts at each end of the pipe. Fit the appropriate blanking plugs to the delivery valve holder, injector inlet adaptor and injector pipe nuts.

3. Remove the injector leak-off pipe by unscrewing the union nut at the rear of the cylinder head and the special bolts connecting the leak-off pipe to the injectors. Take care not to drop any of the bolts into the engine.

4. Remove the injector after unscrewing the two securing bolts. If the injector is tight in its housing, the injector lifting bar (Part No. E1ADDN-17098) should be used (see Fig. 26).

TESTING AN INJECTOR

Complete injectors received for servicing should be briefly tested before any cleaning or adjustment is carried out, to ascertain their approximate condition.

A satisfactory injector must pass four tests :—

(1) Nozzle opening pressure.
(2) Needle seat leakage.
(3) Needle valve stem back leakage.
(4) Atomisation.

Care should be taken when testing injectors that the fuel spray does not contact the hands, as it will penetrate the skin due to the high pressure and atomisation of the fuel.

1. Nozzle Opening Pressure

Connect the injector to the injector testing machine and check the nozzle opening pressure. This should be between 175 and 185 atmospheres. To obtain a more accurate reading of the pressure, open the valve on the tester not more than half a turn from the closed position, which will effectively reduce needle fluctuation.

If the opening pressure is outside the above limits, slacken the injector cap nut and adjust the pressure by rotating the spring adjusting nut through the leak-off pipe drilling in the cap nut (see Fig. 27). Tighten the cap nut securely, taking care that the spring adjusting nut does not move.

2. Needle Seat Leakage

Wipe the nozzle tip dry. Operate the tester three or four times and the nozzle tip should remain dry.

In doubtful cases hold the injection pressure at 10 atmospheres below the nozzle opening pressure, and hold a piece of blotting paper against the nozzle tip (see Fig. 28). The fuel oil stain should not exceed $\frac{1}{2}$ in. (12.7 mm.) in diameter in one minute.

If the injector satisfactorily passes the above tests, it can be refitted to the engine. If, however, it fails the nozzle seat leakage test or if the spray is distorted or does not atomise properly, the injector should be completely dismantled, cleaned, reassembled and tested once again.

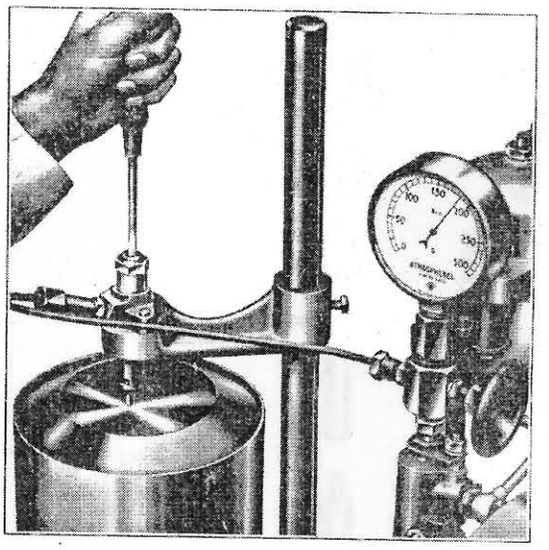


Fig. 27.
Setting Nozzle Opening Pressure.

3. Needle Valve Stem Back Leakage

Fully open the valve on the nozzle tester, bring the test pressure up to 150 atmospheres and check the time for it to fall to 100 atmospheres. The time taken should be between 6 and 45 seconds for a service injector. The time taken for a new injector from stock should be between 15 and 45 seconds (see Fig. 29).

If the time taken is less than six seconds the lapped faces on the nozzle and injector body may be damaged or distorted, or there may be dirt between the nozzle and injector body faces.

If the time taken is more than 45 seconds it is possible that the needle valve is seized in the nozzle body, or the spray holes are completely blocked.

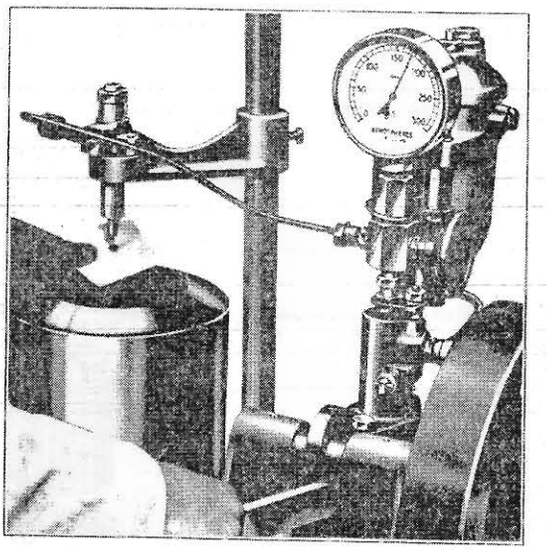


Fig. 28.
Testing Needle Seat Leakage.

4. Atomisation

Close the valve on the nozzle tester, operate the machine at 60 to 85 actions per minute and examine the four sprays.

Each spray should atomise well with no visible streaks or distortion, spreading out about 2 ins. (50 mm.) at a point 4 ins. (100 mm.) from the nozzle tip. All four sprays must be similar and spaced at approximately right angles to each other in a horizontal plane, and the injector should break with a hard note.

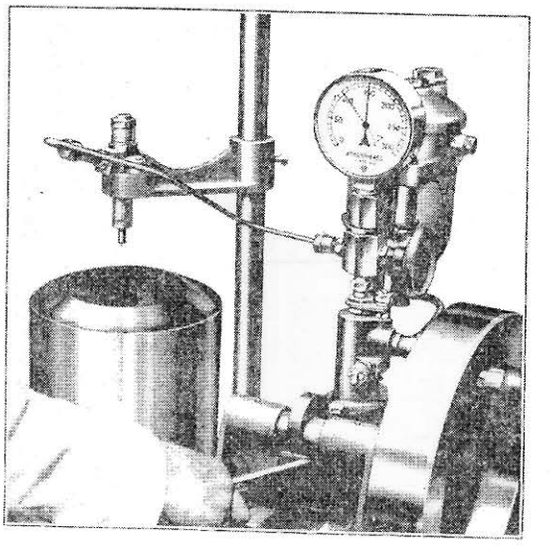


Fig. 29.
Checking Needle Valve Stem Back Leakage.

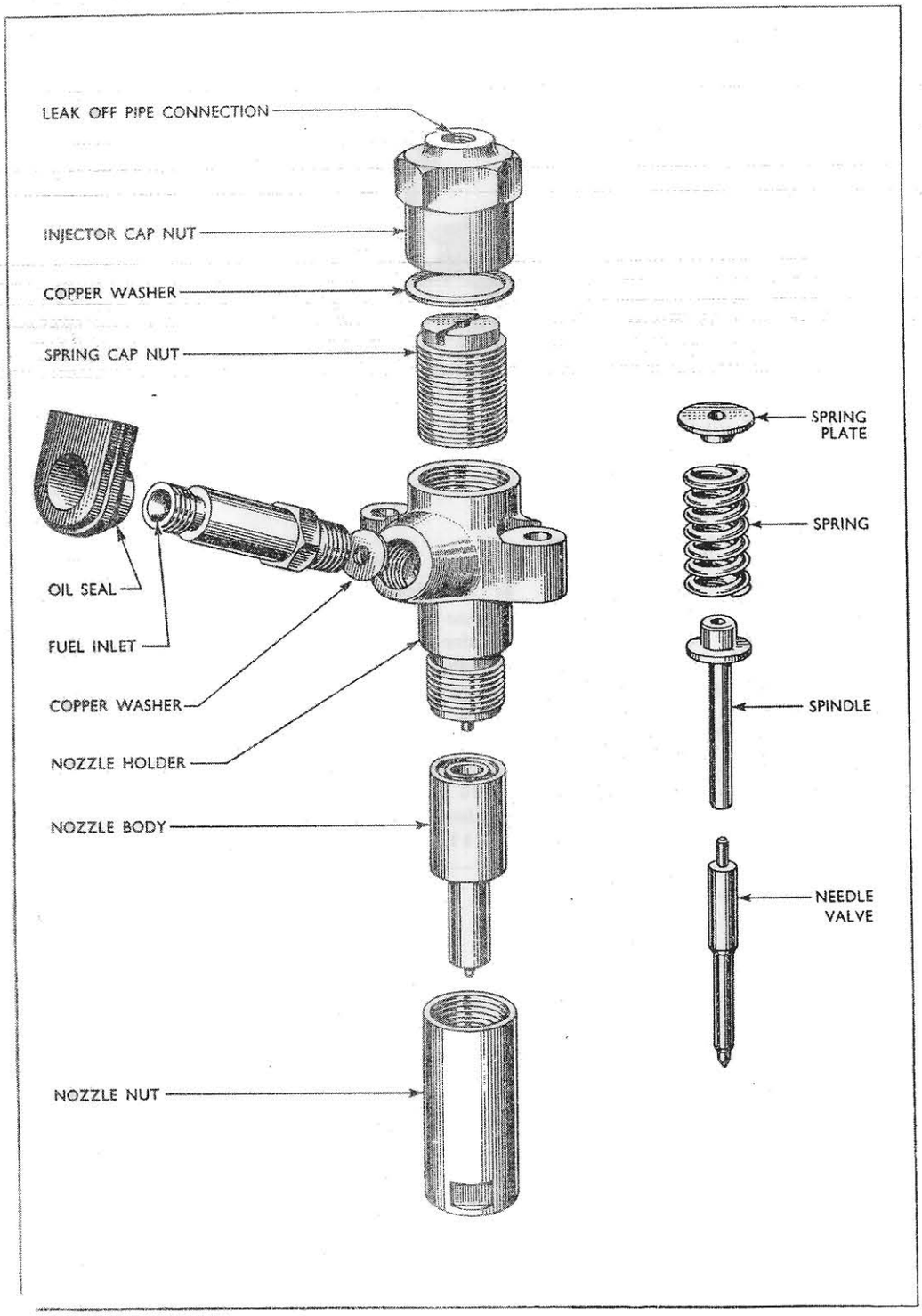


Fig. 30.
Fuel Injector—Exploded.

CLEANING AN INJECTOR

Before dismantling an injector it is advisable to clean it externally with a soft brass wire brush and fuel or substitute oil.

1. Fit the injector to the injector testing machine but do not connect the fuel pipe line.
2. Remove the injector cap nut and unscrew the spring adjusting nut. Lift off the upper spring disc, injector spring and spindle.
3. Unscrew the nozzle nut, using the special socket (Tool No. CT.9009) and remove the nozzle and its valve.

   Note.—As nozzles and needle valves are a lapped fit, they should never be interchanged.
4. Unscrew the injector inlet adaptor.
5. Wash all the injector parts in clean fuel or substitute oil and, using a soft brass wire brush remove all carbon from the nozzle and needle valve.

Then, using the tools in the nozzle cleaning kit (Tool No. CT.9014), remove all carbon from the interior of the nozzle (see Fig. 31).

If necessary, the spray holes in the nozzle can be cleaned out, using a wire probe fitted in the small hand chuck. Only use wire suitable for a .010 in. (.25 mm.) diameter hole and have just a small amount protruding from the chuck to prevent breakage. Rotate the chuck slowly without applying undue pressure to the wire probe.

When spray holes in fuel injectors become blocked with carbon it is sometimes difficult to clear them. To speed up the process a chemical method has been developed to soften the carbon deposits on the nozzle and in the spray holes, thereby reducing the labour and time taken in cleaning injectors.

The nozzles should be treated as follows :—

1. Dissolve 2 ozs. (56.7 gms.) of caustic soda in 1 pint (.56 litres) of water. Add ½ oz. (14 grms.) of detergent.
2. Place the nozzles in the liquid and boil for a minimum of 1 hour and not more than 1½ hours.

   Care must be taken not to let water evaporate too much, because, if the percentage of caustic soda rises above 15% the surface of the nozzle may be damaged.

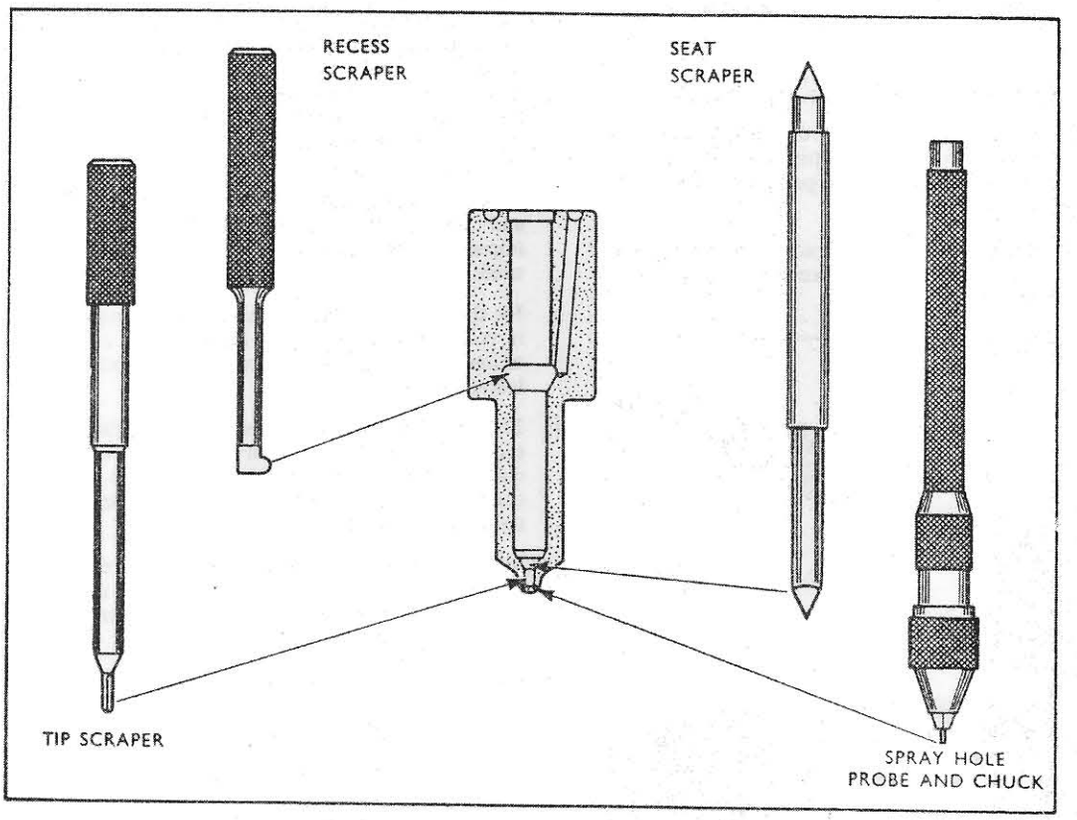


Fig. 31.
Nozzle Cleaning Kit Showing Application.

3. Remove the nozzles, wash in running water, and then immerse in de-watering oil. Remove surplus oil by draining.

4. It will be found that the carbon can easily be removed with a wire brush and a standard pricker wire, or in some cases blown clean with compressed air.

   Alternatively, when a hard carbon deposit is formed in the spray holes, it may be softened by immersing the nozzle in "Acetone" for a short period. Up to half an hour is normally sufficient.

Warning.—"Acetone" is a highly inflammable liquid and must not be brought near a naked flame.

It is important that immediately the nozzle is removed from the fluid, it must be rinsed in clean fuel or substitute fuel oil to prevent corrosion on the highly finished surfaces.

Finally, using the reverse flush adaptor (Tool No. CT.9024) fitted to the injector testing machine, flush out the interior of the nozzle. When all particles of carbon have been removed, enter the needle valve into the nozzle and ensure that it is quite free (see Fig. 32).

REASSEMBLING AN INJECTOR

All injector parts should be reassembled wet after rinsing in clean fuel or substitute oil. Do not use rag to clean any of the internal parts, if required, use a chamois leather.

1. Fit the injector inlet adaptor into the injector body, ensuring that a new copper sealing washer is fitted.

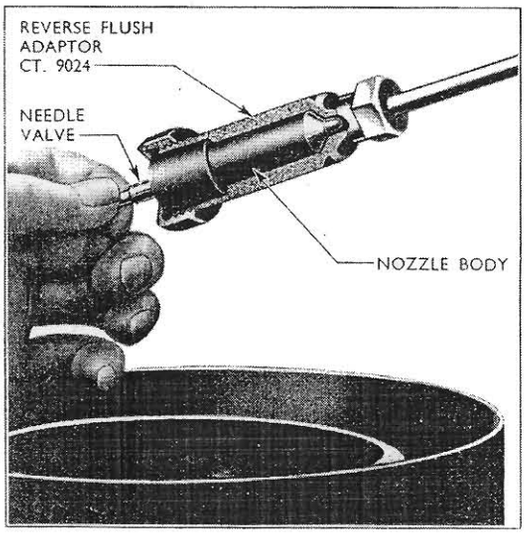


Fig. 32.
Reverse Flushing the Nozzle.

2. Fit the nozzle and the needle valve to the injector body, ensuring the dowels in the body enter their correct location in the nozzle. Screw on the nozzle nut and tighten securely to a torque of 60 - 75 lbs. ft. (8.29 - 10.36 kg.m.) with the special nozzle nut socket (Tool No. CT.9009).

   Note.—It is essential that this figure is not exceeded otherwise serious distortion of the nozzle assembly may occur.

3. Fit the injector spindle, spring, upper spring disc and the spring adjusting nut. Screw down the adjusting nut until pressure can be felt on the spring.

4. Fit the injector cap nut and copper washer, but do not tighten.

5. Connect the injector to the testing machine pipe. Adjust the nozzle opening pressure to 185 atmospheres and retighten the injector cap nut securely.

6. Test the injector as previously outlined.

Replacing an Injector

1. Check the injector housing in the cylinder head to ensure that it is clean and free from any carbon deposit. Fit the rubber oil seal to the injector inlet adaptor, a new copper washer in the housing and insert the injector. Carefully tighten the injector bolts evenly to a torque not exceeding 15 lbs. ft. (2.1 kg.m.).

   Note.—These bolts are of high tensile steel and are fitted without lockwashers. It is important that only the correct type bolts are used.

2. Fit the injector leak-off pipe after checking that it is in good condition, with no leaks at the unions and adaptors. Reconnect the external leak-off pipe.

3. Fit the fuel injector pipe, first rinsing it thoroughly in clean fuel or substitute oil and check that the olives at either end are in good condition and are seated correctly. Tighten the union nuts securely.

4. Run the engine for a short time to ensure that the injector is making a gas-tight seal in its housing and that there are no leaks from the leak-off pipe and injector inlet adaptor.

5. Fit the rocker cover and gasket.

THE FUEL LIFT PUMP
(Agricultural Tractors)

The fuel lift pump on standard agricultural tractors is located on the right-hand side of the cylinder block and has remained basically unchanged since the introduction of the Mark I engine. Changes which have been made are detailed in the dismantling procedure.

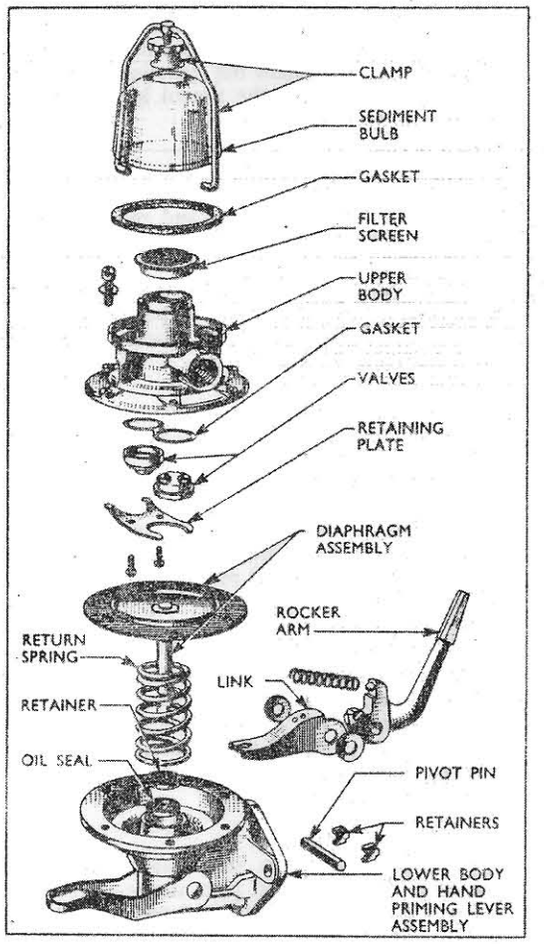


Fig. 33.
Fuel Lift Pump—Exploded (tractors less exhauster)

To Remove the Fuel Lift Pump

1. Turn off the fuel tap and disconnect the fuel pipes from the pump.
2. Remove the screws securing the fuel lift pump to the cylinder block and detach the pump and gasket.

To Dismantle the Fuel Lift Pump

1. Release the sediment bulb clamp screw, swivel the clamp downwards, and remove the bulb, filter screen and gasket.
2. Suitably mark the flanges of the upper and lower pump bodies, remove the six screws and spring washers, and remove the upper body.
3. Push down on the diaphragm assembly and turn it through 90° in either direction to release the pull rod from the pump operating link.

Remove the diaphragm assembly taking care not to damage the pull rod oil seal. Lift out the diaphragm return spring.

4. The pump inlet and outlet valves are retained by a plate held by two screws. Remove the screws and plate, extract the two valves and the gasket. Note the position of the valves as it is possible to replace them incorrectly.
5. On earlier type fuel lift pumps the rocker arm pivot pin was supported in open holes in the lower body, the outer ends of the holes being slightly closed by peening the surrounding metal to retain the pin. To remove the rocker arm and link from this type of pump press the pivot pin from the lower body and lift away the rocker arm, link washers (either side of the link) and the rocker spring.

After engine No. 1356500 the method of pin retention was changed, the through holes being deleted and the lower body re-designed to allow shaped retainers to be inserted in machined slots to support a shorter rocker pivot pin. At the same time an improved type of pull rod oil seal and retainer were introduced.

To remove the rocker arm on this pump, punch back the four staking marks holding the rocker arm pin retainers in their slots, and remove the retainers. Lift away the rocker arm, link washers and pivot pin as an assembly, followed by the rocker spring. The rocker arm assembly can then be dismantled by removing the pivot pin.

To Reassemble the Fuel Lift Pump

1. If necessary, extract the pull rod oil seal and retainer and fit a new oil seal with the raised centre portion away from the retainer, press the retainer into position and carefully peen over the edge of the lower pump body in three places to prevent the retainer from moving out of position.
2. On current type pumps reverse the dismantling procedure to build up the rocker assembly. Ensure a spacing washer is fitted on either side of the rocker link, and insert the assembly in the lower body of the pump. Fit the rocker pivot pin retainers, and securely stake them in position in their slots.
3. On early type pumps insert the rocker pivot pin into one of the supporting holes in the pump body, and pass one of the spacing washers over the inner end of the pin. Assemble the rocker link to the rocker arm, position this assembly in the lower body of the pump with the rocker spring located between the rocker and the register in the body. Press the pivot pin through the holes in the arm and link.
4. Fit a further spacing washer over the pivot pin so as to locate on the opposite side of the link and press the pivot pin fully into position.

5. Check that the rocker arm and hand priming lever work freely and correctly, and then peen over the metal adjacent to the outer ends of the rocker arm pin to retain it in position.

6. Locate the diaphragm return spring in position in the lower body. Enter the diaphragm pull rod carefully through the oil seal, locate the rod in the slot of the rocker arm link and rotate the diaphragm assembly through 90° to retain it in position.

   This operation will be simplified by holding the rocker arm firmly outwards.

7. Install the valve gasket in the upper pump body and fit a valve assembly into the inlet port, with the three ports of the cage towards the diaphragm. Fit the other valve assembly in the outlet port with the three ports of the cage towards the top of the pump. Install the valve retainer, each pair of lugs locating the valve assemblies, and secure with the two screws.

8. Press the rocker arm fully inwards. Line up the holes in the diaphragm with the holes in the lower body, fit the upper body with the marks previously made on the flanges in line, and replace the six retaining screws and spring washers. Before fully tightening the screws work the rocker arm for several complete strokes to free off the diaphragm.

9. Refit the filter screen and new gasket. Position the glass filter bulb and retaining clamp on the pump and tighten the clamp screw securely.

To Replace the Pump on the Tractor

1. Clean off the pump and cylinder block mounting faces and turn the engine over until the back of the eccentric on the camshaft is opposite the fuel lift pump mounting face.

2. Fit the fuel pump into its location, using a new gasket and secure with the two retaining screws and spring washers.

3. Reconnect the fuel inlet and outlet pipes.

4. Bleed the fuel system as detailed on page 2.

FUEL LIFT PUMP
(Industrial Tractors)

On industrial tractors fitted with exhausters the fuel lift pump is mounted on the fuel injection pump cambox and operated through a spring-loaded arm from an eccentric on the injection pump camshaft.

The lift pump differs from that fitted to standard agricultural tractors and when servicing the pump the following repair procedure should be adopted :—

To Remove the Fuel Lift Pump

1. Turn off the fuel tap and disconnect the fuel pipes from the lift pump.

2. Unscrew and remove the two nuts and spring washers securing the fuel lift pump to the injection pump and detach the fuel pump, canting it slightly to allow the operating lever to clear the eccentric and the slotted hole in the injection pump cambox.

To Dismantle the Fuel Lift Pump

1. Unscrew the filter cover bolt and remove the cover and filter screen.

2. Remove the five screws and spring washers securing the upper and lower fuel pump bodies, taking care when separating the flange joint to avoid damaging the diaphragm.

3. Turn the diaphragm through approximately a quarter of a turn (in either direction) to free the diaphragm rod from the operating lever, and detach the diaphragm.

4. The diaphragm and pull rod are riveted together and should not be dismantled. Remove the diaphragm spring, oil seal retaining washer and rubber oil seal.

5. (*a*) Prior to April 1956 :

   The inlet and outlet valves are retained by a plate held in position by three screws. Remove the three screws and lift the plate and gasket, then each valve, together with its spring, and the inlet valve retainer, may be detached from the upper body (see Fig. 35).

   (*b*) After April 1956 :

   The inlet and outlet valve assemblies are retained by a spring steel plate secured by two screws. Remove the screws and plate, and lift the two valves assemblies, together with the gasket from the upper body (see Fig. 35).

6. Should it be necessary to dismantle the lower body, remove the circlip from one end of the pin on which the rocker arm operates and press the pin from the lower pump body. On some pumps, when no circlip is fitted, it may be necessary to relieve the staking on the body before it is possible to remove the pin. The rocker arm, spring, link and two washers can then be removed.

To Reassemble the Fuel Lift Pump

If the lower body has been completely dismantled, first replace the rocker arm and link assembly as follows :—

1. Insert the rocker arm pin through one hole in the lower pump body, so there is sufficient room to position one of the thrust washers in the longitudinal aperture adjacent to the pin.

2. Fit one thrust washer, insert the link, slotted end first, with the two holes in line with the pin, and the central web uppermost.

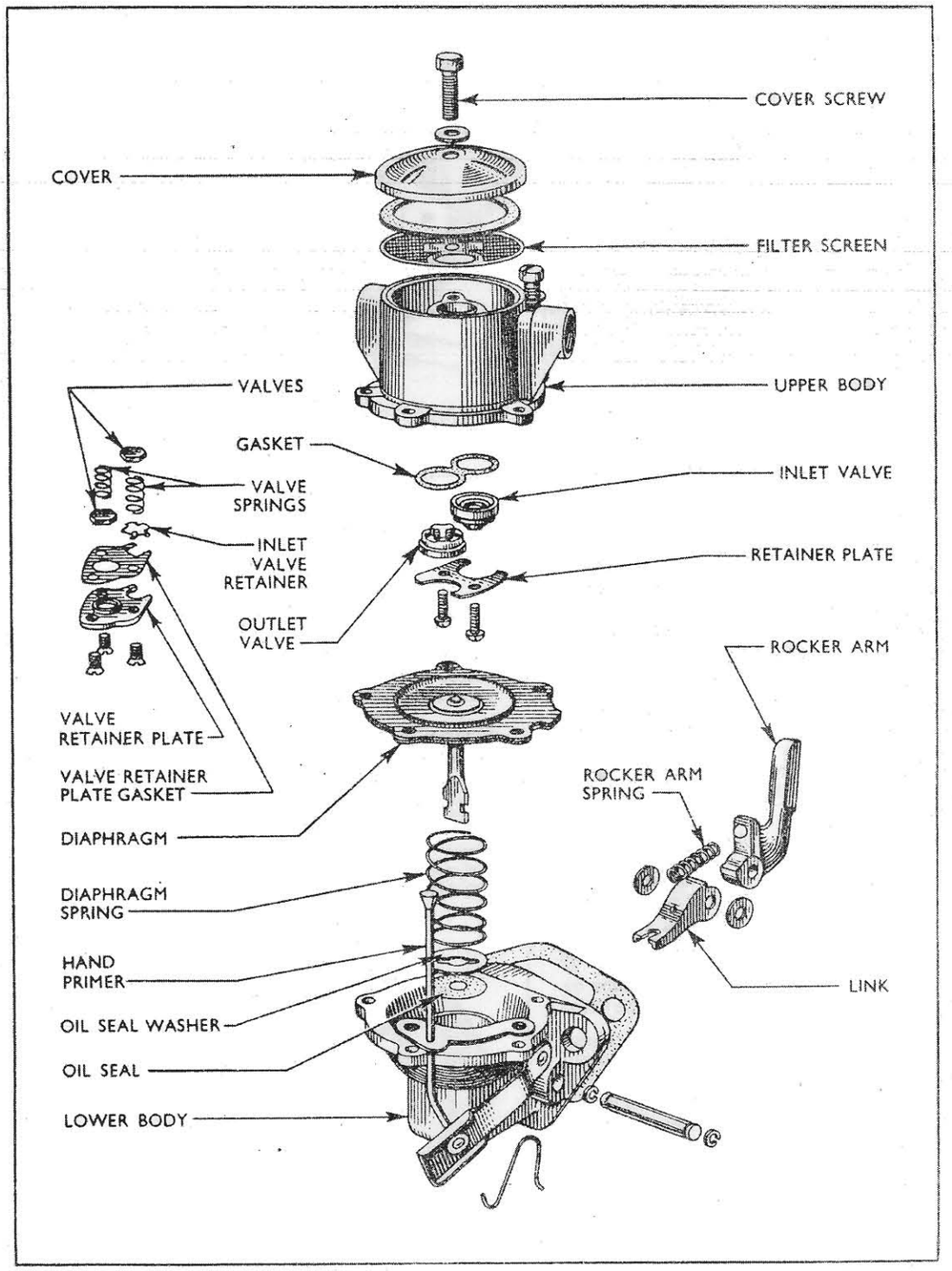


Fig. 34
Fuel Lift Pump—Exploded (tractors with exhausters)

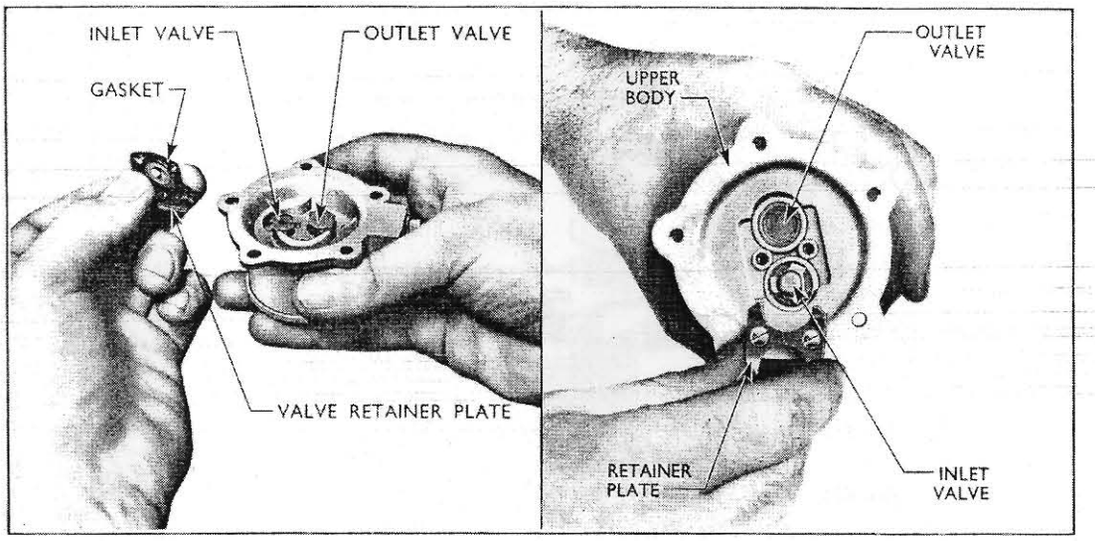


Fig. 35.

Prior to April 1956. **After April 1956.**

Fuel Lift Pump Valves.

3. Insert the rocker arm, with the boss between the flanges of the link and place the rocker arm spring in position so that the ends are located by registers on the body and the rocker arm.

4. Press the pin into position, fitting the second thrust washer between the link and body, ensuring that the pin passes through the two washers, two holes in the link and the rocker arm. Inspect the pin to make sure it is properly positioned and that the rocker arm and link operate correctly.

   Test by moving the rocker arm towards the pump body, when the link should move downwards. If the link is held downwards as will occur in operation when the fuel filter and the injection pump fuel gallery is full, the rocker arm should be free to move without transmitting any movement to the diaphragm and link. If the linkage is satisfactory, refit the circlips on the pin to retain it in position, or stake the body.

5. Assemble the spring, oil seal washer and oil seal to the diaphragm pull rod, taking care to avoid damaging the seal. Insert the end of the rod in the slotted end of the link, engaging the groove in the pull rod end by turning the diaphragm a quarter of a turn (see Fig. 36), so that the small tab on the diaphragm aligns with the mating mark on the lower body flange.

6. (*a*) Prior to April 1956 :
   Assemble the inlet valve spring and inlet valve retainer in the inlet valve port (see Fig. 35). Fit the outlet valve spring and valve in the outlet port. Carefully fit the gasket and valve plate over the valves, securing it with three screws, and check that the valves operate correctly.

   (*b*) After April 1956 :
   Fit the gasket in the upper body, then fit the two valve assemblies as shown in Fig. 35. Note that these will only seat properly when in the correct locations. Assemble the retainer plate, securing it with the two screws.

7. Position the fuel lift pump upper body over the diaphragm on the lower body so that the inlet and outlet unions are directly opposite the mounting flange. Ensure that the mating mark on the lower body is in line with the small tab on

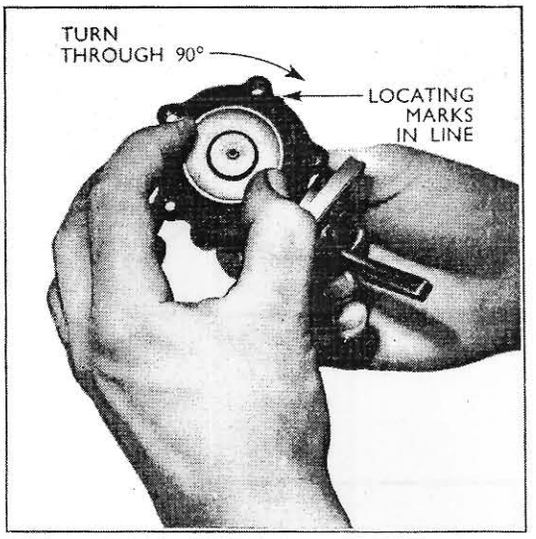


Fig. 36.
Fitting the Diaphragm.

the diaphragm. Depress the rocker arm until the diaphragm is level with the flange, fit the five screws with spring washers, locate the priming lever bracket and then tighten the screws finger-tight.

8. Work the rocker arm several complete strokes to centralise the diaphragm and tighten the five screws evenly and securely, with the diaphragm in the down position.

To Replace the Fuel Lift Pump

1. Fit the fuel pump into its location using a new gasket and secure with the two nuts and spring washers.
2. Reconnect the fuel inlet and outlet pipes.
3. Turn on the fuel and bleed the fuel system as detailed on page 2.

FAULT DIAGNOSIS

Fault diagnosis on the Diesel Engine can be a straightforward operation if this is carried out methodically.

To distinguish between a mechanical knock and a fuel knock, run the engine at maximum speed and pull the stop control, if the knock is no longer present it is due to the fuel, if it is still audible, it is due to mechanical reasons. When the fuel supply to the engine is cut off, the mechanical knock will be reduced in volume, but will still be present.

Running faults will be due mainly to faults arising in one or more of the following sections. By checking through as outlined, the faulty component or section can be isolated.

Fuel System

1. **Bleed all air** from the fuel system in the normal manner, if this cannot be eliminated, check back over the pipeline from the lift pump to the fuel tank.
2. **Operate the excess fuel device** and note that the control rod moves freely to the excess fuel position.
3. **Loosen off the injector pipes** at the injector ends, and operate the starter motor, observing approximate equal delivery from each fuel pipe.
4. **Pull the stop control** with the pipes still disconnected from the injectors and operate the lift pump hand primer. Any flow of fuel indicates a faulty delivery valve or broken delivery valve spring.
5. **Reconnect the pipes** to the injectors and start the engine if possible. As a rough check of injector condition, run the engine just above the idling speed, and loosen the injector pipes one at a time. As each injector is cut out in this way, a definite drop-off in speed should be noticed, if the injector is operating correctly.

Timing

1. **Check the fuel injection pump** timing by turning the engine crankshaft until the timing marks are in line as outlined on page 4. At this position, the mark on the fuel injection pump coupling should be in line with the mark on the timing plate on the pump.
2. If any doubt arises as to the accuracy of the timing marks on the pump coupling and timing plate, the fuel injection pump should be spill-timed to the engine. To carry out this operation, set the engine on the firing point for No. 1 cylinder as outlined in the previous paragraph. Disconnect No. 1 injector pipe, remove the delivery valve holder and extract the volume reducer, delivery valve and spring. Refit the delivery valve holder to the injection pump body. Fit the spill pipe to the delivery valve holder, slacken the two claw bolts on the engine half of the pump coupling, and fully retard the coupling. Operate the hand primer on the lift pump, and fuel should run from the end of the spill pipe. Slowly advance the injection pump coupling until the flow of fuel from the spill pipe just ceases. Tighten the two claw bolts on the pump coupling, the injection pump is now timed correctly to the engine. Refit the delivery valve, spring, volume reducer, and reconnect the injection pipe.

Air Supply

1. **Remove the oil bath** of the main air cleaner, wash out and refill with oil of the correct grade to the correct level if necessary. Ensure that the gauze of the main filter is clean and free from obstructions, and refit the oil bath to the air cleaner.
2. **Remove the rubber hose** between the main air cleaner and the inlet manifold, check for obstructions and operate the governor control and ensure that the throttle plate travels as far as its stop, giving sufficient opening at the throttle.
3. **Check all valve clearances.**
4. **Check the evenness** of the cylinder compressions by turning the crankshaft with the starting handle.

Governing

1. **Check the maximum no-load speed** of the engine. This should be 1,900 r.p.m. If the air system has previously been checked as outlined, and the maximum no-load speed is low, check the governor main spring. The length of the spring should be as outlined in the Specification on page 29.
2. If the air supply has not been previously checked, and the maximum no-load speed is low, it is advisable to carry out the complete check as outlined.

3. If erratic running at idling speeds is experienced, readjust the damping valve on the governor housing.

4. If erratic running is experienced under load conditions, check the fuel injection pump control rod for stickiness by pulling the stop control lever sideways to ensure that the control rod will move freely to the "excess fuel" position.

5. If the engine no-load speed is too high, check for leaks in the system between the inlet manifold and the governor diaphragm.

   To check the governor diaphragm for leaks, disconnect the vacuum and balance pipes from the governor housing. Pull the stop control lever to the "stop" position, and seal the two holes in the governor casing, release the stop control lever and there should be no movement on the control rod. If movement of the control rod is observed, it indicates a leaking diaphragm.

6. If excessive black smoke is emitted from the exhaust under load conditions and all the foregoing checks have been carried out, screw in the maximum fuel stop on the injection pump until the maximum load is pulled easily, but with only the slightest smoke haze.

The foregoing is intended as a guide for a complete diagnosis of running faults. By carrying out the checks as outlined, faulty components, such as injectors or injection pumps, can be easily and accurately diagnosed.

ENGINE KNOCKS

FUEL SYSTEM

- Injector pipe partially blocked
- Faulty injectors
- Faulty calibration

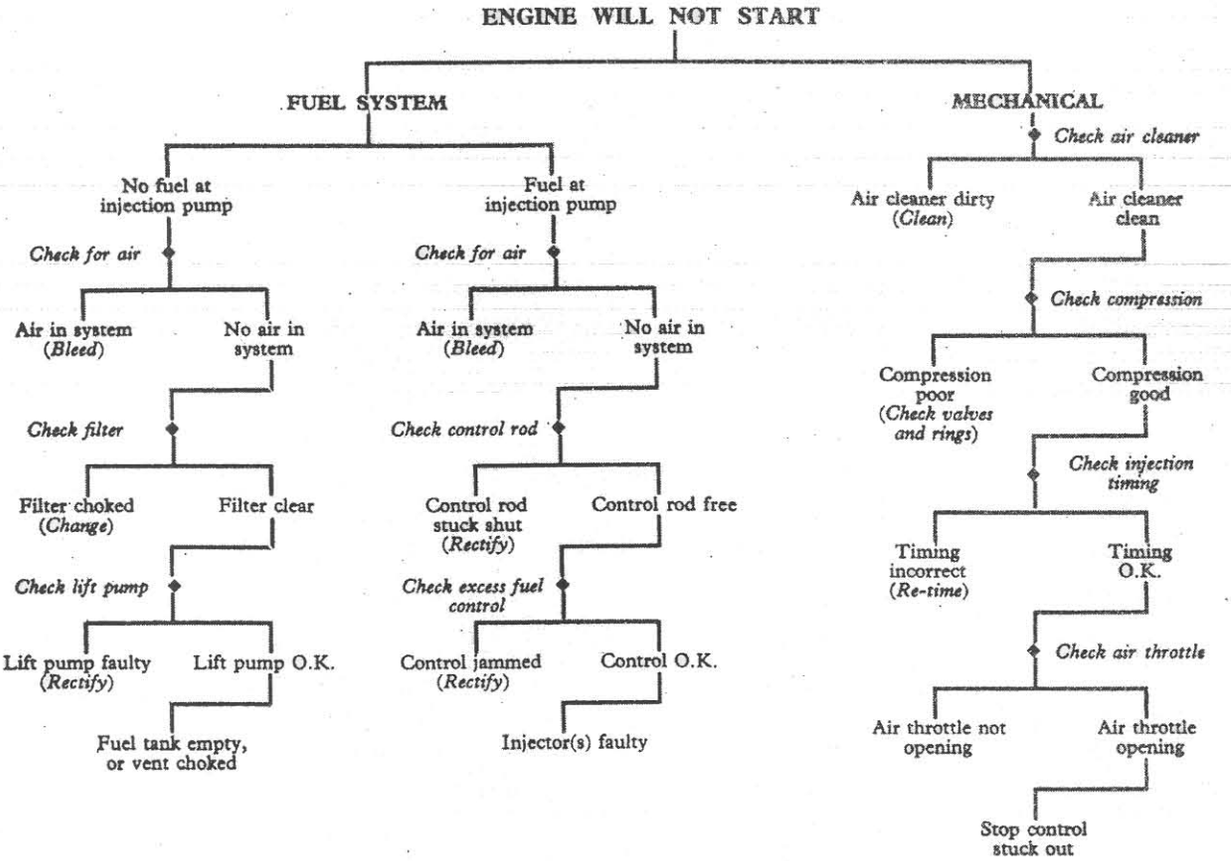
MECHANICAL

- Injection timing too early
- Bearing(s) worn
- Piston(s) worn
- Broken valve spring(s)

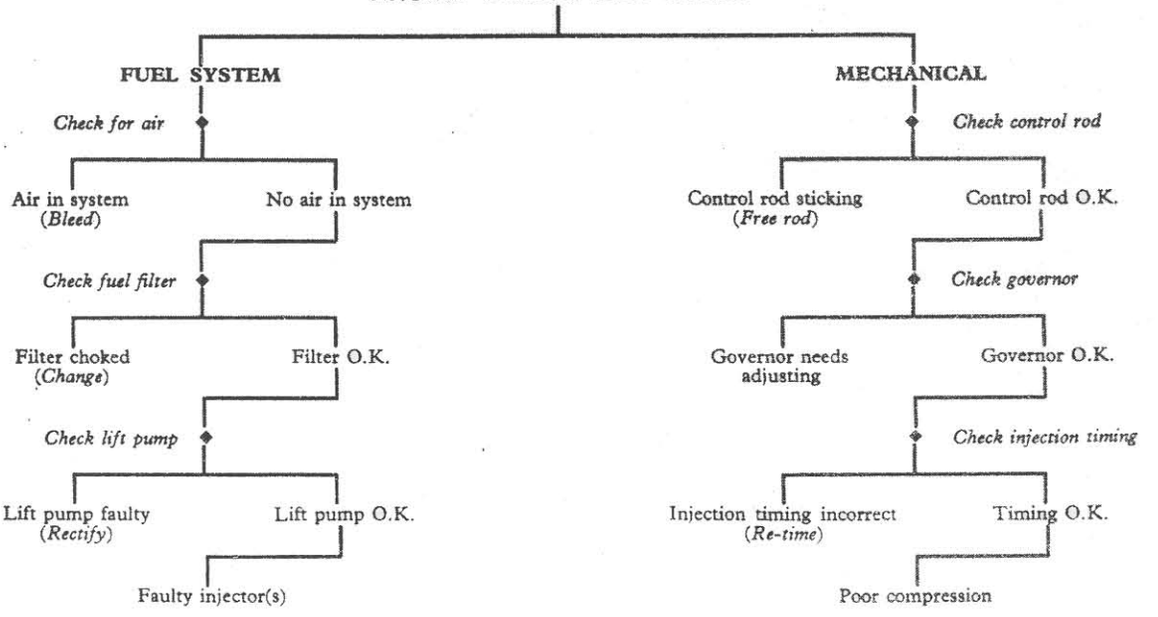
ENGINE EMITS EXCESSIVE SMOKE

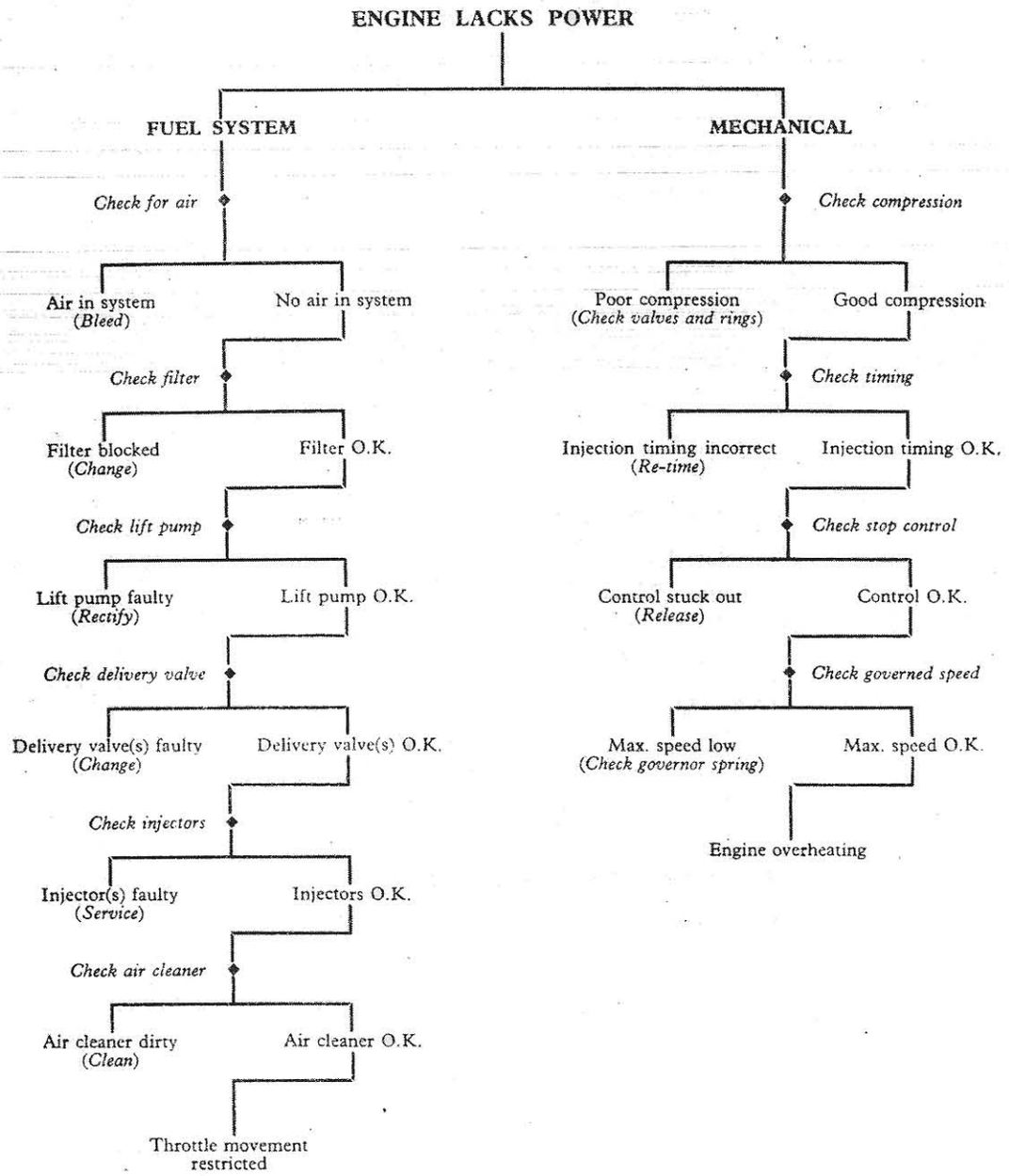
- Excess fuel device stuck out
- Maximum fuel stop screw incorrectly set
- Injection retarded
- Faulty delivery valve(s)
- Faulty injector(s)
- Poor compression

ENGINE WILL NOT START



ENGINE STARTS AND STOPS




ENGINE LACKS POWER
FUEL SYSTEM
MECHANICAL
Check for air
Air in system
(Bleed)
No air in system
Check filter
Filter blocked
(Change)
Filter O.K.
Check lift pump
Lift pump faulty
(Rectify)
Lift pump O.K.
Check delivery valve
Delivery valve(s) faulty
(Change)
Delivery valve(s) O.K.
Check injectors
Injector(s) faulty
(Service)
Injectors O.K.
Check air cleaner
Air cleaner dirty
(Clean)
Air cleaner O.K.
Throttle movement
restricted
Check compression
Poor compression
(Check valves and rings)
Good compression
Check timing
Injection timing incorrect
(Re-time)
Injection timing O.K.
Check stop control
Control stuck out
(Release)
Control O.K.
Check governed speed
Max. speed low
(Check governor spring)
Max. speed O.K.
Engine overheating

SPECIFICATION—FUEL SYSTEM

	Mk. I Engines Prior to Engine No. 1425097	Mk. II Engines Engine Nos. 1425097 to 1481090	Mk. III Engines After Engine No. 1481090
Fuel Tank			
Capacity (including 1 Imperial gallon (4.55 litres) reserve) ..	14.7 Imp. gallons (66.8 litres or 17.7 U.S. gallons)	14.7 Imp. gallons (66.8 litres or 17.7 U.S. gallons)	14.25 Imp. gallons (64.8 litres or 17.1 U.S. gallons)
Fuel Lift Pump (Agricultural tractors without exhausters)			
Type—Diaphragm, with hand primer. Mechanically operated from engine camshaft	As stated	As stated	As stated
Delivery pressure	1½–2½ lbs./sq. in. (.105–.176 kg./sq. cm.)	1½–2½ lbs./sq. in. (.105–.176 kg./sq. cm.)	1½–2½lbs./sq. in. (.105–.176 kg./sq. cm.)
Diaphragm spring test length and pressure	6 lbs. ±4 oz. at .640 in. (6.72 kg. ±.11 kg. at 16.27 mm.)	6 lbs. ±4 oz. at .640 in. (6.72 kg. ±.11 kg. at 16.27 mm.)	6 lbs. ±4 oz. at .640 in. (6.72 kg. ±.11 kg. at 16.27 mm.)
Fuel Lift Pump (Industrial tractors fitted with exhausters)			
Type—Diaphragm, with hand primer. Mechanically operated from fuel injection pump camshaft	As stated	As stated	As stated
Delivery pressure	6–10 lbs./sq. in. (.422–.703 kg./sq. cm.)	6–10 lbs./sq. in. (.422–.703 kg./sq. cm.)	6–10 lbs./sq. in. (.422–.703 kg./sq. cm.)
Diaphragm spring test length and pressure	12 lbs. ±2 oz. at .468 in. (5.443 kgs. ±56.7 gms. at 11.89 mm.)	12 lbs. ±2 oz. at .468 in. (5.443 kgs. ±56.7 gms. at 11.89 mm.)	12 lbs. ±2 oz. at .468 in. (5.443 kgs. ±56.7 gms. at 11.89 mm.)
Air Cleaner			
Type	Oil bath, centrifugal pre-cleaner	Oil bath, centrifugal pre-cleaner	Oil bath, centrifugal pre-cleaner
Oil capacity	1.6 Imp. pints (1.9 U.S. pints or .91 litres)	1.6 Imp. pints (1.9 U.S. pints or .91 litres)	1.6 Imp. pints (1.9 (U.S. pints or .91litres)
Fuel Injection Pump			
Type	Enclosed camshaft with pneumatic governor	Enclosed camshaft with pneumatic governor	Enclosed camshaft with pneumatic governor
Plunger stroke, diameter and helix angle	Prior to pump No. 61994 7 mm. ×7 mm. ×45° After pump No. 61994 7 mm. ×7 mm. ×50°	7 mm. ×7.5 mm. ×50°	7 mm. ×7.5 mm. ×50°
Camshaft rotation	Clockwise from drive end	Clockwise from drive end	Clockwise from drive end
Cold starting device	Excess fuel control	Excess fuel control	Excess fuel control
Lubrication	Self-lubricating after initial filling	Self-lubricating after initial filling	Self-lubricating after initial filling
Camshaft end-float	.002–.006 in. (.05–.15 mm.)	.002–.006 in. (.05–.15 mm.)	.002–.006 in. (.05–.15 mm.)
Camshaft end-float shims	.004 and .008 in. (.1 and .2 mm.) thick	.004 and .008 in. (.1 and .2 mm.) thick	.004 and .008 in. (.1 and .2 mm.) thick
Injection pump calibration (200 injections at 600 r.p.m.)	11.4–12.0 ccs.	11.4–12.0 ccs.	11.8–12.4 ccs.
Phasing tolerance..	±1° (pump) between elements	±1° (pump) between elements	±1° (pump) between elements
Phasing spacers	See page 13	See page 13	See page 13

Stroke to close inlet port	.110–.118 in. (2.8–3.0 mm.)	.110–.118 in. (2.8–3.0 mm.)	.122–.130 in. (3.1–3.3 mm.)
Plunger head clearance	.043–.063 in. (1.1–1.6 mm.)	.043–.063 in. (1.1–1.6 mm.)	.055–.075 in. (1.4–1.9 mm.)
Plunger to lower spring seat clearance	.002–.014 in. (.05–.35 mm.)	.002–.014 in. (.05–.35 mm.)	.002–.014 in. (.05–.35 mm.)
Plunger arm shims	.015 in. (.381 mm.) thick	.015 in. (.381 mm.) thick	.015 in. (.381 mm.) thick
Tightening torques :			
Delivery valve holder	30 lb. ft. (4.15 kg.m.)	30 lb. ft. (4.15 kg.m.)	30 lb. ft. (4.15 kg.m.)
Coupling flange nut	45 lb. ft. (6.22 kg.m.)	45 lb. ft. (6.22 kg.m.)	45 lb. ft. (6.22 kg.m.)
Injection pump timing	26° (early type with with fixed pointer 29°)	19° (steel cylinder head gasket) 23° (Copper-Permanite-rubber asbestos gasket)	23°

Injectors

Number of spray holes	4	4	4
Diameter and length of spray holes	.25 mm. (.010 in.) diameter × .5 mm. (.020 in.) long	.27 mm. (.011 in.) diameter × .5 mm. (.020 in.) long	.25 mm. (.010 in.) diameter × .5 mm. (.020 in.) long
Spray cone angle	150° at 20° to vertical axis	150° at 20° to vertical axis	150° at 20° to vertical axis
Needle lift	.0047–.0071 in. (.12–. 18mm.)	.0047–.0071 in. (.12–.18 mm.)	.0047–.0071 in. (.12–.18 mm.)
Injector pressure	175–185 atmospheres	175–185 atmospheres	175–185 atmospheres
Back leak test-time for pressure to drop from 100 to 150 atmospheres :			
New injectors	15–45 secs.	15–45 secs.	15–45 secs.
Reconditioned and service injectors	6–45 secs.	6–45 secs.	6–45 secs.
Tightening torques :			
Nozzle nut	60-75 lb. ft. (8.29-10.36 kg.m.)	60-75 lb. ft. (8.29-10.36 kg.m.)	60-75 lb. ft. (8.29-10.36 kg.m.)
Injector holding down bolt	15 lb. ft. (2.1 kg.m.)	15 lb. ft. (2.1 kg.m.)	15 lb. ft. (2.1 kg.m.)

Governor

Type	Pneumatic	Pneumatic	Pneumatic
Idling speed	540–560 r.p.m.	540–560 r.p.m.	540–560 r.p.m.
Maximum speed—" No Load "	1,900 r.p.m.	1,900 r.p.m.	1,900 r.p.m.
Rated speed—under load	1,600 r.p.m.	1,600 r.p.m.	1,600 r.p.m.
Governor spring :			
Free length (approx.)	Prior to pump No. 176929 7.16 ins. (182 mm.) After pump No. 176929 6.08 ins. (152.5 mm.)	6.08 ins. (152.5 mm.)	6.08 ins. (152.5 mm.)
Test length	1.97 ins. (50 mm.)	1.97 ins. (50 mm.)	1.97 ins. (50 mm.)
Test load	Prior to pump No. 176929 3 lbs. 8 ozs.– 3 lbs. 13½ ozs. (1.588 kgs.–1.744 kgs.) After pump No. 176929 3 lbs. 0 oz.– 3 lbs. 5 ozs. (1.361 kgs.–1.503 kgs.)	3 lbs. 0 oz.– 3 lbs. 5 ozs. (1.361 kgs.–1.503 kgs.)	3 lbs. 0 oz.– 3 lbs. 5 ozs. (1.361 kgs.–1.503 kgs.)
Length to be 1.69 ins. (43 mm.) with the addition of a further	3.5 ozs. (.099 kgs.)	3.5 ozs. (.099 kgs.)	3.5 ozs. (.099 kgs.)
Colour identification	After pump No. 176929 Blue paint	Blue paint	Blue paint

MECHANICAL GOVERNORS AND ASSOCIATED FUEL INJECTION PUMPS

On industrial diesel engines which require accurate and sensitive speed control a mechanical centrifugal type governor is fitted at the rear of a conventionally operated type of fuel injection pump.

Two basic types of mechanical governor may be encountered in service, the GV type on early engines and the GM type on current production engines. Both types may, however, be found with various speed ranges depending on the engine application.

The basic principles of operation of the fuel injection pump have been fully covered in previous tractor bulletins and existing repair manuals, therefore, using the pneumatic governed pump fitted to standard tractor diesel engines, as a basis for comparison, the differences which exist in build-up and design of individual components are detailed below.

The mounting of a mechanical governor on the rear of the injection pump necessitates the fitting of a slightly modified excess fuel and stop device at the front of the injection pump. It also means that a special pump control rod is fitted which operates in the opposite direction to that on the pneumatic governed pump. In consequence the helices on the pump plungers are machined in the opposite direction and the elements are not therefore interchangeable with those fitted to tractor pumps.

The pump body is a special one having a fuel inlet at the front, whereas when a pneumatic governor is fitted the fuel inlet is at the rear of the body. Likewise a different cambox is used on which provision has been made for mounting the fuel lift pump directly to the side of the casing.

The injection pump camshaft incorporates a thread and keyway at both ends, which means that care must be taken on assembly to ensure that it is fitted correctly. View the camshaft from one end and rotate it in a clockwise direction, observing the positioning of the cams. The end which shows the peaks of the cams coming to the vertically upward position in the order 1, 2, 4, 3 must be assembled away from the governor end of the injection pump.

It should also be noted that where a GV governor is fitted, the camshaft front and rear bearing housings are identical with that used at the front of the pneumatic governed pump, whereas the rear bearing housing on the latter is slightly different in that it has no through bore. Where a GM governor is fitted the rear bearing is accommodated in the front housing of the governor.

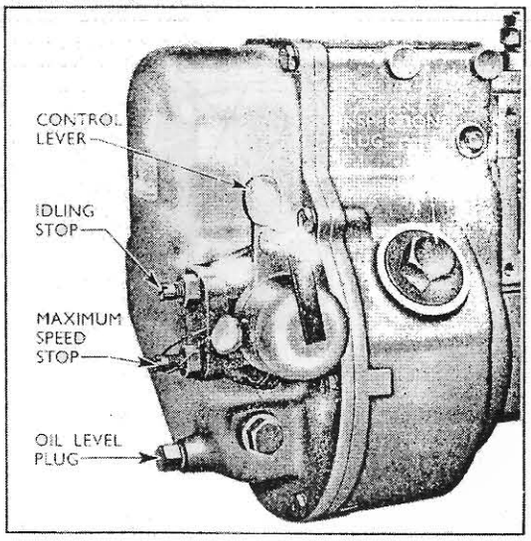


Fig. 37
The " GV " Mechanical Governor

" GV " TYPE MECHANICAL GOVERNOR

The GV governor may either be of a type which gives a variable governed engine speed range of 700 to 1,500 r.p.m. or of a type which gives similar control of engine speed between 700 and 1,800 r.p.m.

The difference in speed range is obtained by varying the control springs and weights whilst the spring retainers, telescopic control link and connecting link (to fuel injection pump control rod) are also particular to the speed range requirements of the governor. It is therefore essential that the correct parts are fitted when servicing these governors, identification of which may be established by examination of the plate fixed to the rear of the housing.

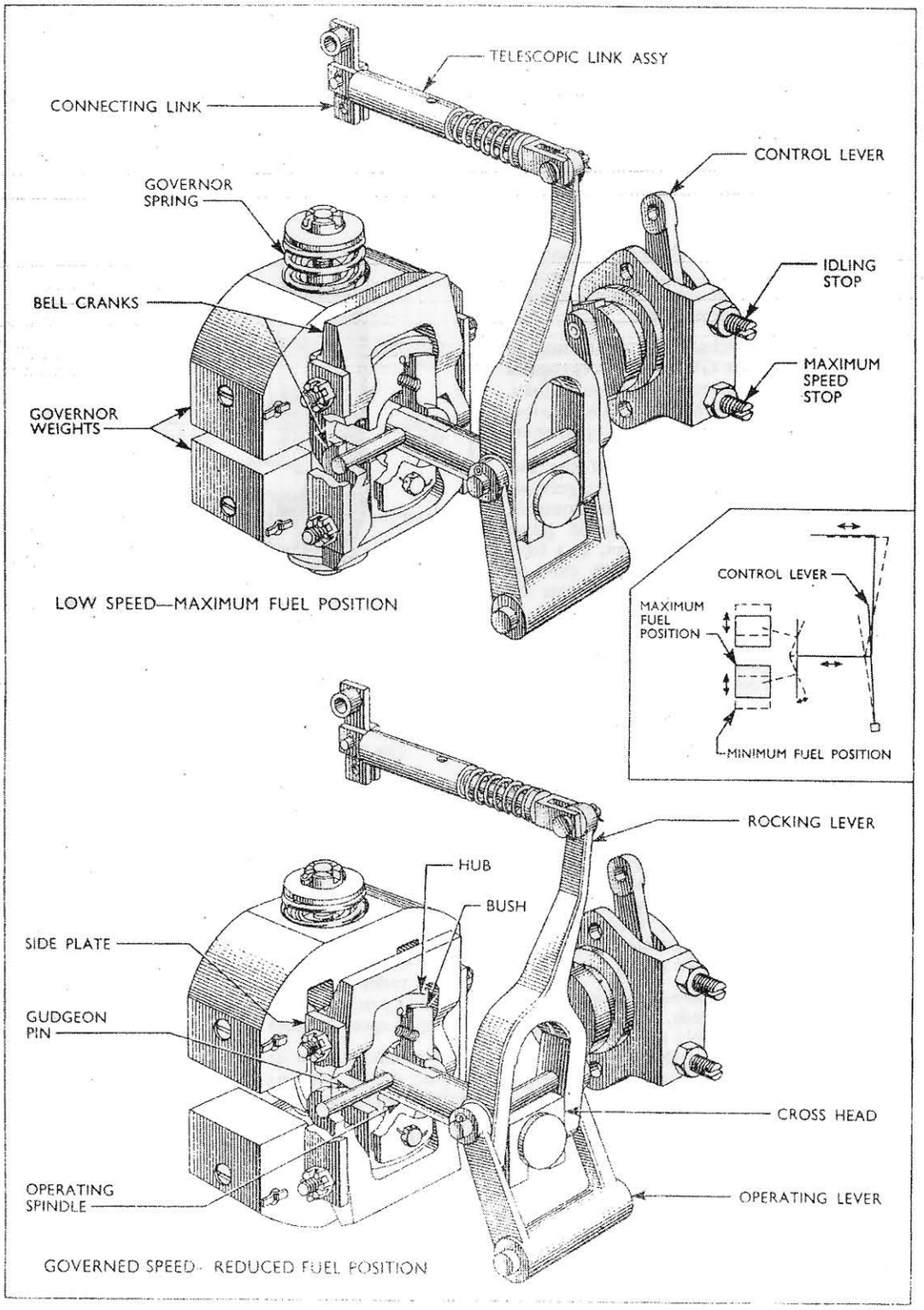


Fig. 38

The "GV" Mechanical Governor—Diagrammatic View
(Showing Maximum Speed and Idling Positions)

The identification plate shows the type of governor and the speed range in pump r.p.m. (half engine speed)—GVA 350/750 indicates a governed engine speed range of 700 to 1,500 r.p.m. and GVA 350/900 a governed range of 700 to 1,800 r.p.m.

Constructionally the GV governor consists of a flyweight assembly keyed to the end of the pump camshaft and connected by linkage to the fuel pump control rod. The control lever is interconnected with this linkage through the medium of a torsion spring which prevents excessive force from being applied to the linkage when the lever is moved to increase the governed speed. The control lever is limited in its movement by adjustable idling and maximum speed stops (see Fig. 37).

Each of the two flyweights operate against a pair of coil springs which are compressed by the tendency for the weights to move out under centrifugal force. The outer spring of each pair controls the idling speed whilst the inner spring gradually comes into operation to act in conjunction with the outer spring as the required governed speed increases.

A telescopic link is fitted between the rocking lever of the main linkage and the injection pump control rod for the purpose of allowing the control rod to be moved to the fuel cut-off position without having to act against the governor control springs.

Operation

If the engine is running at some intermediate speed between idling and maximum, but at less than full load, any change in load will cause a speed change. This in turn will cause the flyweights to move "out" if there is a reduction in load, or "in" if there is an increase in load. As the weights are indirectly connected to the fuel pump control rod any movement of the weights will effect an adjustment of the position of the pump control rod, and hence the pump delivery, so stabilising the engine speed.

If it is desired to increase the engine speed the governor control lever must be moved forward. The first result is to move the control rod up against the maximum fuel stop (at the forward end of the pump) and then to wind up the buffer spring in the control lever assembly. Increased engine speed will then cause the governor weights to move outwards until the spring resumes its neutral position, i.e. when the dogs on the lever and the buffer are in line. The engine speed will then stabilize in accordance with the position of the governor control lever.

The control lever position (limited by suitable stops) sets the maximum speed at which full delivery can be obtained, i.e. the maximum speed at which full power is developed. The maximum fuel stop at the front of the pump limits the forward travel of the control rod and so sets the maximum fuel delivery.

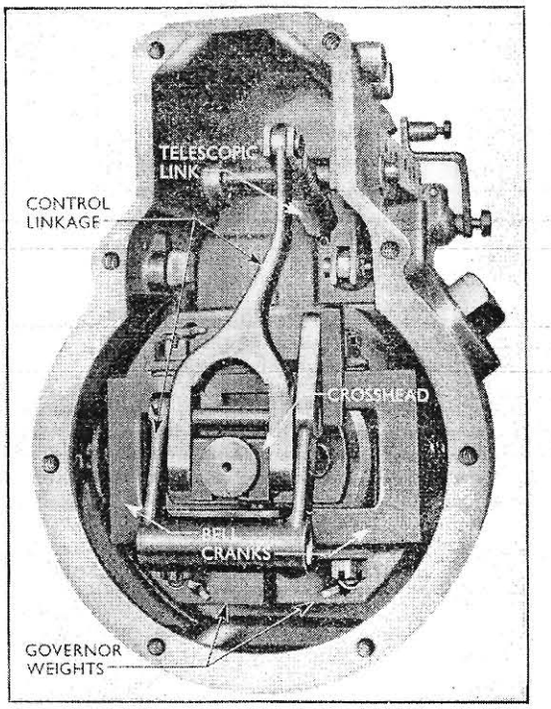


Fig. 39
The " GV " Mechanical Governor—End View

Lubrication and Adjustment

The governor oil level plug should be removed after every 50 hours operation and, if necessary, clean engine oil should be added through the inspection plug hole (see Fig. 37) until it flows from the level plug hole. Overfilling the governor should be avoided as this will cause sluggish operation.

Maximum and idling speeds can be adjusted within the design range of the governor by the stops provided. The spring adjusting nuts on the flyweight assembly must not be used to adjust the engine speed unless the required speed cannot be obtained by adjustment of the maximum speed stop (see " Testing the Governor ").

To Dismantle

1. Remove the injection pump assembly, extract the level plug from the mechanical governor housing and drain the oil.

2. Extract the two countersunk screws retaining the control lever and shaft assembly to the side of the governor rear housing.

If it is desired to dismantle this assembly, loosen the nut holding the cap retainer to the control arm, turn the retainer anti-clockwise and remove the cap.

Drive out the taper pin retaining the buffer plate to the shaft and remove the buffer plate and spring. Withdraw the shaft from the control lever and the control lever from the bearing housing.

3. Unscrew the two hexagon-headed plugs from the rear half of the governor housing and push out the operating lever fulcrum pin.

4. Unscrew the bolts securing the two halves of the governor housing and remove the rear half.

5. Remove the clevis pin securing the rocking lever to the telescopic link and remove the rocking lever, operating lever and crosshead as an assembly.

If necessary further dismantle this assembly by rotating the crosshead until the flats on the pins line up with the slots in the ends of the rocking lever fork, then slide the crosshead out of the fork. Remove the split pin and extract the rocking lever fulcrum pin.

6. Remove the split pin and clevis pin securing the connecting link to the fuel pump control rod, extract the "E" clip, plain washer and "O" ring from one side of the connecting link cross-shaft and withdraw the cross-shaft from the housing.

Remove the telescopic link and connecting link as an assembly and dismantle, if necessary, by removing the pin securing the two links together.

The telescopic link may be further dismantled by compressing the plunger and spring until the plunger pin (inside the sleeve) lines up with the two holes drilled in the sleeve and then driving out the pin.

7. Remove the split pins, unscrew the nuts and remove one of the side plates from the bell cranks. Note that a flat washer is fitted between each end of the side plates and the bell cranks. Remove the gudgeon pin and the governor operating spindle.

8. Remove the locking wire, unscrew the two bolts retaining the brass-flanged bush to the rear face of the governor hub, and detach the bush.

9. Unscrew the slotted nut securing the governor mass to the injection pump camshaft and remove the nut with special wrench (Tool No. T.9048). Extract the spring washer and screw the special puller (Tool No. T.9047) into the threaded centre of the governor hub. Tighten the centre screw of the tool to withdraw the governor mass from the injection pump camshaft.

10. Remove the remaining side plate and flat washers from the bellcrank fulcrum pins.

11. Remove the split pins and unscrew the spring adjusting nuts using special tongued tool (No. T.9049). Withdraw the spring retainers followed by the inner and outer springs and unscrew the stop nuts. Detach the spring collars, spring guide bushes and flat washers from the spring retaining pins on the governor hub.

12. Remove the split pins passing through the governor weights, extract the pins from the weights and detach the weights from the bellcranks.

13. To remove the bellcranks press out the bellcrank fulcrum pins from the governor hub.

NOTE.—In some instances the fulcrum pins are located in the governor hub by small dowels. Remove the dowels before pressing out the pins.

Inspection

After the governor has been completely dismantled, thoroughly clean and inspect all components. If the fulcrum pins, bushes or linkage components are worn they must be renewed, otherwise the accuracy of governing will be seriously affected.

The governor weights are supplied in pairs and should be used as such. Likewise each governor weight inner and outer spring are supplied as a matched pair but it is recommended that both pairs of springs are renewed if any one requires replacement.

To Reassemble

1. Locate the bellcrank levers on the governor hub and press the fulcrum pins into position so that they are located centrally in the hub, retaining them with dowels if necessary. Take care not to damage the threads on the ends of the fulcrum pins or to distort the bellcrank levers. Ensure that the bellcrank levers move with perfect freedom on the pins without binding in any position.

2. Locate the governor weights over the spring retainer pins of the hub, position the bellcrank lever arms and install the short governor weight pins.

3. Align the holes in the pins with the holes in the weights and lock the pins in position with split pins through the weights and weight pins. Recheck that the weights and bellcrank levers are free to move.

4. Fit a flat washer, spring collar guide bush, spring collar and stop nut to each spring retaining pin on the hub. Securely tighten the stop nuts.

5. Install an inner and outer spring, spring retainer and adjusting nut on each spring retaining pin of the hub. Screw on the adjusting nuts until the outer springs are just retained by their free lengths without any pre-load. The top of the nuts must always be flush with or below the tops of the studs, but not more than two turns below. If this setting cannot be obtained renew the springs.

6. Fit a flat washer on each bellcrank lever fulcrum pin (one side only) and assemble the corresponding side plate, securing it in position with two castellated nuts which should be tightened securely and then split-pinned.

7. Locate the governor mass on the key in the camshaft, fit a spring washer and a special slotted nut. Tighten the nut to a torque of 45 lbs. ft. (6.2 kg.m.), using Tool No. T.9048 in conjunction with standard type torque wrench.

8. Install the flanged bush and secure to the governor hub with two hexagon-headed screws. Wire the bolt heads to retain them in position.

9. Insert the governor operating spindle in the bush and pass the gudgeon pin through the bellcrank levers and the spindle.

10. Fit flat washers and the remaining side plate to the bellcrank lever fulcrum pins and retain with two castellated nuts and split pins. Push in the operating spindle and check if any free movement exists in either of the governor weights. Any such movement indicates a weak or incorrectly adjusted control spring.

11. If the telescopic link has been dismantled, place the spring seat on the plunger followed by the spring. Assemble the plunger to the sleeve and compress the assembly at the same time rotating the sleeve until the holes in the sleeve line up with the hole in the plunger. Drive the stop pin into position to give even protrusion each side of the plunger and check that the plunger is free to slide in the sleeve.

12. Attach the telescopic link to the centre hole of the connecting link with the appropriate clevis pin and split pin. The tongue on the sleeve locates on the same side as the circular boss of the connecting link.

13. Attach the forked end of the connecting link (circular boss to the left) to the fuel injection pump control rod and retain with a clevis pin and split pin.

14. Align the hole in the connecting link boss with the cross-shaft bores in the governor housing and assemble the cross-shaft. Assemble an " O " ring, flat washer and " E " clip to each end of the cross-shaft to retain it in position.

15. Assemble the rocking lever to the governor operating lever, retaining the rocking lever fulcrum pin with a split pin. Assemble the crosshead to the rocking lever and install this assembly in the governor, sliding the crosshead into the annular groove in the governor operating spindle. Connect the upper end of the rocking lever to the telescopic link using an appropriate clevis pin and split pin.

16. Place a new gasket on the governor front housing flange and locate the rear half of the governor housing over the lower end of the governor operating lever. Assemble the operating lever fulcrum pin to the governor rear housing picking up the operating lever on the pin.

17. Fully assemble the rear half of the governor housing and fit the appropriate retaining screws and spring washers.

18. Fit the operating lever fulcrum pin retaining plugs with a sealing washer under each plug.

19. Assemble the control lever to the bearing housing then insert the shaft into the bore of the control lever. Place the buffer spring inside the buffer and connect the tag ends of the spring to one

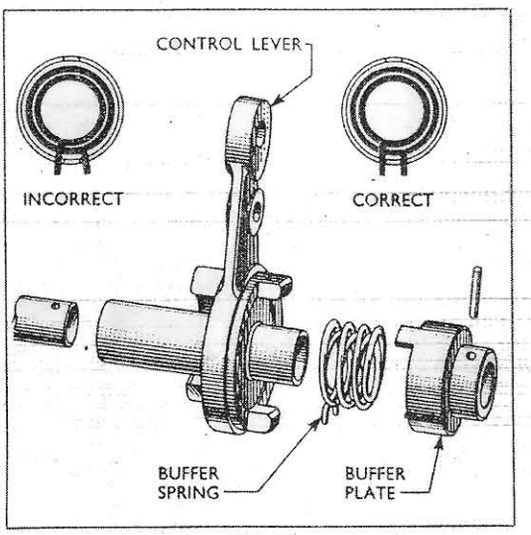


Fig. 40

The " GV " Mechanical Governor—Control Lever Assembly

of the lugs which project from the inner face of the buffer. It is important that when assembled the tag end of the inner spring crosses **over** the end of the outer spring (when viewed from the control lever end as shown inset in Fig. 40).

20. Assemble the buffer and spring to the shaft linking the projecting ends of the spring with one of the lugs on the control lever. The particular lug will be determined by the positioning of the spring in the buffer as the buffer and shaft are taper drilled to accept a taper cotter pin. The buffer must, therefore, be positioned so that the larger of the two holes in the buffer lines up with the larger end of the drilled hole in the shaft. Drive the cotter pin into position to hold the buffer securely to the shaft.

21. Assemble the cap over the buffer and rotate the flat spring steel retainer plate to a central position on the cap. Tighten the retainer fixing nut onto the inner face of the control lever.

22. Fit the control lever and shaft assembly to the governor housing picking up the rectangular link of the governor operating lever in the slot in the shaft. Use a new gasket between the bearing housing and the governor housing and ensure that the small dowel locates in the dowel hole in the mounting face. Secure the bearing housing to the governor housing by two countersunk screws and spring washers.

23. Ensure that the governor linkage is free to move without undue slackness and refill to the level plug with engine oil.

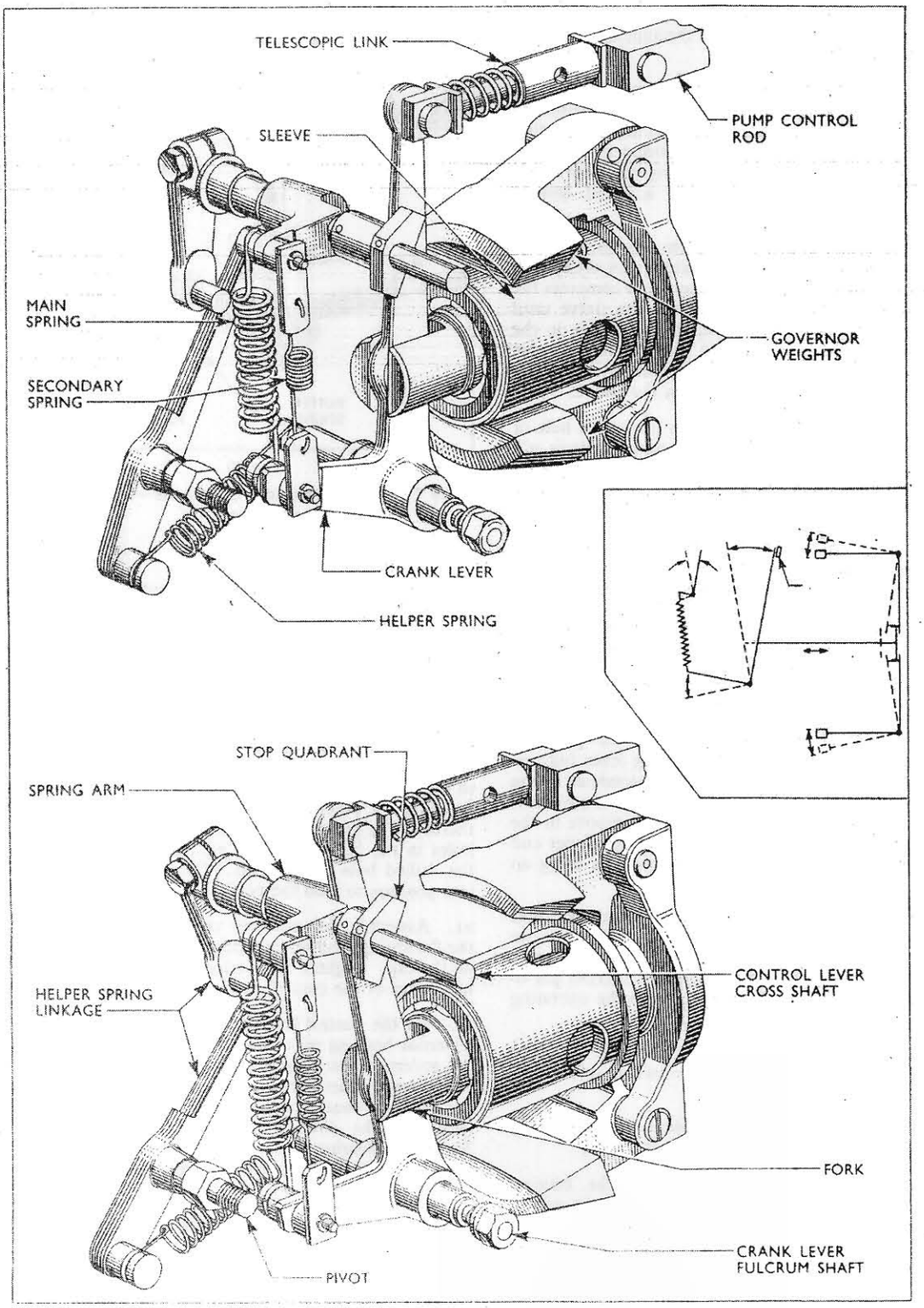


Fig. 41

The "GM" Mechanical Governor—Diagrammatic View
(Showing Maximum Speed and Idling Positions)

"GM" TYPE MECHANICAL GOVERNOR

This type of governor may be encountered giving any one of three engine speed ranges, i.e. 500 to 1,500 r.p.m., 500 to 1,800 r.p.m. and 500 to 2,250 r.p.m. They are identical in construction apart from the flyweights, a lighter pair of weights being fitted to the 2,250 r.p.m. governor than to the 1,500 and 1,800 r.p.m. units (see Fig. 43.). The weights used on the 1,500 and 1,800 r.p.m. units are identical and the variation in speed range is obtained by adjustment of the maximum speed stop screw on the governor housing. The same control springs are used on all three governors.

On the high speed unit, the type and the complete speed range in pump r.p.m. (half engine speed) is inscribed on a plate which is fixed to the rear half of the governor housing, i.e. GMVA 250/1125, indicating a governed engine speed range of 500 to 2,250 r.p.m.

On the two lower speed governors, although the minimum governed speed is still 250 r.p.m. (pump), the plate carries the inscription GMVA 750/900, indicating a governed maximum engine speed of **either** 1,500 or 1,800 r.p.m. It will therefore be necessary to determine which of these maximum speeds is required for the particular engine application before adjusting the maximum speed stop.

Constructionally, the GM governor consists of two wedge-shaped flyweights pivoting about pins which are secured to the governor hub, and this in turn is keyed and secured by a slotted nut to the fuel injection pump camshaft. Supported, and free to slide, on the hub is a sleeve, one end of which carries a forked shaft in a ball bearing whilst the other end is in contact with the toes of the flyweights. A cranked lever, the longer arm of which is connected through the medium of a telescopic link with the fuel injection pump control rod, locates in the forked shaft and pivots on a fulcrum pin which is fixed to the governor housing. The shorter arm of the cranked lever is connected through a pair of tension springs with an arm which is fixed to the control lever cross-shaft. The control lever is limited in its movement by stop screws, in the rear of the governor, which bear against a stop quadrant fixed to the control lever cross-shaft, so setting the maximum and idling speeds.

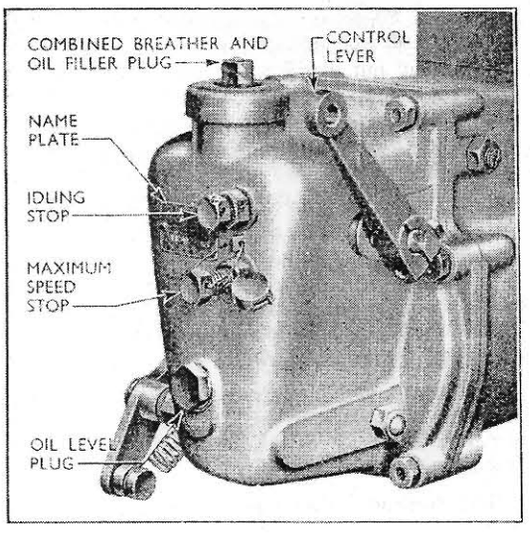


Fig.42
The "GM" Mechanical Governor

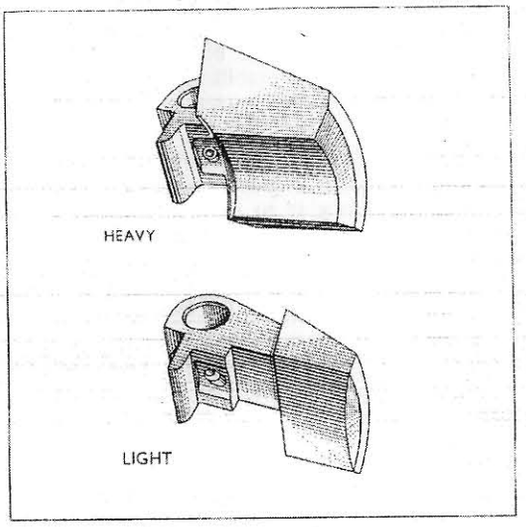


Fig.43
The "GM" Governor Weights

The telescopic link between the cranked lever and the fuel injection pump control rod allows the control rod to be moved to the fuel cut-off position without having to act against the governor control springs.

Fitted externally is a helper spring which is connected through suitable linkage with the control lever in such a manner that the effort required to move the lever to obtain a speed increase is relatively constant throughout the speed range.

Operation

In operation, initial movement of the control lever in a forward direction, to provide an increase in governed speed, loads the governor springs causing the cranked lever to pivot about the fulcrum pin, moving the hub sleeve forward against the toes of the weights and the injection pump control rod into the maximum fuel position. As the engine speed rises, centrifugal force causes the flyweights to move

out, so bringing the hub sleeve and injection pump control rod rearwards until the centrifugal force from the governor weights is balanced by the loading of the governor springs, thus stabilizing the engine speed in accordance with the position of the control lever.

Should the engine load decrease with the control lever in the same position, engine speed will rise and cause the governor weights to move outwards, so moving the injection pump control rod towards the minimum fuel position, and vice versa. Fig.41 shows the relative governor weight and control rod positions when the engine is at idling and full load positions.

The main governor spring controls the idling and lower speeds of the governor and the secondary spring gradually comes into effect as higher speeds are attained.

Lubrication

The governor should be lubricated every 50 hours by adding clean engine oil through the combined oil filler and breather (see Fig.42). Remove the breather cap and the oil level plug provided near the bottom of the governor housing and add oil until it flows from this hole. Do not overfill, as this will cause sluggish governor operation.

To Dismantle

1. Unscrew the bolt retaining the control lever to the cross-shaft and remove the lever.

2. Remove the screws securing the governor rear housing to the front housing.

3. Pull away the governor rear housing assembly sufficiently to remove the self-locking nut from the set screw securing the crank lever to the telescopic link. Unscrew the set screw from the crank lever and completely remove the rear housing assembly.

4. Withdraw the hub sleeve complete with ball bearing and fork.

This assembly may be dismantled, if necessary, by pressing the bearing and fork assembly from the housing and then pressing the fork from the bearing. Note the shims fitted between the fork and the bearing to provide a specified dimension (see assembly instructions) between the inside of the fork and the rear flange of the front governor housing.

5. Using special slotted wrench (Tool No. T.9048), remove the nut securing the governor weight assembly to the camshaft and remove the spring washer.

6. Screw the special extractor (Tool No. T.9047) into the hub of the governor weight assembly and tighten the centre screw of the tool to withdraw the assembly from the camshaft.

NOTE.—The hub and governor weights are serviced as a balanced assembly and no attempt should be made to dismantle.

7. Unscrew the nut securing the injection pump control rod stop pin to the side of the governor front housing, remove the fuel injection pump side cover

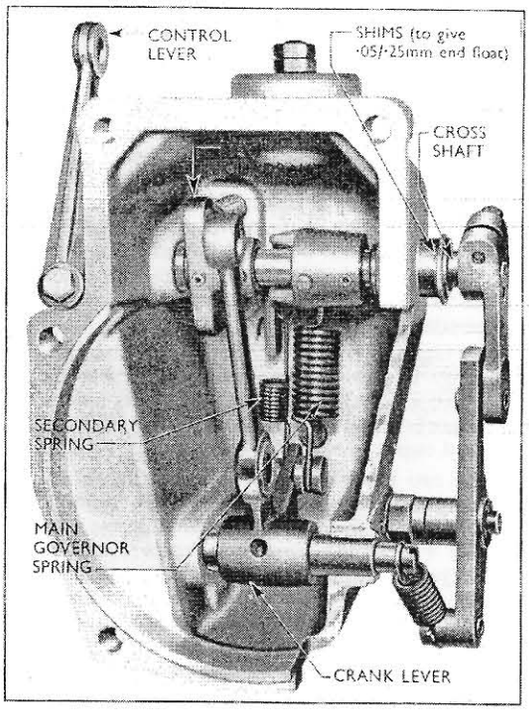


Fig.44
The " GM " Mechanical Governor—End View

and slacken the screws retaining the forks to the control rod. Withdraw the telescopic link and control rod as an assembly and, if necessary, remove the self-locking nut, flat washer and threaded pin securing the rod to the link.

The telescopic link may be further dismantled by compressing the plunger and spring until the plunger pin (inside the sleeve) lines up with the two holes drilled in the sleeve, and then driving out the pin.

8. Release the locking wire, extract the screws and remove the front governor housing from the injection pump. Note that the screws also retain an oil deflector plate, the purpose of which is to divert oil thrown up by the weights into the centre of the weight assembly and lubricate the pivots.

9. If necessary, withdraw the fuel injection pump camshaft front bearing cup and the oil seal from the governor housing. Tool No. CT.9018 is suitable for extracting the bearing cup.

10. To dismantle the rear governor housing assembly, remove the pinch bolt holding the upper lever of the external helper spring linkage to the control lever cross-shaft and remove the arm and the key.

11. Remove the helper spring.

12. Extract the " E " clip and washer securing the lower arm of the helper spring linkage to its pivot

pin and remove the arm. If necessary, straighten the locking tab and unscrew the pivot pin from the governor housing.

13. Extract the " E " clip and remove the lower plate connecting the secondary spring to the crank lever.

14. Remove the secondary spring and the spacer from the crank lever.

15. Remove the governor main spring.

16. Extract the " E " clip, spring connecting plate (upper) and spacer from the spring arm pin.

17. Remove the spring connecting pins from the spring arm and crank lever.

18. Remove the self-locking nut and copper washer from the crank lever fulcrum shaft, withdraw the shaft from the housing and remove the crank lever.

19. Tap out the pins securing the stop quadrant and spring arm to the control lever cross-shaft, remove the " E " clips, flat washers and " O " sealing rings and withdraw the cross-shaft spring arm and stop quadrant. Note that shims may be fitted between the flat washers and the cross-shaft bushes to control end-float of the shaft.

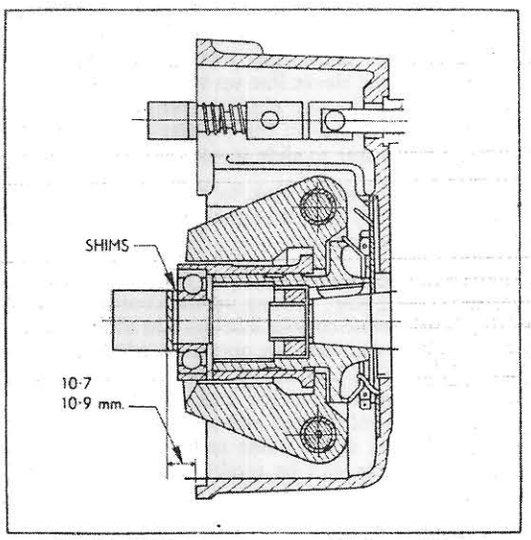


Fig. 45
Fork Adjustment—" GM " Governor

To Reassemble

1. Insert the control lever cross-shaft in the rear governor housing picking up the stop control quadrant and the spring arm on the shaft. Pin the quadrant and arm to the shaft.

2. Place new " O " rings in the recess of each cross-shaft bush, assemble a flat washer and " E " clip on each end of the shaft and check the end-float of the shaft. Fit shims as necessary between the flat washer and the bushes to restrict the end-float to within .05 to .25 mm.

3. Fit a new " O " sealing ring to the groove in the crank lever fulcrum shaft and insert the shaft in the housing picking up the crank lever. Secure the shaft in position with a self-locking nut and a copper washer.

4. Replace the governor spring connecting pins to the crank lever and spring arm making the assemblies so that the heads of the pins are to the right when looking into the housing.

5. Fit a spacer, the longer of the two spring connecting plates and an " E " retaining clip to the spring arm pin.

6. Install the main governor spring, locating the hooked ends in the grooves immediately behind the heads of the crank lever and spring arm connecting pins.

7. Attach the shorter spring connecting plate to one end of the secondary spring and attach the other end of the spring to the longer plate.

8. Fit a spacer to the crank lever pin, expand the secondary spring and assemble the shorter connecting plate to the pin. Secure the plate in position with an " E " clip.

9. Fit the pump camshaft rear oil seal to the governor housing.

10. Fit the pump camshaft rear bearing cup, using replacer Tool No. CT.9019 (previously No. TTr/DD 993203B2).

11. When reassembling the governor front housing it should be noted that if this housing is to be renewed or if the hub sleeve, fork and bearing assembly has been dismantled and any of the parts renewed, it should be reassembled with sufficient shims between the fork and the bearing to give a dimension of 10.7 to 10.9 mm. between the front face of the governor housing and the inside face of the fork (see Fig.45). This measurement to be taken with the hub bush fully " in " so that the weights are closed and with no gasket fitted. It is therefore advisable, if the stated parts have been renewed, to carry out this check by performing operations 13, 18 and 19 before proceeding with the assembly.

12. Using a new gasket on the end of the pump housing fit the front governor housing.

13. Locate the oil deflector plate against the rear face of the governor housing and insert the retaining screws through the deflector plate and the governor housing. Fully tighten the screws and wire the heads.

14. If the telescopic link has been dismantled, place the spring seat on the plunger followed by the spring. Fit the plunger to the sleeve and compress the assembly, at the same time rotating the sleeve until the holes in the sleeve line up with the hole in the plunger. Drive the stop pin into position to give even protrusion each side of the plunger and check that the plunger is free to slide in the sleeve.

15. Attach the telescopic link to the rear of the pump control rod by means of the appropriate flat washer and self-locking nut.

16. Assemble the control rod and telescopic link assemblies to the pump, picking up the control rod forks. Ensure that the cut-out machined in the front end of the control rod faces the operating side of the excess fuel and stop device. Locate No. 1 fork approximately 1 mm. from the end of the square section at the front of the rod and roughly align the remaining elements at the same angle. The final position of the forks will be established when the pump is calibrated.

17. Replace the injection pump control rod stop pin in the governor front housing and secure with the appropriate nut.

18. Fit the woodruff key to the pump camshaft, install the governor weights and hub assembly (serviced as a balanced assembly) and retain with a spring washer and special slotted nut: Using Tool No. T.9048 and a torque wrench tighten the nut to a torque of 45 lbs. ft. (6.2 kg.m.).

19. Fit the hub sleeve, fork and bearing assembly and ensure that it is free to slide on the hub.

20. Locate a new gasket on the rear flange of the governor front housing and connect the upper end of the crank lever (in the rear housing) with the telescopic control link using the appropriate threaded pin and self-locking nut.

21. Fully assemble the governor rear housing, insert and fully tighten the retaining screws.

22. Place a locking tab on the helper spring lever pivot pin and screw it into the governor rear housing. Bend over the tabs of the washer to retain it in position.

23. Assemble the helper spring lower lever to the pivot pin and retain with a flat washer and "E" clip.

24. Install the helper spring between the crank lever fulcrum shaft and the lower lever of the external linkage.

25. Place a woodruff key in the control lever cross-shaft and assemble the upper lever of the helper spring linkage. Ensure that there is a clearance of 1 to 2 mm. between the inside edge of the upper lever and the outside edge of the lower lever.

26. Tighten the pinch bolt to retain the upper lever in position.

27. Assemble the control lever to the cross-shaft and tighten the fixing bolt.

28. Refill the governor to the level plug with clean engine oil.

29. Calibrate the pump and test the governor.

TESTING THE MECHANICAL GOVERNOR

The operation of the Mechanical Governor can be most satisfactorily tested on a variable speed calibrating machine but should this equipment not be available it is possible to check and adjust the maximum and idling speed on the engine to which it is fitted. The later procedure will, of course, only be satisfactory providing the engine itself is in good condition.

To check the maximum and idling speeds on a variable speed machine, mount the injection pump and governor assembly on the machine, remove the inspection cover from the pump and hold the governor control lever in the maximum speed position. Slowly increase the speed of the machine and note the speed at which the control rod starts to move towards the fuel cut-off position. This should correspond to the maximum speed indicated on the governor housing plate.

Decrease the speed slightly and observe if the control rod moves immediately towards the minimum fuel position. Any sluggishness in response indicates internal stiffness in the governor or binding of the pump control rod and this condition should be corrected before making adjustments.

If the response is satisfactory and the maximum governed speed is incorrect, remove the seal from the maximum speed stop screw, back-off the locknut and adjust the stop to obtain the specified speed.

Re-tighten the locknut then wire and seal the stop to prevent arbitrary adjustment by operators, which could cause consequential damage if the speed is increased beyond that specified.

On GV pumps it is possible to also make a limited adjustment on the control springs by removing the inspection plug and screwing the adjusting nut "In" to increase, or "Out" to decrease, the governed speed. Under no circumstances, however, should the nuts be screwed out beyond the ends of the threaded spring retaining pins or below two threads from the flush position. Ensure that the split pins are replaced to hold the nut in position after completing the adjustment.

Having set the maximum speed the machine should be set to run slightly below the specified idling speed of the governor (350 r.p.m. for GV governors—250 r.p.m. for GM governors). It may be necessary to change the driving belt of the machine to a lower speed pulley to enable this check to be carried out. Set the governor control lever in the minimum fuel position, gradually increase the speed of the machine and again note the speed at which the injection pump control rod moves towards the fuel cut-off position. Adjust the idling speed stop as necessary.

If the tests and adjustments are to be made on the engine the same procedure applies using a tachometer on either the engine crankshaft or crankshaft pulley belt as a guide to speed.

PHASING AND CALIBRATING THE FUEL PUMP (when fitted with Mechanical Governor)

The method to be used when calibrating a fuel injection pump incorporating a mechanical governor differs slightly from that published for performing similar operations on one fitted with a pneumatic governor. Phasing may be checked with the unit mounted on the calibrating machine but should any discrepancies exist it will be necessary to remove the rear governor housing and the injection pump control rod to gain access to the phasing spacers.

The variable speed calibrating machine will enable **all** tests to be carried out on the pump and the governor. Where however the original approved fixed speed machine CT.9000 (previously numbered TTr1/DD.993100) is the only one available it may be adapted to enable calibration of the pump to be performed. It is **not** suitable for checking the mechanical governor.

As the mechanical governor projects below the base of the pump it will require mounting on the CT.9000 machine in such a manner that the governor overhangs the end of the mounting plate. This involves drilling the mounting plate and inserting a suitable extension for the drive to the pump.

The necessary parts to make the adaption can be supplied by Messrs. V. L. Churchill & Co. under Tool No. CT.9000–4/d consisting of a coupling and shaft assembly, CT.9000–4/a template for drilling the mounting plate, CT.9000–2 consisting of a movable coupling, fibre coupling and fixed coupling. The CT.9000–2 will have already been supplied to those dealers who have adapted this machine to suit the Fordson Dexta fuel injection pump. Fig. 46 shows the build-up of the drive.

Calibration

When calibrating disregard the first set of readings and balance the elements so that they all deliver the same amount of fuel for an average of four readings. Allow 10 secs. for the fuel to settle in the tubes after delivery and take the reading from the bottom of the curve of the fuel surface after it has settled. Allow a constant drain period of 10 secs. when emptying on each occasion.

1. After mounting the pump and governor on the calibrating machine turn on the fuel feed and loosen the bleed screw on the pump body to bleed the system of air. Re-tighten the screw and run the calibrating machine at 600 r.p.m. for at least 10 mins. to warm the pump and oil to a temperature of 65 to 70°F. (18 to 21°C.).

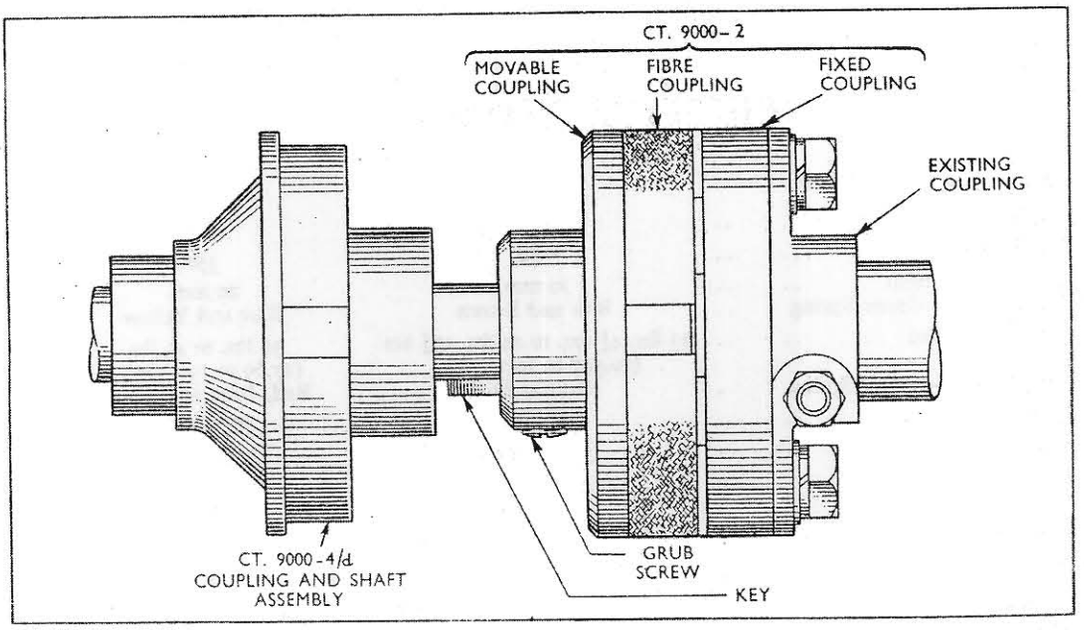


Fig. 46
Mechanical Governor Drive for CT.9000 Calibrating Machine

2. Set No. 1 control fork so that it is approximately 1 mm. from the square section at the excess fuel end of the pump control rod.

3. Run the pump at 600 r.p.m. with the control lever in the maximum speed position and collect 200 injections of fuel from No. 1 element in the graduated test tube. Adjust the maximum fuel stop screw at the front of the pump to obtain a fuel delivery from this element of 11.6 to 11.8 c.cs.

Operate the excess fuel device and ensure that the fork securing screw does not foul on the hexagon head of the bolt which secures the maximum fuel and stop device to the pump.

4. Balance the remaining elements by adjusting the position of the forks on the pump control rod so that the average of four deliveries, each of 200 injections at 600 r.p.m. from all elements is between 11.6 and 11.8 c.cs.

5. When the calibration is satisfactory, run the machine at 200 r.p.m. and check the delivery over 200 injections. Delivery drop on each element should not exceed 2.5 c.cs. below the figure obtained at 600 r.p.m. If the drop exceeds 2.5 c.cs. it indicates a worn element. If the delivery at 200 r.p.m. exceeds that obtained at 600 r.p.m. fit a new delivery valve assembly to the element affected and re-calibrate at 600 r.p.m. and recheck at 200 r.p.m.

6. Check at 600 r.p.m. that when the excess fuel device is operated, all elements deliver at least 19 c.cs. of fuel over 200 injections. It is not necessary for all elements to deliver exactly the same amount.

7. With the control lever in the maximum fuel position increase the speed of the calibrating machine to the maximum specified on the governor plate and adjust the maximum speed stop screw as previously described under "Testing the Mechanical Governor." Tighten the locknut and seal the stop in this position.

8. Adjust the governor idling speed as described under "Testing the Mechanical Governor."

NOTE.—Operations 5 and 6 can only be carried out on calibrating machines fitted with a variable speed control.

9. With the pump running at idling speed check that the delivery from all elements ceases when the stop control lever is operated.

10. Before replacing the pump inspection cover ensure that the fork screws are securely tightened onto the control rod.

11. Irrespective of the setting of the idling speed stop, final idling adjustment should be made after the unit is fitted to the particular engine on which it is to operate.

SPECIFICATIONS

GV MECHANICAL GOVERNOR

Maximum Speed (*Governor r.p.m.*)	750	900
Idling Speed (*Governor r.p.m.*)	350	350
Inner Spring Test Length	20 mm.	20 mm.
Colour Identification—Inner Spring	Blue and Brown	Blue and Yellow
Inner Spring Test Load	23 lbs. 4¾ ozs. to 24 lbs. 12¾ ozs. (10.567 to 10.774 kg.)	39 lbs. to 43 lbs. (17.69 to 19.50 kgs.)
Colour Identification—Outer Spring	Red and Blue	Red, Blue and White
Outer Spring Test Length	25 mm.	36.75 mm.
Outer Spring Test Load	5 lbs. 4 ozs. (2.381 kg.)	4 lbs. 9 ozs. (2.069 kg.)

GM MECHANICAL GOVERNOR

Maximum Speed (*Governor r.p.m.*)	750	900	1125
Idling Speed (*Governor r.p.m.*)	250	250	250
Governor Weight	Heavy	Heavy	Light
Main Spring Rate	44 lbs./in. (7.85 kg./cm.)		
Colour Identification—Main Spring	Red and Yellow		
Secondary Spring Rate	26 lbs./in. (4.64 kg./cm.)		
Colour Identification	Blue and Yellow		
Helper Spring Rate	40 lbs./in. (7.14 kg./cm.)		

SEPARATING THE TRACTOR

TO SEPARATE THE ENGINE AND FRONT AXLE ASSEMBLY FROM THE FRONT TRANSMISSION

Should it be necessary at any time to dismantle the Tractor in order to carry out repairs to the clutch or gearbox the following general procedure should be adopted.

1. Drain the cooling system through the two taps, one at the base of the radiator and the other on the left-hand side of the cylinder block beneath the generator.

2. Remove the primary air cleaner, vertical exhaust silencer (where fitted) and remove the bonnet by unscrewing the two screws in the rear bracket and lifting the bonnet rearwards.

3. Disconnect the proofmeter drive cable from the drive gear assembly adjacent to the front of the fuel injection pump.

4. Disconnect the stop control cable at the stop lever on the fuel injection pump.

5. Remove the spring clip and disconnect the horizontal throttle control rod from the throttle relay cross-shaft at the right-hand side of the rear of the engine.

6. Turn the fuel tap to the "OFF" position and disconnect the fuel tank to fuel lift pump pipe at the fuel lift pump.

7. Disconnect the fuel injector leak-off pipe at the rear of the right-hand side of the cylinder head by removing the banjo union bolt, taking care not to loose the copper washers fitted at either side of the banjo union.

8. Disconnect the battery.

9. Disconnect the crankcase breather pipe at the valve rocker cover pipe.

10. Disconnect the air inlet hose from the air cleaner by unscrewing the hose clamp at the air cleaner end.

11. Disconnect the two wires from the starter relay switch and remove the main feed cable from the terminal at the front end of the starter motor. Remove the split pin and clevis pin, and disconnect the starter operating rod at the starter motor end.

12. Disconnect the two wires from the generator and release the wiring loom from the clip on the generator bracket.

13. Disconnect the feed wire from the oil pressure warning light switch assembly.

14. Pull out the snap connectors of the headlamp wiring at the left-hand side of the radiator cowl and release the wires from the two clips on the side of the radiator and a further clip on the left-hand side of the engine front mounting plate.

15. Remove the temperature gauge bulb from the front of the cylinder head and release the capillary tube from the clip on the radiator brace rod. Position the capillary tube and the wiring loom clear of the front of the tractor.

16. Unscrew the two screws retaining the tool box to the tractor, and remove the tool box.

17. Disconnect the steering drag link from the drop arm by removing the split pin and unscrewing the securing nut. Force the tapered ball pin from the tapered bore in the drop arm using a suitable ball joint separator.

18. If a horizontal exhaust is fitted, remove the exhaust pipe, silencer and tail pipe complete, by removing the two nuts and bolts and one nut at the exhaust manifold, the nut from the silencer bracket at the side member and the bolt securing the tail pipe bracket to the underside of the left-hand axle shaft housing.

19. Support the engine and transmission, using the tractor dismantling stand (Tool No. Tr/NMD 27). Place the two rail sections of the stand under the tractor and position the engine and gearbox supports in their appropriate positions under the tractor. To ensure that the gearbox support is correctly positioned it will be necessary to disconnect the power take-off lever link at its front end.

If the tractor dismantling stand is not available, place suitable supports under the front transmission housing of the tractor and using a movable overhead gantry or floor crane fit lifting tackle to the engine and take the weight of the engine. Two engine lifting plates (Tool No. CT.6003) are available, one for fitting to the fuel filter boss at the right-hand rear of the cylinder head (this entails removing the fuel filter and pipes) and the other under the two front left-hand side cylinder head retaining bolts.

20. Insert suitable wooden wedges between the cast stops on the front axle centre beam and the front cross-member to prevent movement between the engine and the front axle assembly.

21. Remove the four bolts and spring washers from the rear of each side member, that secure the side members to the front transmission housing.

22. Remove the fourteen bolts retaining the engine to the front transmission housing and withdraw the engine, radiator and front axle as an assembly, moving it forward until clear of the front transmission housing.

TO RECONNECT THE ENGINE AND FRONT AXLE ASSEMBLY TO THE FRONT TRANSMISSION

1. Move the engine, radiator and front axle assembly towards the front transmission housing, ensuring that the main shaft lines up with the clutch pressure plate. On tractors fitted with double clutches, the power take-off input and main drive shafts must be aligned with their resective discs in the double clutch assembly.

2. Replace the fourteen bolts and spring washers retaining the engine to the front transmission housing. The proofmeter drive cable retaining clip fits under the head of the uppermost bolt on the right-hand side of the tractor, and the wiring loom and capillary tube clip fits under the head of the top bolt on the left-hand side directly below the inner edge of the air cleaner. Replace the four bolts and spring washers in each side member.

3. Remove the wooden wedges fitted between the front axle centre beam and the front cross-member.

4. Remove the tractor dismantling stand (Tool No. Tr/NMD 27) or the lifting tackle, supports and engine lifting plates.

5. Replace the tool box and secure with two bolts and flat washers.

6. Reconnect the steering drag link to the drop arm, tighten the nut securely and fit a new split pin.

7. Refit the exhaust system by replacing the two nuts and bolts and the nut at the manifold, the nut and bolt securing the silencer bracket to the side member and the bolt securing the tail pipe bracket to the underside of the left-hand rear axle shaft housing.

8. Re-route the capillary tube under the exhaust manifold, replace the temperature gauge bulb in the front of the cylinder head, and refit the tube in the clip on the left-hand side of the radiator brace rod.

9. Reconnect the headlamp wiring at the snap connectors and replace it in the clip on the left-hand side of the engine front mounting plate and the two clips running up the side of the radiator.

10. Reconnect the oil pressure warning light switch feed wire to the oil pressure warning light switch assembly.

11. Reconnect the two leads to the generator and replace the wiring loom in the clip on the generator bracket.

12. Reconnect the starter operating rod, replace the clevis pin and fit a new split pin. Reconnect the starter motor main feed cable and relay switch wires.

13. Reconnect the air inlet hose to the air cleaner and tighten the hose clamp securely.

14. Reconnect the crankcase breather pipe to the connection at the rear of the valve rocker cover.

15. Reconnect the battery leads.

16. Reconnect the fuel injector leak-off pipe at the right-hand rear of the cylinder head ensuring that there is a copper washer fitted at either side of the banjo union, and refit the union bolt.

17. Reconnect the fuel tank to fuel lift pump pipe at the lift pump, turn the fuel tap to the "ON" position and bleed the fuel system at the fuel filter and injection pump.

18. Reconnect the horizontal throttle control rod to the relay cross-shaft at the right-hand rear of the engine and replace the spring clip.

19. Operate the excess fuel device by pressing the knob on the fuel injection pump, and re-connect the stop control cable to the stop lever so that there is approximately $\frac{1}{4}$ inch (6.4 mm.) free movement of the control at the control panel.

20. Reconnect the proofmeter drive cable ensuring that the drive cable runs in a smooth curve and there are no kinks.

21. Refill the cooling system.

22. Replace the bonnet and refit the two screws securing the rear bracket to the fuel tank.

TO SEPARATE THE REAR AXLE FROM THE FRONT TRANSMISSION AND ENGINE ASSEMBLY

1. Drain the rear axle oil from the drain plug in the hydraulic pump filter screen cover. To facilitate the flow of oil remove the rear axle filler plug.

2. Remove the two nuts and internally-toothed lockwashers securing the rear number plate lamp cover to the lamp, and disconnect the main feed wire from the four-way snap connector in the lamp. Pull the wire from the rubber grommet and remove it from the wiring clips at the top of the hydraulic lift ram cylinder housing and the main gear change lever housing. Position the wire clear of the rear of the tractor.

3. Remove the four bolts and spring washers retaining the main gear change lever housing assembly and remove the assembly.

4. Remove the two bolts and spring washers holding the left-hand foot plate to the left-hand bull pinion housing, the three nuts, bolts, flat washers and spring washers securing the foot plate to the wing, and the three carriage bolts, nuts and spring washers holding the foot plate to the front bracket. Remove the foot plate and clutch pedal stop bracket.

The two inner carriage bolts retain the clutch pedal stop bracket.

5. Remove the split pin and clevis pin and disconnect the left-hand brake cable from the left-hand operating lever.

6. Remove the clutch pedal retracting spring and disconnect the clutch operating rod from the lower end of the clutch balance lever (split pin and clevis pin).

7. Remove the two bolts and spring washers retaining the right-hand foot plate to the bull pinion housing, the three bolts, nuts, flat washers and spring washers holding the foot plate to the wing, and the two carriage bolts, nuts and spring washers securing the foot plate to the front bracket. Remove the foot plate.

The two carriage bolts also hold the brake pedal stop bracket.

8. Remove the split pin and flat washer securing the brake pedal pawl control rod to the brake pedal pawl, and remove the brake pedal stop bracket complete with the brake pedal pawl.

9. Remove the right and left-hand brake pedal retracting springs and disconnect the right-hand brake cable (split pin and clevis pin).

10. Remove the split pin and collar securing the right-hand brake pedal to the brake cross-shaft and remove the pedal. Loosen the clamp bolt on the left-hand brake pedal and move the pedal to the end of the shaft to clear the front transmission housing/rear axle housing flange.

11. Remove the Woodruff key from the right-hand end of the shaft and move the shaft towards the left-hand side of the tractor, until the left-hand brake operating lever is clear of the front transmission housing/rear axle housing flange.

12. Remove the bolt and spring washer securing the exhaust tail pipe bracket to the left-hand rear axle shaft housing, slacken the clamp at the rear of the silencer, and remove the tail pipe.

13. Fit a suitable jack under the rear axle housing to support its weight, and position the gearbox trolley of the tractor dismantling stand (Tool No. Tr/NMD 27) on its rail under the front transmission housing. It will be necessary to disconnect the power take-off lever link at the front end to allow the rear gearbox support to be correctly located.

If the tractor dismantling stand is not available, support the engine and front transmission assembly on a suitable movable overhead gantry or floor crane.

14. Remove the fourteen nuts, bolts and spring washers securing the rear axle housing to the front transmission housing, and disconnect the engine and front transmission assembly from the rear axle.

TO RECONNECT THE FRONT TRANSMISSION AND ENGINE ASSEMBLY TO THE REAR AXLE

1. Fit a new gasket and reconnect the front transmission and engine assembly to the rear axle and replace the fourteen bolts, nuts and spring washers. The foot plate brackets fit under the lower two bolts on the vertical joint face at either side of the tractor.

The upper bolt on the right-hand side retains the brake pedal pawl control bracket.

2. Remove the tractor dismantling stand or lifting tackle.

3. Reconnect the exhaust tail pipe to the silencer assembly, tighten the clamp and replace the bolt and spring washer securing the tail pipe bracket to the left-hand rear axle shaft housing.

4. Push the left-hand brake operating lever back into position against the rear axle housing and replace the Woodruff key in the right-hand end of the brake cross-shaft.

5. Reposition the left-hand brake pedal and tighten the clamp bolt securely. Replace the right-hand brake pedal and retaining collar and secure in position with a split pin.

6. Reconnect the right-hand brake cable, replace the clevis pin and split pin securely. Replace the right- and left-hand brake pedal retracting springs.

7. Reposition the brake pedal stop bracket and reconnect the brake pedal pawl control rod to the brake pedal pawl on the stop bracket. Replace the flat washer and split pin securely.

8. Refit the right-hand foot plate with two bolts and spring washers to the bull pinion housing, three bolts, nuts, flat washers and spring washers to the wing (a flat washer is fitted either side under the bolt head and spring washer), and two carriage bolts, nuts and spring washers to the front bracket. The carriage bolts also retain the brake pedal stop bracket.

9. Reconnect the clutch operating rod to the clutch balance lever, replace the clevis pin and split pin securely. Replace the clutch pedal retracting spring.

10. Reconnect the left-hand brake cable to the left-hand brake operating lever, replace the clevis pin and split pin securely.

11. Refit the left-hand foot plate with two bolts and spring washers to the bull pinion housing, three bolts, nuts, flat washers and spring washers to the wing (a flat washer is fitted under the bolt head and spring washer), and three carriage bolts, nuts and spring washers to the front bracket. The inner two carriage bolts also retain the clutch pedal stop bracket.

12. Fit a new gasket and replace the main gear change lever housing. Secure in position with four bolts and spring washers (one of the rear lamp wiring loom clips fits under the rear right-hand bolt).

13. Relocate the rear lamp wire in the wiring clips, pass it through the rubber grommet in the rear number plate lamp cover and reconnect the wire to the four-way snap connector. Replace the number plate lamp cover and secure in position with two nuts and lockwashers.

14. Refill the rear axle with approximately 9 Imperial gallons (10.8 U.S. gallons or 41 litres) of oil (up to the "high" mark on the dipstick) of the correct grade as shown below.

Temperature Range	*S.A.E. Viscosity Number*	
Above 20°F (−7°C)	30 H.D.	or 20 W/30 H.D.
Below 20°F (−7°C)	20 H.D.	

"LIVE" POWER TAKE-OFF

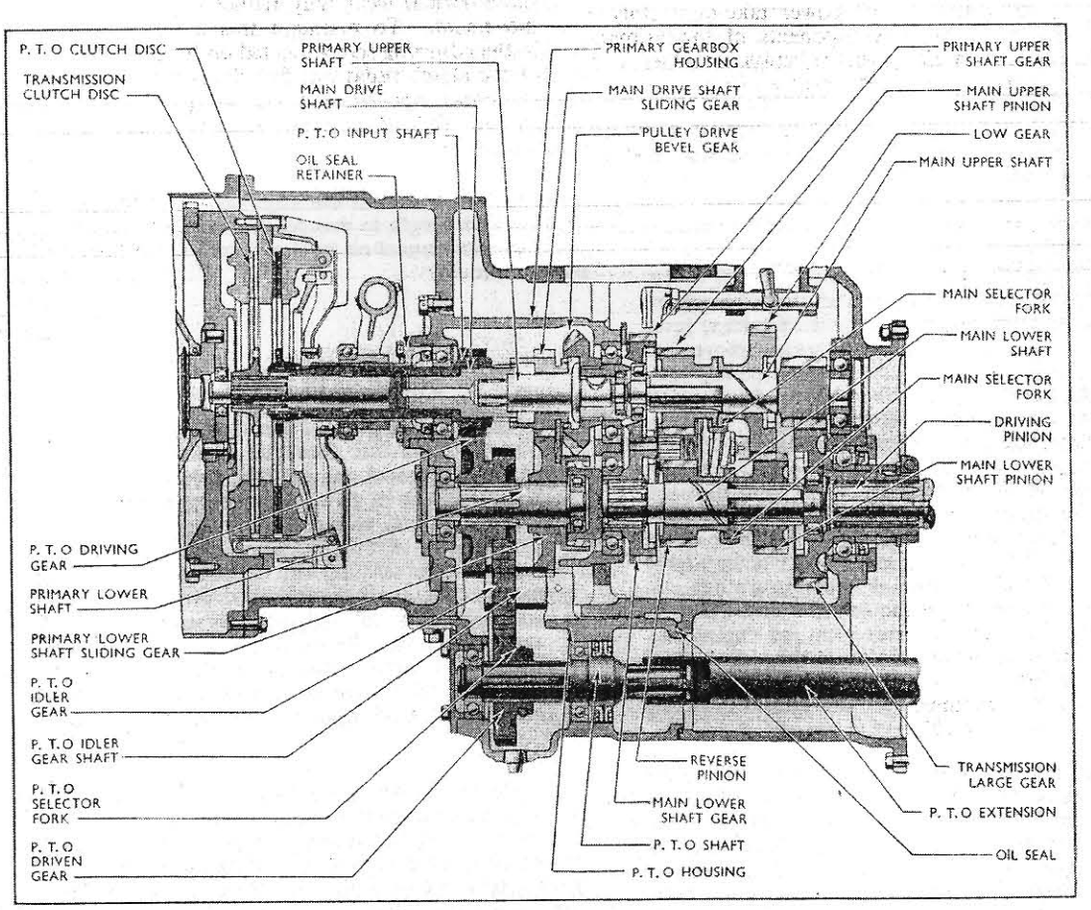


Fig. 1

Sectioned View of Double Clutch and Transmission used for "Live" Power Take-Off

Tractors incorporating "Live" power take-off use a double clutch in place of the single clutch fitted to tractors without "Live" power take-off, and have a modified primary gearbox which enables an additional input shaft to be introduced to drive the power take-off and hydraulics independently of the main transmission.

The system allows the drive from the engine to be disconnected from the transmission without interrupting the drive to the power take-off and hydraulic pump, giving the advantage that all power take-off driven and hydraulically operated equipment can be kept in motion while the tractor is stationary or gear-changing is being carried out.

With the initial introduction of "Live" power take-off (Engine No. 1417988) the main front transmission housing was modified by moving the clutch cross-shaft hole approximately 2 in. (51 mm). farther to the rear. This was to compensate for the increased length of the double clutch, and for standardisation purposes the new housing was also introduced on tractors without "Live" power take-off from Engine No. 1418861.

The result of these changes means that certain parts in the clutch release mechanism and linkage are not directly interchangeable between current standard and previous standard tractors, nor between any standard tractor and one fitted with "Live" power take-off. Care must therefore be taken that the correct combination of parts is used according to the particular application.

The current type primary gearbox housing is suitable for all applications, but the previous type housing is not suitable for use on tractors equipped with "Live" power take-off. Only a few of the internal components of the primary gearbox are interchangeable between standard and "Live" power take-off transmissions.

It is also important that the correct type power take-off housing, shaft and idler gear are fitted. (See "APPENDIX 1.")

Operation

As the clutch pedal is depressed, initial movement takes up the clearance between the release bearing and the transmission clutch release lever adjusting screws. Further downward movement of the pedal moves the transmission clutch pressure plate away from the centre drive plate, freeing the transmission clutch disc and thus disconnecting the drive between the engine and the transmission. The power take-off clutch remains engaged while the pedal is moving through approximately the first half of its total travel, after which continuance of the downward movement results in a definite increase in resistance at the pedal, as the power take-off pressure plate is also moved away from the centre drive plate, thereby disconnecting the drive between the engine and the power take-off shaft. When the clutch pedal is in the fully depressed position, therefore, the drive is discontinued to both the transmission **and** the power take-off shaft.

Total downward movement of the clutch pedal is normally controllled by a stop pin located in the lower holes of the "U" shaped clutch pedal stop bracket. (See Fig. 9.) If it is required to consistently use the transmission clutch only, the stop pin should be moved to the top pair of holes in the bracket. This will ensure that the hydraulic pump drive is not interrupted if the clutch is depressed when using hydraulically operated equipment such as mounted loaders, earth scoops, etc. **To ensure that the power take-off drive may be readily stopped in an emergency, the top holes in the stop bracket should not be used where power take-off driven implements are being operated.**

The procedure for high and low gear selection on models incorporating "Live" power take-off is the reverse of the method used on tractors without "Live" power take-off in that high gear is engaged when the primary gear lever is in the **upward** position and low gear is engaged when it is in the **downward** position.

The low and high gear ratios obtainable from this primary gearbox are the same as those on models without "Live" power take-off and there is no difference in final gear ratios or road speeds as the remainder of the transmission is unaltered; speeds and direction of rotation of the belt pulley and power take-off are also the same.

Operating Adjustments

After the tractor has been in service for some time, normal wear may reduce clutch pedal free movement. To maintain this movement, screw in the adjusting screw located on the left-hand side of the clutch pedal (see Fig. 9), until there is $\frac{1}{2}$ in. (13 mm.) free movement at the pedal pad. Retighten the adjusting screw locknut after the adjustment.

On no account must the adjustable release rod be altered in length to compensate for decrease in pedal free movement on tractors fitted with "Live" power take-off.

DOUBLE CLUTCH

The double clutch is of the double pressure plate, dry friction disc type and is actually two clutches incorporated in one assembly. Engine power is transmitted to the transmission by the forward clutch, and to the power take-off by the rearward clutch, of this assembly. The pressure plates are located on opposite sides of the clutch centre drive plate, which is bolted directly to a special engine flywheel designed to accommodate the double clutch. Between the two pressure plates and the centre drive plate are the clutch friction discs, which are free to slide on splines on the power take-off input and transmission main drive shafts.

Six clutch release levers pivot on pins which also connect them to the clutch cover—three short levers being attached directly to the power take-off clutch pressure plate and three long levers being connected by actuating struts to the transmission pressure plate. Each release lever has an adjusting screw at its inner end, against which the clutch release bearing operates. The transmission clutch release levers are set approximately 0.62 in. (16 mm.) nearer the clutch release bearing than the power take-off clutch release levers, so ensuring that the transmission clutch is disengaged before the power take-off clutch.

When the clutch pedal is in the fully engaged position, the engine drive is transmitted from the flywheel via the centre drive plate to the pressure plates by means of three driving pins. Twelve spring retaining pins, fixed to the transmission clutch pressure plate, pass through clearance holes in the centre drive and power take-off pressure plates, and an equal number of coil springs are located over, and secured through spring seats and retainer washers to, the outer ends of the pins. The springs are compressed between the power take-off pressure plate and the spring seats, thrusting the pressure plates towards the centre drive plate and thus supplying the necessary force to enable the clutch friction discs to transmit engine torque to the transmission and power take-off.

Removal of Double Clutch

To remove the double clutch, the transmission must first be separated from the engine and front axle assemble in the usual manner. The clutch assembly should then be supported whilst removing the nine screws which clamp the top cover and centre drive plate to the rim of the engine flywheel.

There may be slight movement of the clutch cover, away from the centre drive plate, when the screws are removed, but no attempt should be made to dismantle until the complete assembly is removed from the tractor.

Dismantling the Double Clutch

1. Place the double clutch on the Assembly Fixture T.7502 with the cover facing upwards and mark the clutch centre drive plate, transmission pressure plate and power take-off pressure plate, so that they can be reassembled in the same relative position.

2. Remove the pins and split pins securing the three transmission plate actuating struts to the transmission pressure plate.

3. Remove the circlips from the three pins that secure the power take-off clutch release levers (shorter levers) to the clutch cover, and remove the pins and release lever torsion springs.

4. Remove the power take-off clutch release lever adjusting screws, move the lever into a vertical position and lift off the clutch cover with the transmission clutch release levers and actuating struts attached.

5. Using spring compressor T.7502-1, compress the clutch pressure springs and remove the spring retainers. Lift off the spring seats, springs and insulating washers.

Note.—Do not attempt to remove the springs by releasing the self-locking nuts securing the spring retaining pins to the transmission pressure plate.

6. The power take-off clutch pressure plate, power take-off clutch disc, centre drive plate, transmission clutch disc and transmission clutch pressure plate are now free and can be removed for cleaning and inspection.

Inspection

Inspect the clutch discs to ensure that the linings are not loose and that they are perfectly clean and free from oil. The discs should be replaced if there are signs of excessive wear, of over-heating due to clutch slip, or if there appears to be any distortion.

Note.—It is not recommended that individual clutch discs should be replaced, i.e. if it becomes necessary to renew either disc, both the power take-off **and** the transmission clutch disc should be renewed.

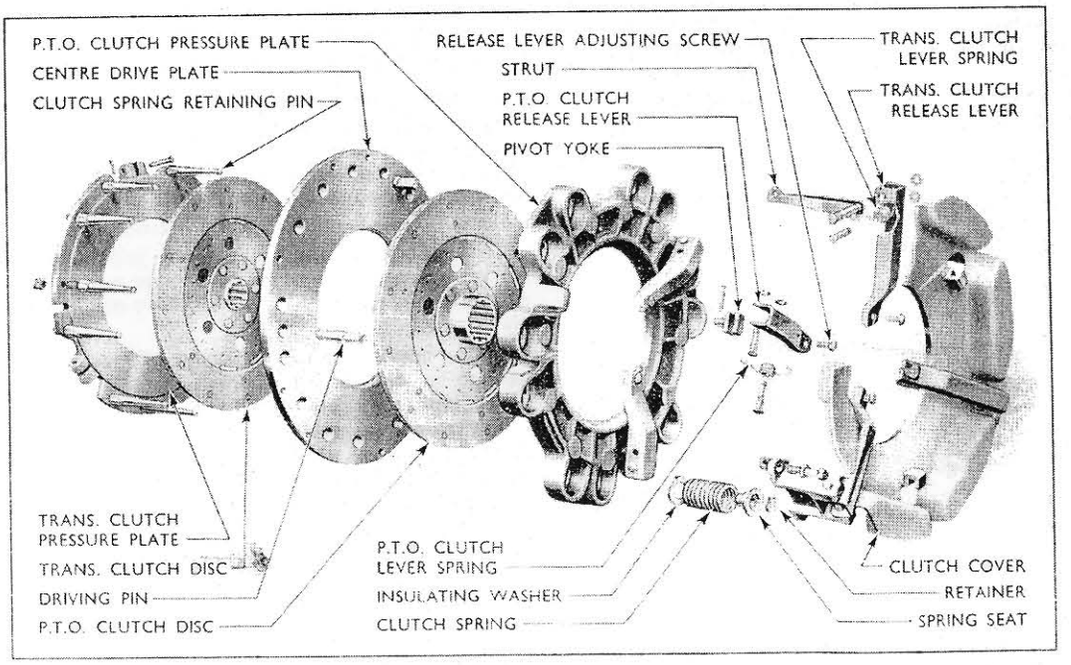


Fig. 2
Exploded View of Double Clutch

Both discs originally incorporated centre plates having a "crimped" or wavy form on the face of the plates, but the modifying of these plates to an improved design resulted in the deletion of the "crimping" and the type of plate fitted can be determined by a careful inspection of the peripheral edge of each disc.

If clutch slip is known to exist, the pressure plates and centre drive plate should be examined to make sure that they are not scored or cracked due to over-heating. Particular attention should be paid to the flatness of the centre drive plate and it should be ensured that the three driving pins are not loose in the plate.

If any of the spring retaining pins secured to the transmission pressure plate are bent or damaged they should be replaced with new parts. Before fitting a new spring pin, however, check that the hole in the pressure plate has a .04 in. (1mm.) x 45° chamfer to accommodate the small radius at the shoulder of the current pin as shown in Fig. 3. The radiused pin and chamfered hole were introduced some time after the introduction of the double clutch, therefore when fitting a new spring pin to an early pressure plate it will be necessary to chamfer the edge of the hole as specified.

Two different clutch pressure springs may be encountered on double clutches, the one initiallly used being replaced, at approximate Engine No. 1517331 by a heavier spring (marked with red paint). It is preferable that these springs are not inter-mixed on a double clutch, i.e., that the current one is not used as an individual replacement on early clutches fitted with the lighter springs. Used clutch pressure springs which do not meet the following specification should be discarded.

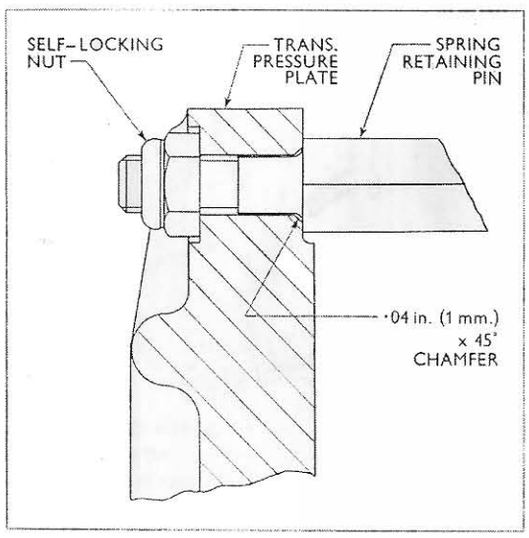


Fig. 3
Spring Retaining Pin Secured to Transmission Pressure Plate

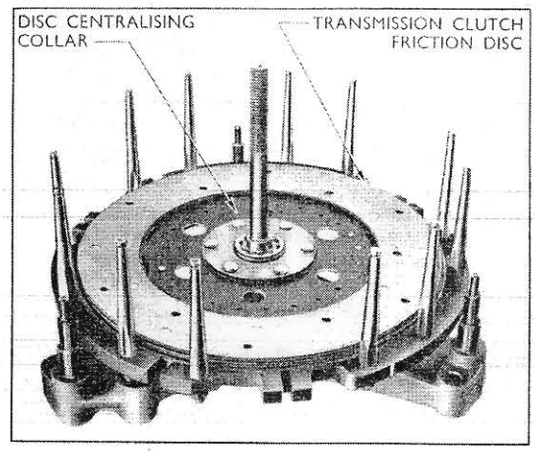


Fig. 4
Transmission Pressure Plate and Clutch Disc Installed on Assembly Fixture

Free Length	*Min. Load to Compress to 2 in. (51 mm.)*
Previous spring 3.23 in. (82 mm.)	92.5 lbs. (41.9 kg.)
Current spring 3.23 in. (82 mm.)	109.5 lbs. (49.7 kg.)

The adjusting screws in the clutch release levers should be checked to ensure that they cannot be turned with a torque of less than 5 lbs./ft. (.69 kg.m.). This will necessitate the use of a suitable low range torsion wrench. A new clutch release lever or adjusting screw should be fitted as necessary if the specified torque cannot be obtained.

Reassembling the Double Clutch

The centre drive plate, power take-off clutch pressure plate and transmission clutch pressure plate are balanced before assembly, but early production plates were not marked to indicate their relative positions in the final assembly.

To facilitate assembly in service, yellow paint marks, indicating the heavy points, are now being placed on the edges of the three above-mentioned plates.

If, for any reason, one or more of these parts have to be replaced, they should be positioned in the complete double clutch assembly with the yellow paint marks evenly spaced. If, however, the original parts are to be replaced, the marks made before disassembly should be adhered to during the assembly operation.

The double clutch should be assembled in the following manner using the Assembly Fixture T.7502 in conjunction with adaptor set T.7502-2 and the spring compressor T.7502-1.

1. Fit the transmission pressure plate in the assembly fixture so that it is resting on the three raised lugs cast in the base arms, and position the plate so that the slots for the actuating struts are situated centrally between the centre drive plate locating pegs on the assembly fixture. (See Fig. 4.)

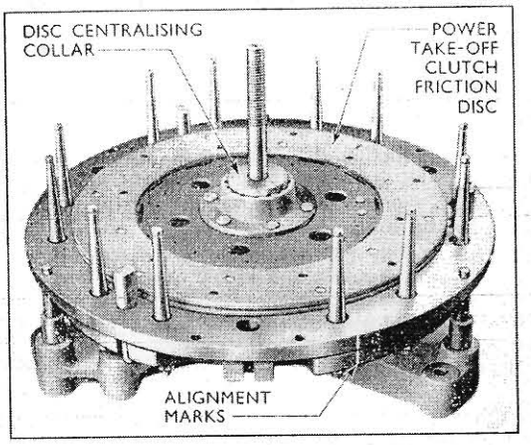


Fig. 5
Centre Drive Plate and Power Take-Off Clutch Disc on Assembly Fixture

2. Install the transmission clutch disc over the fixture centre pillar and disc centralising collar T.7502-2/aa with the long boss of the disc hub facing downwards. (See Fig. 4.)

3. Fit the centre drive plate over the three locating pegs with the spigoted side of the plate facing downwards, matching up the alignment marks made at the time of dismantling on the centre drive plate and transmission pressure plate, and locating the clutch driving pins in the slots in the transmission clutch pressure plate. (See Fig. 5.)

4. Install the power take-off clutch disc over the centre pillar and disc centralising collar T.7502-2/b, with the long boss on the disc hub facing upwards. (See Fig. 5.)

5. Fit the power take-off clutch pressure plate and engage the driving slots with the centre plate driving pins, at the same time matching up the alignment marks on the two plates.

6. Lift the power take-off clutch release levers so that they are in a vertical position and place the coil spring insulating washers, coil springs and spring seats loosely in position over the spring retaining pins. Compress each spring in turn, using spring compressor T.7502-1, and fit one of the special retainers into the groove at the outer end of each retaining pin. Ensure that the spring retainers are fully located in the spring seats.

7. Fit the clutch cover, with the power take-off clutch release levers located through the holes in the cover, and the lower ends of the transmission clutch actuating struts in their respective slots in the transmission clutch pressure plate.

8. Install the power take-off clutch release lever torsion springs, locating the cranked ends in the small holes in the top of the power take-off clutch release levers, and replace the release lever to clutch cover securing pins. Fit circlips to retain the pins in position.

9. Align the lower holes in the actuating struts with the corresponding holes in the transmission pressure plate, and insert the retaining pins and split pins.

10. Replace the power take-off release lever adjusting screws.

Adjustment of Double Clutch Release Levers

1. Using six temporary nuts and bolts, secure the clutch cover to the centre drive plate.

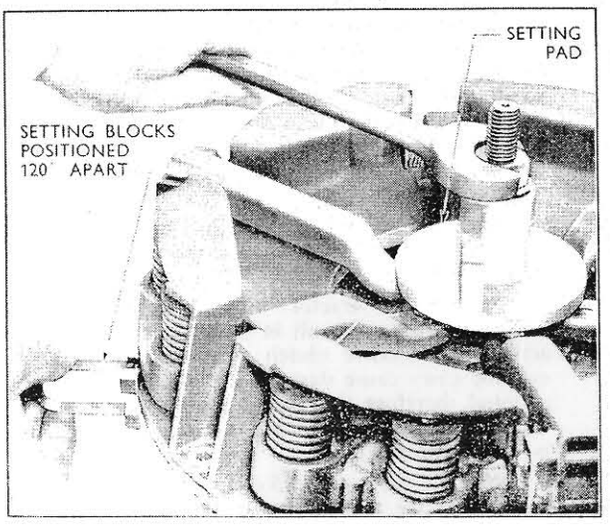


Fig. 6
Fitting Setting Blocks

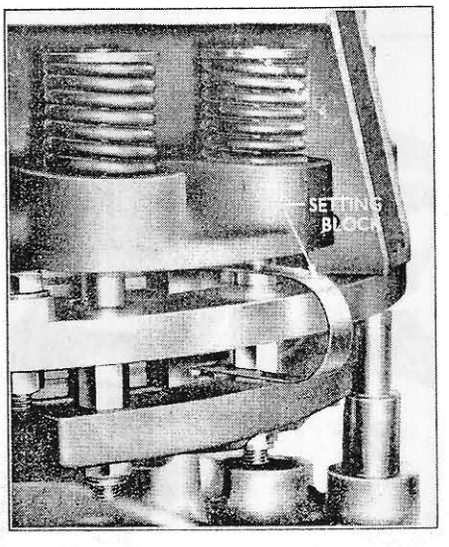


Fig. 7
Setting Block in Position Against Discs

2. Fit the setting pad T.7502-2/d over the centre pillar of the assembly fixture, so that the flat side of the pad contacts the transmission clutch release lever adjusting screws. Fit the flat washer and nut to the centre pillar and screw down the nut until the setting blocks T.7502-2/e can be inserted between the centre drive plate and the pressure plates. (See Fig. 6.) The three setting blocks should be positioned 120° apart and **must** be touching the outer periphery of the clutch friction discs. (See Fig. 7.)

It is most important that the blocks locate between the centre drive plate and the raised operating surfaces of the pressure plates, i.e. when assembled these surfaces will appear as ridges slightly larger in diameter than the clutch disc.

3. Remove the setting pad, reverse it, and replace on the centre pillar with the stepped side downwards. Do not refit the nut and flat washer. The shorter machined step of the pad is used to set the transmission clutch release levers, and the longer machined step to set the power take-off clutch release levers.

4. Hold the setting pad firmly against the power take-off disc centralising collar and rotate the pad until the appropriate step is immediately above one of the clutch release lever adjusting screws. Turn the adjusting screw until a .005 in. (.13 mm.) feeler gauge can just be inserted between the top of the screw and the underside of the appropriate step on the setting pad. (See Fig. 8.) Repeat the operation on each of the five remaining release levers.

If any free play exists in the release lever, care must be taken to hold the lever down when making the adjustment.

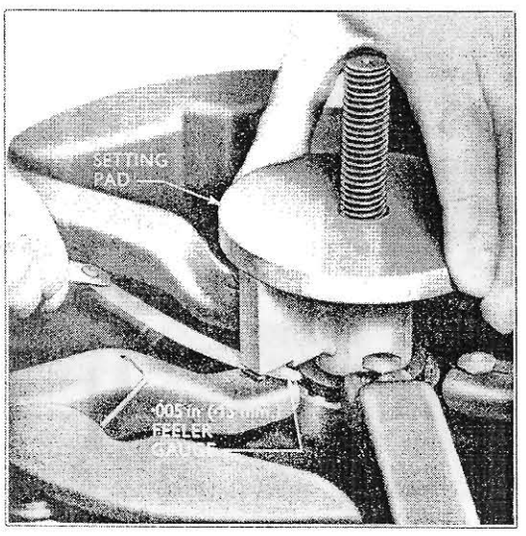


Fig. 8
Checking Adjustment of Release Lever Screw

Note.—During the adjusting operation ensure that the setting pad bottoms on the power take-off clutch disc centralising collar, and that this in turn is down on the shoulder of the fixture centre pillar.

5. After completing the adjustment, invert the setting pad and fit the flat washer and nut to the centre pillar. Screw down the nut until the setting blocks can be extracted. Remove the nut, flat washer and setting pad. Remove the temporary nuts and bolts securing the clutch cover to the centre drive plate.

Providing these instructions have been carefully followed the assembly is correctly adjusted and can be fitted to the flywheel.

Replacement of Double Clutch

Before replacing the double clutch assembly the flywheel spigot bearing should be checked and replaced if worn or rusty and the recess behind the bearing lightly packed with good quality high melting point grease.

1. Secure the double clutch assembly to the flywheel, taking care to fit locking washers under the heads of the nine retaining screws.

2. Replace the engine and front axle assembly in the usual manner, with the exception that when making the assembly, the splines on both the power take-off input **and** the main drive shafts must be aligned with the splined hubs of their respective clutch discs. This may be accomplished by turning the engine whilst easing it towards the gearbox, or alternatively by removing the belt pulley or cover plate, whichever is fitted, from the front transmission housing and turning the shafts from within the primary gearbox.

Adjustment of Double Clutch Pedal Linkage

Adjusting the effective length of the clutch release rod, by screwing the clevis onto the rod or vice-versa, provides on tractors fitted with the double clutch a means of controlling the total effective movement of the clutch pedal which, due to the two-stage action of the clutch, is necessary to ensure correct clutch operation.

The release rod which is set correctly at initial assembly should be checked and adjusted if necessary after the normal " bedding-in " period, after extended periods of usage or after carrying out any repair operation on the clutch or associated parts.

Operating the tractor with the release rod incorrectly set can result in unsatisfactory clutch action or excessive clutch wear and could in extreme cases cause damage to the clutch. It is essential, therefore, that care is taken when making this adjustment and that the following procedure is strictly adhered to.

1. Remove the power take-off shaft guard and cover from the rear of the tractor to expose the shaft.

2. Loosen the locknut and rotate the pedal free movement adjusting screw to its shortest length. (See Fig. 9.)

3. Loosen the clutch release rod clevis locknut and disconnect the release rod from the balance lever. (See Fig. 9.) Adjust the clevis to give a distance of 15 in. (38.1 cm.) between the centre of the pinhole in the clevis and the centre of the pin connecting the other end of the rod to the clutch release arm and reconnect the release rod to the balance lever with the pin (do not secure with a split pin).

4. Ensure that the stop pin is in the lower pair of holes in the clutch pedal stop bracket, as shown in Fig. 9. (This pin governs the distance the clutch pedal may be depressed.)

5. Move the power take-off lever into the engaged position and start the engine.

6. Fully depress the clutch pedal. The power take-off shaft should stop revolving just before the clutch pedal contacts the stop pin, if however the shaft does not stop, screw the clevis onto the release rod until the required condition is obtained.

Note.—Do not screw the clevis onto the rod to such an extent that the total release movement of the clutch is taken up **before** the clutch pedal contacts the stop pin. If the clevis is screwed on too far the clutch mechanism will " bottom " before the pedal meets the stop pin—this can be felt if the pedal is slowly depressed. Movement of the pedal beyond this point may cause damage to the clutch and under such circumstances the clutch and its associated parts should be removed for examination to determine why over-adjustment of the release rod has been necessary.

7. Having carried out the above adjustment, alter the position of the stop pin to the upper pair of holes in the clutch pedal stop bracket.

8. Again depress the clutch pedal until it contacts the stop pin, at which point the transmission clutch should be completely disengaged and this can be verified by engaging and disengaging a gear. If this condition is in effect no further adjustment of the release rod is required, if not it will be necessary to re-adjust the release rod, screwing the clevis onto the rod to obtain the required condition.

Note.—If re-adjustment of the release rod has been necessary, replace the stop pin in the lower pair of holes in the stop bracket and carry out a final check to ensure that the clutch pedal, when depressed, contacts the footplate before the total clutch release movement is expended. (See previous Note under Operation 6.)

9. With the release rod adjustment completed move the power take-off lever into the disengaged position and stop the engine.

10. Secure the pin connecting the release rod to the balance lever with a split pin and tighten the release rod clevis locknut.

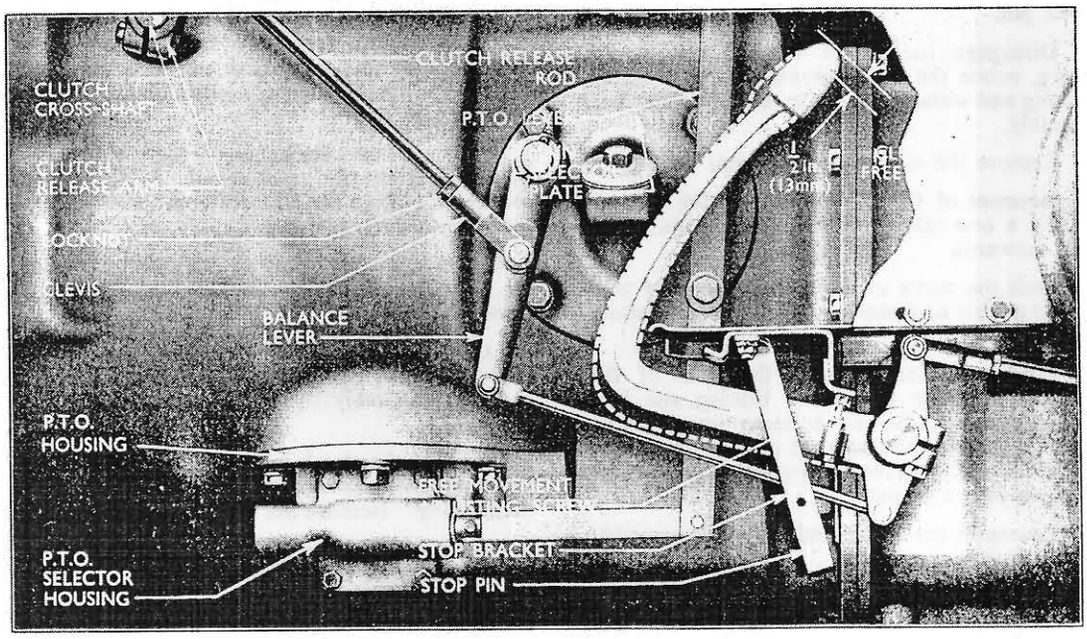


Fig. 9
Left-Hand Side of Tractor with " Live " P.T.O. Showing Clutch Pedal and Linkage

11. Position the stop pin in the appropriate pair of holes in the stop bracket for the required clutch pedal operation and retain with the spring clip.

12. Screw out the pedal adjusting screw to give ⅛ in. (13 mm.) free movement at the pedal pad. (See Fig. 9.) Tighten the adjusting screw locknut.

13 Refit the power take-off shaft cover and guard to the rear of the tractor.

CLUTCH RELEASE BEARING

The double clutch release bearing is of more robust construction and is mounted on a shorter hub than that used with the single clutch.
Note.—The clutch release bearing hub used on standard tractors prior to Engine No. 1418861 (before the clutch cross-shaft hole was moved further back) is shorter than that used on current standard tractors.

The bearing should require little attention in service, it is pre-lubricated and must not be cleaned in solvent. If the bearing has excessive side movement or is loose on the hub it should be renewed as described in the following procedure. This procedure is basically the same as used for tractors without "Live" power take-off after Engine No. 1418861 but differs slightly from that used on these models before this engine number.

Removal of Clutch Release Bearing

1. Separate the engine and front axle assembly from the transmission in the usual manner.

2. Disconnect the clutch release rod from the clutch release arm by removing the split pin and clevis pin.

3. Disengage the clutch release fork return spring, rotate the fork towards the front of the housing and withdraw the release bearing and hub assembly.

4. Remove the release bearing from the hub.

Replacement of Clutch Release Bearing

1. Fit a new release bearing to the hub, thrust face outwards.

2. Pack the recess in the release hub bore with a good quality high melting point extreme pressure grease.

3. Rotate the fork towards the front of the housing and slide the release bearing and hub assembly into position at the same time engaging the fork with the slotted arms of the hub. Rotate the fork to its most rearward position and engage the fork return spring.

4. Reconnect the engine and front axle assembly to the transmission.

5. Check and adjust if necessary the clutch pedal linkage (see "Adjustment of Double Clutch Pedal Linkage") ensuring that on completion the release rod to release arm clevis pin is secured with a split pin.

CLUTCH PEDAL

Removal and Replacement of Clutch Pedal

The method of removing and replacing the clutch pedal on tractors equipped with "Live" power take-off is basically the same as used on tractors without "Live" power take-off, although the pedal itself is different, and other detail differences such as the pedal stop bracket and the anchorage of the pedal retracting spring will be encountered.

PRIMARY GEARBOX

On tractors fitted with "Live" power take-off, the introduction of an extra input shaft, to transmit the drive to the power take-off shaft independently of the main transmission, necessitates a modified primary transmission from that used on tractors without "Live" power take-off.

The main drive shaft is altered to operate within the power take-off input shaft, and the entire primary upper shaft and associated parts, also the primary and main lower shafts are redesigned to facilitate the introduction of a system of sliding gears to replace the dog type couplings used in the standard primary gearbox.

As with the standard primary gearbox, running clearances are controlled by production tolerances and bearings require no adjustment.

Removal of Primary Gearbox from Front Transmission Housing

The following procedure should be followed if it is required to remove the "Live" power take-off primary gearbox from the front transmission housing, and this procedure can now be used equally well for removing any standard primary gearbox.

1. Separate the engine and the front axle assembly from the transmission in the usual manner and drain the oil from both the front and rear transmission housing.

Note.—It is not necessary to drain the oil from the rear transmission housing on tractors without power take-off.

2. Disconnect the clutch release rod from the release arm and remove the clutch release bearing and hub assembly. (See "CLUTCH RELEASE BEARING.")

3. Remove the clutch release fork to cross-shaft retaining pins and withdraw the cross-shaft from the housing. Remove the fork and return spring.

4. Partially withdraw the power take-off extension shaft at the rear of the tractor. Disconnect the power take-off engagement lever at the selector shaft and remove the power take-off selector housing assembly followed by the power take-off housing assembly. (See Fig. 9.) Remove the belt pulley (if fitted).

5. Disconnect the clutch pedal to balance lever rod at the balance lever, remove the power take-off engagement lever and the main gearbox selector plate assembly, complete with the clutch balance lever and clutch release rod. (See Fig. 9.)

6. Place the primary gear lever in the downward position. Remove the wire and loosen the square headed screw securing the connector lever to the primary gear change upper shaft inside the main transmission housing.

7. Disengage the connector lever from the primary gear change upper shaft by raising the primary gear lever, lift the connector lever from the hole in the end of the primary gearbox selector shaft and withdraw the lever from the housing.

Note.—If the connector lever does not disengage completely from the primary gear change upper shaft when the primary gear lever is fully raised the connector can be removed after partially removing the primary gearbox assembly.

8. Remove the primary gearbox assembly from the front transmission housing using locating studs CT.6076 in the right—and left—centre screw holes of the primary gearbox flange.

Dismantling the "Live" Power Take-Off Primary Gearbox

The primary gearbox is so designed that, in accordance with standard engineering practice, bearings are a push fit in the housing and a press fit on the shaft.

Roller bearings with detachable cups must, when removed, be kept in their original pairs in readiness for reassembly. This is extremely important as each bearing is matched with its own cup.

1. Extract the locking wire and remove the four screws securing the power take-off input shaft oil seal retainer. Withdraw the retainer complete with oil seal and extract the oil seal, if necessary.

2. Withdraw the power take-off input and main drive shaft assemblies from the housing as one unit. After removal, draw the main drive shaft away from the power take-off input shaft assembly, and extract the oil seal from the counterbore at the splined end of the input shaft. (See Fig. 23.)

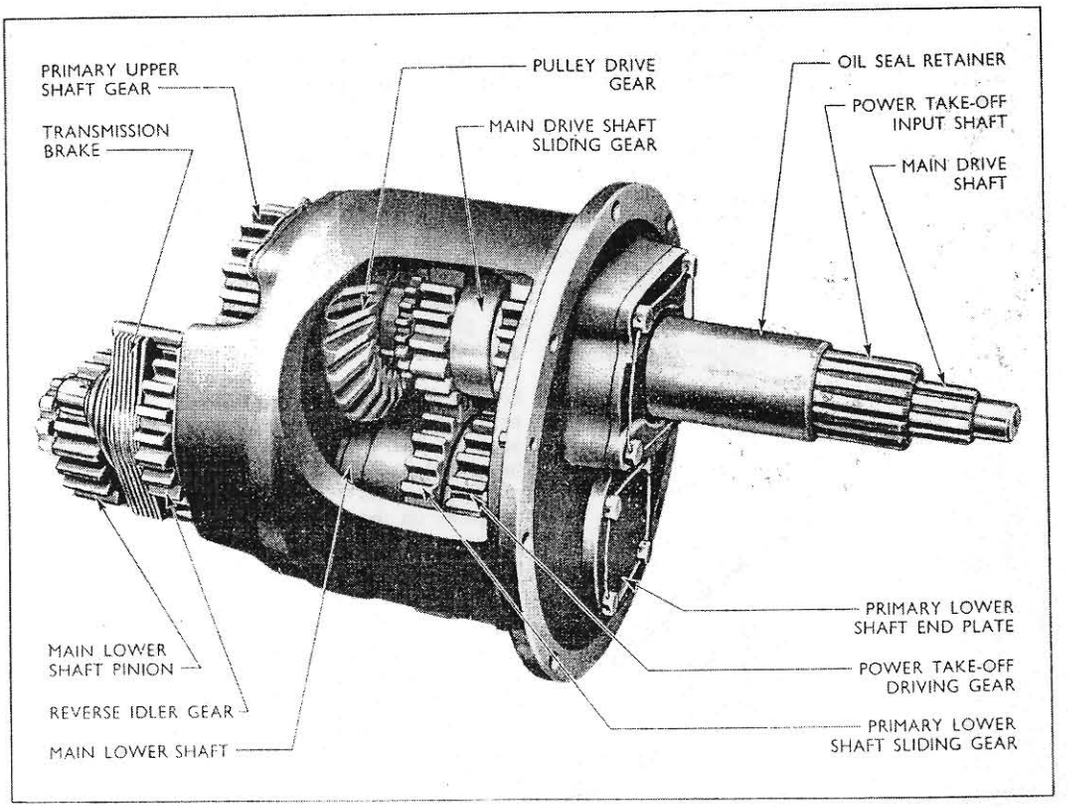


Fig. 10
"Live" Power Take-Off Primary Gearbox

3. Removal of the power take-off input shaft ball bearing or oil seal sleeve necessitates the withdrawal of both these components. If such dismantling is necessary, remove the circlip immediately in front of the oil seal sleeve, fit the split adaptors T.7000-8/a around the bearing and place this assembly in Main Tool T.7000. Locate the thrust pad T.7000-8/b in the front end of the shaft and press the shaft through the bearing and oil seal sleeve. (See Fig. 11.)

4. Extract the needle roller spigot bearing from the main drive shaft if necessary.

Note.—If this bearing is removed it must be discarded and a new part fitted on reassembly.

5. The procedure for the next operation is governed by the presence, or absence, of a transmission brake.

(a) **If a transmission brake is fitted:—**
Extract the split pin and remove the brake adjusting nut, followed by the brake springs, spring retainer, brake plates, and the reverse idler gear and hub assembly. Withdraw the brake shaft through the cast hole in the housing.

(b) **If no transmission brake is fitted:—**
Remove the self-locking nut, outer spigoted washer and reverse idler gear, then withdraw the centre bolt and inner spigoted washer from inside the housing.

6. Place the Main Tool T.7015 over the main lower shaft, position the splined adaptors T.7015-1 behind the roller bearing inner race, and, with the Main Tool located against the adaptors, draw the bearing race from the shaft. Remove the main lower shaft pinion and reverse pinion from the main lower shaft.

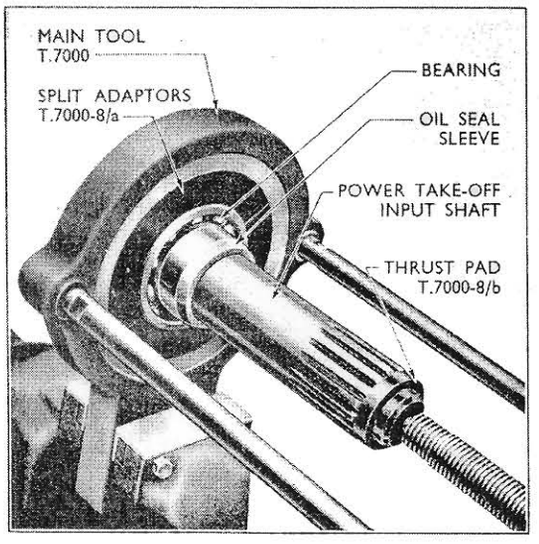


Fig. 11

Removing Bearing and Oil Seal Sleeve from Power Take-Off Input Shaft

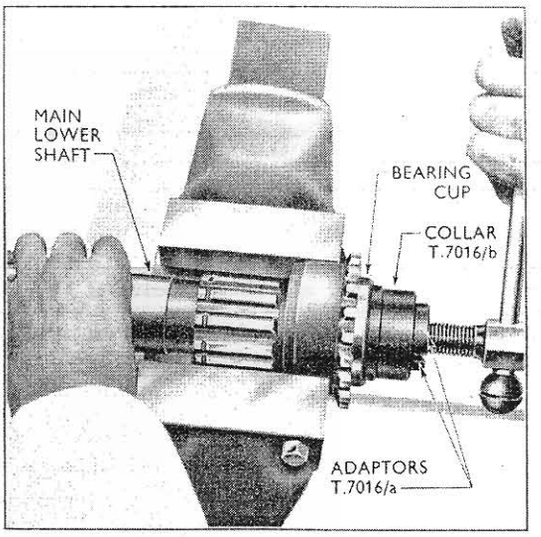


Fig. 12

Removing Bearing Cup from Main Lower Shaft with Tool T.7016

7. Stand the housing on its front face, and press the selector shaft into the housing until it reaches its innermost position, i.e. with the selector ball located in the second notch from the inner end of the selector shaft. Extract the locking wire and remove the two securing screws from the main lower shaft bearing locking plate. Remove the plate, followed by the main lower shaft assembly.

8. To dismantle this assembly, remove the gear retaining circlip, place the assembly, with split adaptors T.7000-2/a in position around the bearing, in Main Tool T.7000 and press the shaft out of the gear and bearing assembly. Relocate the adaptors on the opposite side of the bearing and replace the gear and bearing assembly, with adaptors, in Main Tool T.7000. Fit the thrust pad T.7000-2/b in the gear bore, and press the gear out of the bearing.

To extract the primary lower shaft bearing cup, which is seated in the recessed end of the main lower shaft, use tool T.7016, placing the adaptors and collar of the tool inside the bearing cup, with the feet of the adaptors located behind the cup. (See Fig. 12.)

9. Straighten the primary upper shaft locking nut retainer, remove the nut, using special key T.7030, and extract the retainer.

10. Place the selector shaft in its outermost position. Extract the locking wire and two secur-

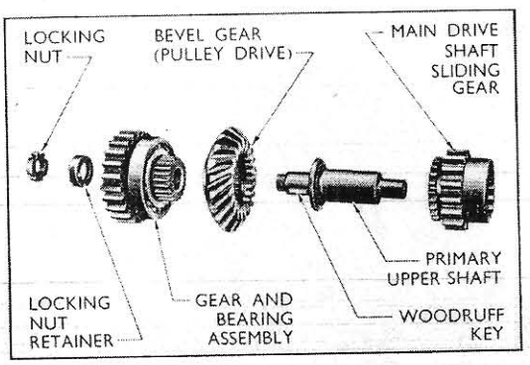


Fig. 13
Primary Upper Shaft and Gears

ing screws from the primary upper shaft bearing locking plate, and remove the plate. Withdraw the primary upper shaft gear and bearing assembly from the housing, leaving the bevel gear located on the primary upper shaft (in the housing). Place the housing on its side, and press the selector shaft into its innermost position. Move the primary upper shaft and main drive shaft sliding gear (as one unit) away from the bevel gear, leaving the latter in the housing. Extract the shaft and sliding gear through the cast hole in the side of the housing, and then withdraw the bevel gear. Separate the shaft and gear.

11. Position the split adaptors T.7000-2/a around the primary upper shaft gear bearing, and place the assembly in Main Tool T.7000. Fit the thrust pad T.7000-2/d in the gear bore (at the bearing end) and press the gear out of the bearing.

The main upper shaft roller bearing cup is seated in the recessed end of the primary upper shaft gear, and may be removed, if necessary, by using a suitable pin punch through the two holes provided in the gear.

12. Extract the locking wire and remove the securing screw from the gear shifter fork. Place a cloth over the selector ball hole in the housing to prevent the spring-loaded ball from flying out, and withdraw the selector shaft. The shaft will be removed more easily if it is revolved as it is withdrawn. Remove the selector ball and spring. Revolve the gear shifter fork until it can be lifted out of the groove in the gear and withdrawn through the cast hole in the side of the housing.

13. Drive out the expansion plug from the end of the selector shaft bore.

14. Rest the housing on its front face and place the adaptors T.7015-2/a within the main lower shaft bearing bore, with the feet of the adaptors located behind the primary lower shaft roller bearing inner race. With the top ends of the adaptors pressed together, lower the Main Tool T.7015 over the adaptors and rest it on the face of the primary lower shaft sliding gear. The tool frame must be positioned so that the pillars are approximately in line with the open sides of the adaptors. Move the top ends of the adaptors apart and place the thrust pad T.7015-2/d in the adaptor bore, with the two arms of the thrust pad located between the split halves. The dimpled end of the thrust pad should be directly below the centre pressure screw. Lift the tool until the base ring is located under the flanged ends of the adaptors. Screw in the centre pressure screw and draw the roller bearing inner race from the end of the primary lower shaft. (See Fig. 14.)

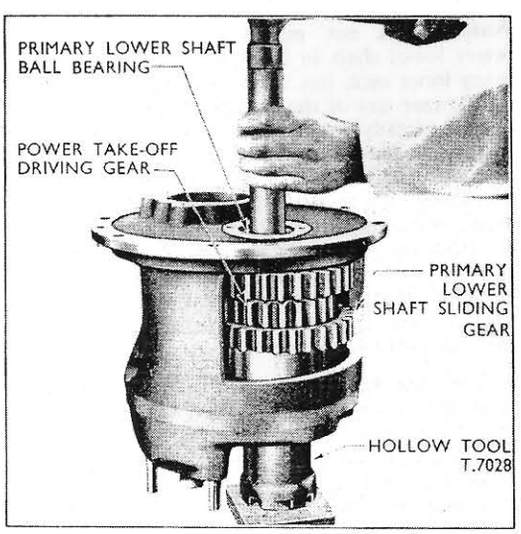


Fig. 14
Removing Roller Bearing Inner Race from Primary Lower Shaft

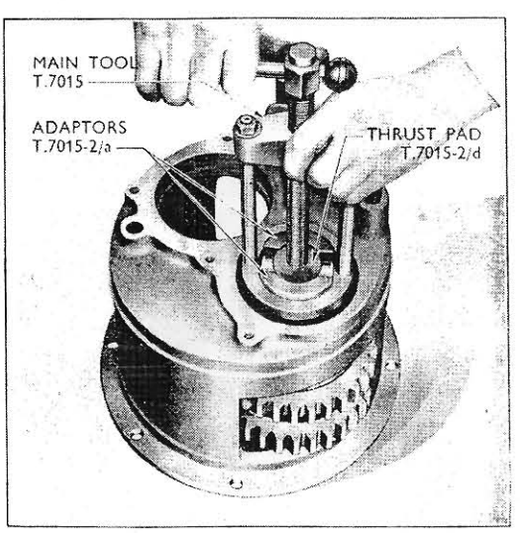


Fig. 15
Removing Primary Lower Shaft

15. Extract the locking wire, withdraw the four securing screws and remove the primary lower shaft end plate. Place the hollow tool T.7028 so that it rests firmly on a piece of wood, with the dog tooth end of the tool against the wood. Invert the housing and place it over the hollow tool with the primary lower shaft located inside the tool and the recessed rear face of the primary lower shaft sliding gear located against the tool upper face. Drive the shaft into the hollow tool. (See Fig. 15.) Remove the housing and extract the power take-off driving gear and lower shaft sliding gear through the cast hole.

16. Remove the primary lower shaft ball bearing from the housing.

Reassembling the "Live" Power Take-Off Primary Gearbox

1. Fit the small roller bearing inner race to the rear of the primary lower shaft.

2. Enter the primary lower shaft ball bearing into the appropriate bore in the front of the housing. Locate the dummy end plate T.7026 in the bearing bore, and push plate and bearing into position until the flange of the dummy end plate is against the front face of the housing. Invert the housing and stand it on the dummy end plate.

3. Ensure that the appropriate circlip is fitted to the groove in the bore of the power take-off driving gear. Place the primary lower shaft sliding gear and the power take-off driving gear in the housing, with hub of the power take-off driving gear against the primary lower shaft ball bearing and the external teeth of the sliding gear adjacent to the power take-off driving gear. This assembly will be facilitated by first entering the sliding gear

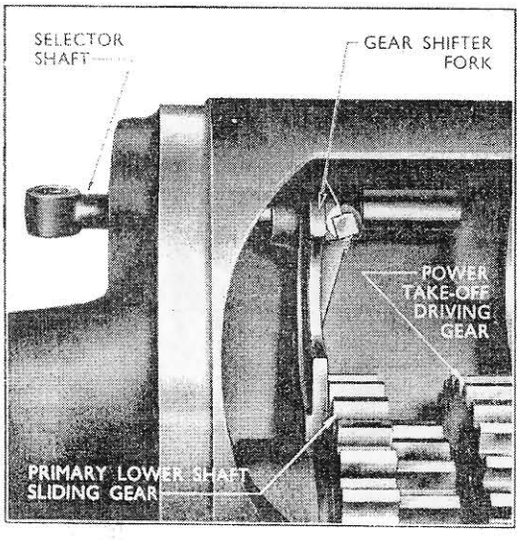


Fig. 16
Gear Shifter Fork Assembly

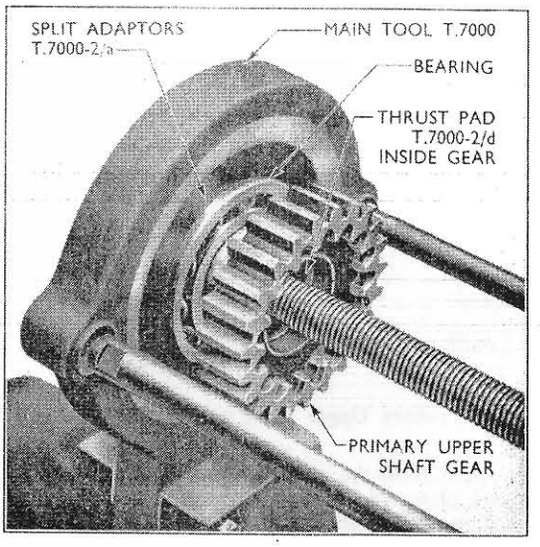


Fig. 17
Replacing Bearing on Primary Upper Shaft Gear

into the housing, positioning the power take-off driving gear, lowering the sliding gear onto it.

4. Pass the primary lower shaft and roller bearing assembly through the sliding gear, taking care not to damage the bush, and pick up the power take-off driving gear on the splines of the shaft. Carefully drive the shaft into the ball bearing until the shaft shoulder abuts the circlip in the power take-off driving gear. Any attempt to drive the shaft beyond this position will result in damage to the circlip, circlip groove and splines.

Note.—It is not necessary to remove the primary lower shaft in order to service the roller bearing inner race, but when assembling this race onto the rear end of the primary lower shaft with the shaft already positioned in the primary gearbox, the end plate must be removed and the shaft supported. This will obviate any tendency for the primary lower shaft to be driven past the correct position as the bearing is replaced. When this operation is completed, replace the dummy end plate tool T.7026 and lightly tap the rear end of the shaft to check that it still abuts the circlip in the power take-off driving gear as previously described.

5. Place the housing on its side, remove the dummy end plate and fit the correct end plate, using a new gasket. Replace the four securing screws, fully tighten and lock with wire. Lightly tap the rear end of the primary lower shaft to ensure that the shaft bearing abuts the spigot of the end plate.

6. Enter the gear shifter fork through the large cast hole in the side of the housing (fork securing screw hole towards the flanged end of housing) and locate the larger radius of the fork in the

machined groove of the primary lower shaft sliding gear. Revolve the fork until it rests against the wall of the housing directly opposite the cast hole. Position the selector spring and ball in the housing. Assemble the selector shaft from the rear of the housing, picking up the gear shifter fork, and move the shaft fully into position with the selector ball engaging in one of the two notches on the shaft. Assembly will be facilitated if a tapered pilot is used to compress the ball and spring ahead of the selector shaft.

Note.—At Engine No. 1435545 a new main drive shaft sliding gear and selector shaft were introduced to improve gear engagement. The change to the gear increased the length of the small external teeth from .38 in. (9.7 mm.) to .44 in. (11.2 mm.), and should it be necessary to replace the previous type gear with one having the longer, small external teeth a current selector shaft must be fitted in place of the one previously used Similarly, a current selector shaft must not be fitted with the previous type main drive shaft sliding gear.

The selector spring and ball hole in the primary gearbox housing was deepened in production by .03 in. (.8 mm.) at Engine No. 1436181 to prevent any possibility of the spring becoming coil bound. Before fitting a selector shaft to any tractor before this engine number it should be ensured that the spring-loaded selector ball can be pressed below the surface of the selector shaft bore in the housing, if necessary deepening the hole by .03 in. (.8 mm.)—**do not exceed this depth**. A zinc-plated selector spring was used initially but a copper-plated spring was introduced for the primary gearbox shortly after the introduction of "Live" power take-off.

7. Move the primary lower shaft sliding gear and shifter fork to bring the tapped hole in the fork into line with the countersunk hole in the selector shaft, fit the shifter fork securing screw, tighten and lock with wire. (See Fig. 16.)

8. Drive the expansion plug, open end outwards, into the selector shaft bore at the front end of the housing. The plug is located when the outer edge is flush with the housing face.

9. Drive the main upper shaft roller bearing cup into the recessed end of the primary upper shaft gear, using tool T.7017 with the 550 handle.

10. Fit the split adaptors T.7000-2/a around the primary upper shaft bearing and install the assembly in Main Tool T.7000. Insert the thrust pad T.7000-2/d in the bore at the gear end of the primary upper shaft gear, position the gear in the bearing bore and press in until fully located. (See Fig. 17.)

11. Push the selector shaft into the innermost position, i.e., with the selector ball located in the second notch from the inner end of the shaft. Place the pulley drive bevel gear in the housing, with the gear hub inside the primary upper shaft bearing bore. Ensure that the Woodruff key is located in the primary upper shaft and assemble the main drive shaft sliding gear onto the primary upper shaft, with the small external gear against the shaft shoulder. Place the shaft and sliding gear in the housing, pass the threaded end of the shaft through the bevel gear bore and locate the sliding gear in the shifter fork.

Note.—See previous note concerning main drive shaft sliding gear under reassembly operation 6. In addition, the current main drive shaft sliding gear has two oil holes drilled through from the root of the large gear teeth as shown in Fig. 18 and only this type of gear should be used on Power Major tractors equipped with "Live" power take-off.

12. Stand the housing on its front face, then position the bevel gear so that the internal gear teeth mesh with the involute dog teeth of the main drive shaft sliding gear. With the shifter fork locating the sliding gear, the primary upper shaft, sliding gear and bevel gear are now positioned for the reassembly of the primary upper shaft gear and bearing assembly.

13. Assemble the primary upper shaft gear and bearing to the housing, adjusting the position of the primary upper shaft to pick up the bore of the gear, and mating the Woodruff key with the

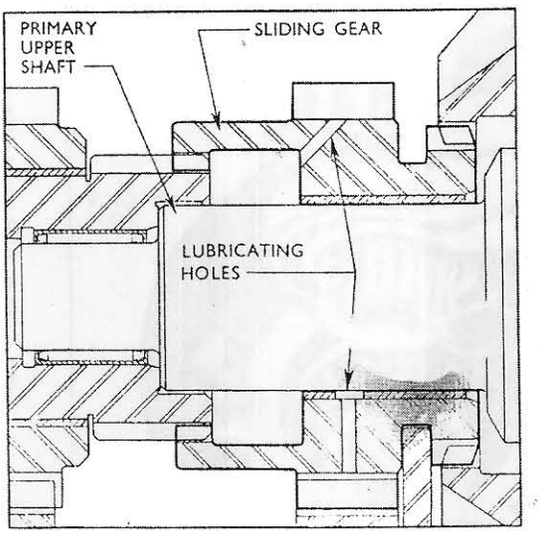


Fig. 18
Section Showing Current Main Drive Shaft Sliding Gear

keyway in the gear. (See Fig. 19.) It is important that the key is correctly aligned as the gear is pushed in, otherwise there is a possibility that the key will be dislodged.

14. Push the gear and bearing assembly into the housing until the end of the gear abuts the bevel gear. Place one hand through the cast hole in the housing, lift the bevel gear and locate it on the splines of the primary upper shaft gear. Hold the bevel gear and lift the primary upper shaft until the threaded end protrudes through the primary upper shaft gear. Fit the locking nut retainer on the threaded end of the shaft, with the small tongue on the retainer locating in the keyway in the primary upper shaft gear. Fit and tighten the locking nut to 100 lbs. ft. (13.8 kg.m.) torque, using the special key tool T.7030. Bend the edges of the retainer into the four slots in the locking nut.

15. Replace the primary upper shaft bearing locking plate and two securing screws. Tighten the screws and lock with wire.

16. Drive the primary lower shaft roller bearing cup fully into position in the main lower shaft, using tool T.7017 with the 550 handle.

17. Place the main lower shaft ball bearing on the larger splined diameter of the main lower shaft and locate the main lower shaft gear, bearing hub first, on the splines. With split adaptors T.7000-2/a installed in Main Tool T.7000, place the above assembly so that the rear face of the gear locates in the adaptors, and press the shaft partially through the gear. Locate the bearing on

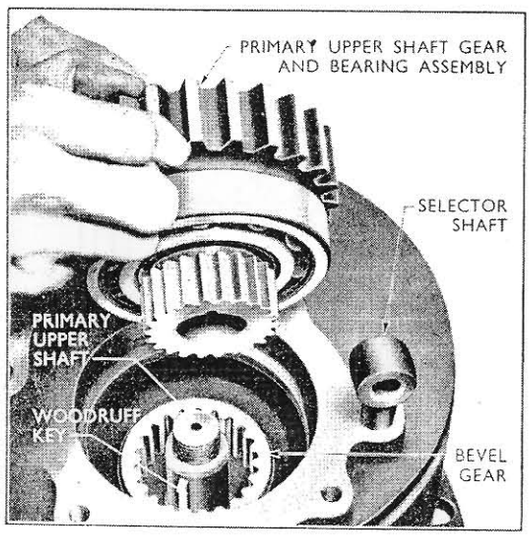


Fig. 19

Installing Primary Upper Shaft Gear and Bearing Assembly

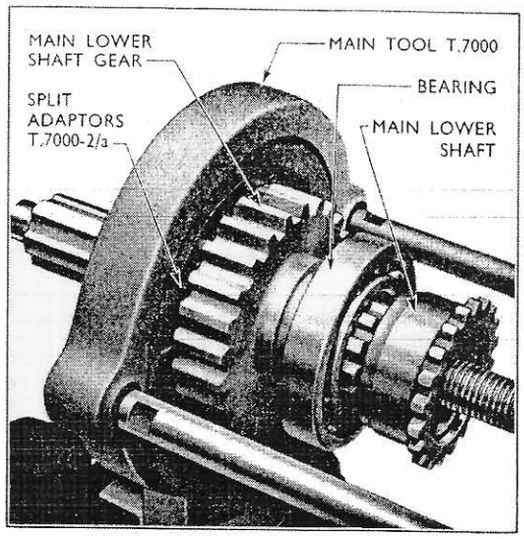


Fig. 20

Replacing Bearing and Gear on Main Lower Shaft

the gear hub and continue to press the shaft through the gear (see Fig. 20) until the bearing is firmly seated between the main lower shaft and the gear hub shoulders. Retain the gear to the shaft with the appropriate circlip.

18. Slide the reverse pinion, gear end first, onto the shaft, followed by the main lower shaft pinion, small flange end adjacent to the flange on the reverse pinion, and carefully tap the roller bearing inner race onto the rear end of the shaft.

19. With the selector shaft still in the innermost position, fit the main lower shaft assembly to the housing. (See Fig. 21.) As the assembly is replaced it may be necessary to turn the shaft in the bearing to align the involute dog teeth on the shaft with the internal gear in the primary lower shaft sliding gear.

20. Replace the main lower shaft bearing locking plate and two securing screws with the square end of the plate towards the selector shaft. Fully tighten the screws and lock with wire.

21. The procedure for the next operation is governed by the presence, or absence, of a transmission brake.

(a) **If a transmission brake is fitted:—**

Check the projection of the reverse idler gear shaft above the face of the raised section at the rear of the housing. This dimension must be 1.20 ins. (30.5 mm.) to 1.23 ins. (31.2 mm.) to give the required clearance between the brake plates necessary to ensure correct operation of the brake. (See Fig. 22.)

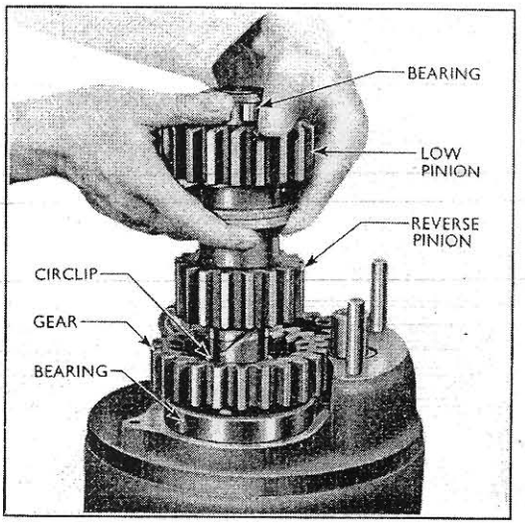


Fig. 21

Installing Main Lower Shaft Assembly

If this dimension is not within these limits, reposition the shaft accordingly.

The brake incorporates seven stationary and five revolving plates; the stationary plates anchor between the pins located one either side of the idler gear shaft and the revolving plates locate on the splined idler gear hub.

Position one stationary brake plate against the face of the housing and slide the reverse idler gear and hub assembly onto the shaft, with the recessed face of the gear against the brake plate. Starting with another stationary brake plate, alternate stationary and revolving plates until the remaining six stationary and five revolving plates are located as described.

Fit the transmission brake shaft through the idler gear shaft, making the assembly from inside the housing. Position the small coil spring and locate the spring retainer on the square portion of the brake shaft, with the locating spigot for the large conical spring away from the housing. Turn the retainer and shaft until the retainer can be anchored between the pins.

Replace the conical spring, with the larger end located on the retainer spigot, and fit the transmission brake adjusting nut. Tighten the nut until the distance from the inner face of the housing front flange to the radiused end of the nut measures 13.870 ins. (352.3 mm.) to 13.895 ins. (352.9 mm.). Lock the transmission brake adjusting nut with a new split pin.

(b) **If no transmission brake is fitted :—**

Check that the idler gear shaft projects from the housing a distance of 1.30 ins. (33 mm.) to 1.31 ins. (33.3 mm.). (See Fig. 22.) This will ensure that the idler gear has .010 ins. (.25 mm.) to .025 ins. (.64 mm.) end-float when assembled. If this dimension is incorrect, reposition the shaft accordingly.

Place the spigoted washer on the idler gear retaining bolt, with the large diameter against the head of the bolt. Fit the bolt through the hollow idler gear shaft, making the assembly from inside the housing, so that the small spigot diameter of the washer locates in the bore of the idler gear shaft.

Place the reverse idler gear in position on the shaft, with the gear hub facing away from the housing, and fit another spigoted washer at the threaded end of the bolt, locating the small spigot diameter in the bore of the idler gear shaft. Fit and fully tighten the self-locking nut.

22. When fitting a new needle roller spigot bearing to the main drive shaft, pass the shaft through the ring adaptor T.7000-7/b until the face of the large spline abuts the adaptor. Install the slave ring in Main Tool T.7000 and place the shaft and adaptors within the slave ring. Locate the bearing on the replacer T.7000-7/a **with the end of the bearing having the stamped identification marking against the shoulder of the replacer,** and position in the tool so that the bearing is adjacent to the main drive shaft bearing bore. (See Fig. 23.) Press the bearing into the bore until the flange face of the replacer abuts the counterbore face in the shaft.

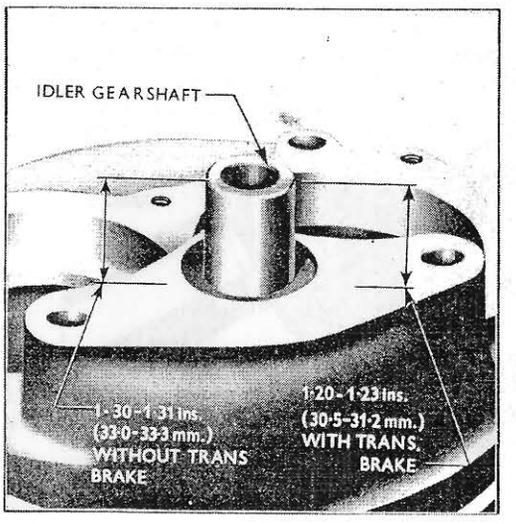


Fig. 22
Reverse Idler Gear Shaft Protrusion

Note.—It is important to adhere to the above procedure when replacing this bearing and it is essential that the bearing should be inserted to the correct depth. **Do not in any circumstances attempt to seat the bearing by forcing it onto the inner face of the bearing bore.**

23. Place the ball bearing and oil seal sleeve (chamfered corner of the outside diameter away from the bearing) onto the power take-off input shaft, followed by the ring adaptor T.7000-6/a, so that the end of the sleeve locates in the counterbore in the adaptor. Fit the slave ring to Main Tool T.7000 and install the ring adaptor and shaft in the slave ring. Place the thrust pad T.7000-6/b in the bore at the gear end of the shaft, press the shaft into the bearing and sleeve (see Fig. 24) and retain with the appropriate circlip.

24. Slide the main drive shaft through the hollow power take-off input shaft until fully located. The main drive shaft should be allowed to "feel" its way into position to prevent damage to the power take-off input shaft bushes.

25. At Engine No. 1493622 a spring-loaded rubber oil seal was introduced to replace the composition oil seal packing and steel retainer used in the bore of the power take-off input shaft. The current rubber seal can be used as a direct replacement for the previous packing and retainer, but in all cases the following procedure must be adopted to ensure that the oil seal is not damaged and that it is inserted to the correct depth in the input shaft.

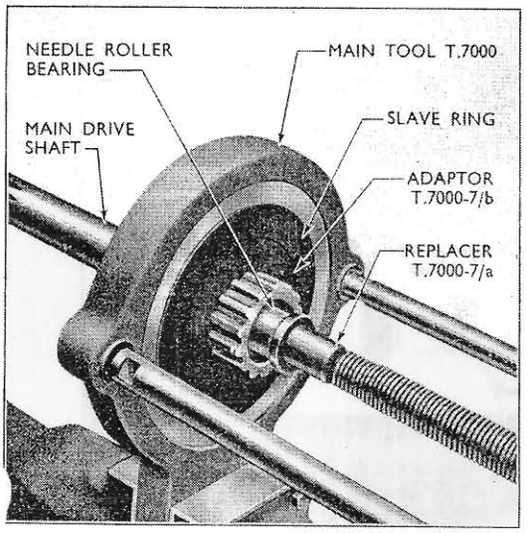


Fig. 23

Installing Needle Roller Spigot Bearing in Main Drive Shaft

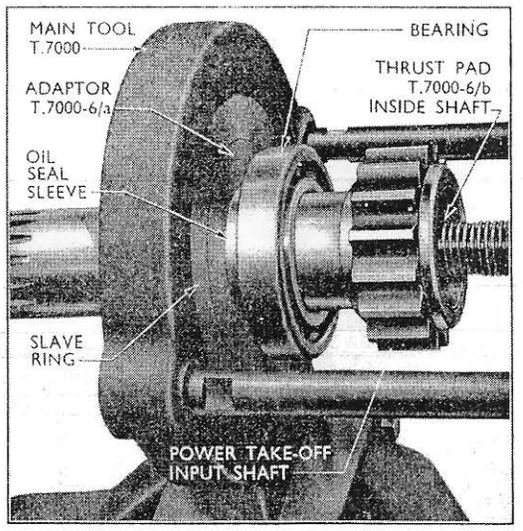


Fig. 24

Replacing Bearing and Oil Seal Sleeve on Power Take-Off Input Shaft

Place the main drive shaft and power take-off input shaft assembly in an upright position with the face of the involute splined diameter of the main drive shaft resting on a suitable piece of wood. Install the driver T.7094/a over the end of the main drive shaft to contact the front bush of the power take-off input shaft and using a hide mallet drive the bush into the shaft until the shoulder of the driver contacts the end of the input shaft. (See Fig. 25 (a).) This relocation of the bush should be necessary only if a composition oil seal packing and retainer were removed at the time of dismantling; current production input shafts have the bush correctly positioned. After ensuring that the power take-off input shaft front bush is correctly located, remove the driver and check that the main drive shaft can be rotated freely within the input shaft.

With the shafts still resting on the piece of wood, remove the protector T.7094/e from the pilot sleeve T.7094/b and fully locate the sleeve on the main drive shaft. **Thoroughly lubricate the oil seal and the outside diameter of the pilot sleeve—this is most important.** Slide the oil seal, sealing lip first, over the sleeve and install the collar T.7094/d against the shoulder of the driver T.7094/a. Locate the driver on the pilot sleeve and, again using a hide mallet, drive the seal into position in the input shaft. The collar and driver ensure that the seal is located at the correct depth in the input shaft (see Fig. 25 (b)) and under no circumstances should the tool previously used to fit the oil seal packing and retainer be used to drive the current seal onto the front bush of the input shaft.

Note.—Having correctly installed the oil seal, the two shafts should be kept in the fully assembled position otherwise the seal may be damaged, particularly if fitted with an early type main drive shaft, and it is recommended that the seal be renewed if the shafts are, for any reason, separated at all. It should, of course, be renewed if there is evidence of oil leakage or if it appears in any way to be worn or damaged.

26. Move the selector shaft to the outermost position and place the gearbox on its side. Ensure that the circlip is positioned in the power take-off input shaft bearing bore (in the gearbox housing), and install the main drive shaft and power take-off input shaft assembly in the housing as one unit.

It will be necessary, as this assembly is replaced, to mesh the power take-off shaft gear with the power take-off driving gear, and then align the involute splines on the main drive shaft with the internal involute splines in the main drive shaft sliding gear. The assembly is fully located when the power take-off input shaft bearing abuts the circlip in the housing bore.

27. When fitting a new oil seal to the power take-off input shaft oil seal retainer, locate the oil seal against the shoulder of tool T.7031, ensuring that the lip of the seal faces towards the shoulder. Assemble the 550 handle to the tool and drive the oil seal onto the shoulder of the retainer counterbore.

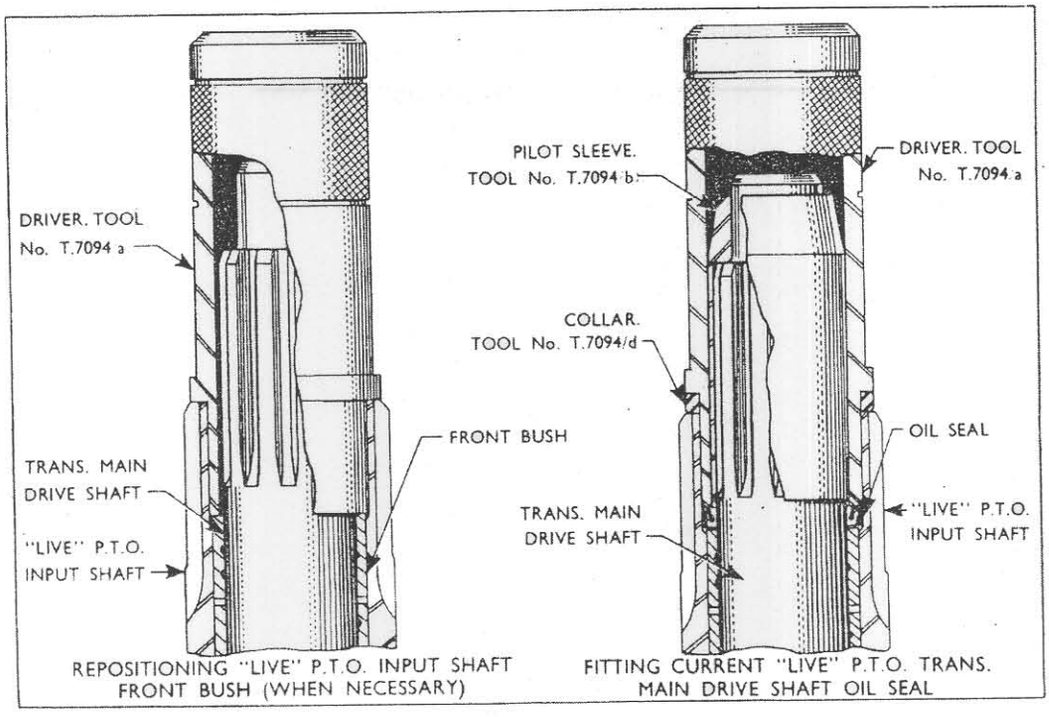
28. Fit a new gasket to the oil seal retainer. Slide the retainer, complete with oil seal, over the power take-off input shaft and locate the spigot diameter in the power take-off input shaft bearing bore. Fit the four securing screws, tighten fully and lock with wire.

Replacement of Primary Gearbox in Front Transmission Housing.

As with the procedure previously outlined for removing the primary gearbox, the following can be applied for replacing any primary gearbox. Where gaskets are used, new ones should be fitted.

1. Place the primary gear lever in the raised position, press the selector shaft in the primary gearbox into the innermost position and install the primary gearbox, using the locating studs CT.6076 as previously described for removal, but do not push the gearbox fully home.

2. Locate the end of the connector lever in the hole in the end of the primary gearbox selector shaft, inside the main transmission housing, and



(a) *(b)*

Fig. 25
Using Tool T.7094

move the primary gear lever downwards to pick up the bore of the connector lever with the primary gear change upper shaft.

3. Push the primary gearbox fully home, secure to the front transmission housing and lock the securing screws with wire.

4. Align the screw hole in the connector lever with the one in the primary gear change upper shaft, secure with the square-headed screw and lock with wire.

5. Fit the main gearbox selector plate assembly, complete with clutch balance lever and clutch release rod, at the same time installing the power take-off engagement lever, and reconnect the clutch pedal to balance lever rod. (See Fig. 9.)

6. Install the belt pulley (if fitted). Using a new sealing ring fit the power take-off housing assembly (the left- and right-centre securing screws are pilot screws), secure the selector housing assembly to the power take-off housing and connect the power take-off engagement lever at the selector shaft. (See Fig. 9.)

7. Re-engage the power take-off extension shaft by pushing it into position from the rear of the tractor and secure in position.

8. Fit the clutch release return spring, fork and cross-shaft to the front transmission housing, securing the fork to the cross-shaft with the crank in the arms facing forward.

9. Install the clutch release bearing and hub assembly and connect the clutch release rod to the release arm. (See "CLUTCH RELEASE BEARING.")

10. Refill the front and rear transmission housings, as necessary, with good quality oil of the correct specification (see note below), and replace the engine and front axle assembly, bearing in mind that on tractors equipped with "Live" power take-off both the main drive shaft and the power take-off input shaft have to be aligned with the splined hubs of their respective clutch discs.

Note.—The oil capacity of the front transmission remains unchanged at 4½ Imp. galls. (20.4 litres) with "Live" or standard power take-off and 4¼ Imp. galls. (19.3 litres) without power take-off. The capacity of the rear transmission is unaltered at 9 Imp. galls. (40.9 litres), but the oil specification for front and rear transmission is now as follows.

Temperature Range	*S.A.E. Viscosity No.*	
Above 20°F (−7°C)	30 H.D.	or 20W/30 H.D.
Below 20°F (−7°C)	20 H.D.	

APPENDIX 1

Power Take-Off Assemblies

With the introduction of " Live " power take-off (Engine No. 1417988), modifications were made to some parts of the power take-off assembly to enable it to be used on tractors with " Live " power take-off as well as without. To provide clearance for the primary lower shaft sliding gear of the " Live " power take-off primary gearbox the power take-off housing had added to the rear support lug, carrying the idler gear shaft, a similar chamfer to the one already machined on the front lug. For the same reason, the power take-off idler gear was machined on the long boss to reduce the outside diameter, the idler gear being previously unmachined at this location.

Subsequently, with the introduction of the Power Major another power take-off assembly was introduced to accommodate the additional power developed by the Power Major engine. This assembly uses a different idler gear with two needle roller bearings, in place of the bushes previously used. (See Fig. 26.) The larger internal diameter of the needle roller bearings necessitates a slightly larger diameter idler gear shaft, identifiable by the oil drillings as shown in Fig. 26, which in turn necessitates an increased bore size in the power take-off housing to accommodate the shaft.

Both the above power take-off assemblies are available, and three different assemblies may therefore be encountered in service, as detailed below.

1. Original type used on tractors prior to Engine No. 1417988, on which the housing and idler gear are suitable only for tractors without " Live " power take-off up to the introduction of the Power Major. All other parts are completely interchangeable.

2. Modified type introduced at Engine No. 1417988, on which the housing, idler gear and idler gear shaft are suitable only for tractors with or without " Live " power take-off up to the introduction of the Power Major. All other parts are completely interchangeable.

3. The current type with the housing, idler gear, idler gear bearings and idler gear shaft which **must** be used on Power Major tractors with or without " Live " power take-off. All other parts are completely interchangeable.

If it is required to fit new needle roller bearings to the idler gear of the latter type power take-off assembly, place the gear in ring adaptor T.7000-27/a and install the assembly in Main Tool T.7000. Assemble one of the needle roller bearings on the replacer T.7000-27/b, with the end carrying the identification marking against the shoulder of the replacer, and locate in the entrance to the bore of the gear. Rotate the centre screw of the main tool to press the bearing into position. Remove the replacer, reverse the gear in the ring adaptor and repeat the operation to assemble the opposite bearing.

Primary Gear Shift Lever and Housing

The primary gear shift lever and housing used on Power Major tractors with or without " Live " power take-off are suitable only for the re-styled control panel used on this model, and are not interchangeable with the previous type.

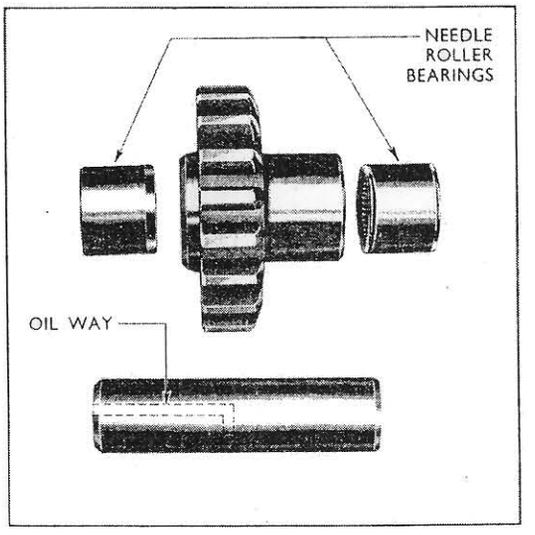


Fig. 26

Power Take-Off Idler Gear, Bearings and Shaft Used on Power Major Tractors

CLUTCH/GEARBOX

Whilst the internal components of clutch and gearbox used on the Super Major are identical with those previously used, the fact that the footplates are raised higher than on previous models has necessitated the introduction of a new clutch pedal which is common to standard and " Live " P.T.O. Super Major tractors. A new pedal stop bracket has also been introduced.

With these changes the clutch pedal free travel has been standardised at 1½ to 2 ins. (38.1 to 50.8 mm.) for all Super Major tractors, whether fitted with standard or " Live " P.T.O.

The procedure for adjusting this free travel on " Live " P.T.O. Super Major tractors has also been standardised with that by which the single clutch pedal free travel is obtained, i.e. by adjusting the length of the clutch release rod in the following manner :—

1. Loosen the clutch release rod clevis locknut and remove the pin securing the clevis to the balance lever.

2. Adjust the length of the release rod until the pedal free travel is 1½ to 2 ins. (38.1 to 50.8 mm.). Tighten the locknut after adjustment.

3. If a double clutch is fitted, ensure that the pedal stop pin is removed from the stop bracket, start the engine, engage the P.T.O. and check that the P.T.O. ceases to rotate when the clutch pedal is fully depressed. Shorten the effective length of the release rod as necessary to obtain this condition.

4. Fit the stop pin to the lower hole in the stop bracket, depress the pedal onto the stop pin and check that gear changing can be effected without excessive clutch spin. Further shortening of the release rod may be necessary if excessive spin is evidenced.

REAR AXLE

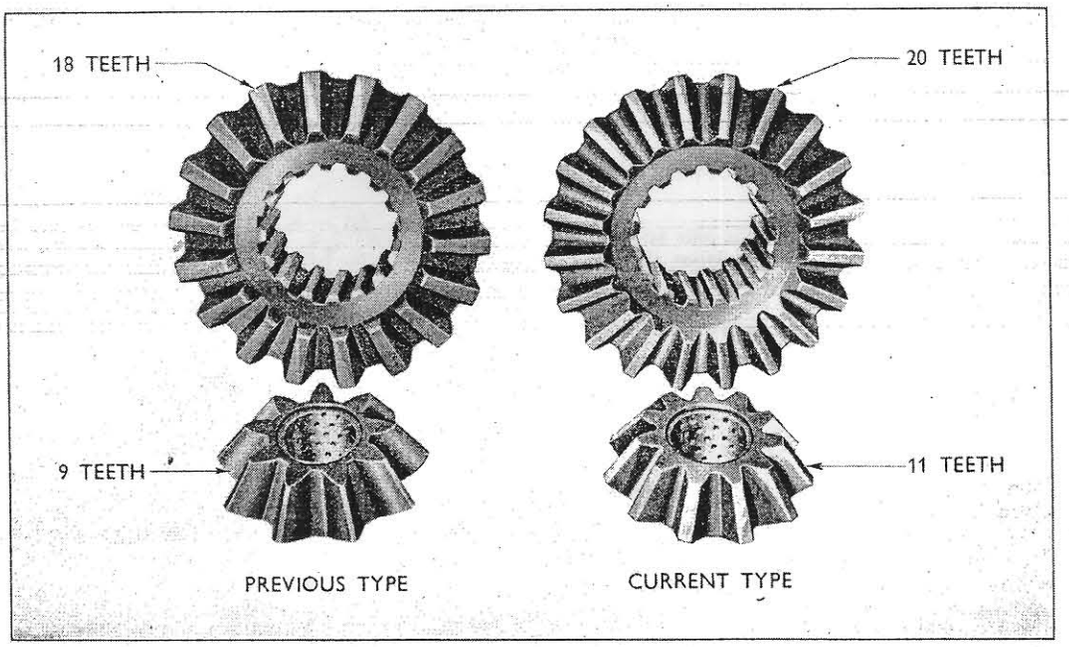


Fig. 1

Differential Side Gears and Pinions

DIFFERENTIAL ASSEMBLY

Various changes have been made to the components of the differential assembly since the inception of the Fordson Major in 1952. Servicing of early assemblies is simplified however by the fact that only the strengthened and redesigned parts as fitted to the Fordson Power Major are supplied in service.

The parts that were redesigned—the differential side gears and pinions—have more teeth than the previous parts (differential side gear—20 as against 18, and the pinion—11 as against 9, as shown in Figure 1). The side gear thrust washer was also changed from brass to bronze to give greater resistance to wear consistent with the heavier loading.

Only the latest type of pinions, side gears and thrust washers should be used on the Power Major, but where dealers have stocks of previous parts they may be used on tractors prior to the Power Major.

Where the latest type parts are used as replacements for previous type parts they must be used in sets, i.e., the new pinions and side gears must not be mixed with the previous type.

CROWN WHEEL AND DIFFERENTIAL CASE

To obviate the necessity of replacing the complete crown wheel and differential case assembly when only one of the parts requires renewal, a separate differential case assembly, and crown wheel and pinion assembly were made available in service in August 1956 and they are suitable for use on all Fordson Major and Power Major Tractors.

Special retaining bolts, spacers and self-locking nuts are also available to replace the twelve rivets which have to be removed when separating the differential case from the crown wheel (see Fig. 2).

To Remove the Crown Wheel and Differential Assembly

1. Drain the rear axle oil by removing the drain plug in the underside of the housing.

2. Support the rear of the tractor on jacks or lifting tackle, and remove the left-hand rear wheel.

3. Disconnect the side and rear lamp wires and remove the left-hand mudguard and footplate as an assembly.

4. Disconnect the brake cable from the left-hand brake operating lever.

5. Remove the locking wire and six bolts securing the left-hand bull pinion and brake extension housing assembly to the rear axle housing, and remove the bull pinion and brake extension housing assembly.

The two lower bolts retain the brake cable conduit support.

6. Remove the split pins and clevis pins and disconnect the hydraulic lifting rods from the lift arms.

7. Remove the driver's seat assembly (four bolts, flat washers and spring washers).

8. Unscrew the retaining bolts securing the hydraulic ram cylinder housing to the rear axle housing and remove the ram cylinder housing.

9. Remove the vertical feed pipe from the top of the hydraulic pump.

10. Unscrew the three retaining bolts and lockwashers securing the hydraulic pump to the pedestal, and remove the pump.

11. Remove the split pin and castellated nut (left-hand thread) securing the left-hand large reduction gear to the axle shaft, using the special wrench (Tool No. T.4065) as shown in Fig. 3.

12. Lift the lips of the left-hand rear axle shaft oil seal retainer from the outer end of the rear axle shaft housing, and partially withdraw the left-hand axle shaft from the housing so that the large reduction gear may be removed.

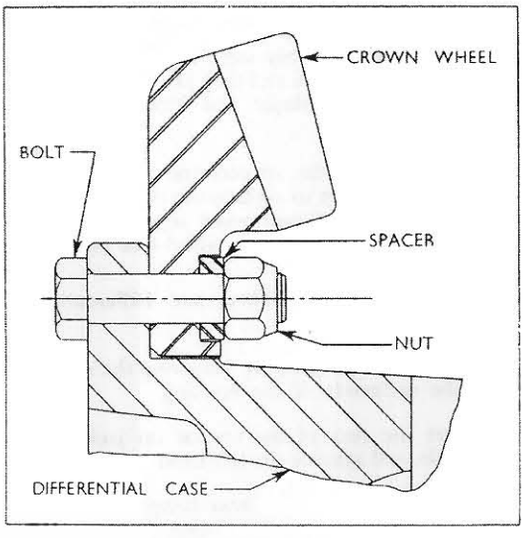


Fig. 2

Crown Wheel and Differential Case Bolts

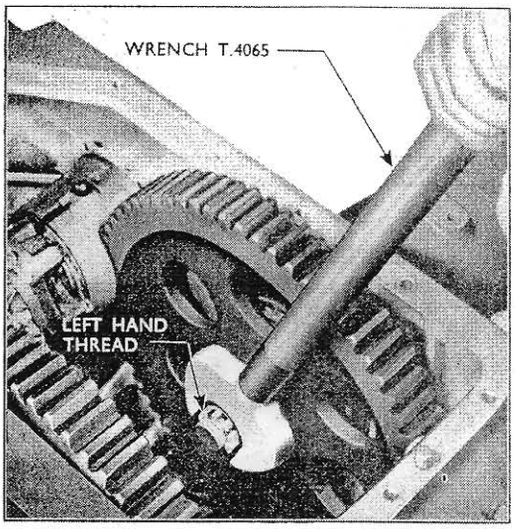


Fig. 3

Removing the Large Reduction Gear

13. Unscrew the three bolts securing the oil deflector assembly and remove the oil deflector assembly. (See Fig. 6.)

14. Withdraw the left-hand bull pinion housing from the axle housing. If necessary, removal of the bull pinion housing may be facilitated by use of two bolts inserted in the tapped holes provided.

Note the thickness of shims fitted between the rear axle and bull pinion housing as the same thickness must be replaced on reassembly.

15. Remove the crown wheel and differential assembly from the rear axle housing.

To Dismantle the Crown Wheel and Differential Assembly

1. Ensure that the two halves of the differential case have mating marks and remove the eight wired bolts.

2. Lift off the top half of the differential case and remove the differential spider, gears, pinions and thrust washers. (See Fig. 4.)

To Remove the Crown Wheel from the Differential Case

1. With the crown wheel and differential case assembly securely held, centre punch the upset end of each of the twelve retaining rivets, i.e., on the gear side of the crown wheel.

2. Drill pilot holes into each of the twelve rivets with a drill of approximately $\frac{1}{8}$ in. (3.2 mm.) diameter, using the centre punch marks as a guide.

3. Using a drill of $\frac{1}{2}$ in. (12.7 mm.) diameter, drill along the pilot holes until the hardened face of the crown wheel is reached.

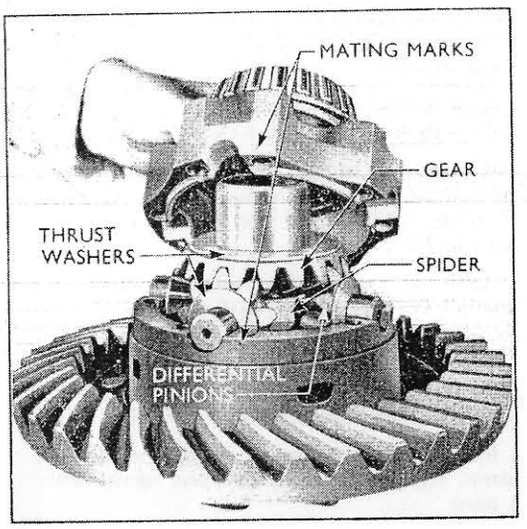


Fig. 4

Assembling the Crown Wheel and Differential

Note.—Drilling the rivets completely out may enlarge the holes.

4. Drift out the remainder of the rivet using a drift of approximately $\frac{3}{8}$ in. (9.5 mm.) diameter.

To Reassemble the Crown Wheel to the Differential Case

1. Thoroughly clean and inspect the part which is to be used again, taking care to ensure that the mating face is free from burrs.

2. Assemble the crown wheel to differential case with the spacers, bolts and nuts as shown in Fig. 2.

3. Tighten down the nuts evenly to a torque of 40 to 45 lbs. ft. (5.53 to 6.22 kg.m.).

To Reassemble the Crown Wheel and Differential Assembly

1. Position the larger part of the differential case on the bench with the crown wheel gear teeth facing upwards.

2. Fit a washer to the differential gear (only use bronze type thrust washers on the Power Major bronze or brass may be used on the Major), and place in position in the differential case.

3. Fit a pinion and thrust washer on each arm of the spider and locate it in position in the differential case.

4. Fit a thrust washer to the remaining differential gear and place it in position on the pinions so that the gear is in mesh with the pinions.

5. Re-locate the top part of the differential case with the mating marks in line, replace the eight retaining bolts, and tighten to a torque of 65/75 lbs. ft. (8.98/10.37 kg.m.). Wire the heads of the bolts securely.

To Replace the Crown Wheel and Differential Assembly

1. Relocate the crown wheel and differential assembly in the rear axle housing with the teeth on the crown wheel in mesh with those on the drive pinion.

2. Fit the locating studs (Tool No. PT 4063) to the rear axle housing and refit the left-hand bull pinion housing, together with the same thickness of shims as were removed, and secure with two bolts.

3. Using feeler gauges, check the backlash between the crown wheel and drive pinion, which should be .004 in.—.018 in. (.102—.457 mm.).

The backlash can be adjusted by moving the shims that are interposed between the bull pinion and rear axle housing, from one side of the axle housing to the other. It must be remembered, however, that at all times the total shim thickness must be .016 in. (.407 mm.), to ensure correct pre-load on the differential bearings.

If the backlash is not within the limits stated it will be necessary to remove the right-hand bull pinion housing (adopt a similar procedure to that detailed for the left-hand bull pinion housing), and adjust the thickness of shims under the housing flanges, i.e., if the backlash exceeds .018 in. (.457 mm.) removing shims from the left-hand side and fitting them under the right-hand side will decrease the backlash.

If the backlash is less than .004 in. (.102 mm.), moving shims from the right-hand to the left-hand side bull pinion housing will increase the backlash.

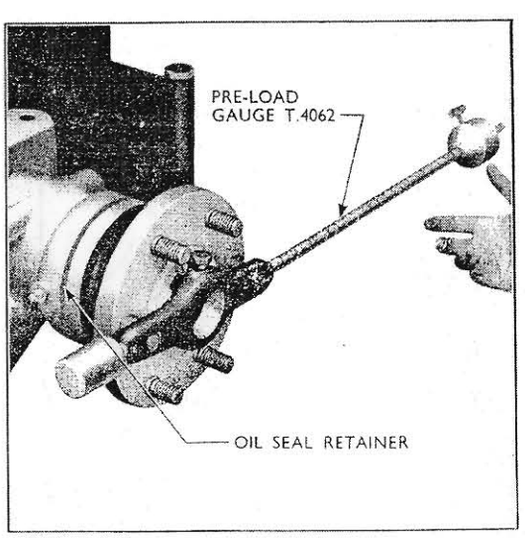


Fig. 5
Checking Axle Shaft Pre-Load

If the backlash is adjusted by the transference of shims, it will also be necessary to check the clearance between the crown wheel and the thrust pad, which should be .004 to .014 in. (.102 mm. to .356 mm.). The clearance may be adjusted by adding or removing gaskets between the thrust pad and rear axle housing to increase or decrease the clearance as required.

4. Position the large reduction gear in the rear axle housing and reposition the left-hand axle shaft, until the axle shaft splines enter those in the large reduction gear.

5. Secure the shaft to the gear with the castellated nut, using the special wrench (Tool No. T.4065) and then pre-load the axle shaft bearings to 40-45 in. lbs. (.460-.518 kg.m.), using the pre-load gauge (Tool No. T.4062) as shown in Fig. 5. Securely split pin the castellated nut.

6. Stake the axle shaft oil seal retainer to the axle shaft housing.

7. Replace the left-hand bull pinion and brake extension housing assembly and secure with six bolts. Wire the bolt heads securely. The lower two bolts also secure the brake cable conduit support.

8. Refit the oil deflector assembly to the bull pinion housing and secure with three bolts and spring washers. Check for .004 in. (.102 mm.) clearance between the oil deflector plate and the periphery of the crown wheel, adjust, if necessary, by moving the plate in the elongated holes. (See Fig. 6.)

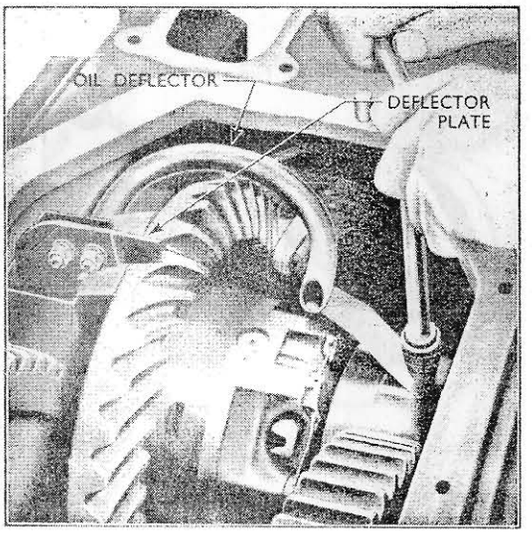


Fig. 6
Oil Deflector Plate

9. Reconnect the brake cable to the left-hand brake operating lever, replace the clevis pin and split pin securely.

10. Replace the hydraulic pump and secure in position with three bolts and lockwashers.

11. Replace the vertical feed pipe in the port in the hydraulic pump, ensuring that new rubber "O" rings are fitted to the upper and lower grooves in the pipe.

12. Refill the axle housing with approximately 9 Imperial Gallons (10.8 U.S. Gallons, 41 litres) of the correct grade of oil, up to the "high" mark on the dipstick.

13. Relocate the hydraulic ram cylinder on the rear axle housing and replace the retaining bolts.

14. Reconnect the hydraulic lifting rods to the lift arms, replace the clevis pins and secure with split pins.

15. Replace the driver's seat assembly and secure in position with four bolts, spring washers and flat washers.

16. Replace the left-hand mudguard and foot plate as an assembly. Reconnect the side and rear lamp wires.

17. Replace the left-hand rear wheel and remove the lifting tackle or jacks.

REAR AXLE SHAFTS AND HOUSINGS

To provide additional strength when extremely heavy auxiliary equipment is mounted on the tractor a modified axle shaft was introduced as a production option effective with approximate tractor number 1406540. At the same time the axle shaft housing flange thickness was increased from approximately .6 in. (15.2 mm.) to .8 in. (20.3 mm.). The modified shaft is machined slightly smaller than standard at the grease retainer location and gives a larger blending radius into the axle shaft flange, thus relieving stresses set-up at this point.

To compensate for the reduction in diameter a bearing abutment sleeve was also introduced, together with a new grease retainer and felt.

The strengthened axle shaft may be used as a replacement for the previous type without changing the axle housings, if it is so desired. It should, however, be remembered that the new abutment sleeve and grease retainer assembly must also be fitted.

The strengthened rear axle housing may also be interchanged with the previous type.

LUBRICATION

Extensive testing has proved that a lighter grade of oil than previously specified may be used on all Fordson Major and Power Major Tractors produced since 1952.

For service the specification is as follows:—

Temperature Range	*S.A.E. Viscosity Number*	
Above 20°F (—7°C)	30 H.D.	or 20W/30 H.D.
Below 20°F (—7°C)	20 H.D.	

DIFFERENTIAL CASE BUSHES

Effective with approximate tractor number 1367376 the two parts of the differential case assembly were fitted with bushes at the side gear location.

To assist the installation of these bushes in service, it is recommended that a driver be made locally to the dimensions shown in Figure 7.

This driver will ensure that the bush is installed to the correct depth, i.e., with the inner edge of the bush flush with the bottom of the chamfer on the inside of the housing.

The bush is pre-sized and no reaming is necessary after assembly, but care must be taken not to close it in during fitting and so prevent the gear rotating freely.

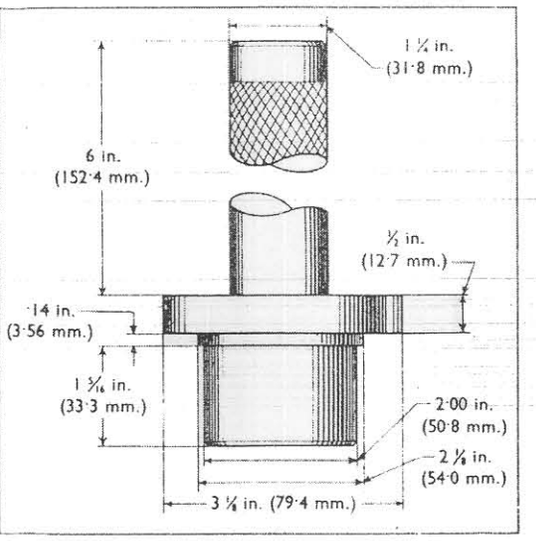


Fig. 7
Differential Case Bush Driver

REAR TRANSMISSION

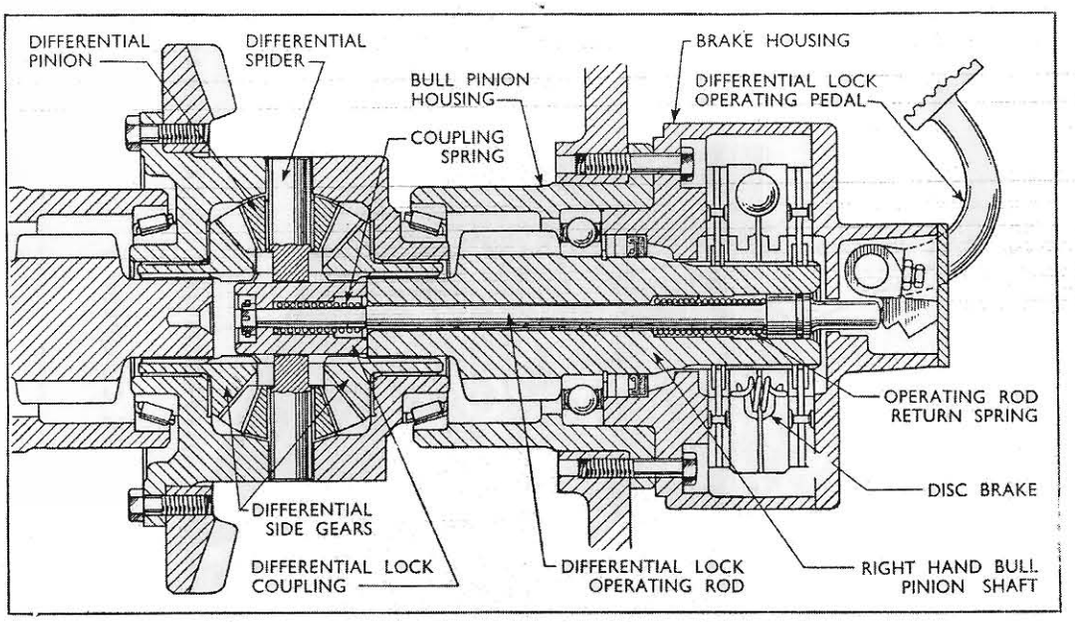


Fig. 8
Differential Lock

Although the basic gear train function is unchanged, considerable redesigning of the rear transmission differential has taken place to enable a locking device to be incorporated (see Fig. 9) and the opportunity has been taken to generally strengthen the differential components. At the same time the bull pinion extension housings have been discontinued as the disc brakes fitted to the Super Major are mounted directly onto the side of the transmission housing.

Transmission Housing

A new rear transmission housing, incorporating a modified top flange to locate the hydraulic lift inlet and exhaust pipes, is used on the Super Major. The overall dimensions and mounting points have, however, been retained and the new housing can, therefore, be used on previous Major tractors.

Differential Lock

Where conditions occur whereby one rear wheel encounters a soft patch, without a differential lock this wheel will have a tendency to spin, nearly all the drive being taken to this wheel and relatively little to the other wheel, with the result that the tractor is either considerably slowed down or comes to a complete halt.

The differential lock fitted to the Super Major overcomes this disability and enables additional traction to be obtained from the wheel which is on firm ground, thus enabling the tractor to pull through the soft patch.

The differential locking arrangement is illustrated in Fig. 8, and consists of an externally splined sliding coupling locating in the internal splines of the right-hand differential side gear. The coupling is of sufficient length to enable engagement to be also made with the internal splines of the left-hand differential side gear when it is moved axially by a foot pedal mounted on the right-hand disc brake cover.

A spring loaded plunger, passing through the central bore of a new type right-hand bull pinion shaft, connects the sliding coupling with a cam which, in turn, is connected to the foot pedal.

In operation, depression of the foot pedal rotates the cam and moves the plunger and sliding coupling to the left, thus locking the left- and right-hand differential side gears together. The differential gears and pinions are then unable to rotate independently and the drive is thereby equally distributed to both rear wheels.

If the splines of the coupling and left-hand side gear are not completely aligned when the foot pedal is depressed, engagement will not take place immediately, but the operating plunger will continue to move to the left thus compressing the coupling spring (Fig. 8). This spring remains in compression until the splines on the relative parts are aligned, when it will automatically move the coupling into engagement with the left-hand side gear.

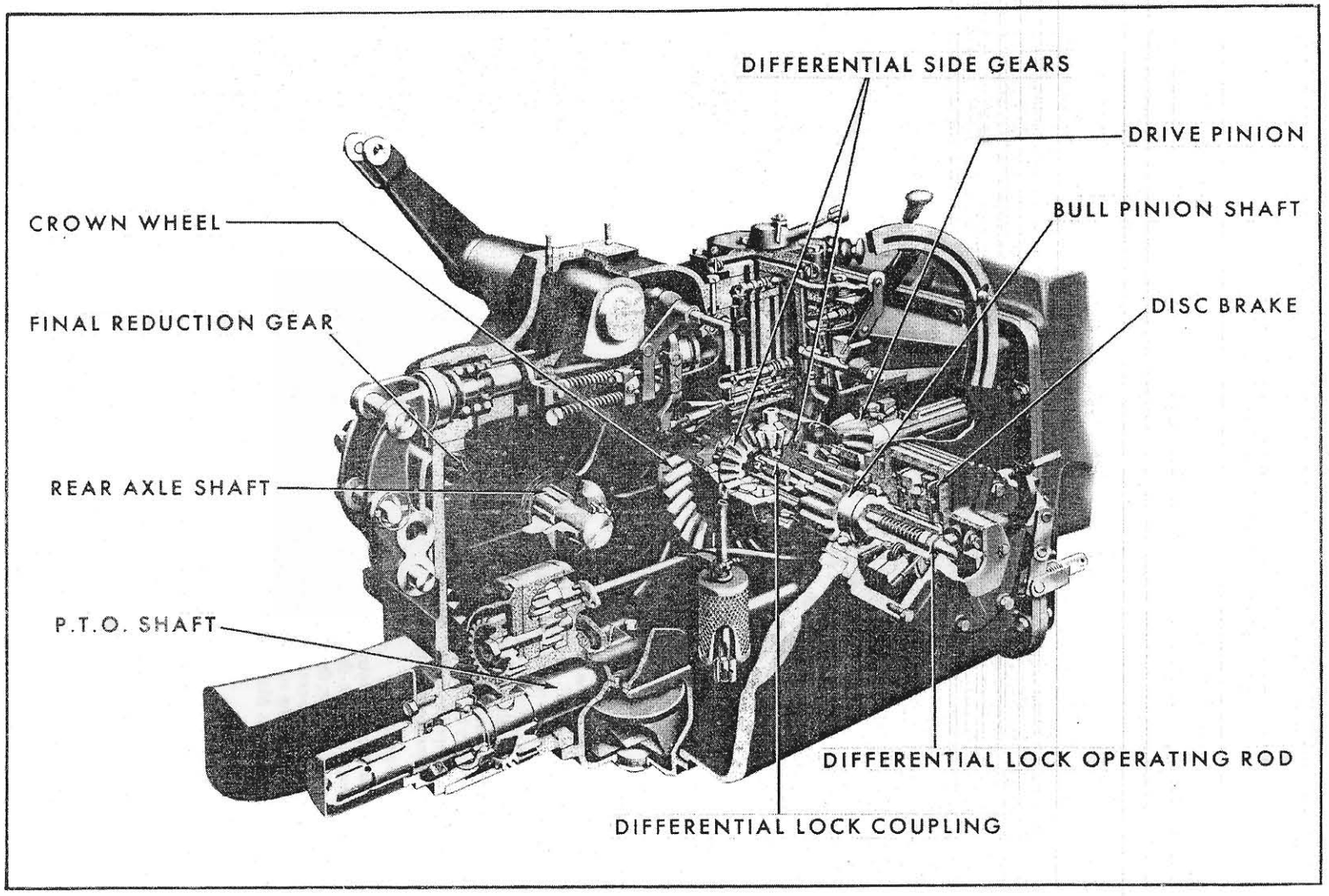


Fig. 9 **Sectioned View of Rear Transmission**

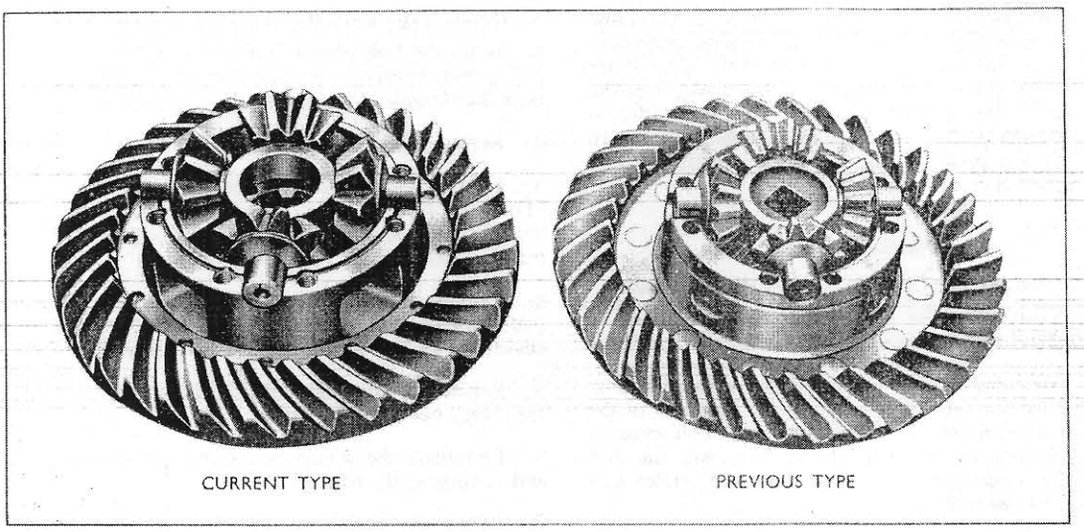


Fig. 10
Crown Wheel and Differential Assembly with Right-hand Casing Removed

Differential Assembly

Quite apart from the locking device a completely new differential assembly (Fig. 10) is used on the Super Major, none of the parts being interchangeable with those used on previous Major tractors. Generally speaking, every component is larger than its counterpart on the previous Major and, in addition, the number of teeth on the side gears has been changed from 20 to 16, and those on the pinions from 11 to 9.

To compensate for the increased overall width of the differential casing the supporting taper roller bearings have been decreased in width but increased in diameter, necessitating new bull pinion housings to accept the new bearing cups.

Crown Wheel

The new crown wheel (larger internal bore to suit the Super Major differential case, but with the same number of gear teeth as previously used) is secured to the left-hand differential casing by twelve self-locking bolts—as against the previous rivetted method of retention. The larger diameter differential casing flange has also necessitated a modified crown wheel thrust pad.

Bull Pinions and Final Reduction Gears

The introduction of disc brakes, still operating on the bull pinion shafts but fitting directly onto the transmission housing, has obviated the necessity of fitting brake extension housings and, in consequence, the bull pinion shafts are shorter than those previously used, also the right-hand shaft is hollow to accept the differential lock operating rod.

Each bull pinion shaft is now supported at its centre by a bearing within the bull pinion housing and at its inner end by the differential side gear.

Changes in tooth form of the large reduction gears mean that the Super Major parts are not interchangeable with those previously used.

Lubrication

To provide improved lubrication of the drive pinion bearings, a new scraper and trough assembly (see Fig. 11) collects oil from the periphery of the crownwheel and directs it into the drilled passage in the front wall of the transmission housing, where it is fed into the space between the drive pinion taper roller bearings.

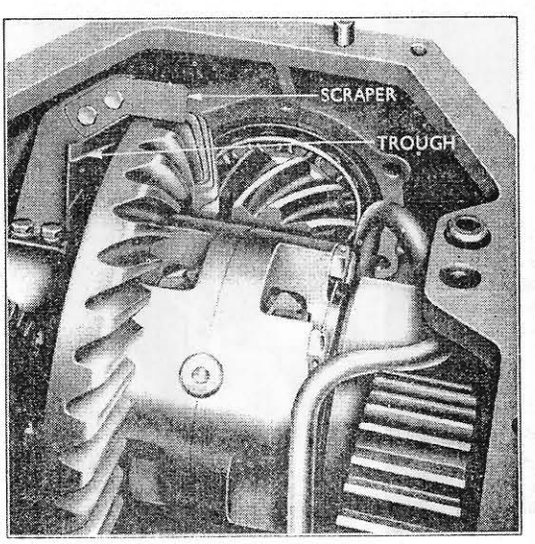


Fig. 11
Oil Scraper and Trough

The new scraper assembly locates in the same position as the scraper, box and oil pipe previously used to feed oil to the differential. The latter assembly is not required on the Super Major as the larger " windows " incorporated in the new differential casings permit oil, forced from between the crown wheel and pinion teeth, to be fed directly into the differential components.

REPAIR PROCEDURE

To Remove the Left-Hand Bull Pinion Shaft

1. Disconnect the battery and the wiring, to the left-hand side and tail lamp.

2. Disconnect the clutch pedal return spring. Remove the four bolts securing the platform to the platform bracket and brake housing, the bolt securing the fender to the platform bracket, and the two fender mounting bolts. Remove the fender and platform as an assembly.

3. Remove the left-hand brake cover, disconnect the brake actuating linkage and remove the brake discs and actuating plates assembly from the brake housing.

4. Remove the six self-locking bolts securing the brake housing to the rear transmission housing, and withdraw the brake housing taking care not to disturb the bull pinion housing and shims during this operation.

5. Remove the oil baffle from the bull pinion shaft bearing, and withdraw the bull pinion shaft from the bull pinion housing, once again taking care not to disturb the bull pinion housing and shims.

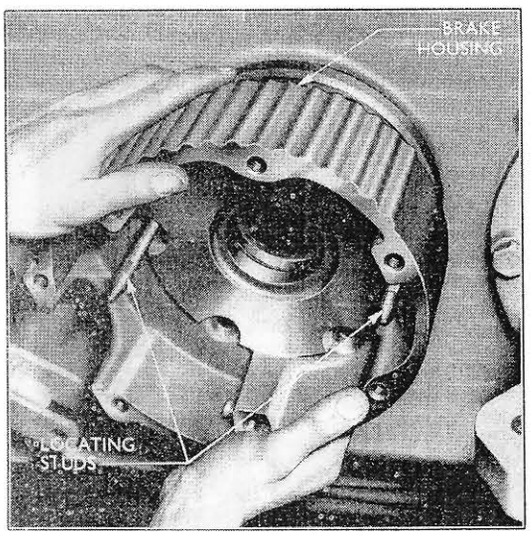


Fig. 12
Replacing Brake Housing

To Replace the Left-Hand Bull Pinion Shaft

1. Insert the bull pinion shaft and bearing into the bull pinion housing, ensuring that the bearing contacts the shoulder within the bull pinion housing.

2. Replace the bull pinion shaft oil baffle.

3. Fit the two bull pinion housing locating studs (Tool No. PT.4063) and replace the brake housing (see Fig. 12), tightening the six self-locking bolts to a torque of 55-65 lb./ft. (7.61-8.99 kg.m.).

4. Replace the brake inner friction disc, actuating plates assembly, outer friction disc and brake housing cover then re-connect the brake actuating linkage.

5. Replace the platform and fender assembly and the clutch pedal return spring.

6. Reconnect the wiring to the tail and side lamp and re-connect the battery.

7. Adjust the brakes as described in the Super Major Supplement Section 8.

To Renew the Left-Hand Bull Pinion Shaft Bearing

1. Remove the left-hand bull pinion shaft as previously described.

2. Remove the bearing retaining circlip, and drive the bearing from the shaft using a suitable drift located between the teeth of the bull pinion.

3. Fit a new bearing to the bull pinion shaft and secure the bearing in position by means of a new circlip.

4. Replace the bull pinion shaft as described above.

To Remove the Right-Hand Bull Pinion Shaft and Differential Lock Assembly

1. Disconnect the battery and the wiring to the right-hand side and tail lamp.

2. Remove the four bolts securing the platform to the platform bracket and brake housing, remove the bolt securing the fender to the platform bracket and the two bolts securing the fender to the rear axle housing. Remove the fender and platform as an assembly.

3. Remove the brake cover and differential lock operating pedal assembly, disconnect the brake actuating linkage and remove the brake discs and the actuating plates assembly from the brake housing.

4. Remove the six brake housing retaining bolts and withdraw the brake housing, taking care not to disturb the bull pinion housing and shims during this operation. Remove the oil baffle from the bull pinion shaft bearing.

5. Withdraw the bull pinion shaft and differential lock assembly once again taking care not to disturb the bull pinion housing.

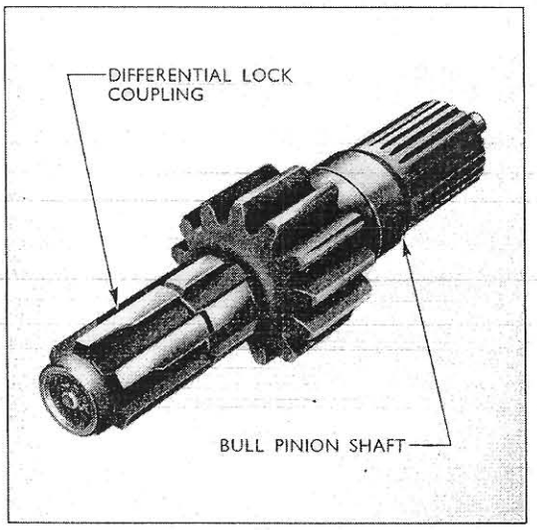


Fig. 13
Differential Lock Coupling Spline Alignment

To Replace the Right-Hand Bull Pinion Shaft and Differential Lock Assembly

1. Align the splines of the differential lock coupling with the splines on the inner end of the bull pinion shaft as illustrated in Fig. 13. Insert the bull pinion shaft and differential lock assembly into the bull pinion housing so that the differential lock coupling and the end of the bull pinion shaft engage with the right-hand differential side-gear.
2. Replace the bull pinion shaft bearing oil baffle.
3. Fit the two bull pinion housing locating studs (Tool No. PT4063) and replace the brake housing, tightening the six self-locking bolts to a torque of 55-65 lb./ft. (7.61-8.99 kg.m.).
4. Replace the brake discs, actuating plates assembly and brake housing cover and reconnect the brake actuating linkage and differential lock operating pedal assembly.
5. Replace the fender and platform assembly, reconnect the wiring to the side and tail lamp and reconnect the battery.
6. Adjust the brake as described in the Super Major Supplement Section 8.

To Dismantle the Right-Hand Bull Pinion Shaft and Differential Lock Assembly

1. Remove the bull pinion shaft and differential lock assembly as described on page 10.
2. Remove the split pin and castellated nut from the inner end of the differential lock operating rod and remove the differential lock coupling, coupling spring and thrust washer.
3. Withdraw the operating rod and return spring from the bull pinion shaft.
4. Remove the bull pinion shaft bearing retaining circlip and drive the bearing from the shaft by means of a suitable drift.

To Reassemble the Right-Hand Bull Pinion Shaft and Differential Lock Assembly

The illustration, Fig. 14, shows an exploded view of the bull pinion shaft and differential lock assembly.

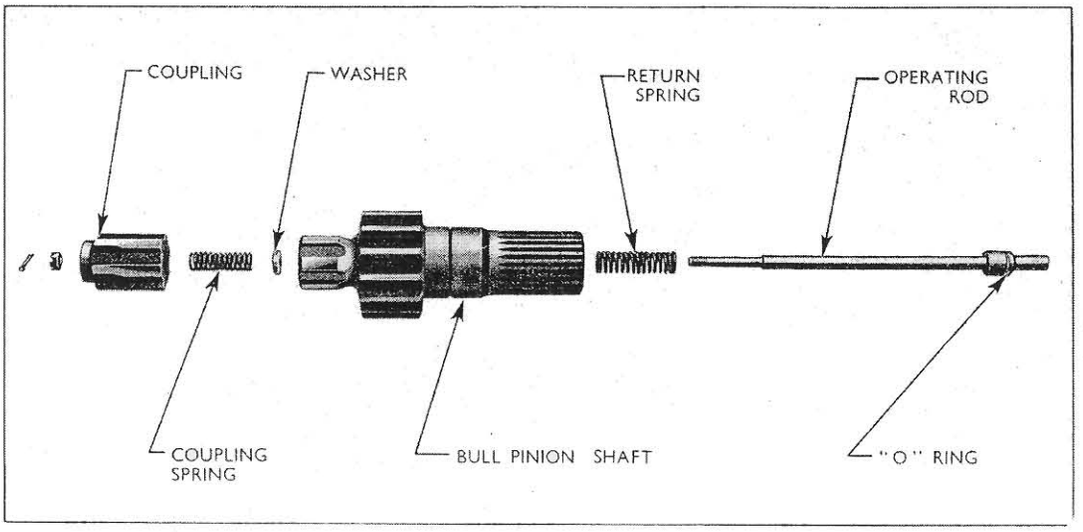


Fig. 14
Bull Pinion Shaft and Differential Lock Assembly

1. Replace the bull pinion shaft bearing and fit a new bearing retaining circlip.
2. Fit a new " O " ring to the outer end of the operating rod and insert the return spring and operating rod into the bull pinion shaft.
3. Replace the thrust washer, coupling spring and coupling on the inner end of the operating rod.
4. Replace the castellated nut to retain the coupling and, by means of this nut, adjust the protrusion of the differential lock operating rod from the outer end of the bull pinion shaft to 1.30-1.32 in. (33.02-33.53 mm.) as illustrated in Fig. 15.
5. Fit a new split pin to lock the castellated nut at the end of the operating rod, ensuring that the split pin does not project beyond the end of the coupling.
6. Replace the bull pinion shaft and differential lock assembly as described on page 10.

To Overhaul the Differential Lock Operating Pedal

1. Remove the brake housing cover and differential lock operating pedal assembly.

2. Remove the two bolts securing the operating lever cover plate and remove the cover plate.

3. Drive the pin from the cross shaft retaining collar and remove the collar.

4. Slacken the locking nut and remove the grub screw from the operating pedal. Withdraw the operating pedal and cross shaft, and remove the lever.

5. Drive out the pin securing the pedal to the cross shaft and remove the pedal from the cross shaft.

6. Inspect the cross shaft bearing bushes and fit new bushes if necessary.

7. Fit the pedal to the cross shaft ensuring that the pedal is fitted to the correct end of the shaft. This may be checked by noting the position of the dimple in which the grub screw locates.

8. Insert the cross shaft into the front bearing and position the operating lever so that the shaft may be passed through the lever and lever bearing.

9. Replace the grub screw and lock nut to secure the lever to the cross shaft.

10. Replace the locking collar and fit a new pin to secure the collar to the shaft.

11. Replace the operating lever cover plate.

12. Replace the brake housing cover and differential lock operating pedal assembly to the brake housing, and secure by means of the seven bolts and spring washers.

To Remove a Rear Axle Shaft

1. Disconnect the battery and wiring to the tail lamp.

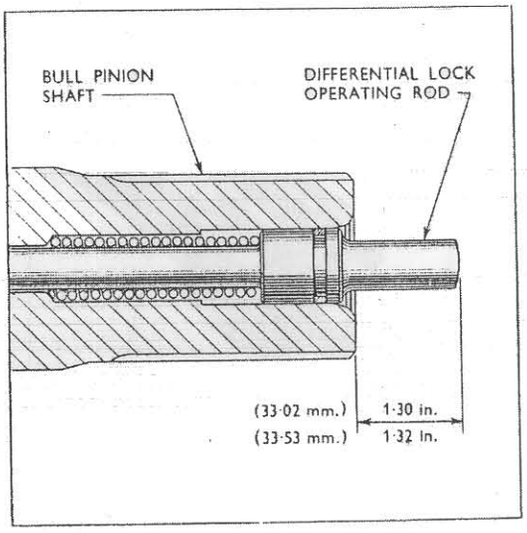


Fig. 15
Differential Lock Operating Rod Adjustment

2. Remove the rear transmission housing top cover plate and seat, or if hydraulic power lift is fitted, remove the hydraulic lift top cover and lifting rods.

3. Jack up the rear of the tractor and remove the appropriate rear wheel.

4. Lift the edge of the rear axle shaft oil seal retainer at the three points where it is peened over into the groove in the rear axle shaft housing.

5. Remove the split pin and castellated nut securing the final reduction gear to the rear axle shaft, support the final reduction gear and withdraw the rear axle shaft from the axle shaft housing.

To Replace a Rear Axle Shaft

1. Support the final reduction gear with its bearing cone located in the bearing cup at the inner end of the rear axle shaft housing and insert the axle shaft complete with bearing, oil seal and oil seal retainer into the axle housing. Engage the splines on the rear axle shaft with the splines in the final reduction gear.

2. Replace the final reduction gear retaining nut (left hand thread), initially tightening the nut until there is no end-float on the shaft.

   To adjust the rear axle shaft bearing preload it is necessary to remove the bull pinion shaft as described on page 10. Locate the preload gauge (Tool No. T.4062) on two of the wheel retaining bolts and by means of the final reduction gear retaining nut, adjust the bearing preload to 45 lb. in. (6.23 Kg.m.).

3. Replace the split pin to secure the final reduction gear retaining nut and " stake " the oil seal retainer, at diametrically opposite points, into the retaining groove in the axle shaft housing.
4. Replace the wheel and remove the jack.
5. Fit a new gasket to the top face of the rear transmission housing and replace the rear transmission housing top cover or hydraulic lift top cover and lifting rods if fitted.
6. Replace the seat, connect the wiring to the tail lamp and reconnect the battery.

To Renew a Rear Axle Shaft Outer Bearing Cone or Oil Seal

1. Remove the rear axle shaft as described on page 12.
2. Insert the " U " shaped portion of the bearing remover (Tool No. T.4061), behind the bearing cone; it will be necessary to distort the oil seal retainer in order to position the tool correctly. Withdraw the bearing from the shaft, taking care that the side rods of the tool are not allowed to twist during this operation.
3. Remove the oil seal and retainer from the shaft.
4. Fit a new oil seal and felt to a new oil seal retainer and locate the retainer on the shaft.
5. Draw the new bearing cone onto the shaft using Tool No. T.4059.
6. Replace the rear axle shaft and adjust the bearing preload as described on page 12.

To Remove the Final Reduction Gear

1. If H.P.L. is fitted, drain the oil from the rear transmission housing and remove the hydraulic lift top cover and hydraulic pump as described in the Super Major Supplement Section 6.
2. Remove the rear axle shaft as described on page 12.
3. Lift the final reduction gear from its location in the rear transmission housing.

To Replace the Final Reduction Gear

1. Support the final reduction gear within the rear transmission housing with the bearing cone located in the bearing cup in the rear axle shaft housing.
2. Replace the rear axle shaft as described on page 12.
3. Replace the hydraulic pump, if fitted, before replacing the hydraulic lift top cover.

To Remove a Rear Axle Shaft Housing

1. Drain the oil from the rear transmission housing or lower the oil level until it is below the rear axle shaft housing.
2. Remove the rear axle shaft as described on page 12.
3. Disconnect the check chain from the check chain bracket and remove the fender.
4. Remove the rear axle housing retaining bolts and withdraw the axle housing from the rear transmission housing.

To Replace the Rear Axle Shaft Housing

1. Fit the two rear axle housing locating studs (Tool No. CT.6076), to the rear transmission housing, fit a new gasket and replace the rear axle shaft housing.
2. Replace the rear axle shaft and adjust the bearing preload as described on page 12.
3. Replace the fender and connect the check chain to the check chain bracket.
4. Fill the rear transmission housing to the correct level with the appropriate grade of oil.

To Renew the Rear Axle Shaft Housing Bearing Cups and Final Reduction Gear Bearing Cone

1. Remove the rear axle shaft and rear axle shaft housing as described on page 12.
2. Locate the split adaptors T.4060-1a behind the final reduction gear bearing cup and withdraw the bearing cup using main tool No. T.4060.
3. Remove the axle shaft bearing cup using split adaptors T.4060-1b and main tool T.4060.
4. Fit new rear axle shaft and final reduction gear bearing cups using tool No. T.4055. The bearing cups may be fitted simultaneously using this tool.
5. Remove the final reduction gear from the rear transmission housing.

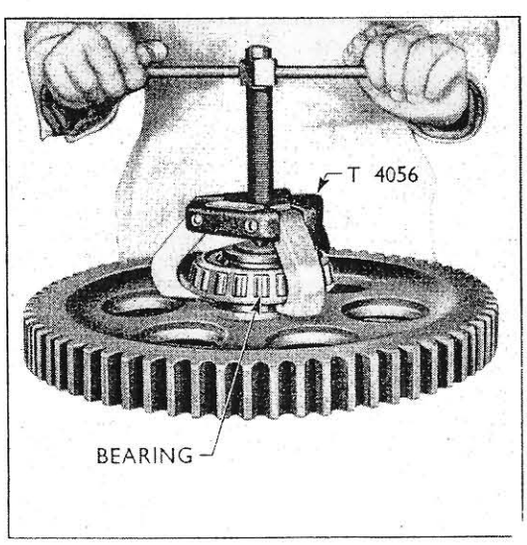


Fig. 16
Removing Final Reduction Gear Bearing

6. Remove the bearing cone from the final reduction gear using the three clawed bearing remover (Tool No. T.4056), as illustrated in Fig. 16. Before removing the bearing ensure that the claws of the tool are correctly located behind the bearing in order to avoid damage to the tool.

7. Fit a new bearing cone to the final reduction gear using the bearing replacer adaptor T.4057 with the 550 handle.

8. Replace the final reduction gear within the rear transmission housing.

9. Replace the rear axle housing and rear axle shaft as described on page 12.

To Remove the Crown Wheel and Differential Assembly

1. Remove the left-hand bull pinion shaft, right-hand bull pinion shaft and differential lock assembly and the left-hand final reduction gear.

2. Remove the oil scraper and trough from the left-hand bull pinion housing.

3. Remove the three bolts which retain the crown wheel thrust pad and withdraw the thrust pad.

4. Remove the hydraulic oil feed pipe, return pipe and filter, if fitted, as described in the Super Major Supplement Section 6.

5. Support the crown wheel and differential assembly and withdraw the left-hand bull pinion housing and shims.

6. Lift the crown wheel and differential assembly from the rear transmission housing.

To Replace the Crown Wheel and Differential Assembly

1. Fit the two bull pinion housing locating studs (Tool No. PT.4063) to the left-hand side of the rear transmission housing.

2. Fit the bull pinion housing shims over the locating studs. Enter the inner end of the bull pinion housing into the rear transmission housing.

3. Support the crown wheel and differential assembly with the right-hand differential case bearing cone located in the bearing cup in the right-hand bull pinion housing and slide the left-hand bull pinion housing into position to engage the left-hand differential bearing cup with the bearing cone.

4. Securely bolt the left-hand and right-hand bull pinion housings to the rear transmission housing and check the backlash between the crown wheel and drive pinion by means of a feeler gauge inserted between the teeth. The specified backlash is .004-.018 in. (.102—.457 mm).

5. If necessary, adjust the position of the crown wheel and differential assembly to bring the backlash within the specified limits. Adjustment of the backlash is achieved by repositioning the shims behind the flanges of both bull pinion housings. Note that the total thickness of shims should at all times be .016 in. (.406 mm) in order to maintain the correct preload on the differential case bearings.

6. Replace the crown wheel thrust pad and check that the clearance between the thrust pad and the crown wheel is within the specified limits of .004-.014 in. (.102—.356 mm). Adjustment of this clearance is effected by varying the number of gaskets behind the flange of the thrust pad.

7. Replace the oil scraper and trough and adjust the clearance between the scraper and the crown wheel to .004 in. (.102 mm).

To Dismantle the Crown Wheel and Differential Assembly

1. Remove the crown wheel and differential assembly as previously described.

2. Inspect the differential casing to ensure that both halves of the casing have mating marks adjacent to the joint face. If no mating marks are present, the casing should be marked before commencing to dismantle.

3. Remove the eight wire locked bolts which secure the right-hand half of the casing to the left-hand half.

4. Lift off the right-hand half of the casing and remove the right-hand side-gear and thrust washer.

5. Remove the differential spider complete with the four pinions and thrust washers. Remove the pinions and thrust washers from the spider.

6. Remove the side gear and thrust washer from the left-hand differential casing.

7. If necessary drive the bearing cones from the differential casings by means of a punch located in the holes behind the bearings.

Note that if the bearing cones are renewed, the bearing cups within the bull pinion housings should also be renewed.

8. If necessary, remove the twelve self-locking bolts securing the left-hand differential casing to the crown wheel and withdraw the casing from the crown wheel.

9. Inspect the differential case bushes for wear or damage and, if necessary, renew the bushes as described on page 15.

To Reassemble the Crown Wheel and Differential Assembly

1. Replace both differential case bearing cones ensuring that they locate against the shoulder on the differential casings.

2. Refit the left-hand differential case to the crown wheel and secure by means of the twelve self-locking bolts, tightening the bolts to a torque of 45-55 lb./ft. (6.2-7.6 kg.m.).

3. Replace the left-hand thrust washer and differential side-gear ensuring that the thrust washer is correctly located in its recess in the casing.

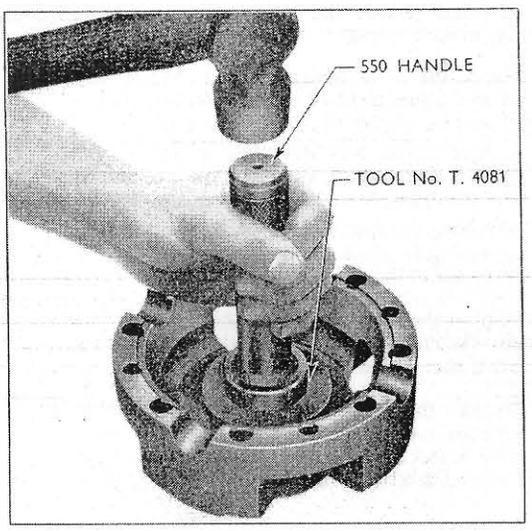


Fig. 17
Replacing Differential Case Bush

4. Fit the four pinions and thrust washers to the spider and replace the assembly in the left-hand differential casing.

5. Replace the right-hand side-gear and thrust washer in the right-hand differential case.

6. Locate the right-hand differential casing and side-gear on the left-hand casing with the mating marks correctly aligned.

7. Check that both side-gear thrust washers are located correctly. Replace, tighten and wire lock the eight bolts securing the two halves of the differential casing.

8. Replace the crown wheel and differential assembly as described on page 14.

To Renew the Differential Case Bushes

1. Remove and dismantle the crown wheel and differential assembly as previously described. Note that it is not necessary to separate the crown wheel and left-hand differential case.

2. Drive the damaged or worn bushes from the two halves of the differential case taking care not to damage the surface of the bore of the differential casing which houses the bushes.

3. Drive the new bush into the differential casing using Tool No. T.4081 with the 550 handle as illustrated in Fig. 17. The bush should be driven into position from the inside of the differential casing until the large diameter shoulder of the tool contacts the machined thrust washer face of the casing.

4. Re-assemble and replace the crown wheel and differential assembly.

To Overhaul the Drive Pinion and Bearings Assembly

1. Separate the engine and front transmission from the rear transmission housing as described in Section 3.

2. Remove the crown wheel and differential assembly as described on page 14.

3. Before removing the pinion assembly, straighten the tabs of the locking washer and slacken the drive pinion locking nut, and adjusting nut using adjusting nut wrenches (Tool No. T.4067).

4. Remove the six drive pinion housing retaining bolts and withdraw the drive pinion and bearings assembly from the rear transmission housing. It may be necessary to drive the assembly from the rear transmission housing; this can be accomplished by using a drift located on the drive pinion housing. Under no circumstances should the drive pinion and bearings assembly be driven from its location by striking the drive pinion as this could result in damage to the rear bearing.

5. Remove the nuts, thrust washer and lock washer then withdraw the drive pinion and rear bearing cone from the drive pinion housing. The front bearing cone will then be released.

6. Withdraw the front and rear bearing cups from the drive pinion housing using Tool No. T.4060 and adaptors T.4060-2.

7. Remove the rear bearing cone from the drive pinion using main Tool No. T.7000 with the clawed ring adaptor T.7000-22.

8. Renew any parts which may be worn or damaged. Note that if it is necessary to fit a new drive pinion it

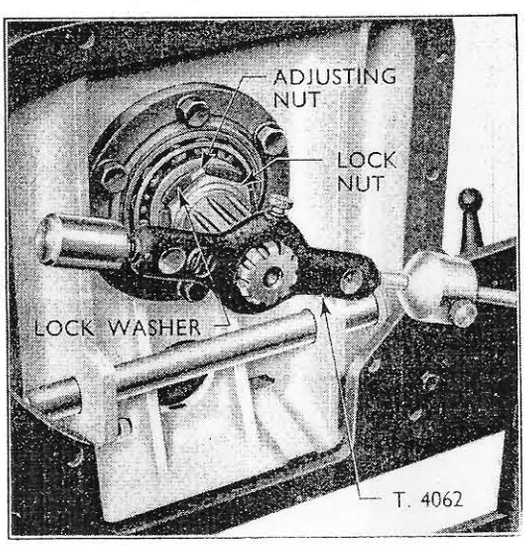


Fig. 18
Checking Drive Pinion Bearing Pre-load

ill also be necessary to fit a new crown wheel as ese parts are manufactured as a matched assembly.

Bearing cups and cones should also be renewed as an assembly.

9. Replace the drive pinion rear bearing cone using tool number T.7000 with the adaptor ring T.7000-22.

10. Fit both the front and rear drive pinion bearing cups to the drive pinion housing using Tool No. T.4060 and adaptors T.4060-2.

11. Insert the drive pinion into the pinion housing and replace the front bearing cone and thrust washer.

12. Replace the drive pinion bearing adjusting nut and position the nut so that the pinion is just free to rotate in its bearings. Fit a new locking washer and replace the locking nut, but do not tighten the locking nut.

13. Fit the drive pinion and bearings assembly to the rear transmission housing using guide studs CT.6076 and replace the six bolts securing the assembly to the housing.

14. Check the drive pinion bearing preload (see Fig. 18) and adjust to 12-16 lb./in. (1.66-2.07 kg.m.) using Tool Nos. T.4067, T.4064 and T.4065.

The drive pinion is held by the splined wrench Tool No. T.4064 whilst adjusting the preload by means of the drive pinion lock nut wrenches T.4067.

After setting the bearing preload, tighten the locking nut and again check the preload. Lock the two nuts by means of the locking washer tabs.

15. Replace the crown wheel and check the backlash between the crown wheel and pinion. Adjust the backlash if necessary as described on page 14.

16. Replace the bull pinion shaft, brake assembly, platform and rear transmission housing cover plate, adjust the brakes and fill the rear transmission housing to the correct level with the appropriate grade of oil.

HYDRAULIC SYSTEM

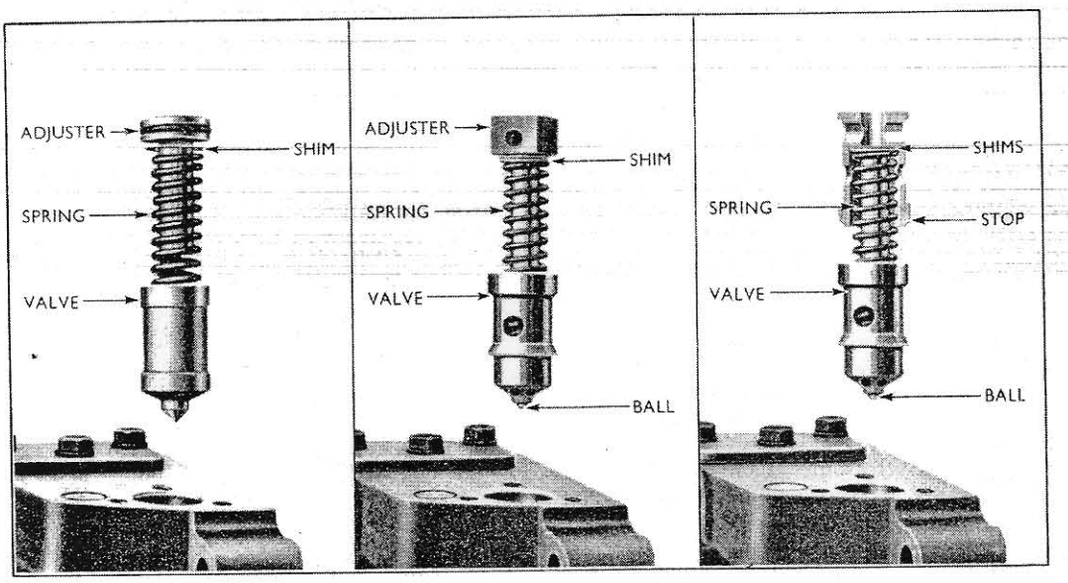


Fig. 1

Hydraulic Power Lift Unloading Valve Assemblies

Only three items on the Hydraulic Power Lift have been affected by changes since the introduction of the Major tractor and details of these modifications together with revised testing instructions are contained in this section.

It is however important to note that the hydraulic unit uses the rear transmission lubricant, the specification of which was changed in January, 1959, to S.A.E. 20 W/30 H.D. for all Major (1952 onwards) tractors.

Unloading Valve and Valve Chest

Effective 100'. with the Power Major the unloading valve was redesigned in order to minimise the tendency of the valve to " blow off " under the application of sudden heavy loads.

The change in the valve also involved changes in dimensions of the valve locating bore and oil passages in the valve chest.

Effective with Engine No. 1502511 further changes were made by deleting the square-headed adjuster and introducing a stop sleeve to limit the movement of the valve and obviate the possibility of the ball becoming displaced and " jamming " under the valve.

Fig. 1 shows the three types of valve which may be encountered and the following points should be noted:—

1. The valve assembly shown at (a) is still serviced for original type hydraulic units, i.e., valve, spring, adjuster and shim are suitable only for the original type unit.

The valve body is no longer serviced and it will be necessary to fit the current type body and valve assembly should the body require replacement.

2. The adjuster shown at (b) is no longer serviced and neither this assembly nor that shown at (c) can be used on a previous type hydraulic unit unless the valve chest is also changed.

This assembly may however be converted to the current type by discarding the adjuster and fitting the current stop and shims. The spring, valve and ball are identical on (b) and (c) type assemblies and the shims used at (b) may be modified for use with the (c) assembly providing the outside diameter of the shims is reduced to .68 in. (17.27 mm.).

Testing the H.P.L. Unloading Valve

The unloading valve is set to open at 2000-2200 lbs./sq in. (140.6—154.7 kg./sq. cm.) and care must be taken that this pressure is not exceeded. When fitting new parts or adjusting the opening pressure of the unloading valve it is essential that pressure testing equipment is installed so that accurate adjustment can be made.

Fig. 2 illustrates the installation when using approved testing equipment T.8503 and shows an oil feed being taken from the jack tapping and returned through the rear axle filler plug hole. An adjustable restrictor valve is inserted in the feed line to control the rate of flow and a pressure gauge is fitted to the pressure side of the restrictor valve.

It cannot be too strongly emphasised that absolute cleanlines is essential when carrying out any work on the hydraulic power lift and it is a wise precaution to rinse the parts removed in cleaning fluid to ensure that all traces of swarf and dirt are removed before reassembly and to carry out the assembly operations whilst the parts are still wet.

Before carrying out any checks the tractor should be operated to bring the transmission oil up to its normal operating temperature, after which the following procedure should be adopted.

1. Remove the jack tapping plug and install the " T " piece of the pressure testing equipment. To prevent excessive loss of oil, the lift arms should be lowered before removing the jack tapping plug.

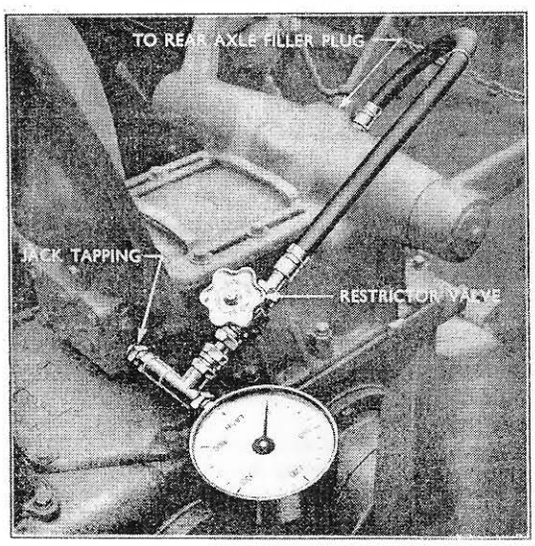


Fig. 2
Hydraulic Power Lift Testing Equipment

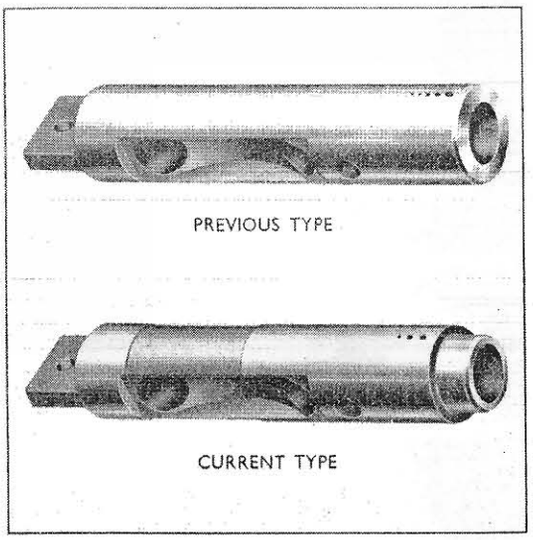


Fig. 3
Control Valve Pistons

2. Mount the pressure gauge in the outer end of the " T " piece and assemble the feed pipe and restrictor valve in the right-angled leg of the " T " piece.

3. Remove the rear transmission filler plug and install the rear end of the feed pipe.

4. Engage the P.T.O.

5. Fully open the restrictor valve.

6. Start the engine and run at a fast idle.

7. Hold the hydraulic lift valve control lever in the " raised " position and gradually close the restrictor valve. If the restrictor valve is progressively closed the pressure will rise until such time as the unloading valve opens when the pressure will immediately drop. " Flick over " of the pressure gauge needle will be very slight, providing the valve is closed **slowly** and an accurate reading will then be possible.

If the pressure is low, shims may be added above the spring, but arbitary adjustment of this nature should never be carried out in this manner. Increase the pressure gradually by adding a small number of shims each time and always pressure test after each addition is made.

Control Valve Piston

Effective with Engine No. 1384132 the control valve piston was modified to provide quicker lowering of the lift when used with light implements and trailers.

On previous units five graduated holes at the inner end of the valve allowed oil to be returned from the ram cylinder during the lowering cycle, the rate depending on the position of the control lever and in consequence the area of holes uncovered.

The modification consisted of the machining of an annular relief instead of the two inner holes (see Fig. 3) thus allowing a more rapid return of the oil.

The maximum rate of return only was affected by this change, the remaining three holes providing an adjustable rate in accordance with the positioning of the control lever.

Hydraulic Single Acting Valve Coupling Kit

This kit consists of a pipe connected into the jack tapping on the hydraulic power lift valve unit, the other end of the pipe being connected to the male half of a self-sealing coupling mounted on a bracket at the rear of the hydraulic power lift ram cylinder housing. (See Fig. 4.) In this position the rear tapping of the self-sealing coupling is readily accessible, allowing quick and easy connection of hydraulic feed pipes from implements, tipping trailers, etc.

An adaptor is provided so that the jack tapping on the hydraulic power lift valve unit will accept the union nut and ferrule on the pipe assembly, but care must be taken to make certain that the adaptor is fitted the correct way round in the jack tapping, i.e., chamfered inner seat outwards, thus ensuring a good seat for the ferrule on the pipe assembly. The support bracket fits under the head of one of the bolts securing the hydraulic power lift ram cylinder housing to the rear transmission housing. (See Fig. 4.)

Should the self-sealing coupling require attention in service, remove the locking spring and unscrew the valve from the valve body. The sleeve assembly and the valve spring can then be removed for inspection and replacement, if necessary. When re-assembling, always use a new "O" ring on the sleeve assembly and ensure that the valve is fully tightened in the valve body. The valve is retained in the body by means of a locking spring, which must be located in one of the drillings in the body and the slot in the end of the valve (see Fig. 5) to prevent the valve from working loose.

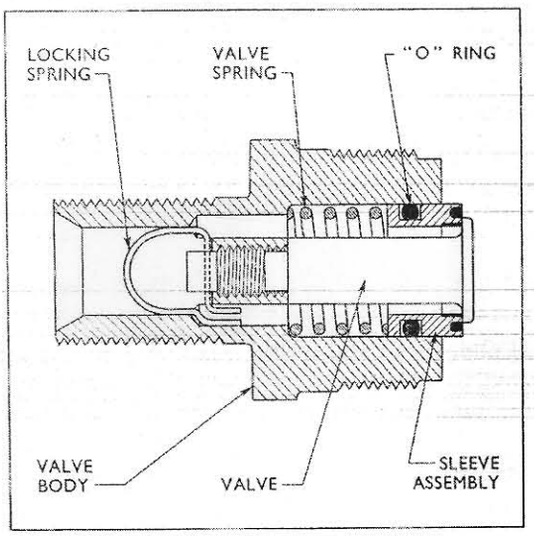


Fig. 5
Self-Sealing Coupling

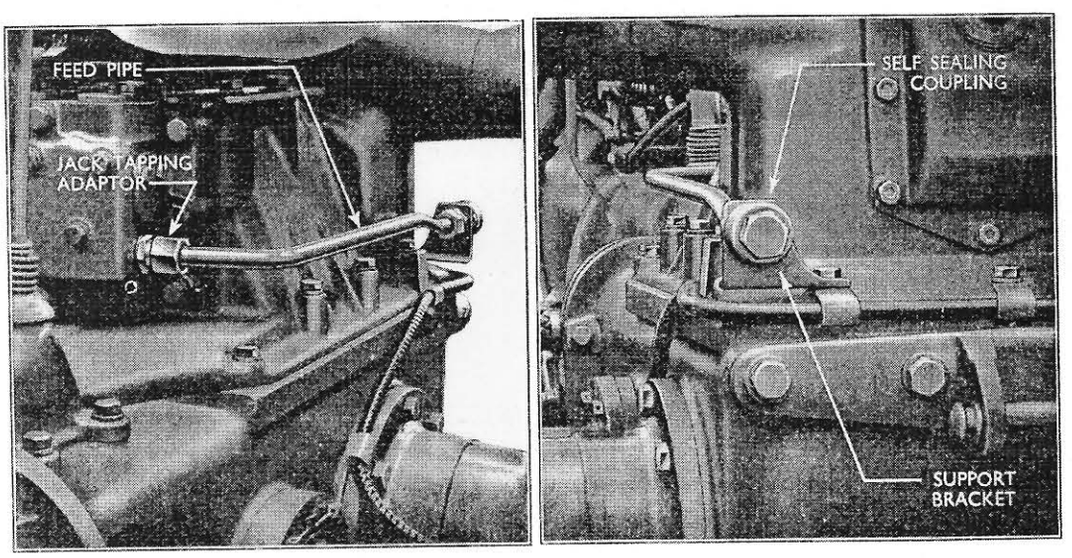


Fig. 4
Hydraulic Single Acting Valve Pipe and Coupling

HYDRAULIC POWER LIFT

GENERAL DESCRIPTION

The hydraulic power lift fitted to the Fordson Super Major offers a choice of operating control enabling either Qualitrol (constant draft) or Position Control (constant depth or height) to be selected according to the work being undertaken and the ground conditions encountered.

An auxiliary control plate is fitted as standard equipment to facilitate operation of remote rams and incorporated in the auxiliary plate assembly is a flow control device enabling the rate of hydraulic work to be adjusted irrespective of engine speed.

" Live " hydraulics are automatically available when a " Live " power take-off (optional equipment) is fitted, and gives the advantage that the tractor may be stopped or gear changes carried out without affecting the operation of the hydraulic system.

Hydraulic Lift Linkage

With the introduction of the new hydraulic system for the Fordson Super Major the layout of the rear linkage has been modified and it is no longer necessary to use the two position lower links to improve weight transference under arduous conditions. This option will, however, continue to be supplied through service for previous production tractors.

The new linkage is readily convertible to suit either Category 1 or Category 2 implements, the necessary conversion parts being supplied as standard equipment with all Super Major tractors. The lower link end swivel balls are removable and the Category 2 balls fitted to the lower links during production can be replaced by the smaller pair supplied with the tractor. Similarly, the top link can be fitted with an alternative rear end piece, again the Category 2 end being fitted in production and the alternative Category 1 part being supplied with the tractor.

A heavy duty check chain bracket is now fitted as standard to all Super Major Tractors, either heavy duty or standard check chains being fitted as requested and the lower links being drilled to take either chain. The check chain shackles incorporate two holes to allow the lift arms to be swung closer or further apart according to the different size of implement in use. Only heavy duty check chain brackets, with either single or double holes, will be supplied in service and can be used for replacement of all previous brackets including heavy duty and standard single hole and heavy duty and standard two position brackets. When replacing a previous type standard bracket (three bolt fixing) with a current heavy duty bracket (four bolt fixing) it will not be necessary to fit the extra bolt.

The automatic clutch release previously used is not suitable for current production tractors mainly due to the changes to the top link pivot bracket. A new installation has been released for use with the new hydraulic system and details of this will be issued as separate information. This unit is normally only used under arduous conditions and has therefore only been released with Category 2 ball ends in the top link.

Top Cover Assembly

Oil is fed, under pressure from the pump, via a feed pipe to a flange at the top of the transmission casing and from here into drillings in the top cover assembly.

The top cover acts as a housing for the control linkage and has attached to it the lift cylinder assembly which acts as a combination of valve chest and ram cylinder housing, and also the auxiliary service and flow control plate assembly.

Fitted in the top cover is a check valve, the purpose of which is to stop the return of oil from the ram cylinder when the implement is in the transport position, and also a pressure relief valve which protects the hydraulic system from damage should an attempt be made to lift an excessive load.

Flow Control Device

Under certain conditions of operation it is preferable to be able to control the rate of flow of oil to the ram cylinder or auxiliaries. When ploughing for instance, only a slow oil feed is required, whereas when using auxiliary equipment such as front end loaders a fast rate is sometimes required. On the Super Major a flow control device is incorporated in the auxiliary service plate assembly which allows such control to be applied. Incorporated in the control unit is a restrictor which locates in the main feed from the pump thus when the control knob is screwed " out " the control unit and hence the restrictor is rotated and greater restriction is applied to the flow of oil, and vice versa. The limiting position either way is indicated by the marking " F " (fast or maximum flow) and " S " (slow or minimum flow) on the auxiliary control housing.

The pump side of the restrictor is connected to the front face of a control valve whilst a branch drilling on the lift (or auxiliary service) side connects with the rear face of the valve. Oil passing the flow control valve restrictor experiences a slight pressure drop due to the restriction to flow, therefore oil at full pressure is fed to the front face of the flow control valve plunger and oil at reduced pressure to the rear face of the plunger. If the pressure difference is sufficient to overcome the pressure of the flow control valve spring, the plunger will move and allow oil from the high pressure side of the restrictor to bleed-off into the transmission. The amount of oil which is bled-off will depend on the pressure difference between the two faces of the flow control valve plunger, this difference being in direct relation to the position of the flow control valve restrictor.

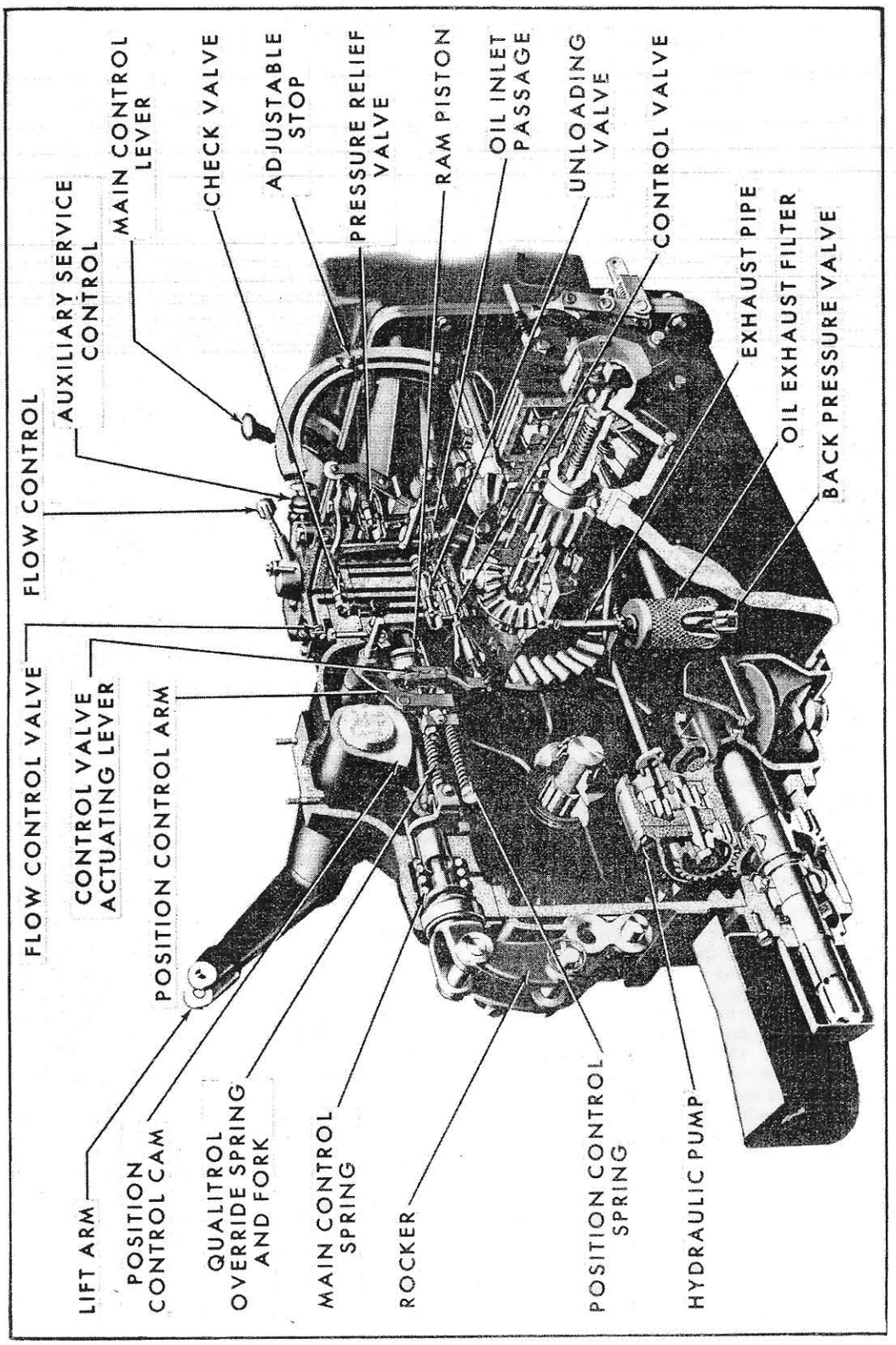


Fig. 6 Sectioned View of Hydraulic System

The rate of oil flow to the ram cylinder or auxiliary service can therefore be controlled by the operator within the design range of the flow control device merely by setting the flow control in the required position.

A further feature of the unit is that regardless of the position at which the flow control is set, when the main control lever is moved to the top of the quadrant the quadrant lever will operate the linkage to the flow control unit, moving it to the " Fast " position so that a quick raise of the implement can be effected.

The correct rate of flow will depend on the implement, speed of operation, operating conditions etc., and the optimum position for any particular unit can only be found under actual operating conditions.

Operating the Auxiliary Service Control

Before operating the auxiliary service control it is recommended that Qualitrol is selected, i.e. the selector lever is placed in the upward position. If the auxiliary service control knob is then pulled out the ram cylinder circuit will be isolated and oil will be directed to the auxiliary ram when the control lever is moved to the top of the quadrant.

As the lever is moved up the quadrant it will move the flow control valve restrictor, via the linkage, to the maximum flow position. If, however, the lift arms are already fully raised the control valve will be held in the neutral position by the ram piston and it will be necessary to move the control lever beyond the top stop in the quadrant to achieve a raise. Before the control lever can be moved to this position it will be necessary to move the spacer from behind the control lever as if the spacer is not moved the flow control valve linkage will prevent the lever being moved beyond the top stop.

Lift Cylinder Assembly

The lift cylinder contains a piston, connected by a connecting rod and ram arm to the cross-shaft, the outer ends of which are splined to the lift arms. A safety valve is located in the front end of the cylinder to obviate damage should shock loads be imposed, as for instance when carrying heavy implements over rough ground.

Control and Unloading Valves

The control and unloading valves operate in bushes in the valve portion of the lift cylinder and control the flow of oil to and from the ram cylinder.

The unloading valve, which is of the shuttle type is operated solely by oil pressure on its front and rear faces, the effective pressure and hence movement of the unloading valve depending on the position of the control valve.

The control valve is connected via an adjustable link and an actuating lever to a cross-shaft to which is attached the main control lever. A spring is located in front of the control valve so that the valve is always held as far to the rear as is permitted by the valve actuating lever. The valve has three positions, " neutral " at mid-travel, " raise " when pushed forward and " lower " when moved to the rear.

The hydraulic valve action is later described in more detail but briefly when moved forward a small distance, it directs oil to the front of the unloading valve causing the latter to move to the rear thus shutting off the neutral passages. Oil under pressure is then supplied to the ram cylinder (thus raising the lift arms) or to the auxiliary service (to operate auxiliary rams). When moved rearwards the valve allows oil to exhaust from the ram cylinder or auxiliary circuit thus lowering the lift arms or auxiliary equipment at a rate depending jointly on the distance the valve is moved from neutral and the weight being carried.

To study the valve operation under all conditions, it is first necessary to understand the forces that can act on the actuating lever which moves the control valve and this is best dealt with by explaining the operation of the system.

LINKAGE OPERATION UNDER QUALITROL

Qualitrol is designed for use with implements such as ploughs on soils of undulating or variable type. It enables the optimum draft for the implement to be selected and the implement will then continue to operate at a depth corresponding to this draft. If hard soil is encountered, or the implement tends to increase its working depth, the control valve linkage will automatically raise the implements until it is again working at the pre-determined draft. Conversely, if the implement encounters softer soil or tends to rise out of the ground the draft will be decreased and the implement automatically lowered.

Qualitrol is obtained by placing the selector lever in a vertical position, such action making the position control linkage inoperative.

When operating, movement of the actuating lever and consequently the control valve is governed by the position of two pivots.

(*a*) The top of the actuating lever :—the position of which is controlled by movement of the main control lever within its quadrant.

(*b*) The qualitrol fork :—the position of which is varied in accordance with the compressive forces on the top link. Soil resistance acting on the implement is transferred through the top link, the rocker and the main spring onto the qualitrol plunger which in turn is connected to the fork. Any compressive force from the implement is resisted by the main spring, the amount of compression being registered as forward movement of the spring plunger. This movement is further transmitted by the qualitrol rod through the qualitrol override spring and fork onto the actuating lever pin. It should be noted that the qualitrol rod is free to slide through the fork, compression of the spring taking place only when :—

(*a*) The control valve is already fully forward against its end stop, in which case the spring will compress to prevent damage.

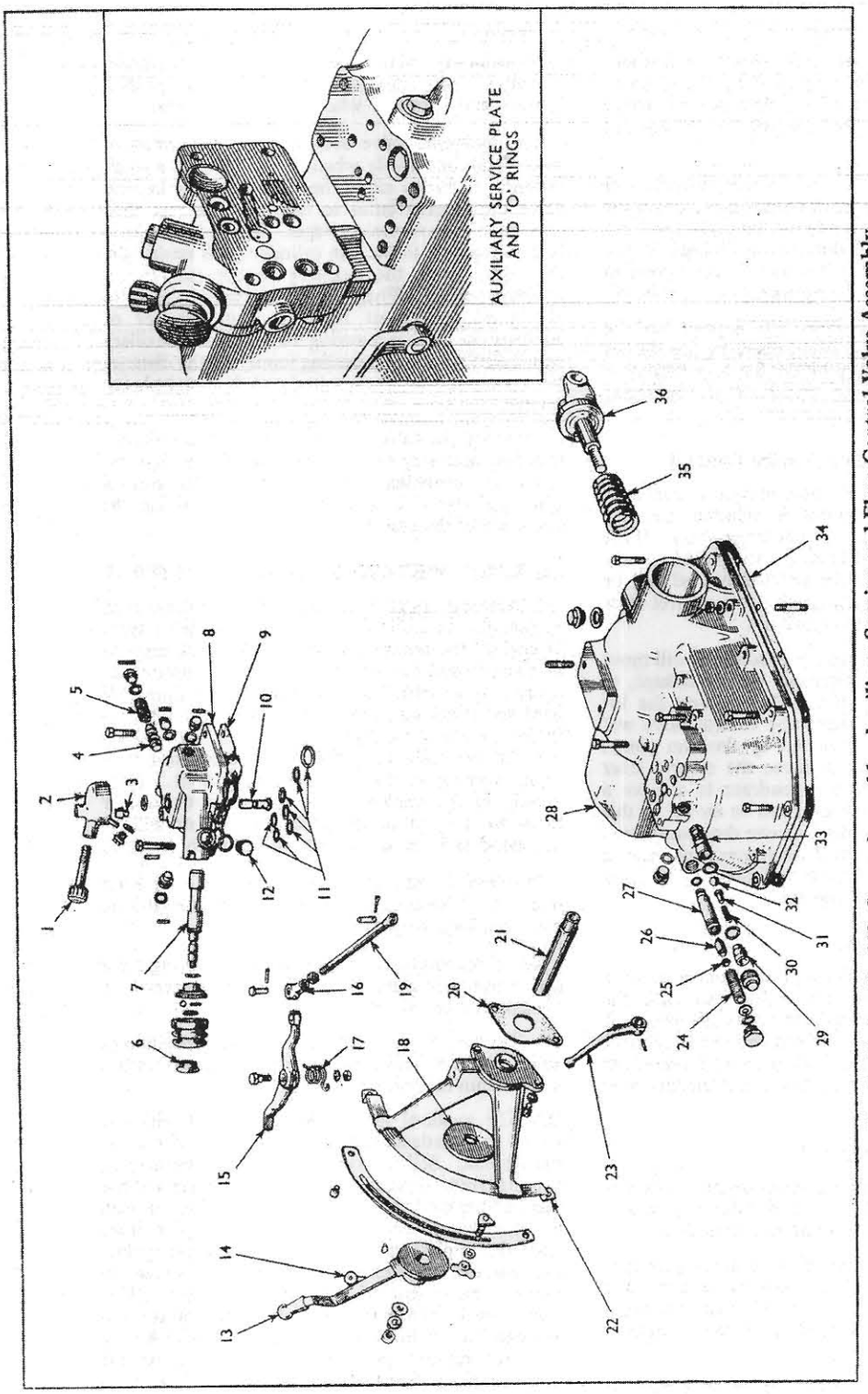


Fig. 7 **Hydraulic Lift Cover Assembly, Auxiliary Service and Flow Control Valve Assembly**

1 Flow Control Spindle and Knob Assembly
2 Flow Control Lever
3 Flow Control Lever Stop
4 Flow Control Valve
5 Flow Control Valve Spring
6 Auxiliary Service Control Knob
7 Auxiliary Service Control Valve Spool
8 Auxiliary Service and Flow Control Valve Housing
9 Auxiliary Service Plate Gasket
10 Flow Control Valve Restrictor
11 "O" Rings
12 Auxiliary Service Take-off Plug
13 Main Control Lever
14 Flow Control Linkage Spacer
15 Flow Control Crank Lever
16 Flow Control Link Clevis
17 Flow Control Link Return Spring
18 Friction Disc
19 Flow Control Link
20 Quadrant Gasket
21 Control Lever Shaft Spacer
22 Quadrant Assembly
23 Selector Lever
24 Pressure Relief Valve Spring
25 Pressure Relief Valve Spring Seat
26 Pressure Relief Valve
27 Pressure Relief Valve Body
28 Lift Cover
29 Check Valve Pilot
30 Check Valve Spring
31 Check Valve Ball and Spring Guide
32 $\frac{1}{4}$" Diameter Ball
33 Check Valve Seat
34 Lift Cover Gasket
35 Main Control Spring
36 Main Control Spring Yoke

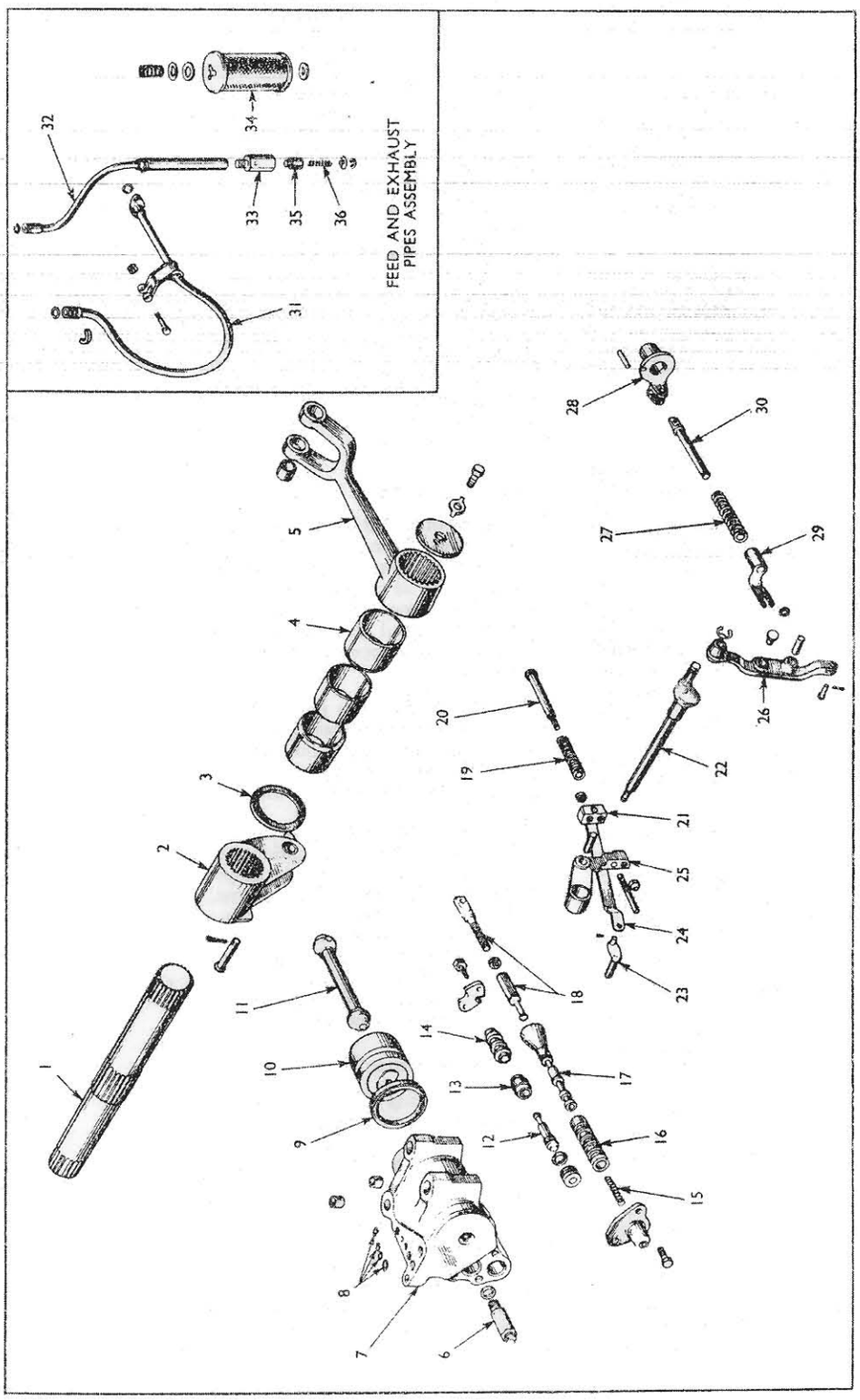


Fig. 8 **Hydraulic Lift Cylinder Assembly, Linkage and Lift Arms, Feed Pipe and Exhaust Filter Assembly**

1 Lift Cross-shaft
2 Ram Arm
3 Ram Arm Thrust Washer
4 Lift Cross-shaft Bushes
5 Lift Arm
6 Ram Cylinder Safety Valve
7 Ram Cylinder
8 "O" Rings
9 Piston Gland
10 Ram Piston
11 Ram Piston Connecting Rod
12 Unloading Valve
13 Unloading Valve Bush (Front)
14 Unloading Valve Bush (Rear)
15 Control Valve Spring
16 Control Valve Bush
17 Control Valve
18 Turnbuckle
19 Position Control Spring
20 Position Control Spring Guide
21 Position Control Block
22 Control Lever Shaft
23 Selector Control Arm
24 Position Control Link
25 Position Control Arm
26 Control Valve Actuating Lever
27 Qualitrol Overtride Spring
28 Main Control Spring Plunger
29 Qualitrol Fork
30 Qualitrol Link
31 Main Oil Feed Pipe
32 Exhaust Oil Pipe
33 Back Pressure Valve Body
34 Exhaust Oil Filter
35 Back Pressure Valve
36 Back Pressure Valve Spring

(*b*) The lift arms are in the fully raised position and the ram piston emerges from the ram cylinder forcing the actuating lever rearwards and thus placing the main control valve in neutral.

Lowering into Work under Qualitrol

When the quadrant lever is pushed down the quadrant the top of the actuating lever is moved forward. The lever will pivot about the qualitrol fork and the bottom end will in consequence move rearwards placing the control valve in the lowering position.

The implement will then drop into work and continue to drop until a sufficiently high force operates through the top link to push the qualitrol fork and actuating lever forward and place the control valve in neutral. The lower the lever is placed in the quadrant the greater the depth at which the implement will work.

Operation in Work in Qualitrol

Assuming that the implement has now reached the required depth corresponding to the required draft, the main control spring will be partially compressed, and as long as the implement draft remains constant the control valve will remain in neutral and no further change in depth will take place.

As soon as an increase in draft occurs a resultant increase in compression of the main control spring takes place, the effect of which is transferred through the qualitrol linkage to move the control valve into the raising position. Oil then flows to the ram cylinder and the implement rises until the draft decreases to the amount previously obtained, thus allowing the main control spring to expand to its former position and the control valve to be moved back to the neutral position.

Conversely, a decrease in draft allows the main control spring to expand and the control valve to move to the lowering position, whereupon the weight and suck of the implement carries it to a greater depth. The draft is thus increased to that previously obtained and the control valve again moves back to the neutral position.

By making these slight corrections, therefore, the hydraulic system automatically adjusts itself to maintain a constant draft at the implement.

Raising under Qualitrol

Raising the main control lever will move the top end of the valve actuating lever rearwards and the lever will pivot around the qualitrol fork, moving the control valve forward into the " raising " position.

When the lift arms reach the fully raised position the ram piston skirt will contact the actuating lever pin and automatically move the control valve into neutral.

Raising can be stopped at any intermediate position by moving the control lever downwards slightly, from the top of the quadrant thus allowing the control valve to move to the neutral position.

LINKAGE OPERATION UNDER POSITION CONTROL

Position control, which is selected by placing the selector lever in the horizontal position, is designed for use on fairly level ground, with no wide variations in soil resistance, and enables the working depth of the implement to be pre-set. For all practical purposes, accurate work at constant depth can be achieved and position control is, therefore, particularly suited to implements such as weeders, steerage hoes, down the row thinners etc. It is also suitable for implements such as sprayers which require to be worked at a fixed height above the ground.

Placing the selector lever in the horizontal position brings the special position control linkage, between the servo cam on the ram arm and the control valve actuating lever, into operation. Under these conditions the qualitrol fork no longer acts as a pivot point for the actuating lever but is replaced by the machined pad, adjacent to the qualitrol fork, on the rear face of the actuating lever.

Lowering into Work

Lowering of the lift arms is effected by moving the control lever down the quadrant. Whereas in Qualitrol the implement is lowered to the ground almost as soon as the control lever is moved away from the fixed stop at the upper end of the quadrant, in position control the implement is lowered an amount directly proportional to the movement of the control lever.

As the control lever is moved down the quadrant the top end of the actuating lever will be moved forward, pivoting around the position control rod, so that the bottom end moves rearwards and allows the control valve to move into the lowering position.

As the lift arms drop the servo cam will move the position control arm roller, spring and rod forward until the control valve spring is compressed and the control valve is moved into neutral. The final position of the implement will depend upon the positioning of the control lever, this setting the pivot point for the actuating lever—the lower the control lever is placed in the quadrant the greater the distance the lift arms will drop before the servo cam moves the control valve into neutral.

Operation in Work

If a soil-engaging implement tends to be forced out of the ground by an obstruction the weight and suck of the implement will cause it to return to its pre-set depth as soon as the obstruction is passed.

If the lift arms fall, due for instance to oil leakage from the ram cylinder, the servo cam is rotated and, as the cam is in contact with the position control roller such movement is transmitted via the position control spring and guide to the position control block and rod. As the rod moves forward it also moves forward the valve actuating lever and places the control valve in the raising position. An automatic correction is therefore made.

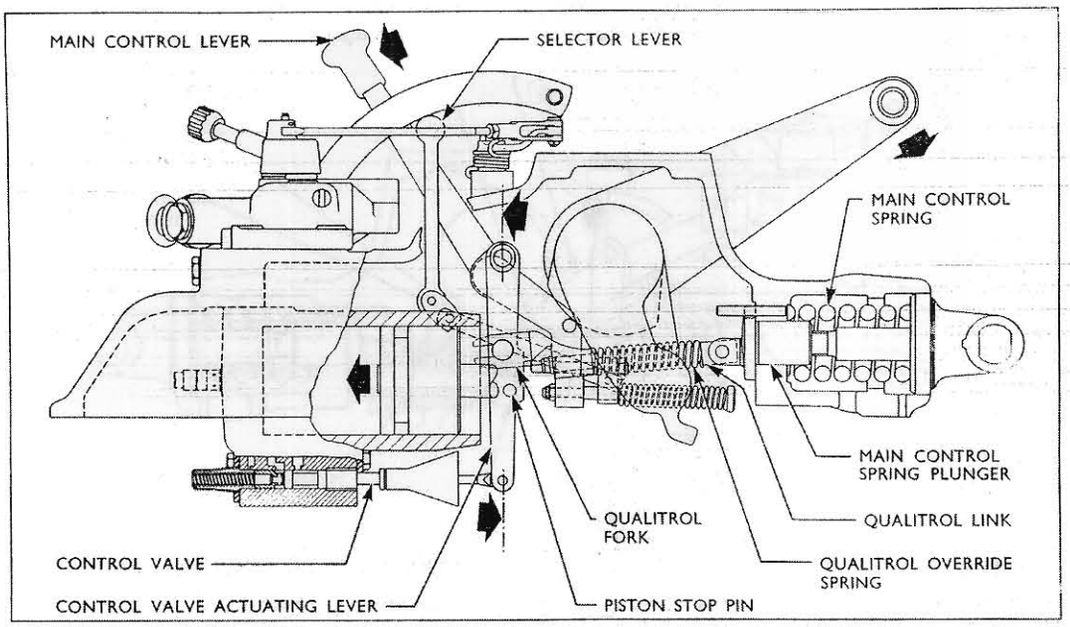


Fig. 9 **Qualitrol Linkage—Lowering**

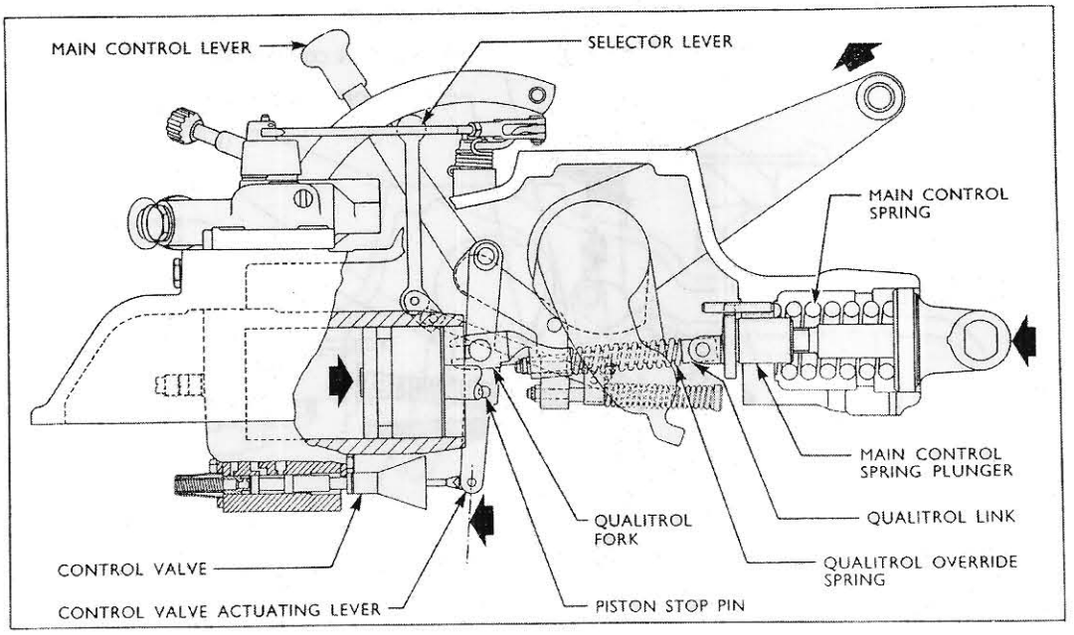


Fig. 10 **Qualitrol Linkage—Raising in Work**

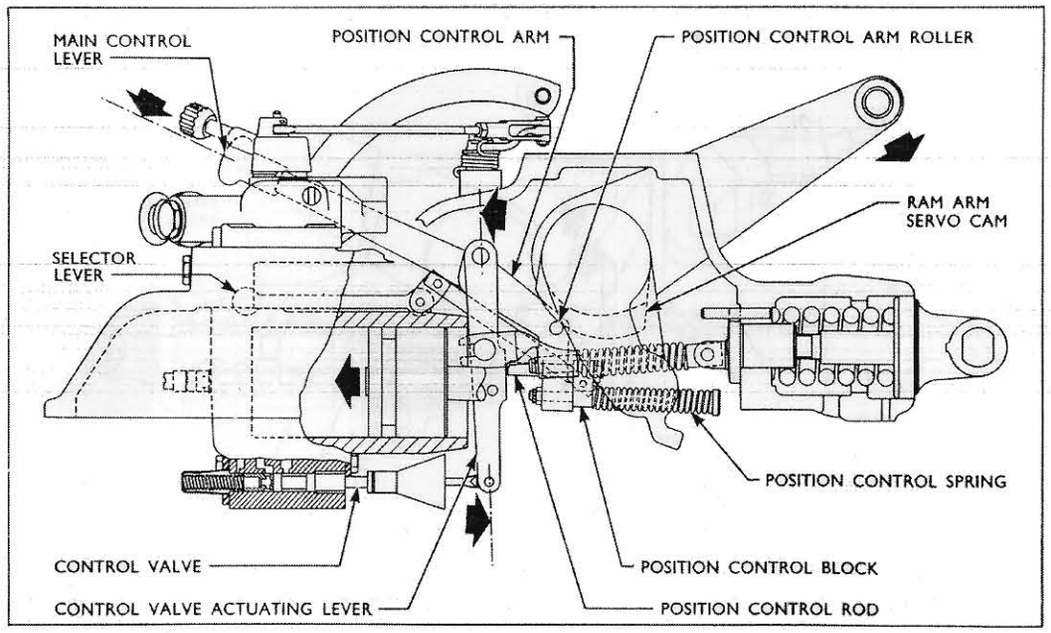


Fig. 11 **Position Control Linkage—Lowering**

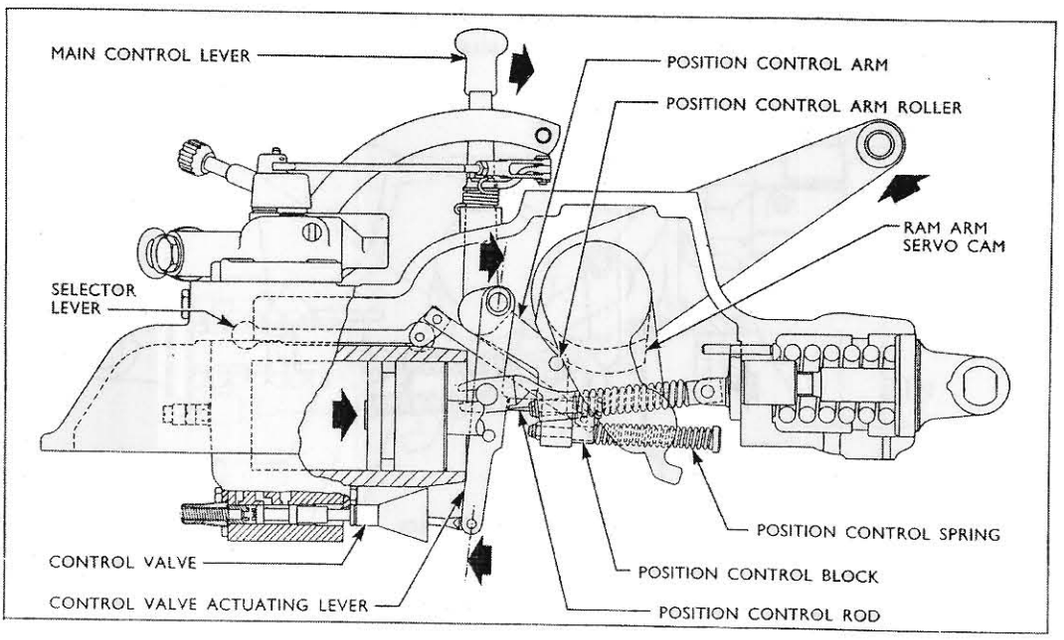


Fig. 12 **Position Control Linkage—Raising**

Raising

Raising the main control lever will move the top of the actuating lever rearwards, pivoting it about the position control rod and moving the lower end forward and the control valve into the raising position.

As the lift arms raise the servo cam will rotate, presenting a lower point on the cam to the position control linkage. When the required height is reached, as set by the positioning of the main control lever, the servo cam will have reached a position where it allows the position control linkage to move rearwards sufficiently for the control valve to be moved into the neutral position.

If the main control lever is moved up to the fixed stop at the upper end of the quadrant the lift arms will continue to raise until the ram piston skirt emerges from the cylinder, contacts the actuating lever pin, and automatically moves the lever rearwards, so allowing the control valve spring to move the control valve into neutral.

HYDRAULIC LIFT OIL FLOW

The oil flow diagrams, Figs. 13, 14 and 15, show schematically the oil flow through the system, the oil flow being identical whether Qualitrol or Position Control is in operation.

Oil Flow in the Neutral Position

The control valve is returned automatically to the neutral position after the desired depth or height is reached and also after a correction is made in operation.

The hydraulic pump supplies oil to the lift cover where it passes through drillings to the pressure relief valve chamber and then to the flow control restrictor. Oil is therefore being fed at pump pressure to the front face of the flow control valve and at slightly reduced pressure, due to the pressure drop across the restrictor, to the rear face of the flow control valve via a small drilling. Due to the difference in pressure, which will be in relation to the position of the restrictor, the flow control valve will move and allow oil to bleed off from the high pressure side and exhaust via the exhaust oil pipe and filter.

The oil then flows via the check valve passage into passage A, passes around an annular groove in the unloading valve bush and enters the unloading valve chamber where it acts on the rear face of the unloading valve, moving the valve forward. Any oil in front of the valve is forced by this movement through passage ' D ' and drillings in the control valve to the control valve spring chamber ' G,' from where it leaks away into the transmission housing.

Oil from passage ' B ' passes into, and is trapped in, the unloading valve rear bushing until, as the unloading valve moves forward, passage ' C ' is opened and the oil passes along it, by-passing the check valve. It is then directed through the auxiliary service plate back to the lift cover and then, via the exhaust pipe and filter, into the main rear transmission lubricant.

Oil Flow in the Raising Position

Oil passes from the pump through the lift cover and flow control device to the check valve chamber as before.

As the control lever is moved to the raise position and the control valve moves forward, a passage is opened leading from the rear to the front face of the unloading valve. The same movement seals off the spring chamber in front of the control valve and prevents oil being exhausted from this point.

Oil therefore flows through passage 'A' into the rear of the unloading valve chamber and is then able to pass to the front face of the unloading valve. As the front face of the unloading valve is larger than the rear face, the total pressure exerted by the oil will be higher on the front face than on the rear face and the valve will move rearwards thus sealing off passages ' B ' and ' C.'

Pressure will then build up in the system until the check valve is lifted off its seat and, as the lower end of passage ' E ' is sealed by the control valve at ' F,' oil passes either to the ram cylinder or auxiliary service depending on the position of the auxiliary control valve spool.

Oil Flow in the Lowering Position

When the control valve is moved to the lowering position, passage ' D ' is shut off from the pump and the oil in front of the unloading valve is free to exhaust through the control valve into the transmission casing.

Oil from the pump follows the usual channels to the check valve chamber and then through passage 'A' to the rear of the unloading valve. Since the passage to the front of the unloading valve is shut off and the oil in front of the unloading valve is free to exhaust, the pressure on the rear of the valve will cause it to move forward. This opens passage ' C ' to oil from passage ' B ' and oil will flow back to the transmission housing via the exhaust oil filter. Thus no pressure can build up and the check valve will return to its seat.

The weight of the implement will cause the lift arms to lower, forcing the ram piston forward and oil will exhaust, via drillings in the top cover to passage ' E.' This passage by-passes the check valve and connects with an annular groove in the unloading valve plug. The oil therefore passes around the unloading valve plug and flows via a drilling to an annulus in the front of the control valve bush, passes through into the bush and exhausts into the transmission casing via the front of the control valve and the control valve spring chamber ' G.'

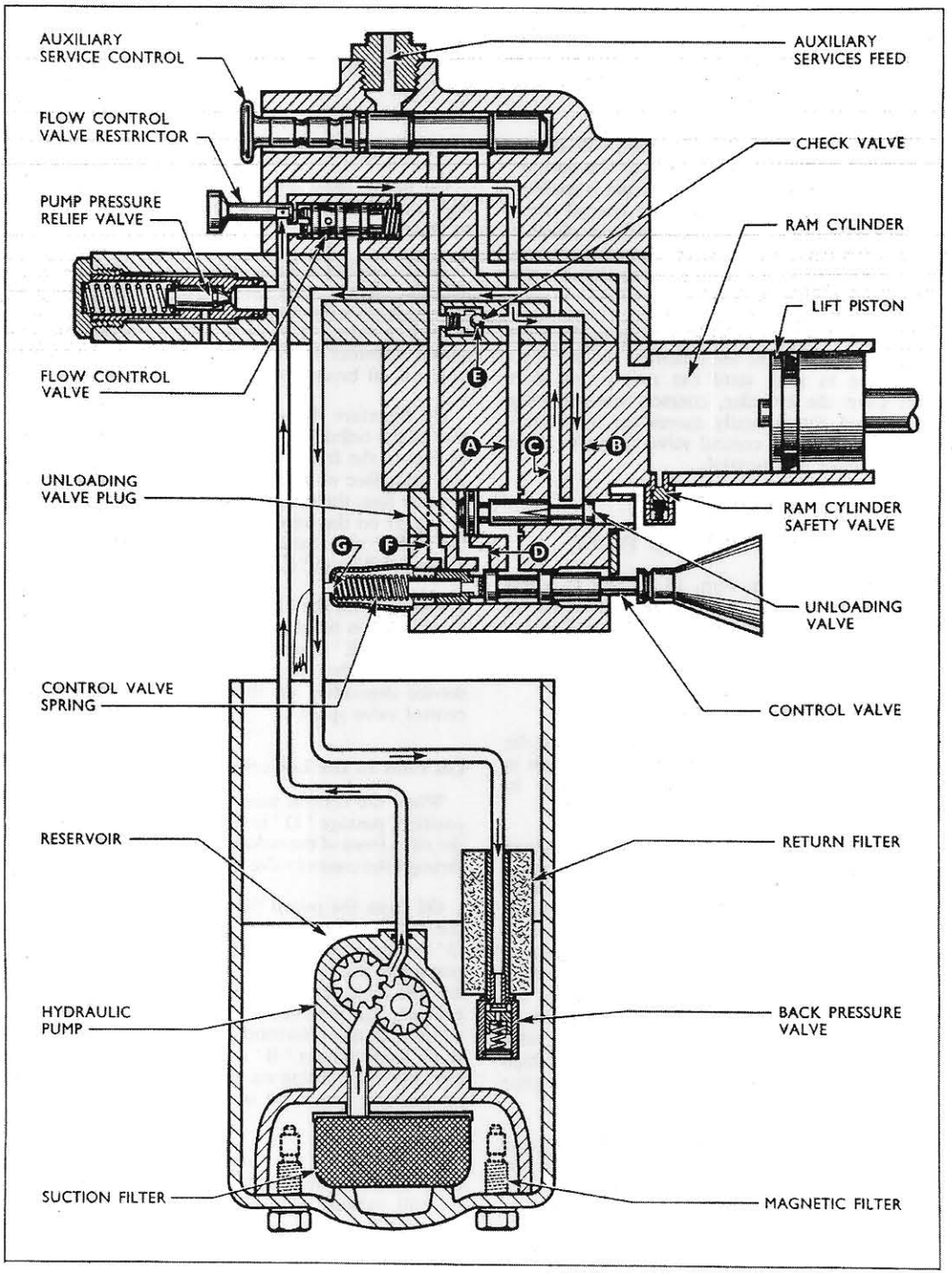


Fig. 13 **Hydraulic Oil Flow—Neutral**

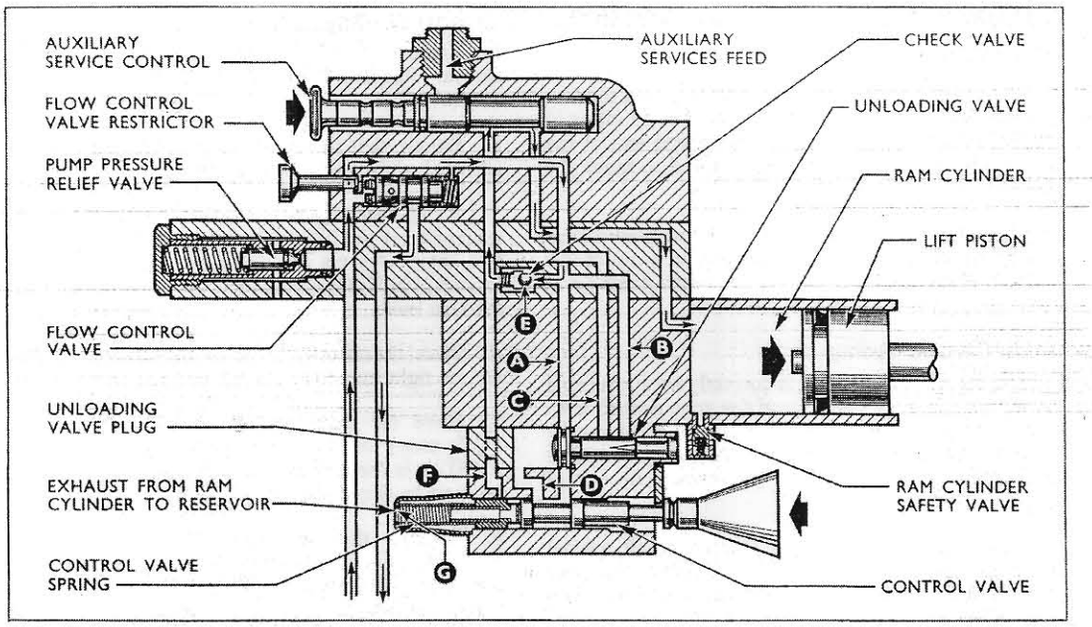


Fig. 14 **Hydraulic Oil Flow—Raising**

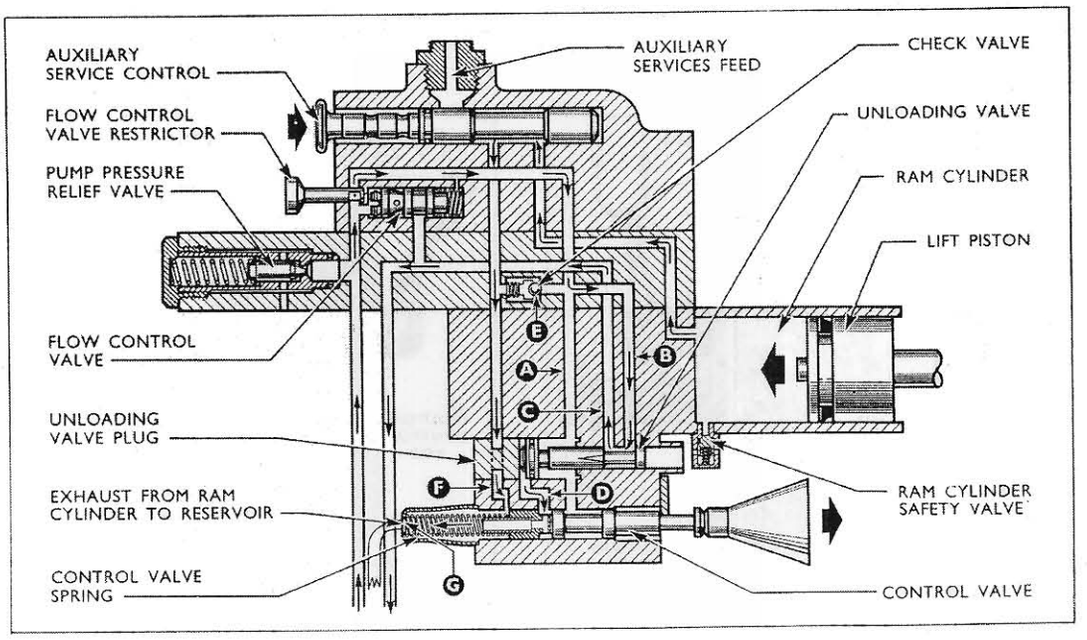


Fig. 15 **Hydraulic Oil Flow—Lowering**

HYDRAULIC CONTROL ADJUSTMENTS

Main Control Lever

The nut securing the control lever friction plate to the quadrant should be tightened so that an effort of 10 lbs. (4.536 kg.) measured at the outer end of the lever, with a spring balance, is required to move the lever.

This adjustment is only likely to be necessary after a long period of operation, resulting in wear of the friction plate and friction disc, has taken place.

Main Control Spring

The main control spring is correctly set for normal operation when the rear face of the yoke is flush with the housing face. If it is not correctly set it can be adjusted by disconnecting the yoke from the rocker and screwing the yoke into (clockwise), or out of (anti-clockwise), the housing.

Whilst the above setting is correct for all normal usage it may be advantageous to screw the yoke further in, increasing the spring compression, when it is required to obtain abnormal penetration from earth-moving equipment operating in Qualitrol. Before this adjustment is made, however, care should be taken to ensure that the implement is correctly set and that the required operating depth cannot be obtained without this increase in spring compression.

This setting will increase the depth at which the implement can be operated but will decrease the sensitivity of the system and the spring setting should therefore be corrected before resuming normal operations.

Qualitrol Linkage Adjustment

1. Remove the lift assembly from the tractor (see section headed " To Remove the Lift Cover Assembly ").

2. Ensure that the main control spring is correctly adjusted with the yoke and housing faces flush.

3. Fit the locating arm, Tool No. T.8517, to the underside of the lift cover flange, attaching it to the two rear holes on the left-hand side. Insert the locating pin T.8512/f through the arm and left-hand lift arm bush.

4. Place the selector lever in the upward position i.e., at right angles to the lift cover.

5. Raise the main control lever to within 0.5 in. (12.7 mm.) of the fixed stop. The slip gauge T.8512/g is the correct width for this setting and can be used to gauge the correct dimension.

6. Remove the slip gauge from the quadrant, loosen the control valve turnbuckle locknut and adjust the turnbuckle until the Qualitrol end of the slip gauge can just be inserted between the control valve and rear face of the control valve bush. After adjustment tighten the turnbuckle locknut and re-check the setting.

Position Control Adjustment

This operation should only be carried out after the setting of the main control spring has been checked and the qualitrol adjustment carried out.

1. Set the selector lever in the horizontal position, i.e. level with the lift cover face.

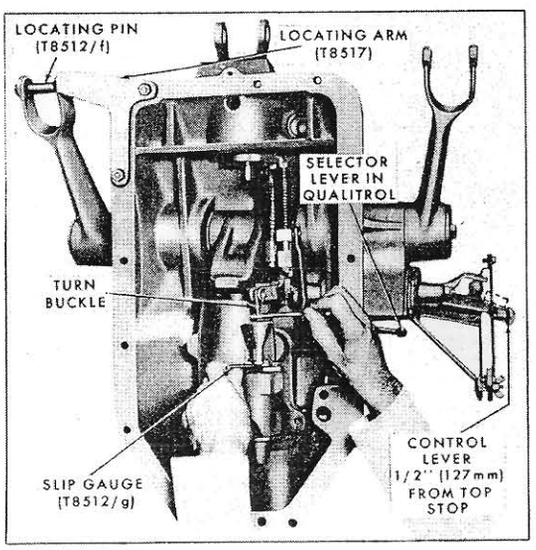


Fig. 16
Qualitrol Linkage Adjustment

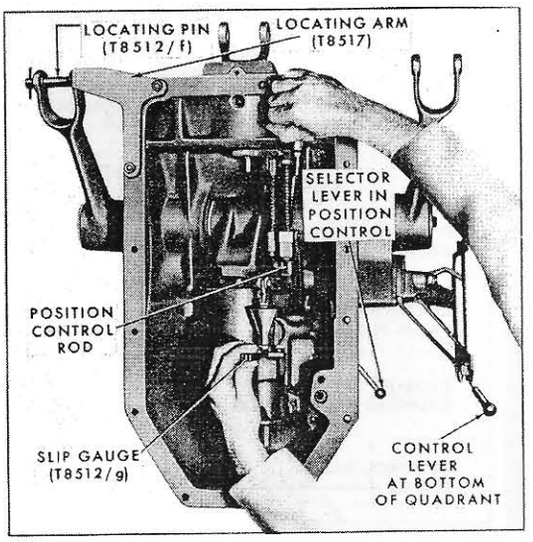


Fig. 17
Position Control Linkage Adjustment

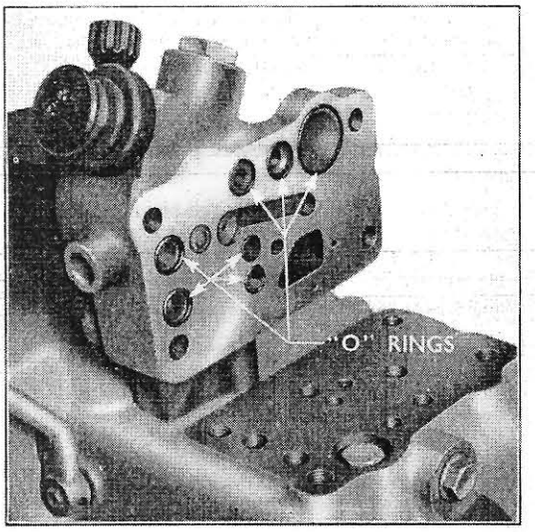


Fig. 18
Auxiliary Service Control Plate

2. Move the main control lever to the bottom end of the quadrant.

3. Hold the position control rod locknut and adjust the position control rod until the position control end of the slip gauge, T.8512/g, can just be slipped between the control valve and the rear face of the control valve bush.

4. Retighten the position control rod locknut.

To Adjust Flow Control Valve Linkage

Move the spacer from behind the quadrant lever, so that the flow control valve crank lever contacts the rear face of the control lever and place the lever against the top stop in the quadrant.

Screw the flow control valve restrictor spindle and knob fully out and turn the lever fully against the 'S' stop. Gradually screw the spindle and knob until the lever **just** moves. It is important that the knob is not screwed in beyond this point.

Remove the split pin and clevis pin securing the flow control rod to the crank lever, slacken the locknut and adjust the clevis so that the crank lever just contacts the main control lever. Tighten the locknut and reconnect the rod to the crank lever.

Replace the spacer behind the main control lever and check the operation of the linkage.

TO DISMANTLE THE HYDRAULIC LIFT ASSEMBLY

Absolute cleanliness is essential in dealing with repairs or internal adjustments to the hydraulic system. It is recommended that all mud and dirt is removed from the tractor before removal of any hydraulic components. Clean receptacles should be provided for small components and highly finished parts should be placed on soft material. All parts should be cleaned and adequately lubricated before replacement.

To Remove the Auxiliary Service Control Plate Assembly

1. Remove the split pin and clevis pin securing the flow control linkage to the flow control valve restrictor lever and move the rod away from the housing.

2. Remove the set-screws securing the auxiliary service plate to the lift cover.

NOTE.—The screws used are of varying length and care should be taken to note from which locations the various screws are removed.

To Dismantle the Auxiliary Service Control Plate and Flow Control Device Assembly

1. Remove and discard the "O" rings fitted between the plate and the lift cover.

2. Drive out the tension pin securing the auxiliary service spool cap and withdraw the spool, together with the knob and rubber cover.

3. Unscrew the knob from the spool and remove the cover and the flat washer fitted inside it. Withdraw the cap from the spool, taking care not to lose the spring and locating ball fitted in the internal recess. Remove and discard the "O" ring fitted to the valve spool.

4. Drive out the pin securing the flow control knob to the restrictor, remove the knob and push the restrictor downwards out of the housing. Remove and discard the "O" ring fitted in the upper recess of the restrictor bore.

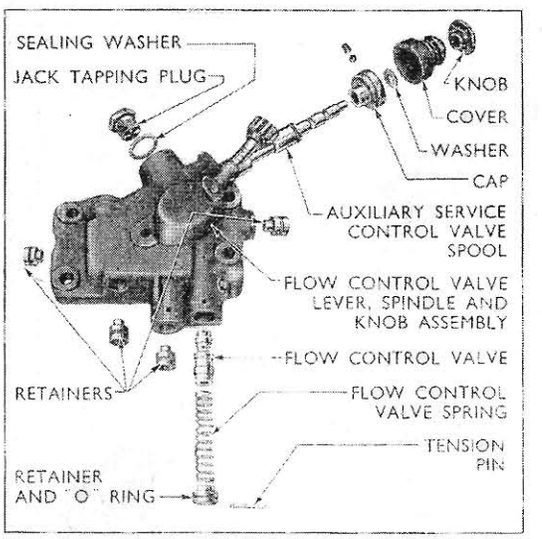


Fig. 19
Auxiliary Service Control Plate and Flow Control Valve

5. Drive out the pin in the end of the flow control valve chamber and withdraw the retainer, spring and valve plunger. Remove and discard the "O" ring fitted to the retainer.

6. Similarly drive out the remaining four tension pins and remove the retainers and "O" rings fitted in the other oil passages in the housing.

To Rebuild the Auxiliary Service Control Plate and Flow Control Device Assembly

1. Fit new "O" rings to the retainers, press into position in their bores and secure with tension pins.

2. Place the flow control valve plunger in its bore. This valve is a selective fit and the largest valve should be fitted which will operate without binding in the bore. Replace the flow control valve spring followed by the retainer, using a new "O" ring on the retainer, and secure by driving in the tension pin.

3. Insert the restrictor in its bore in the plate, keeping the large end to the lower face of the plate. Fit a new "O" ring over the top of the restrictor into the counterbore in the housing. Place the control knob in position over the restrictor and secure with a tension pin, it should be noted that the holes in the restrictor and knob are bored off centre to ensure that the parts are located correctly in relation to one another.

4. The auxiliary service spool is a selective fit in its bore and the largest spool which will operate without binding should be fitted. Place the spring and ball in the internal recess of the auxiliary service spool cap. Depress the ball into the recess and slide the cap on to the spool. Place the flat washer on the end of the spool, followed by the rubber cover and operating knob.

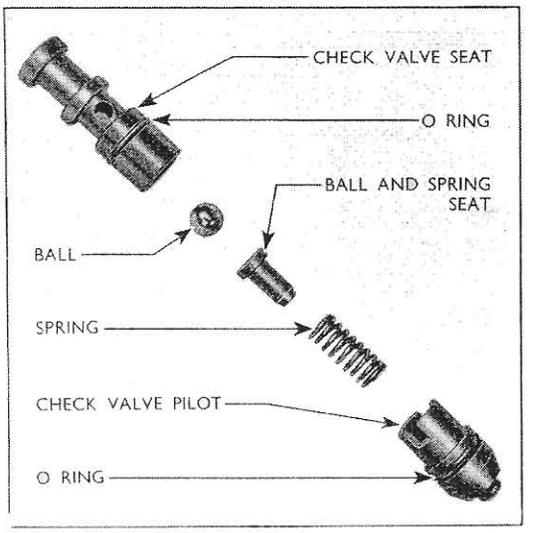


Fig. 20
Check Valve Assembly

5. Fit a new "O" ring to the auxiliary service valve spool and fit the spool to the auxiliary service plate locating the cap in the entrance to the bore and securing with a tension pin.

To Replace the Auxiliary Service Control Plate Assembly

1. Ensure that the mating faces of the plate and lift cover are clean, fit new "O" rings to the oil passage counterbores in the lower surface of the plate and locate the plate (with a new gasket between plate and lift cover) on the cover.

2. Insert and fully tighten the retaining screws.

3. Connect the flow control link to the flow control by means of a clevis pin and split pin.

4. Check the operation of the auxiliary service control and of the flow control device, if necessary, adjusting the flow control linkage as previously described.

To Remove the Lift Cover Assembly

1. Remove the seat and place the control lever at the bottom of the quadrant to allow oil to exhaust from the ram cylinder.

2. Remove the upper link and disconnect the right- and left-hand lifting rods from their respective lift arms.

3. Remove the clevis pin securing the main control spring plunger yoke to the rocker and swing the rocker away from the yoke.

4. Remove the ten bolts and two nuts located around the periphery of the cover which retain it to the rear transmission housing. These bolts are of varying lengths and note should be made from which location the various bolts are removed.

5. Remove the lift cover assembly complete with lift cylinder and control linkage, using lifting bracket Tool No. T.8518, located on the seat mounting studs to facilitate removal.

To Replace the Lift Cover Assembly

1. Fit new 'O' rings at the top of the inlet pipe and exhaust oil passage in the rear transmission housing and locate a new gasket on the top face of the housing.

2. Carefully replace the lift cover, locating it on the dowels at the front and rear of the transmission housing top face and insert and fully tighten the retaining screws and nuts.

3. Adjust the main control spring as previously described, then connect the yoke to the rocker and secure with a clevis pin.

4. Replace the upper link and connect the lifting rods to the lift arms.

5. Replace the seat.

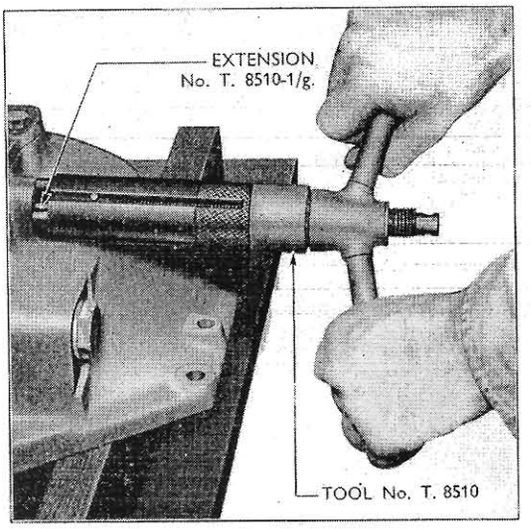


Fig. 21
Removing Check Valve Seat

To Remove the Check Valve

Remove the lift cover as previously described and place the lift cover on a bench, suitably supported to prevent damage to the machined surfaces and internal components.

1. Unscrew the check valve plug and, using a pair of sharp-nosed pliers, extract the valve pilot, spring, spring guide and ball from the check valve passage.

2. The check valve seat is a press fit in the housing but is threaded at its front end to accept the thread of the remover extension T.8510-1/g which is used with Main Tool No. T.8510. The shorter threaded end of the extension screws into the tool and the longer end into the valve seat. Operate the wing nut on the tool to withdraw the seat.

NOTE.—It is most important that the hollow outer tube of the withdrawal tool seats squarely against the lift cover during this operation, as excessive misalignment may result in breakage of the seat which will then be extremely difficult to remove. If the face of the lift cover appears rough, or out of square with the check valve drilling it is advisable to correct this before attempting to remove the valve seat.

To Replace the Check Valve

1. Examine the seat and renew if scored, damaged or chipped on either the outer surface or on the ball seat.

2. Fit a new 'O' ring to the check valve seat, locate the seat in the pilot of Tool No. T.8511, and enter the seat into the check valve passage. Screw the body of the tool into the threaded outer end of the check valve passage and operate the centre screw of the tool to press the valve seat into position.

3. Remove the tool, fit a new 'O' ring to the check valve pilot and assemble the check valve ball, spring guide, spring and pilot to the cover. Replace the check valve plug and tighten to a torque of 45 to 55 lbs/ft. (6.219 to 7.601 kg.m.).

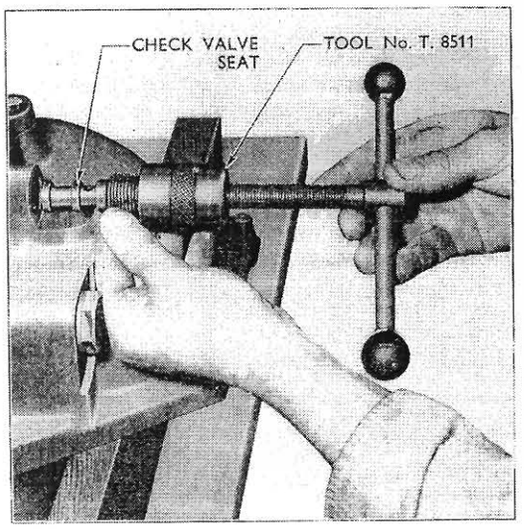


Fig. 22
Replacing Check Valve Seat

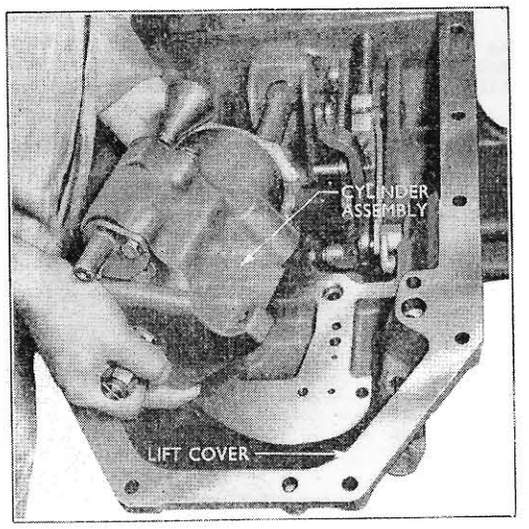


Fig. 23
Removing Lift Cylinder from Cover

To Remove the Ram Cylinder Assembly

1. Remove the lift cover as previously described, then remove the auxiliary service plate and flow control valve assembly from the cover assembly.

2. Disconnect the control valve linkage by removing the pin securing the turnbuckle assembly to the actuating lever and remove the turnbuckle.

3. Remove the four screws securing the ram cylinder to the lift cover (one of these is recessed into the cover in the area covered by the auxiliary service control plate) and withdraw the cylinder from its locating dowels in the cover.

To Dismantle the Ram Cylinder Assembly

1. Remove the ram cylinder safety valve by turning it anti-clockwise, using a spanner on the hexagon head of the body. Do not attempt to dismantle the safety valve assembly ; the slot in the centre portion is for adjustment during initial assembly, after which the valve is sealed and should not be disturbed. It is set to open at 2,750 to 2,850 lbs/sq. in. (193.35 to 200.38 kg/sq. cm.) and if the valve is suspected of being faulty it should be removed and replaced with a new one.

2. If necessary, remove the two ring dowels from the top face of the cylinder assembly.

3. Remove and discard the 'O' rings fitted in the counterbores of the various oil passages in the ram cylinder.

4. Ensure that the bench surface is clean and turn the ram cylinder onto its top face or, if preferred, secure it in a soft-jawed vice.

5. Remove the two screws securing the front cover plate to the lift cylinder and remove the plate and control valve spring.

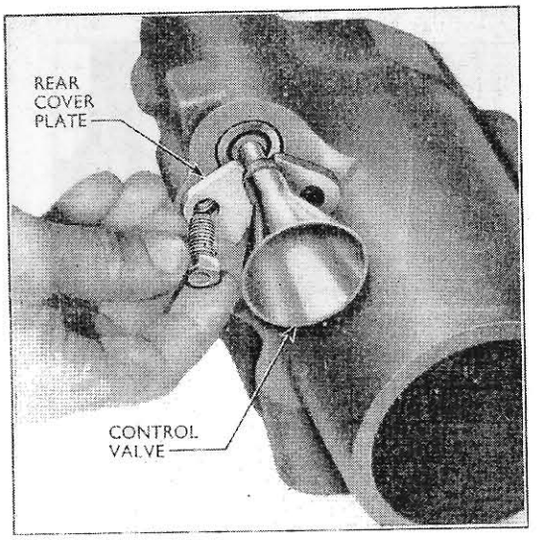


Fig. 24
Removing Rear Cover Plate from Cylinder

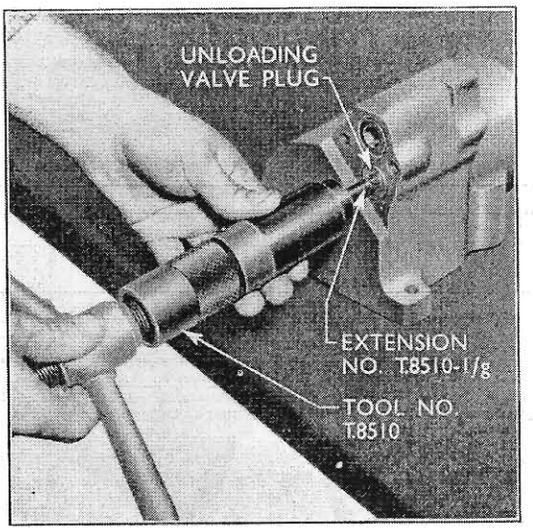


Fig. 25
Removing Unloading Valve Plug

6. Remove the two set screws securing the rear cover plate to the lift cylinder and remove the rear cover plate.

7. Remove the control valve, withdrawing it from the rear of the cylinder. Care should be taken in handling the valve to avoid damage or scoring to the lands of the valve or distortion of the valve as a whole.

8. Attach remover adaptor T.8510/g to Main Tool No. T.8510 and screw the outer end of the adaptor

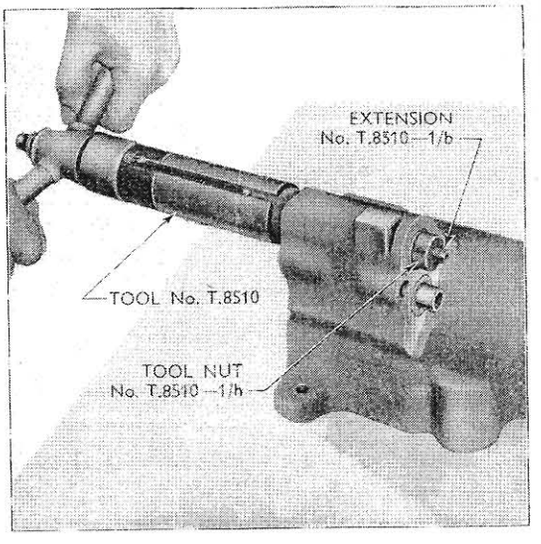


Fig. 26
Removing the Control Valve Bush

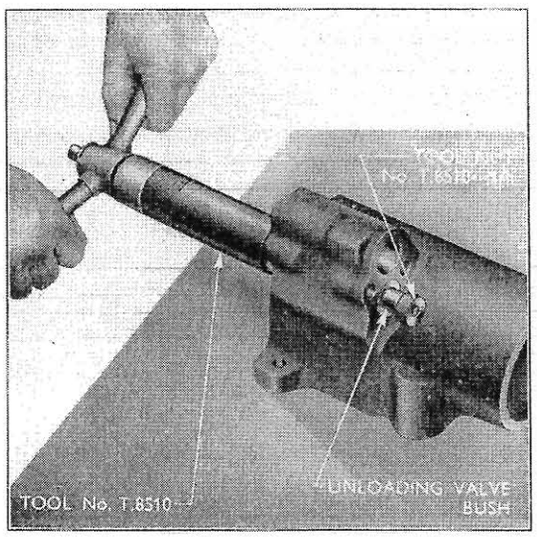


Fig. 27
Removing the Unloading Valve Bushes

into the unloading valve plug (at the front end of the unloading valve chamber) and remove the unloading valve plug.

Care should be taken to avoid damage to the lands of the plug as leakage at this point will affect the operation of the unloading valve.

9. Remove the unloading valve from its chamber and discard the 'O' ring fitted to the large end of the valve.

10. Attach the short threaded end of extension T.8510-1/b to Main Tool No. T.8510 and pass the extension through the control valve bush with the main tool at the front end of the cylinder. Screw the special nut, Tool No. T.8510-1/h onto the rear end of the extension until it locates squarely against the rear face of the bush with the small tapered portion of the nut located inside the bush for centralisation. Operate the wing nut of the main tool and withdraw the bush, then remove the special nut and bush from the main tool.

11. Repeat this operation for the unloading valve bushes, seating the nut against the rear face of the rear bush, i.e. with the main tool at the front of the cylinder, and withdrawing both bushes at the same time.

12. Insert a suitably sized rod through the safety valve locating hole and push the piston out of the ram cylinder. Care must be taken to avoid damage to the threads in the locating hole and to avoid scoring of the ram cylinder walls.

13. Unless the piston gland is known to be giving an absolutely perfect seal it is recommended that the gland is discarded and a new one fitted on reassembly.

To Rebuild the Ram Cylinder Assembly

The valves, bushes and sealing plugs used on the ram cylinder are machined to extremely accurate limits and it is important that any part which is worn, scratched or damaged in any way is discarded and only perfect parts fitted on reassembly. Each bush is a press fit in its respective bore in the cylinder and the control valve is a selective fit in its bush. All 'O' rings and sealing gaskets should be discarded and replaced by new parts on reassembly.

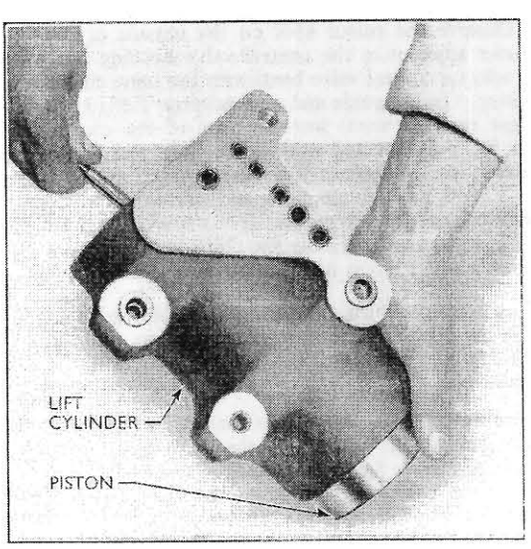


Fig. 28
Removing Ram Cylinder Piston

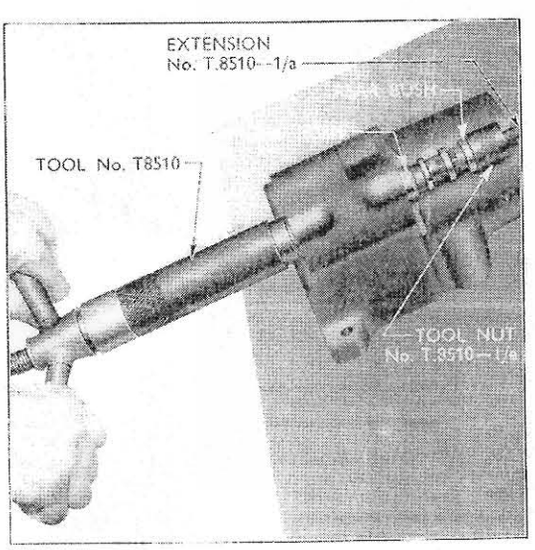


Fig. 29
Replacing the Unloading Valve Bushes

The outside of the lift cylinder bears colour spots, adjacent to the unloading valve and control valve bores, for identification of the bore sizes. The unloading valve bushes, unloading valve plug and control valve bush are marked with similar colours.

The colour **spots** on the housing should not be confused with a colour **streak** adjacent to the control valve bore. This streak is used to indicate the **internal** diameter of the control valve bush during initial assembly of the unit at the factory and bears no relation to the size of a new bush assembled in service.

1. Observe the colour spot on the outside of the cylinder adjacent to the unloading valve chamber and select a front and rear unloading valve bush with the same colour marking.

Attach the short threaded end of extension T.8510-1/a to Main Tool No. T.8510 and, working from the front of the cylinder pass the extension through the unloading valve bushing bore, using guide adaptor T.8510-1/k to centralise the tool in the bore.

Place the unloading valve front bush over the extension and locate it at the entrance of the bore. The bush has small notches in its end periphery, one small notch at one end and two larger notches at the other. The bush should be fitted to the housing with the small, single notched end to the front. Place the rear bush over the extension with the long spigot end away from the front bush and screw the special guide nut T.8510-1/e onto the extension, locating the spigot end of the rear bush in the nut. Lubricate the outsides of the bushes and draw them into the bore until the back face of the rear land on the rear bush is flush with the rear face of the housing,

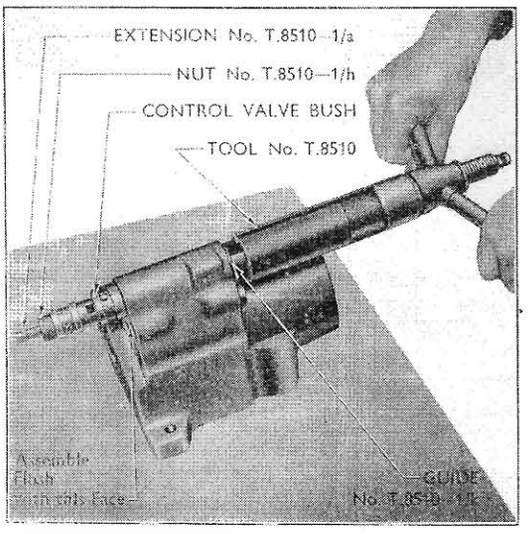


Fig. 30
Replacing the Control Valve Bush

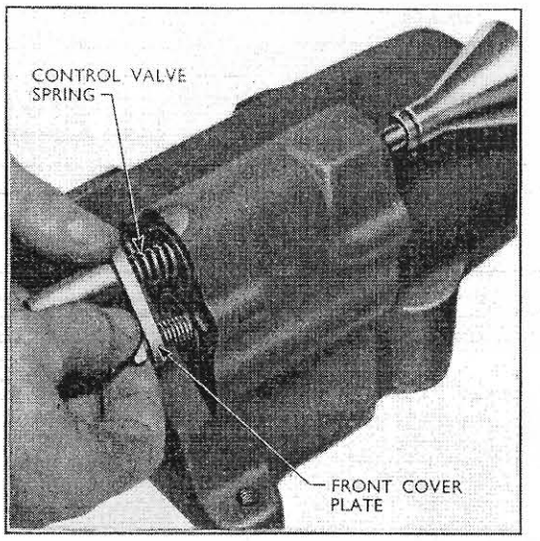


Fig. 31
Replacing Cylinder Front Cover Plate

the bushes being correctly located when the front face of the guide nut is in contact with the housing. Care should be taken to ensure that the rear bush is accurately centralised when making the assembly, otherwise difficulty may be experienced in obtaining entry into the bore.

It is important to the correct functioning of the lift that the bushes be correctly located.

2. Release the nut and withdraw the tool from the unloading valve bushes.

3. Observe the colour spot on the outside of the cylinder adjacent to the control valve bushing bore and select a control valve bush with the same colour marking. Insert guide and stop adaptor T.8510-1/k (spigot end foremost) into the rear of the control valve bushing bore and working from the rear of the cylinder, pass extension T.8510-1/a, fitted to Tool No. T.8510, through the guide and locate the control valve bush over the extension. The lands of the bush vary in width, and assembly should be made with the longest annular recess to the rear of the cylinder.

Lubricate the bush and, using nut T.8510-1/h to retain the bush and centralise the extension, pull the bush into the bore until the rear face contacts the guide.

Slacken the wing nut of the tool and reverse the guide, passing the spigot into the body of the tool, so that the larger face of the guide is against the rear face of the cylinder. Retighten the wing nut and draw the bush fully into the bore.

The position of this bush is important for correct operation of the valve gear and its front face should be flush with the front face of the cylinder.

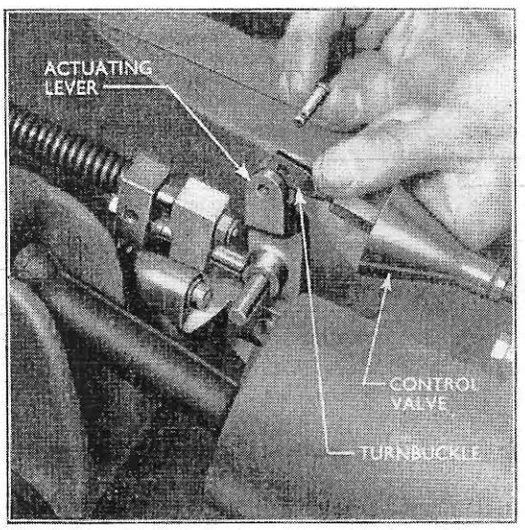


Fig. 32
Replacing Control Valve Turnbuckle

4. Fit a new 'O' ring in the recess at the large end of the unloading valve, lubricate the valve and 'O' ring and insert the valve in its bushes in the lift cylinder, small end to the rear.

5. Select an unloading valve plug of the same colour marking as the unloading valve bush and press this plug into the unloading valve bore, with the threaded central hole in the plug facing outwards, until it is flush with the front face of the cylinder.

6. The control valve is colour marked to assist identification, this should not, however, be used as a means of selecting a valve to match the bush. The internal diameter of the bush will vary according to the interference fit between the bush and the bore and the control valve selected should be the largest size which will operate without binding in the bush. It is essential that the internal bore of the bush and the lands of the valve are completely free from burrs as these could give a false impression of the fit of the valve.

7. Having selected a suitable valve, retain it in the bush by assembling the rear retaining plate, securing the plate with two set screws.

8. Replace the control valve spring in the front cover plate and secure the plate to the housing with two set screws.

9. If removed, replace the two ring dowels in the appropriate diagonally opposite counterbored holes in the top face of the ram cylinder.

10. Fit a new gland to the piston using the tapered replacer, Tool No. T.8519-a. Lubricate the gland and press the gland over the taper until it locates on the parallel portion of the tool.

Locate the gland and replacer on the closed end of the piston and slide the gland off the tool so that it locates in its groove in the piston.

11. Lubricate the outer face of the piston and, after allowing the gland to contract to its original size, insert the open end of the piston into the replacer guide, T.8519-b, so that the gland is compressed into its groove.

Fit the piston to the ram cylinder by inserting the front end of the piston into the ram cylinder until the replacer guide contacts the rear end of the ram cylinder ; slide the piston from the replacer into the ram cylinder.

12. Replace the ram cylinder safety valve assembly using a new sealing washer between the valve and the cylinder.

To Replace the Ram Cylinder

1. Ensure that the mating faces of the ram cylinder housing and lift cover are clean and free from burrs.

2. Fit new 'O' rings to the counterbores in the oil passages, fit the cylinder assembly to the lift cover, entering the piston rod into the cylinder bore and secure with the retaining screws.

3. Replace the control valve turnbuckle assembly, inserting the ball end in the control valve sleeve and securing the rear end to the valve actuating lever with a cotter pin and split pin.

4. Carry out the Qualitrol and Position Control adjustments as previously described.

5. Refit the auxiliary service and flow control plate assembly, assemble the lift cover assembly to the tractor and replace the driver's seat.

To Dismantle the Lift Cover Assembly

1. Remove the seat, disconnect the lift arms and main control spring yoke and remove the lift cover from the tractor as previously described.

2. Remove the auxiliary service plate and ram cylinder.

3. Remove the quadrant retainer.

4. Remove the self-locking nut, double coil spring washer and flat washer securing the friction plate to the lift control lever shaft and withdraw the friction plate, woodruff key and friction disc.

5. Remove the two screws and spring washers securing the quadrant assembly to the lift cover and slide the quadrant assembly off the control lever cross-shaft.

6. Remove the locating spacer tube situated within the control lever cross-shaft housing.

7. Turn the lift cover on the bench, so that it rests on its top face, suitably supported to protect the machined faces.

8. Straighten the lockwasher tab and remove the screw and flat washer securing each lift arm to the cross-shaft. Remove the lift arms.

9. Remove the cross-shaft together with the two supporting bushes and spacer from one side of the housing.

10. Unscrew the main control spring plunger yoke and remove the main control spring.

11. Remove the Qualitrol plunger, link and spring assembly, sliding the fork off the pin in the actuating lever. The link and spring can be removed from the plunger by removing the clevis pin and split pin.

12. Remove the snap ring securing the valve actuating lever to the control lever shaft and remove the actuating lever.

13. Remove the split pin retaining the position control link to the selector arm.

14. Remove the position control assembly and control lever cross-shaft from the lift cover and slide the position control assembly from the cross-shaft.

The position control assembly can, if required, be further dismantled by removing the self-locking nut securing the spring guide to the position control arm. The position control rod can be removed by removing the locknut and unscrewing the rod from the block. The position control link is secured to the block by a pin which is a press fit and can be removed by carefully pressing out this pin. A washer is fitted between the link and the block and care should be taken not to lose it. The position control arm roller can be removed by carefully pressing out the pin from the arm.

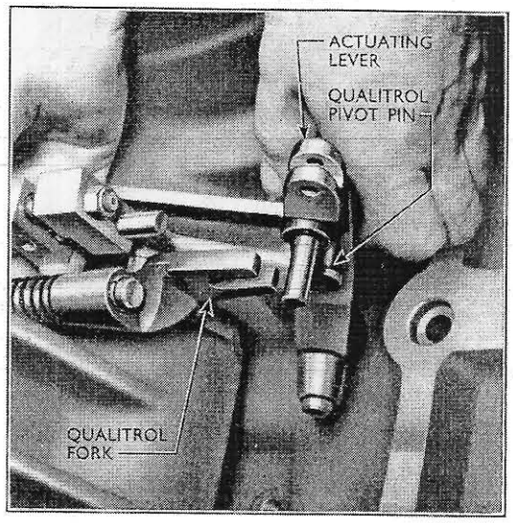


Fig. 33
Removing Control Valve Actuating Lever

15. Remove the ram arm, piston rod and thrust washer from the lift cover. Remove the remaining cross-shaft bushes and spacer.

16. Remove the pin securing the selector lever to the selector control arm and remove the selector control arm.

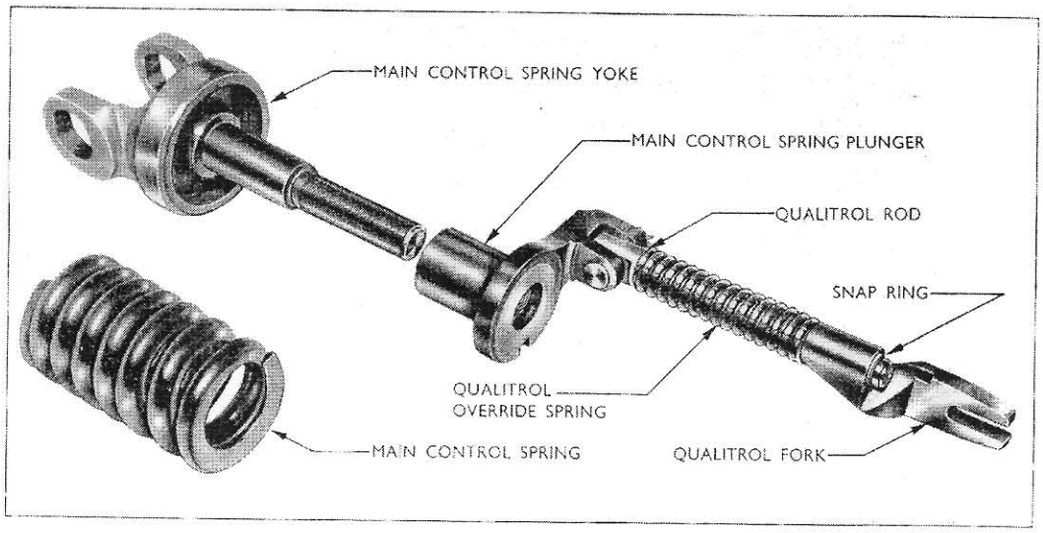


Fig. 34 **Qualitrol Link, Spring and Plunger Assembly**

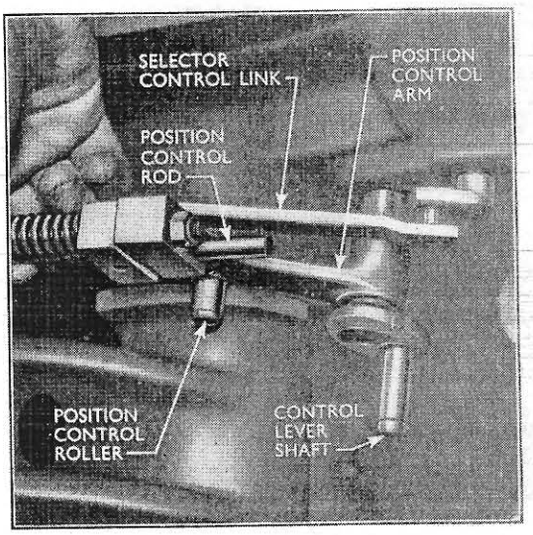


Fig. 35
Assembling Position Control Linkage to Cover

To Rebuild the Lift Cover Assembly

1. Place the ram arm and piston rod in position in the lift cover with the cam on the same side as the selector control arm.

2. If removed, replace the pin and roller in the position control arm, pressing the pin in as far as possible whilst still leaving the roller free to rotate.

Similarly, secure the position control link to the block by pressing in the pin, locating the flat washer between the link and block.

Slide the position control guide rod through the spring, block and arm and secure with a self-locking nut. Tighten the nut until the shoulder on the guide rod seats securely against the position control arm. Pass the position control rod through the position control arm, screw it through the block and secure with a locknut.

3. Slide the control lever cross-shaft through the position control arm and fit this assembly to the lift cover. Install the selector control arm in the lift cover, fit the selector lever and secure with a tension pin.

4. Connect the position control link to the selector arm and secure with a split pin.

5. Assemble the spacer tube into the outer end of the control lever shaft, locating the smaller diameter end in the housing. Using a new gasket, secure the quadrant to the housing with two screws and spring washers. Replace the friction disc, locate the woodruff key in its slot and assemble the friction plate over the key and retain on the shaft with a flat washer, double coil spring washer and self-locking nut. Do not tighten the nut at this stage.

6. Replace the quadrant retainer and secure with two screws.

7. Tighten the self-locking nut on the control lever shaft until a pull of 10 lbs. (4.536 kg.) measured at the ball end of the lever, is required to move the lever.

8. Fit the control valve actuating lever to the control lever shaft with the piston stop pin facing inwards. Secure the actuating lever to the shaft with the special snap ring.

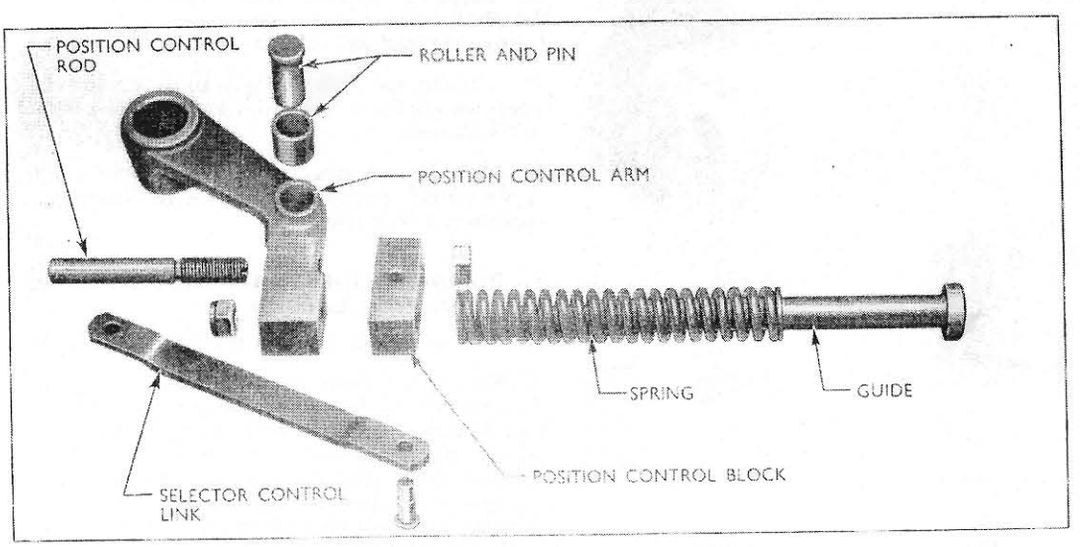


Fig. 36 Position Control Linkage Assembly

9. Assemble the qualitrol rod and spring to the fork and secure with a circlip. Connect the rod to the main control spring plunger with a clevis pin and split pin.

10. Fit the main control spring plunger in its bore at the rear of the lift cover, engaging the slot with the guide stud in the housing and sliding the forked end of the assembly over the qualitrol pin in the valve actuating lever.

11. Place the thrust washer between the ram arm and the top cover on the side away from the control valve linkage. Install the lift cross-shaft, engaging the master spline on the centre portion with the corresponding spline on the ram arm.

12. Assemble the lift arm cross-shaft bushes and spacers (two bushes separated by a spacer on each side) to the cross-shaft. Although the bushes are identical, they are chamfered at one end and each should be installed with the chamfered end facing towards the spacer.

13. Fit the lift arms to their respective left- and right-hand locations, engaging the master splines on the cross-shaft. Secure the lift arms with a retaining washer, tab washer and screw. Fully tighten one screw and then slack off for one turn. Fully tighten the other screw to bed down the parts and then slacken off, retightening until the lift arms just fall under their own weight and no end play is apparent in the shaft. Secure in this position by bending the locking tabs against the screw heads.

14. Install new 'O' rings in the top face of the ram cylinder assembly and replace the ring dowels if removed. Assemble the cylinder to the cover as previously described and connect the control valve turnbuckle to the actuating lever, placing its front end in the control valve shroud.

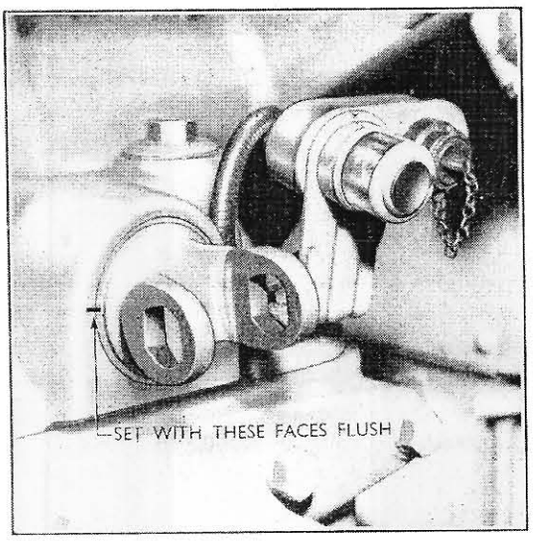


Fig. 37
Main Control Spring Setting

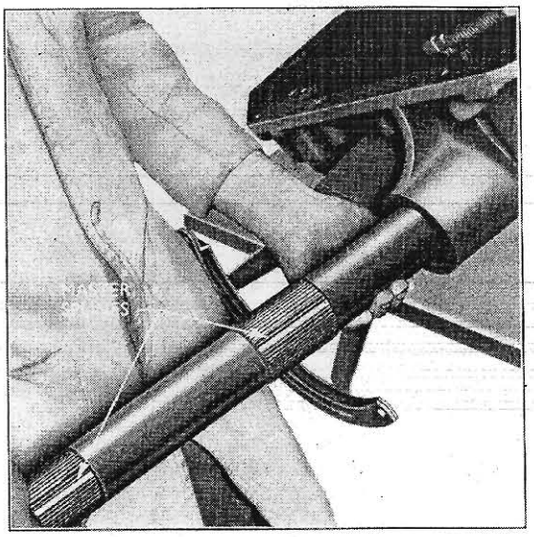


Fig. 38
Assembling Lift Cross-shaft to Cover

15. Place the main control spring in its housing and screw the main control spring yoke into the plunger until its rear face is flush with the housing.

16. Carry out the Qualitrol and Position Control adjustments as previously described.

17. Replace the auxiliary service and flow control valve plate assembly, using new 'O' rings in the various oil passages.

18. Replace the lift cover on the tractor as previously described, using a new gasket and new 'O' rings between the inlet and exhaust oil passages.

19. Connect the main spring yoke to the rocker, attach the top link to the rocker and the lifting rods to the lift arms.

20. Refit the seat, attach an implement and test the lift for correct operation by raising and lowering the implement several times.

To Remove the Exhaust Oil Filter and Back Pressure Valve Assembly

1. Remove the lift cover as previously described.

2. Remove the screws and spring washers securing the feed pipe to the pump. Remove the two feed pipe locating collets and lower both the feed and exhaust pipes, together with the filter and back pressure valve, until the pipes are free from the passages in the transmission housing, and can be withdrawn through the hydraulic lift cover aperture in the rear transmission housing.

To Replace the Exhaust Filter and Back Pressure Valve Assembly

1. Discard the 'O' rings fitted at the top ends of the pipes and between the pump and pipe flange. Lower the pipes and filter into the transmission housing as an assembly.

2. Pass the top ends of the pipes up through their respective bores in the housing and fit new 'O' rings to the grooves in the pipes. Place the locating collets in the groove in the feed pipe and pull the pipe down to nip the collets in position. Pull the exhaust pipe down until it is flush with the top of the transmission housing and locate a further 'O' ring at this point.

3. Fit a new 'O' ring between the feed pipe flange and the pump and secure with two screws and spring washers.

4. Replace the lift top cover assembly as previously described, using a new gasket between the cover and the transmission housing.

To Overhaul the Back Pressure Valve

1. Remove the exhaust oil filter, feed and exhaust pipe assembly as previously described.

2. Remove the wire retainer from the internal bore of the back pressure valve and extract the plate, spring and valve.

Before reassembly the valve surface and bore of the body should be examined for damage or scoring and renewed if necessary. The valve should be a free, sliding fit in the body which should be free from dirt or obstruction.

If necessary, check the tension of the spring (see Specification). Reassemble in the reverse order to that described above and replace the complete oil filter and pipe assembly in the rear transmission.

To Renew the Exhaust Oil Filter

This filter will normally only require servicing when major overhauls are being carried out on the hydraulic lift and rear transmission assemblies.

1. Remove the complete exhaust oil filter, back pressure valve and pipes assembly as previously described.

2. Unscrew the back pressure valve from the exhaust oil pipe.

3. Remove the sealing washer from below the filter then withdraw the filter from the pipe.

4. Remove the sealing washer, plain washer and spring from above the filter.

5. Fit the new filter by reversing the dismantling procedure, using new sealing washers if the old ones show signs of deterioration.

6. Refit the complete assembly into the rear transmission housing and replace the lift top cover as previously described.

HYDRAULIC PUMP

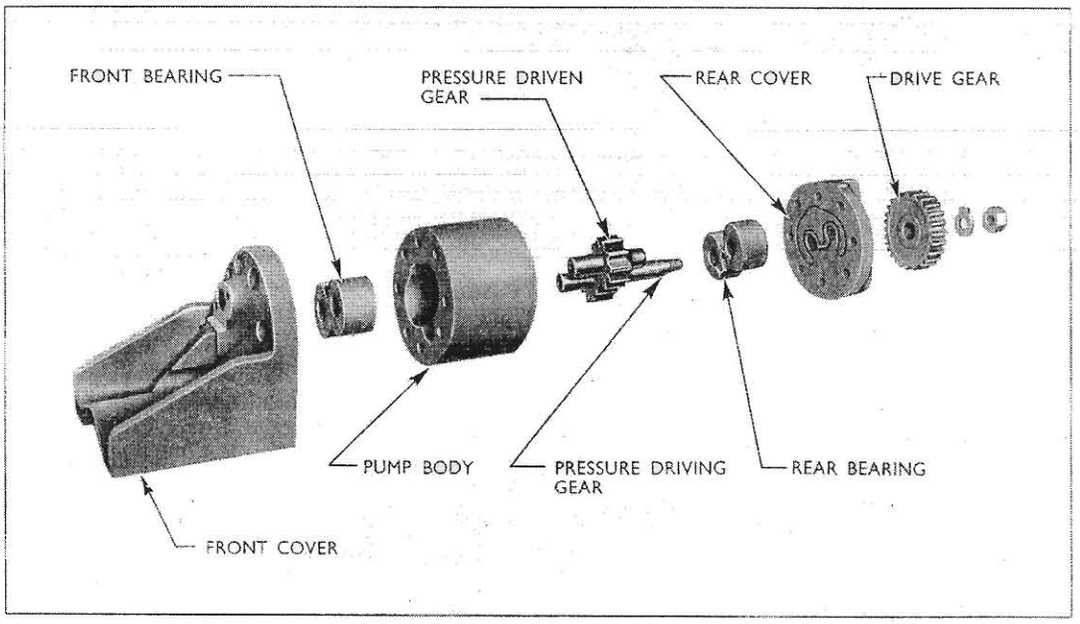


Fig. 39 **Hydraulic Pump Assembly**

The single stage, gear-type, pump is mounted on a pedestal at the base of the rear transmission housing and is driven by a gear on the power take-off extension shaft.

The two spur type gears which produce the high pressure oil required to operate the hydraulic power lift operate in specially designed bearing blocks which are a precision fit in the pump housing. The pressure driving gear is formed integrally with a shaft, the end of which protrudes through the pump casing and is tapered to accept an external gear which is keyed to the shaft. This external gear meshes with a driving gear keyed to the power take-off extension shaft and the hydraulic pump is therefore only in operation when the power take-off selector lever is in the engaged position.

When a " Live " power take-off is fitted the transmission clutch may be disengaged without affecting the drive to the pump.

Rotation of the pressure gears draws oil from the rear transmission housing, past two magnetic filters in the pump pedestal and through a wire gauze strainer into the inlet side of the pump. The oil then fills the spaces between the gear teeth and is carried around the outside of the chamber until, as the teeth in the two gears mesh, the oil is forced from between the teeth and delivered through an outlet port in the front face of the pump. The feed pipe is connected to this port, being sealed with 'O' rings at either end and connected at its upper end to a flange in the top of the transmission housing from where the oil is led to the hydraulic lift.

An oil duct incorporated in the high pressure side of the pump directs oil to the back faces of the bearings where is is trapped between the bearings and their respective cover plates. An 'O' ring is fitted in a specially shaped groove in each cover plate to prevent leakage between the bearings and the cover plate. This high pressure oil has the effect of loading the bearings, moving them towards the gears, and keeping end-float to a minimum with the effect of automatically compensating for wear and ensuring maximum efficiency from the pump.

A duct on the low pressure side of the pump, together with spiral grooves in the bearing and small reservoirs in the cover plates, ensures a continuous supply of low pressure oil to the bearing surfaces for lubrication purposes.

A special seal fitted in the rear cover plate safeguards the pump by keeping out air ; this seal should always be fitted with the sealing lip facing outwards, its purpose being to prevent ingress of air, not leakage of oil.

To Remove the Hydraulic Lift Pump

1. Drain the oil from the rear transmission housing.

2. Remove the lift top cover as previously described.

3. Disconnect the feed pipe leading from the pump to the top of the transmission housing.

4. Remove the three screws and lockwashers securing the pump to the pedestal and lift the pump free of the two locating dowels.

To Dismantle the Hydraulic Pump

1. Straighten the locking tab and remove the nut securing the external driven gear to the pump pressure driving gear shaft.

2. Using puller tool No. T.8515, remove the external driven gear from the shaft.

3. Remove the woodruff key from the pump pressure driving gear shaft.

4. Remove the nuts, bolts and washers securing the two end covers. The two bolts in line with the screws securing the feed pipe adaptor are dowel bolts, machined to fine limits, and must not be mixed with the other retaining bolts. These dowel bolts are marked with a " D " on their heads for identification purposes.

5. Remove the two covers and extract the "O" ring from its locating groove in each cover.

6. If necessary the seal can be removed from the front cover, after removal of the retaining circlip, by carefully driving the seal from the cover with a drift of approximately the same size as the seal. A washer is fitted between the oil seal and the pump cover and care should be taken not to misplace it.

7. Remove the pump gears and bearing blocks as an assembly. Under no circumstances should any force be applied to the gear shafts.

8. Examine the bearings for signs of seizure or scoring on the face or journals. Light score marking can be removed by careful lapping on a surface plate, using "O" grade emery paper and paraffin.

9. Examine the body for wear in the gear running track. If the track is worn deeper than 0.0025 in. (0.0635 mm.) on the inlet side, the body must be replaced.

10. Examine the gears for excessive wear or damage on journals, faces or teeth. Run-out across the gear face to the tooth edge should not exceed 0.001 in. (0.025 mm.). The gear journals can, if required, be lightly polished with "O" grade emery paper to remove wear marks. The gear faces may be polished by sandwiching the emery paper between the gear and a scrap bearing and rotating the gear.

If new gears are fitted the journal sizes on either side of each individual gear must be paired within 0.001 in. (0.025 mm.) of each other. The face widths of each pair of gears must be held to within 0.001 in. (0.025 mm.) of each other, this applies equally to the mixing of gears from different pumps or the replacement of single gears.

11. All rubber seals, "O" rings, etc. should be replaced when servicing the pump.

To Reassemble the Hydraulic Pump

The two bearings, although of similar appearance are not identical and they must be assembled in correct relationship to the gears and housings. The pump main body should be placed on the bench on its side and the gears and bearings arranged as shown in Fig. 42. In this position the right-hand (front) bearing will have the small run-out slots from the oil ducts at the **upper** end of the **right**-hand (high pressure) ducts and the **lower** end of the **left**-hand (low pressure) duct.

The left-hand (rear) bearing will have the run-outs at the upper end of the **left**-hand (high pressure) duct and the **lower** end of the **right**-hand (low pressure) duct.

1. With the right-hand (front) bearing in the position shown in Fig. 42, i.e. with the plain side of the bearing downwards and the run-out from the **bores** to the left (i.e. low pressure side of pump) assemble the pump pressure driven gear to the further bore of the bearing.

2. Assemble the pump pressure driving gear to the nearer bore of the bearing, threaded end of the shaft pointing upwards and teeth meshing with the pressure driven gear (see Fig. 41).

3. Turn the left-hand (rear) bearing so that the plain face points upwards and assemble to the gears, so that the small relief on the outer diameter of each

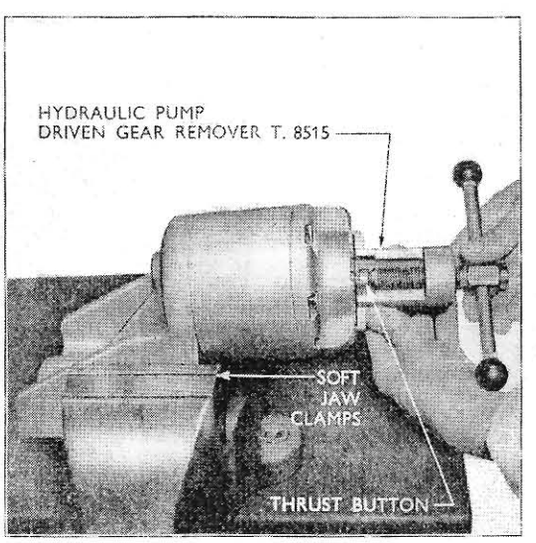


Fig. 40
Removing Hydraulic Pump Driven Gear

bearing (i.e. the high pressure side) is on the right-hand side of the assembly.

4. Install the bearing and gear assembly in the pump housing, with the threaded end of the pressure driving gear pointing to the left and the small reliefs on the outer diameter of the bearings upwards.

5. Fit a new "O" sealing ring to each cover plate and assemble the plates to the pump body.

6. Lightly secure the end covers to the pump body with the two dowel bolts which must be correctly positioned, as previously described. Fit the remaining six bolts together with the nuts and spring washers, taking care to locate the square bolt heads in the square recesses in the front cover. Tighten the nuts evenly to 40 to 45 lbs. ft. torque (5.528 to 6.219 kg.m.).

It is essential that this torque figure is not exceeded and an accurate torque wrench must be used on this operation.

7. Replace the woodruff key in the pump pressure driving gear shaft and assemble the external gear to the shaft. Place a locking tab washer on the threaded end of the shaft, assemble and fully tighten the retaining nut, then turn the tab over to lock the nut in position.

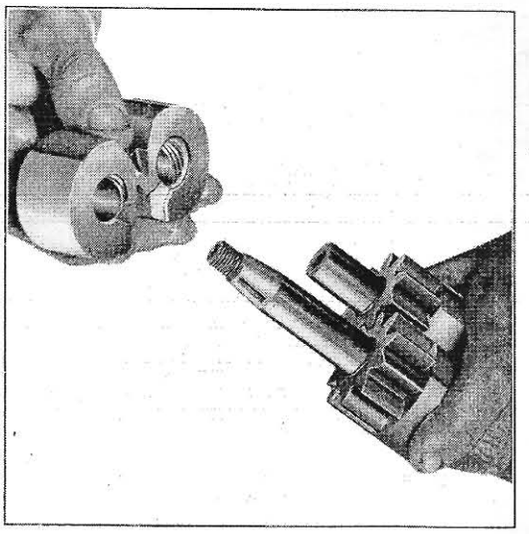


Fig. 41
Assembling Gears and Bearings

To Replace the Hydraulic Lift Pump

1. Locate the pump carefully on the locating dowels in the pedestal and secure the pump with three screws and lockwashers.

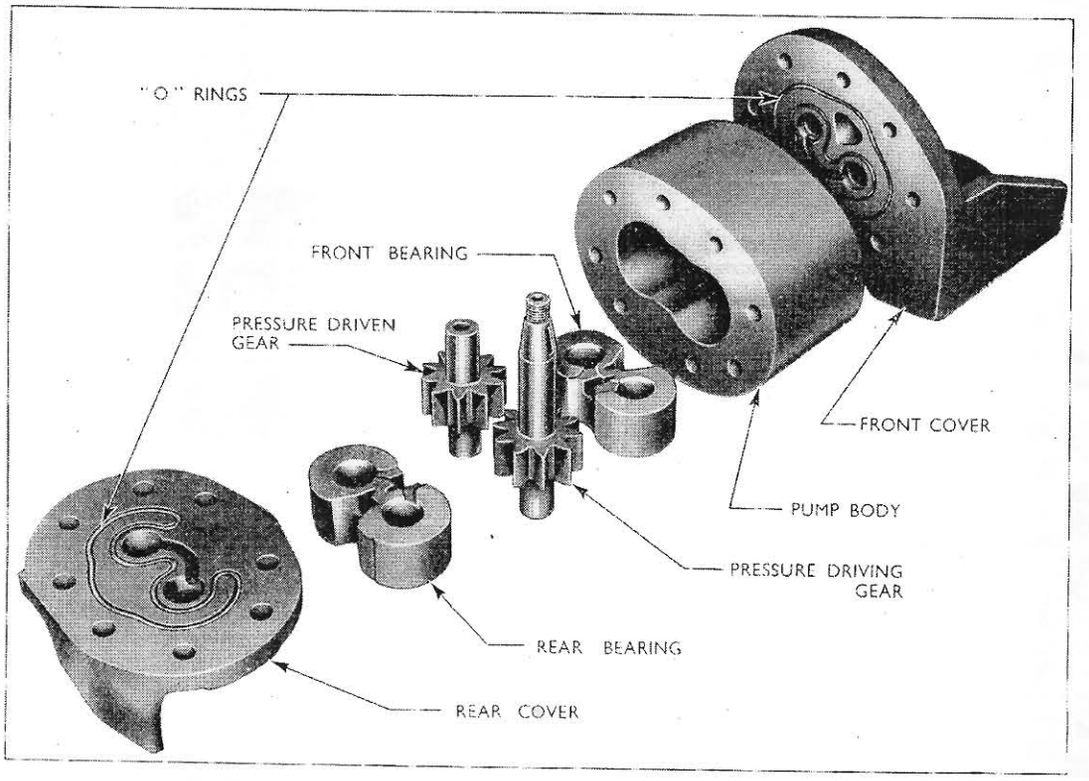


Fig. 42 **Hydraulic Pump Body, Gears and Bearings**

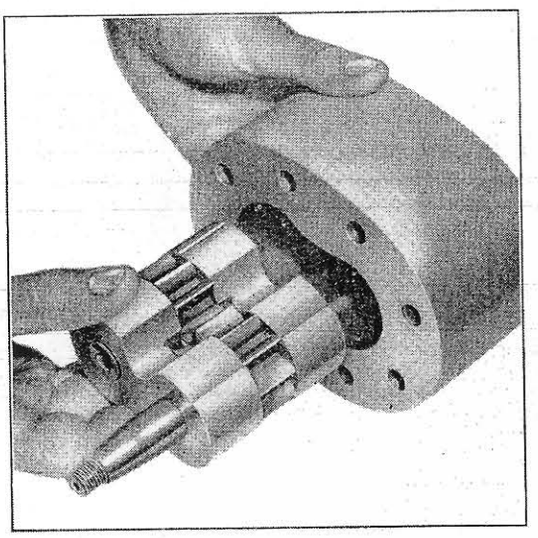


Fig. 43
Assembling Gears and Bearings to Pump Body

2. Secure the feed pipe, using a new "O" ring between the pipe flange and pump.

3. Replace the lift cover as previously described.

4. Fill the rear transmission housing with the correct quantity of oil of the approved grade.

TESTING THE HYDRAULIC SYSTEM

The pressure relief valve located in the hydraulic lift top cover is set during production to open at pressures in excess of 2,450 to 2,500 lbs/sq. in. (172.24 to 175.77 kg/sq. cm.). Should it be suspected that the pressure in the hydraulic system is incorrect it may be checked by installing a pressure testing gauge T.8503 in conjunction with T.8503-1.

Dealers already in possession of this equipment will also require a special adaptor T.8503-3 in order to test the Super Major hydraulic system.

To test the pressure, first operate the tractor to bring the transmission oil to its normal working temperature and then remove the plug from the threaded hole in the front, right-hand side of the lift cover (this hole connects into the main feed from the hydraulic pump). Screw the special adaptor T.8503-3 into the threaded hole then assemble the " T " piece of the pressure testing equipment to the adaptor. Connect the pressure gauge to the " T " piece and then install the return pipe and flow control tap assembly between the " T " piece and the rear transmission filler plug hole as shown in Fig. 45. The flow control tap should be assembled with the arrow pointing in the direction of flow, i.e. towards the rear transmission filler hole.

Fully open the flow control tap in the pressure testing equipment, start the engine and run at a fast idling speed. Move the auxiliary service control to its outer position and move the main control lever to the top of the quadrant. If the lift arms are in the fully raised position the main control lever will need to be taken past the fixed stop at the top of the quadrant. Gradually close the shut-off valve,

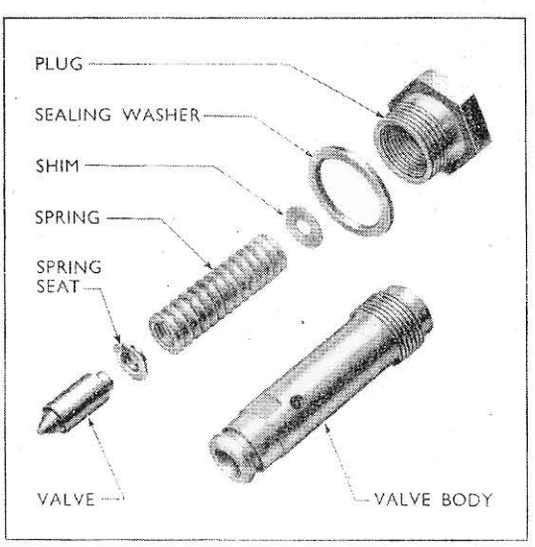


Fig. 44
Pressure Relief Valve Assembly

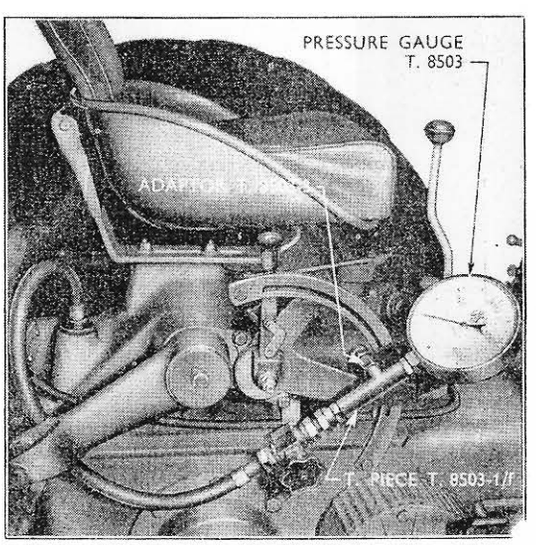


Fig. 45
Hydraulic Pump Test Equipment

observing the reading on the pressure gauge which should rise steadily to 2,450 to 2,550 lbs/sq. in. (172.24 to 175.77 kg/sq. cm.). At this pressure the relief valve should blow-off and the pressure drop to approximately 300 lbs/sq. in. (21.09 kg/sq. cm.).

If the relief valve blows off at a lower pressure than this it may be that insufficient shims have been fitted between the relief valve spring and plug (a faulty relief valve spring can also produce the same symptoms). Shims are available in thicknesses of 0.010 in. (0.254 mm.) and 0.025 in. (0.635 mm.) for this adjustment.

If the pressure relief valve does not blow off, either :—

(1) Too many shims have been added, in which case the pressure shown on the gauge will exceed 2,500 lbs/sq. in. (175.77 kg/sq. cm.) or :—

(2) The pressure may not be sufficiently high, which could be caused by a badly worn or damaged pump or by leaking oil seals either on the main feed pipe from the pump to the lift cover or within the lift cover assembly.

Checking the Hydraulic Lift After Reassembly

The following tests can be quickly applied to a tractor after overhaul of the hydraulic lift as a check for correct adjustment of the internal linkage and against internal oil leaks.

Attach weights of approximately 1,500 lbs, or a suitable implement, to the lower links, start the engine and run at 1,600 r.p.m. Set the lift on Qualitrol and slowly raise the main control lever within the quadrant, the lift arms should start to raise when the lever is approximately 0.9 in. (22.76 mm.) from the top stop.

With the lift arms in the fully raised position the system should not make more than three corrections within two minutes. Any figure in excess of this shows that excessive leakage is occurring either from the ram cylinder or within the valve chest and the system should be checked to locate this fault before putting the tractor back into service.

A further test which can be applied, to check the operation of the internal Qualitrol linkage is as follows :—With the tractor set up as detailed above, slowly raise the control lever until the lift arms raise, move the lever 1 in. (25.4 mm.) down the quadrant, when the lift arms will lower. It should then be possible to cause the lift arms to raise by applying a compressive load to the main control spring yoke.

HYDRAULIC LIFT SPECIFICATION

Lift Cylinder

Ram cylinder diameter .. .. 3.3795 to 3.3810 ins. (85.843 to 85.881 mm.)
Ram piston diameter .. .. 3.378 to 3.379 ins. (85.805 to 85.830 mm.)
Control valve spring :
No. of coils 18
Length .. .. 1.43 ins. under load of 24 to 26 lbs. (36.3 mm. under load of 10.89 to 11.79 kg.)
Cylinder safety valve :
Blow-off pressure .. .. 2,750/2,850 lbs. per sq. in. (193.35/200.38 kg. per sq. cm.)

Control and Unloading Valve Bush Bores

Colour marking	Diameter (ins)	Diameter (mm)
Blue/White	over 0.9994 to 0.9996	25.385 to 25.390
White	„ 0.9996 to 0.9998	25.390 to 25.395
Blue	„ 0.9998 to 1.0000	25.395 to 25.400
Yellow	„ 1.0000 to 1.0002	25.400 to 25.405
Green	„ 1.0002 to 1.0004	25.405 to 25.410
Orange	„ 1.0004 to 1.0006	25.410 to 25.415
Green/White	„ 1.0006 to 1.0008	25.415 to 25.420

Control and Unloading Valve Bushes and Unloading Valve Plug

Colour marking	Diameter (ins)	Diameter (mm)
Blue/White	over 1.0000 to 1.0002	25.400 to 25.405
White	„ 1.0002 to 1.0004	25.405 to 25.410
Blue	„ 1.0004 to 1.0006	25.410 to 25.415
Yellow	„ 1.0006 to 1.0008	25.415 to 25.420
Green	„ 1.0008 to 1.0010	25.420 to 25.425
Orange	„ 1.0010 to 1.0012	25.425 to 25.430
Green/White	„ 1.0012 to 1.0014	25.430 to 25.435
Red/White	„ 1.0014 to 1.0016	25.435 to 25.440

Control Valve

Colour marking	Diameter (ins)	Diameter (mm)
White	over 0.5917 to 0.5919	15.029 to 15.034
Blue	„ 0.5919 to 0.5921	15.034 to 15.039
Yellow	„ 0.5921 to 0.5923	15.039 to 15.044
Green	„ 0.5925 to 0.5926	15.049 to 15.052
Orange	„ 0.5927 to 0.5928	15.055 to 15.057

Auxiliary Service Control Valve Bore in Plate		
Colour marking	Diameter (ins)	Diameter (mm)
Green	from 0.7487 to 0.7490	19.017 to 19.025
White	over 0.7490 to 0.7493	19.025 to 19.032
Blue	„ 0.7493 to 0.7496	19.032 to 19.040
Yellow	„ 0.7496 to 0.7500	19.040 to 19.050
Orange	„ 0.7500 to 0.7503	19.050 to 19.058

Auxiliary Service Control Valve		
Colour marking	Diameter (ins)	Diameter (mm)
Green	from 0.7482 to 0.7485	19.005 to 19.013
White	over 0.7485 to 0.7488	19.013 to 19.020
Blue	„ 0.7488 to 0.7491	19.020 to 19.028
Yellow	„ 0.7491 to 0.7494	19.028 to 19.036
Orange	„ 0.7494 to 0.7497	19.036 to 19.043

Flow Control Valve Plunger Bore Diameter		
Colour marking	Diameter (ins)	Diameter (mm)
Red	from 0.6675 to 0.6677	16.955 to 16.960
Yellow	over 0.6677 to 0.6679	16.960 to 16.965
Blue	„ 0.6679 to 0.6681	16.965 to 16.970
Green	„ 0.6681 to 0.6683	16.970 to 16.975
White	„ 0.6683 to 0.6685	16.975 to 16.981

Flow Control Valve Plunger		
Colour marking	Diameter (ins)	Diameter (mm)
Red	from 0.6670 to 0.6672	16.942 to 16.948
Yellow	over 0.5672 to 0.6674	16.948 to 16.953
Blue	„ 0.6674 to 0.6676	16.953 to 16.958
Green	„ 0.6676 to 0.6678	16.958 to 16.963
White	„ 0.6678 to 0.6680	16.963 to 16.968

Back Pressure Valve

Blow-off pressure .. .. 20 to 29 lb. per sq. in. (1.406 to 2.039 kg. per sq. cm.)
Spring length .. .. 0.74 ins. under load of 2.64 to 2.92 lb. (18.8 mm. under load of 1.197 to 1.324 kg.)

Hydraulic Pump

Flow capacity .. .. 4.93 galls. per minute (22.41 litres per minute) at 1,600 r.p.m.

Lift Cover

Pressure relief valve :
Thickness of shim .. .. 0.010 in. (0.254 mm.), 0.025 in. (0.635 mm.)
Blow-off pressure .. .. 2,450 to 2,500 lb. per sq. in. (172.24 to 175.77 kg./sq. cm.)
Check valve :
Check valve bore diameter .. .. 0.749 to 0.750 in. (19.025 to 19.05 mm.)
Check valve seat land diameter (rear of 'O' ring) .. ..0.7510 to 0.7505 in. (19.08 to 19.06 mm.)
Check valve spring :
No. of coils 9.5
Length .. .. 0.70 in. under load of 10.2 to 12.2 lbs. (17.78 mm. under load 4.65 to 5.53 kg.)
Cross-shaft :
Shaft journal diameter .. .. 2.260 to 2.262 ins. (57.41 to 57.46 mm.)
Bush inside diameter .. .. 2.265 to 2.267 ins. (57.53 to 57.58 mm.)
Bush outside diameter .. .. 2.620 to 2.622 ins. (66.55 to 66.60 mm.)
Position control spring :
No. of coils 21.5
Length .. .. 4 ins. under load of 85 lb. (101.6 mm. under load of 38.56 kg.)
Qualitrol spring :
No. of coils 16
Length .. .. 3.39 ins. under load of 85 lb. (86.11 mm. under load of 38.56 kg.)

Tightening Torque Figures	lbs/ft.	kg/m.
Lift top cover to transmission housing screws	40 to 45	5.33 to 6.22
Lift cylinder to top cover screws	50 to 55	6.91 to 7.60
Auxiliary service plate to top cover screws	40 to 45	5.53 to 6.22
Check valve plug	45 to 55	6.22 to 7.60
Hydraulic pump through bolts	40 to 45	5.53 to 6.22
Flow control valve linkage pivot bolt	5 to 6	0.69 to 0.83
Control lever quadrant to shaft nut	10 lb.*	4.536 kg.

* Measured at ball of main control lever

The service procedures utilizing the new special service tools illustrated in Figures 47, 58, 61, and 63, of the above captioned supplement are being reviewed.

If it is determined that a special tool is not required, an applicable procedure will be developed. If it is determined that a special tool is required, the tool source and price will be announced in a subsequent Service Bulletin.

HYDRAULIC POWER LIFT

Since the introduction of the Super Major a number of changes have been made to the hydraulic system, and whilst details of these changes have been issued in Service Letters, they have not been incorporated in this section of the Manual.

These changes are summarized below as some of the components affected have been carried through to the New Super Major hydraulics, details of which are given at the end of this section.

CONTROL VALVE

To give improved operation of the hydraulic system a modified control valve has been fitted to all Super Majors from Engine No. 1584892. The current valve is the only one which is now being supplied through service and it may be identified from the previous valve by an annular recess in the front land as shown in Fig. 46.

This recess ensures that hydraulic pressure is evenly distributed around the valve when the lift is in the raised position and was introduced to overcome complaints of the valve sticking.

Where complaints of this nature are registered on tractors prior to Engine No. 1584892, the current type valve should be installed. As a general rule the modified valve to be used will have the same colour grading as that originally fitted unless a new bush is also being installed in which case the selected valve should be the largest size which will operate in the bush (without binding) after the bush has been assembled to the valve chest.

It will be necessary to reset the linkage adjustment, as detailed on page 16 of the Hydraulic Section of the Super Major Repair Manual Supplement, when a new control valve is fitted.

MAIN CONTROL SPRING

To obtain maximum sensitivity from Qualitrol it is important that the correct setting is obtained of the main control spring yoke in relation to the main control spring. Control springs vary slightly between production limits and therefore the setting of the yoke will differ between tractors. The common denominator is the compressive force required on the spring to

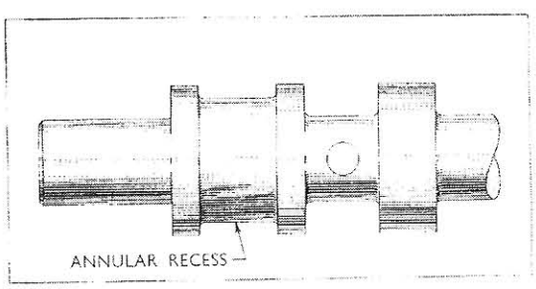


Fig. 46
Modified Control Valve

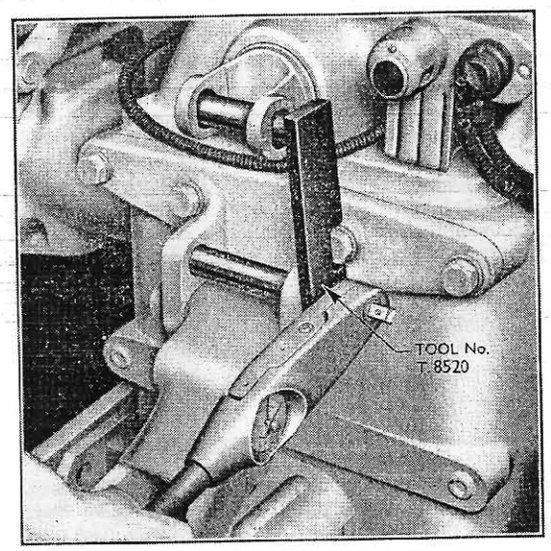


Fig. 47
Checking Main Control Spring Setting

effect a correction and this force may be checked in the following manner :—

With weights, or an implement, attached to the lower links start the engine and set to run at 1,600 r.p.m. Select Qualitrol and move the control lever slowly up the quadrant until a raise is effected, note this point on the quadrant and then move the lever 1 in. (25.4 mm.) back down the quadrant. The weights will then lower and they must lift again on the application of a horizontal thrust on the yoke of not more than 110 lbs. (49.89 kg.).

To check the setting of the spring this thrust may be applied by means of a torque wrench and Tool No. T.8520 as shown in Fig. 47. The adjustment of the yoke should be such that a correction is obtained when the torque wrench registers not more than 48.5 lb. ft. (6.7 kg.m.) which corresponds to the specified direct thrust of 110 lbs. (49.89 kg.).

This is the specified **maximum** figure which should not be exceeded and it will be found that as the yoke is gradually tightened, a point will be reached where a half turn of the yoke will increase the torque above the maximum. The yoke should be left in this position i.e. the position which will require the nearest torque to, but below, that specified to obtain a correction.

For details of the yoke setting on New Super Major Tractors, refer to pages 48 and 50.

FEED PIPE AND BRACKET ASSEMBLY

Effective with approximate Engine No. 1589010 a change was made to the feed pipe and bracket

assembly to improve the accessibility of the screws securing the pipe flange to the hydraulic pump. Failure to tighten these screws has resulted in a few instances of high pressure oil blowing past the ' O ' type sealing ring between the flange and the pump.

The flange was increased in thickness and is now secured with two screws 1¼ in. (31.8 mm.) in length, in place of the ⅞ in. (22.23 mm.) screws previously used.

A further change was made to the feed pipe and bracket assembly effective with Serial No. 08A303242. At this time, the exhaust filter, previously secured to a bracket on the feed pipe, was relocated on a bracket secured to the hydraulic pump front right-hand securing bolt and due to this change the pump securing bolts were increased in length by ⅛ in. (3.17 mm.). The current and previous parts are interchangeable providing that if a new feed pipe is fitted in place of the previous part the current exhaust filter support bracket and longer pump securing bolts are also used.

HYDRAULIC LIFT CYLINDER

Instructions previously given in the Repair Manual Supplement for replacing the control valve bush specify that the bush should be pulled into place until the front face is flush with the front of the cylinder. The control valve is, however, adjusted with the slip gauge on its rear face and to obviate errors caused by variation in the length of the bush it is now specified that the bush is located with its rear face flush with the rear of the cylinder.

BACK PRESSURE VALVE

To overcome complaints of faulty unloading valve operation due to low back pressure, changes were made to the back pressure valve body effective with Serial No. 08B746216. These changes are recognisable by the current valve body having four oil exhaust ports whereas the previous part had only one port.

UNLOADING VALVE SEAL

To minimise the possibility of the unloading valve sticking under conditions of high temperature and pressure the seal fitted to this valve after Tractor Serial No. 08B747301 is manufactured from a different type of rubber to that previously used. To assist identification of the current valve seal it is marked with a white paint spot.

QUALITROL POSITION CONTROL SELECTOR ARM

With effect from Serial No. 08A304421 an ' O ' ring has been fitted to a groove in the spindle of the selector arm to improve oil sealing at this point. Current and previous parts are interchangeable, the ' O ' ring can however only be fitted to the latest part incorporating a machined groove.

AUXILIARY CONTROL VALVE SPOOL AND HOUSING

To minimise the possibility of oil leaking into the ram cylinder when the control valve is in the outer position, changes were made to the spool and housing with effect from Tractor Serial No. 08B764393. These changes, whereby a second ' O ' ring was added to the valve spool and machining modifications made to the housing bore, did not prove suitable and with effect from Serial No. 08B775949 the original type was reinstated for production and service.

Both types of spool are interchangeable but it is essential that the correct ' O ' ring is used. The single seal type should be fitted with 'O' ring, Part No. 87034–ES whilst the double seal type should be

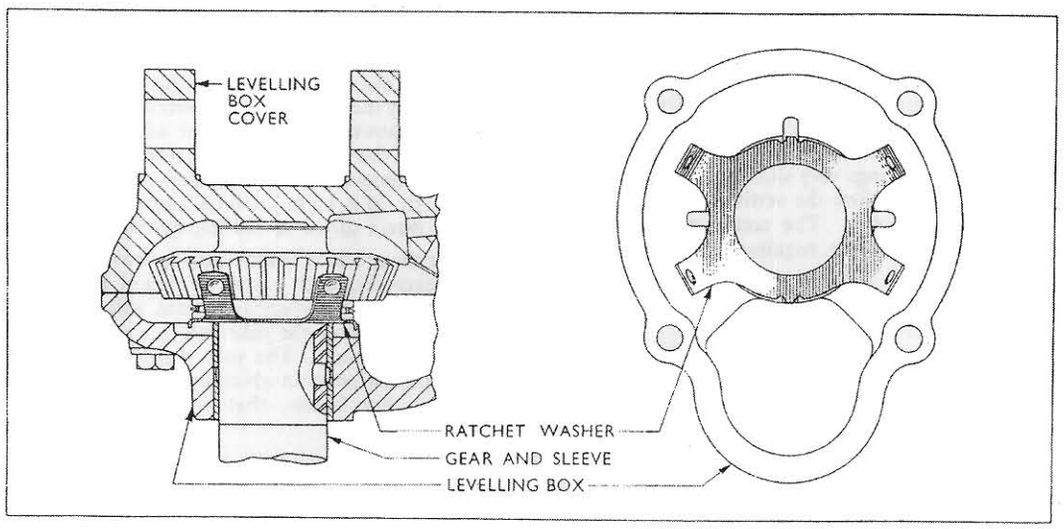


Fig. 48
Levelling Box Modification

fitted with ' O ' ring 87016–ES in the outer location only. No ' O ' ring should be fitted to the inner location on this type of spool.

HYDRAULIC LIFT LEVELLING BOX

Complaints were received on early Super Majors of the hydraulic lift levelling box gears rotating under load and thus upsetting the level of the implement. To overcome this complaint dimensional changes were made to the levelling box, levelling box cover and the vertical gear and sleeve. At the same time a ratchet washer was added between the thrust pad and the housing. Two lugs on the washer engage in the bottom of the housing to prevent the washer rotating and four extended sections engage with the sides of the gear teeth to prevent rotation unless it is being positively turned by the pinion gear. (See Fig. 48.)

The current and previous gear, sleeve and levelling box cover are interchangeable as the changes are only to minor dimensions. Where it is required to fit a previous levelling box with the ratchet washer it will be necessary to use three extra gaskets between the box and the cover. When using the previous internal components in a new levelling box it will be necessary to fit the ratchet washer. If these precautions are not taken the vertical gear and sleeve will not have the correct free movement.

TOP COVER AND CROSS-SHAFT

To serve the dual purpose of preventing oil leaks and dust entry an ' O ' ring has been fitted to each side of the cross-shaft between the lift arms and the adjacent edge of the top cover.

There has been no change in Part No. for the top cover but identification of the current part can be made by the recesses machined in the top cover to accept the ' O ' sealing ring. When fitting the ' O ' rings they should be lightly oiled to prevent friction.

Previous instructions for tightening the lift arm securing bolts were to tighten the bolts until the lift arms just drop under their own weight. If this procedure is followed when ' O ' rings are fitted there will be excessive end-float in the cross-shaft and, therefore, the correct procedure is now to fully tighten one side, back off slightly, finally tightening the opposite side until all end-float is eliminated, but not so tight as to prevent rotation of the lift arms and cross-shaft.

AUXILIARY SERVICE CONTROL VALVE

Complaints are occasionally encountered of oil leakage from the blanking plugs and seals fitted to the oil passages in the auxiliary service control valve unit. Whilst certain of these plugs are drilled and tapped for removal purposes this is not a practical proposition with the smaller plugs, Part No. E148–WP–9, fitted to the drillings marked A, B and C in Fig. 49.

The recommended method of removing these plugs is to insert suitably sized balls in the connecting drillings and then use a screwdriver behind the balls to lever the plugs out of their locations. A careful note should be made of the number of balls inserted and a check made that the same number of balls are removed from the passages after extracting the plugs.

Balls which are available and are suitable for use in this manner are :—

354069–S .. .. $\frac{7}{16}$ in. (11.11 mm.) diameter
353076–S .. .. $\frac{1}{4}$ in. (6.35 mm.) diameter

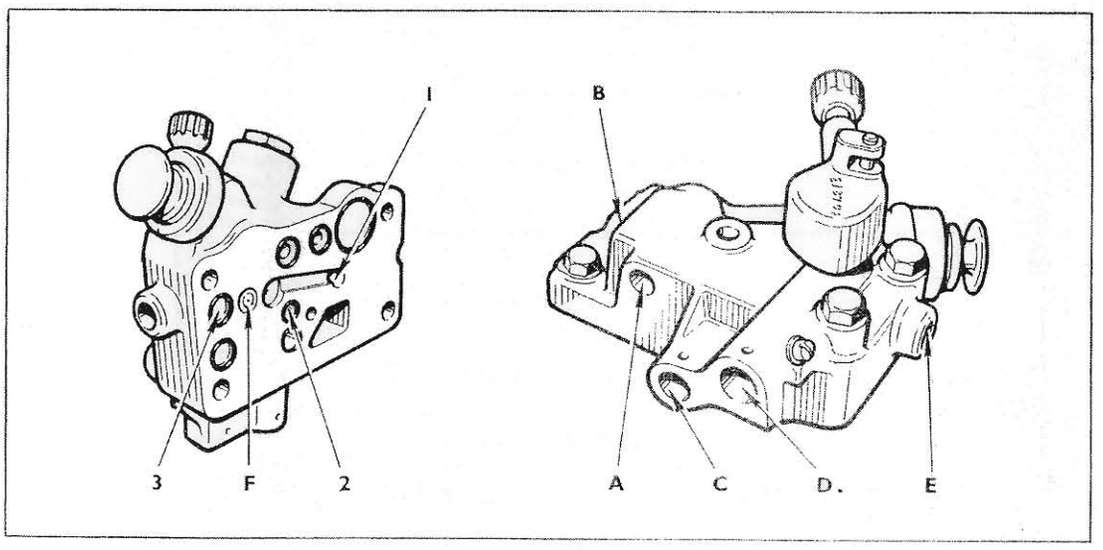


Fig. 49
Auxiliary Service Control Plug Removal

PLUG A

Move the auxiliary service control valve spool to the outer position, feed three or four $\frac{7}{16}$ in. (11.11 mm.) balls into hole marked " 1 " on Fig. 49 then insert a screwdriver into hole " 1 " and lever against the rear face of the balls to force the plug out of its location.

PLUG B

Remove the plug from hole A as detailed above, insert one $\frac{7}{16}$ in. (11.11 mm.) ball through hole A, on to inner face of plug B, and lever out the plug.

PLUG C

Feed twelve $\frac{1}{4}$ in. (6.35 mm.) balls into hole " 2 " and lever the plug out.

PLUG D

This plug is drilled and tapped No. 6–32 NC and a screw with this size of thread may be inserted and gripped with a pair of pliers to effect removal. Alternatively the plug may be dislodged by lightly tapping it as it has the flow control valve spring located behind the plug.

PLUG E

This is also drilled and tapped No. 6–32 NC and may be removed with a screw and pliers in a similar manner to plug ' D.' Alternatively insert one $\frac{7}{16}$ in. (11.11 mm.) ball through hole " 3 " and then use a screwdriver behind the ball to lever the plug out.

PLUG F

This plug, in the base of the chest, is also drilled and tapped No. 6–32 NC and may be removed, with the aid of a screw and a pair of pliers, in a similar manner to plug ' D.'

HYDRAULIC PRESSURE RELIEF VALVE

To increase the efficiency of the hydraulic system a new pressure relief valve was introduced at Tractor Serial No. 08C955882. Whereas the previous valve was of the two stage unloading valve type, i.e., once the valve was lifted off its seat it would remain unseated until the pressure dropped to approximately 300 lb./sq. in. (21.09 kg./sq. cm.), the current valve is a conventional relief valve and will reseat after only a very small drop in pressure.

When operating loaders and other similar equipment, the valve is frequently lifted off its seat due to shock loadings transmitted through the hydraulic system during the raising cycle. Previously this meant moving the hydraulic control lever down the quadrant to neutralise the system or slowing down the engine to allow the pressure to drop and the valve to reseat before the lifting cycle could be continued. The new valve reseats almost as soon as it is unseated thus obviating this complaint, as the pressure will only drop slightly and allow the system to continue raising as required.

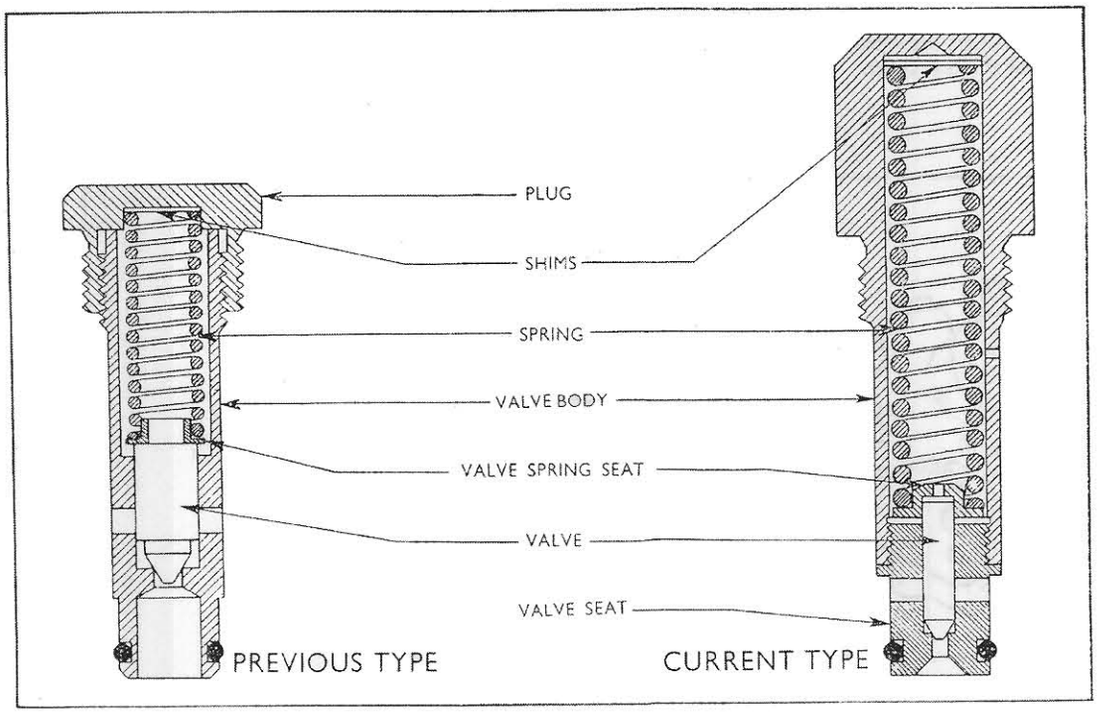


Fig. 50
Pressure Relief Valve

As can be seen from Fig. 50 the construction of the new valve varies considerably from the previous type and, with the exception of the spring adjusting shims, individual components are not interchangeable between current and previous valves. The current valve assembly may, however, be fitted as a complete unit to tractors carrying out loader work, or using heavy implements where the relief valve will prove beneficial.

The correct setting for the relief valve is as before, 2,450–2,500 lb./sq. in. (172.24–175.77 kg./sq. cm.). Care should be taken when setting the valve that shims are not added to the extent that the spring becomes solid. As mentioned previously, with the current valve there will only be a slight drop in pressure when the valve lifts and it will be found when checking the pressure relief valve setting that as the screw-down tap of the testing equipment is closed the gauge will rise to a pressure slightly above the setting, and then drop slightly when the valve lifts.

HYDRAULIC PUMP

Shortly after the above changes to the pressure relief valve changes were made to the hydraulic pump in that new front and rear cover plates were introduced. They differ from those previously fitted in the " run " of the ' O ' sealing ring groove. The ' O ' type sealing ring was also changed, the new ' O ' ring being slightly larger in diameter than the previous part.

The bearing blocks were also modified by removal of the " run-out " slots and a common block is now used at both front and rear of the pump where previously a different type of block was fitted in each location. The new bearing blocks may be fitted to a previous type pump providing that the previous and new type are not mixed, i.e. front and rear bearing blocks must be of the same type.

The new front and rear cover plates may be fitted to a previous type pump provided that the correct ' O ' rings are also used.

The complete pump assembly is interchangeable with that fitted to previous Super Major tractors.

NEW SUPER MAJOR HYDRAULICS

With the hydraulic system fitted to previous Super Major tractors, Qualitrol was effective only as long as the implement draft was sufficient to produce a compressive force in the top link. Certain implements working at shallow depth were sufficiently heavy at the rear end to cancel out the draft forces from the soil and produce tension in the top link with the result that changes in draft were not corrected by the hydraulics.

This disability has now been overcome by modifying the hydraulic assembly, particularly around the main control spring area, so that Qualitrol is now effective with all implements, under all conditions, irrespective of whether the implement produces compression or tension in the top link.

The hydraulic oil flow is unchanged apart from the addition of a " rate of implement drop " control which involves the introduction of a variable restrictor in the exhaust oil passage of the ram cylinder. The ram cylinder becomes a new part as the drilling from the front of the cylinder to the exhaust passage for the drop control restrictor makes it unsuitable for use with the previous Super Major hydraulics. The valves and other ram cylinder components are identical with those previously used, whilst the pressure relief valve is identical to that introduced in April 1963, described in the previous section.

HYDRAULIC PUMP

The hydraulic pump is driven from a gear on the power take-off extension shaft and, therefore, its maximum output is affected by any change in the speed of the shaft. With the introduction of the New Super Major the ratio of engine to P.T.O. speed was increased i.e., the P.T.O. shaft now revolves slower for any given engine speed. Therefore to maintain the hydraulic pump output at the same level as on previous Majors the number of teeth on the pump driving gear has been changed from 33 to 34 and on the driven gear from 21 to 18.

LINKAGE MODIFICATIONS

Most of the detailed parts of the internal linkage have been re-designed and are not interchangeable with those used in previous Super Major hydraulics. It will therefore be necessary to ensure that the

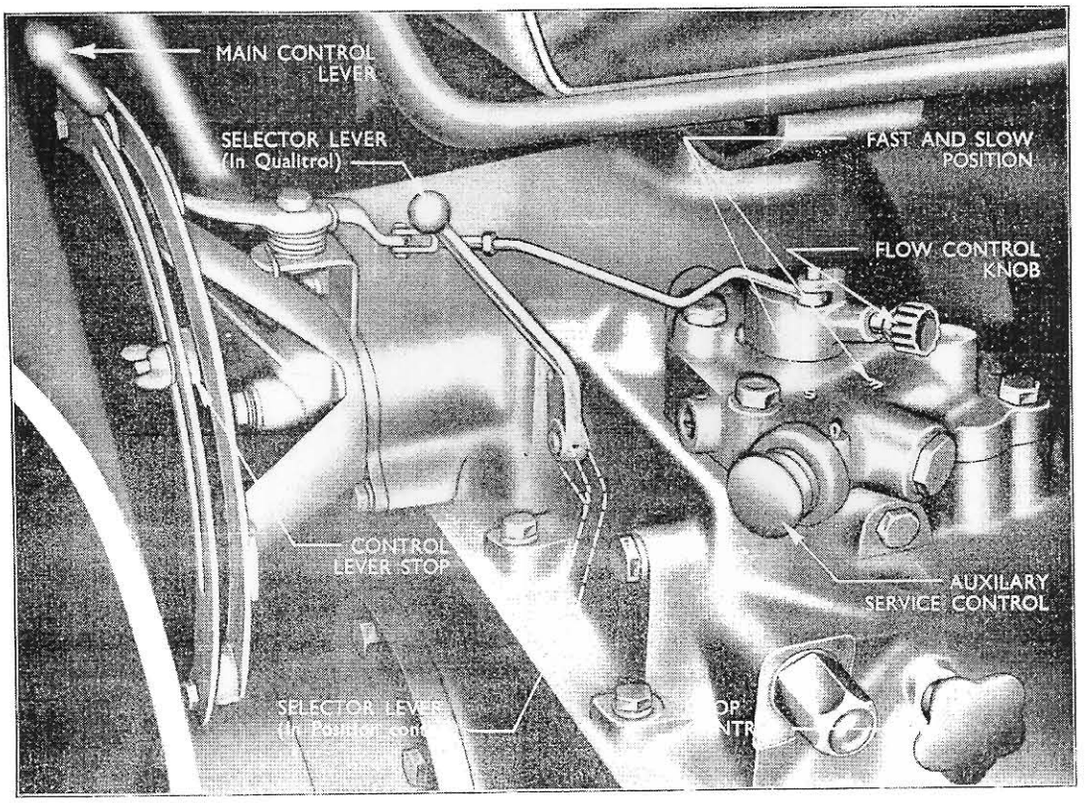


Fig. 51
Hydraulic Controls

correct parts are selected and fitted when overhauling the new hydraulic top cover assembly.

The main control spring, which is now double acting, is fitted between two spring seats, the forward one of which is positioned over, and locates against, the qualitrol plunger at the forward end of the spring chamber in the top cover. The rear seat locates in a threaded retainer nut which screws into the internally threaded outer end of the spring chamber.

The yoke, as on previous Super Major hydraulics, passes through the main control spring and screws into the qualitrol plunger but it now slides inside the retainer nut instead of directly in the housing.

To minimise free play in the spring and bouncing of the implement in the transport position the ram arm has been modified and has a machined thrust face on its rear surface. This face contacts the qualitrol plunger when in the fully raised position, eliminating free play in the spring components. The position control cam profile on the ram arm has been modified to suit the latest position control parts and under no circumstances must current and previous parts be mixed.

As the ram arm is now in contact with the qualitrol plunger when the lift arms are fully raised, the position at which the ram piston contacts the knock-off pin in the actuating lever and moves the control valve into the neutral position is now more critical than on previous assemblies. The pin has therefore been made eccentric and adjustable, being secured to the actuating lever with a self-locking nut (see Fig. 52). The adjustment of this eccentric is covered under the heading " Setting The Hydraulic Linkage."

To facilitate adjustment of the position control linkage the position control arm and block have been modified and the rod now passes through the arm and block below the spring where it is more accessible than

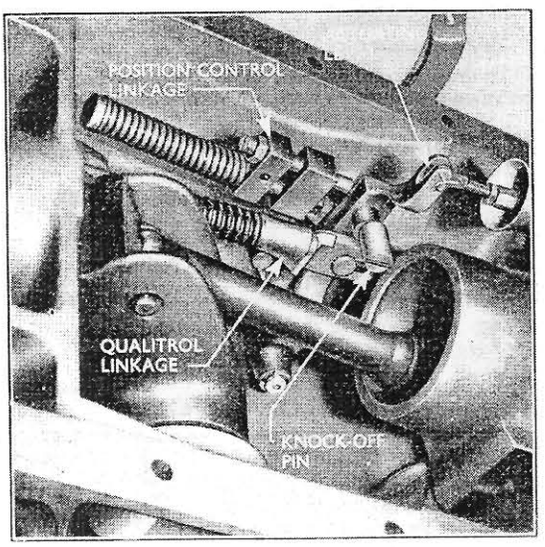


Fig. 52
Internal Hydraulic Linkage

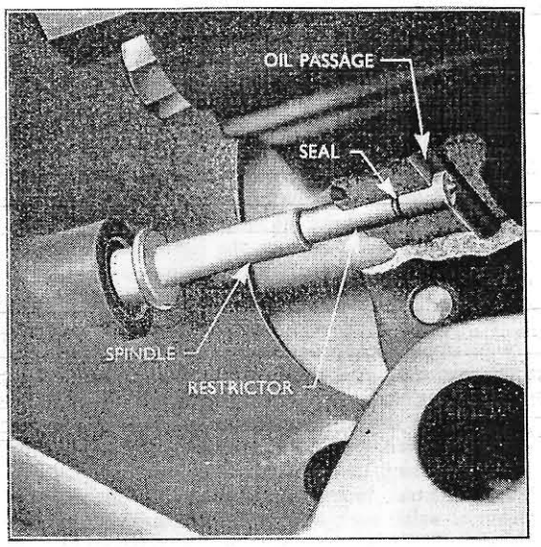


Fig. 53
Drop Control Restrictor

on the previous hydraulics where it was located above the spring.

The re-arrangement of the position control linkage has made it desirable to extend the length of the Position Control Qualitrol selector lever and a new, longer lever is now fitted at this point.

The new piston knock-off pin and the modified position control linkage has necessitated a new control valve actuating lever. A new control lever cross-shaft has also been introduced which may be identified from the previous shaft by the larger throw of the eccentric section.

To prevent operators from connecting the top link direct to the yoke, and thus risking damage to the internal components of the hydraulics by over-compression of the main control spring, the rocker has been modified and now fits inside the yoke.

DROP CONTROL

When the control lever of the previous hydraulics is placed in a lowering position the rate of implement drop is dependent upon the amount of rearward movement of the control valve and this in turn is governed by the position the main control lever is placed within the lowering section of the quadrant, i.e. the further the control valve is moved to the rear the greater the number of oil exhaust holes uncovered in the control valve bush.

If the control lever is placed so far down the quadrant that the rate of implement drop is too great, then slight movement of the lever in an upward direction will move the control valve forward thus shutting off some of the exhaust holes and slowing down the speed of drop.

With the new hydraulics the rate of drop cannot be controlled in this manner, particularly when a heavy

implement is fitted, as tension in the top link also affects the control valve movement in the following manner :—

When the lift arms are in the fully raised position the ram arm holds the qualitrol plunger firmly against the inside rear face of the cover and compresses the main control spring in a rearward direction. If the control lever is now placed in a lowering position on the quadrant and the lift arms begin to drop the ram arm will move away from the qualitrol plunger, the main control spring will expand and push the plunger forward thus opening up a gap between the plunger and the lift cover.

All implements produce tension in the top link when they are clear of the ground and the geometry of the linkage is such that this tension increases as the implement drops. Because of the gap which now exists between the qualitrol plunger and the cover the increasing tension in the top link tends to draw the qualitrol linkage rearwards thus allowing the control valve spring to push the control valve fully rearwards and open up the maximum number of exhaust holes.

Without some form of additional control a heavy implement would, under these circumstances, fall rapidly to the ground with the risk of consequential damage to the implement. The drop control fitted to the new hydraulics is designed to obviate this possibility by providing a variable restrictor in the exhaust oil passage of the ram cylinder.

The restrictor takes the form of a plunger which, as it is pushed inwards by a control knob located on the front of the top cover, progressively closes the exhaust passage (see Fig. 53). The control knob has a threaded spindle which screws into a corresponding threaded hole in the cover and its inner end contacts the end of the restrictor plunger.

Control is effected by screwing the knob into, or out of, the cover but there is no direct connection between the control and the restrictor, i.e. as the control knob is screwed into the cover it pushes the restrictor further into the exhaust passage but the restrictor is returned by oil pressure in the exhaust passage when the control knob is screwed out.

It will be necessary, therefore, for the operator to adjust the position of the control knob before commencing work in accordance with the rate of drop he requires with the particular implement he is using. The recommended procedure is to begin with the control knob fully in and then to screw the knob outwards until a satisfactory rate of drop is achieved.

HYDRAULIC OPERATION

Qualitrol

As previously stated, any implement when it is raised clear of the ground produces a tension in the top link. With light implements such as cultivators and one, two or three furrow ploughs this tension turns into compression when the implement is in the ground and the tractor is moving forward.

When tail heavy implements such as large reversible ploughs or four furrow ploughs, and even when three furrow ploughs are operated at shallow depths, the weight of the implement overcomes the draft force from the soil and the top link remains in tension at all times.

The new hydraulics cater for these variations as explained in the following sections.

Light Implements—Lowering into Work using Qualitrol (Fig. 54)

With the selector lever ' A ' in the upward position, downward movement of the main control lever ' B ' moves the top of the actuating lever ' C ' forward pivoting about the qualitrol fork and allowing the control valve spring ' D ' to move the control valve ' E ' into the lowering position.

Lowering stops when the implement draft compresses the main control spring ' F ' in a forward direction a sufficient amount to overcome the pressure of the control valve spring and move the control valve into a neutral position.

Hydraulic Operation when Implement Draft is sufficient to produce Compression in Top Link

(*a*) *Increased Draft* (Fig. 55)

When working in Qualitrol an increase in draft at the implement will compress the main control spring ' F ' in a forward direction thus moving the control valve actuating lever ' C ' forward, overcoming the pressure of the control valve spring ' D ' and moving the control valve ' E ' into the raising position.

As the implement is raised the draft force and hence the pressure on the main control spring decreases to the original amount and the control valve spring will then move the control valve into a neutral position.

(*b*) *Decreased Draft*

A decrease in draft at the implement will reduce the compression of the main control spring ' F ' and hence the pressure on the actuating lever ' C ' thus allowing the control valve spring ' D ' to push the control valve ' E ' into the lowering position.

As the implement runs deeper the draft will increase to its original amount and the control valve will again be returned to the neutral position.

Heavy Implements—Lowering into Work using Qualitrol

The following action occurs when the implement always produces tension in the top link.

Downward movement of control lever ' B ' moves the top of the actuating lever ' C ' forward, pivoting about the qualitrol fork and allowing the control valve spring ' D ' to move the control valve ' E ' into the lowering position.

As the implement descends the tension in the top link increases, compressing the main control spring ' F ' against the spring rear seat ' G.' At the same time the forward pressure on the actuating lever is reduced and the control valve spring is then able to move the control valve further into the lowering position thus increasing the rate of drop.

As explained under " Drop Control " this rate should be adjusted when the particular implement is first mounted on the linkage.

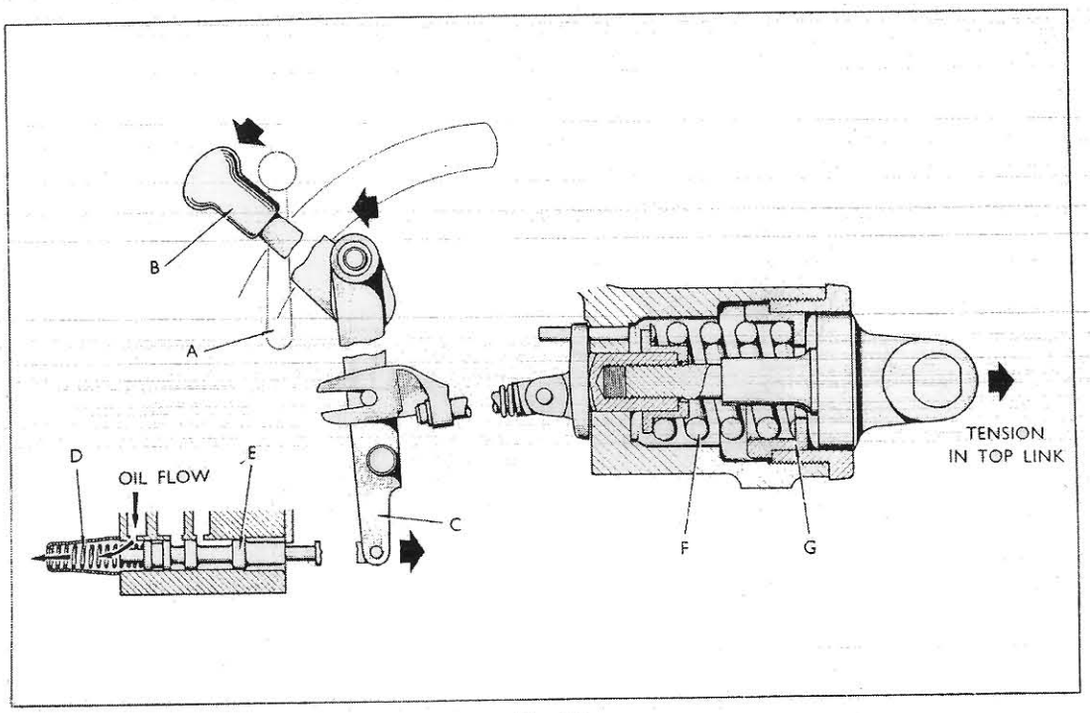


Fig. 54
Qualitrol—Lowering Into Work

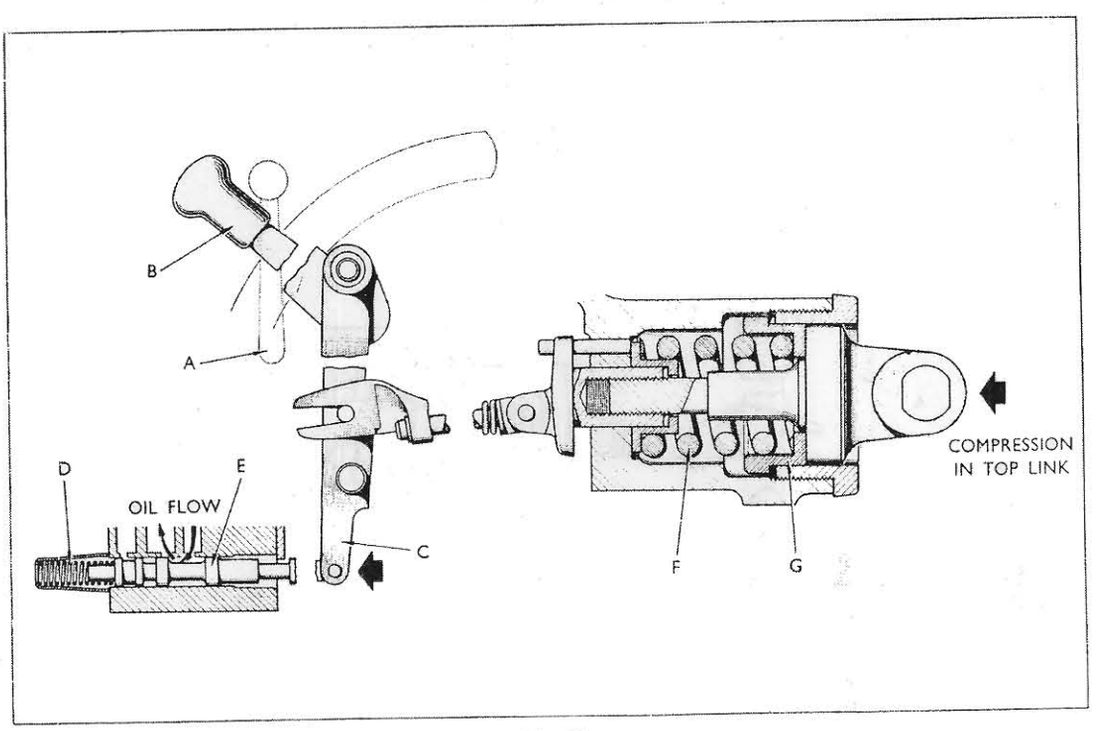


Fig. 55
Qualitrol—Raising In Work Due to Increase in Top Link Compression

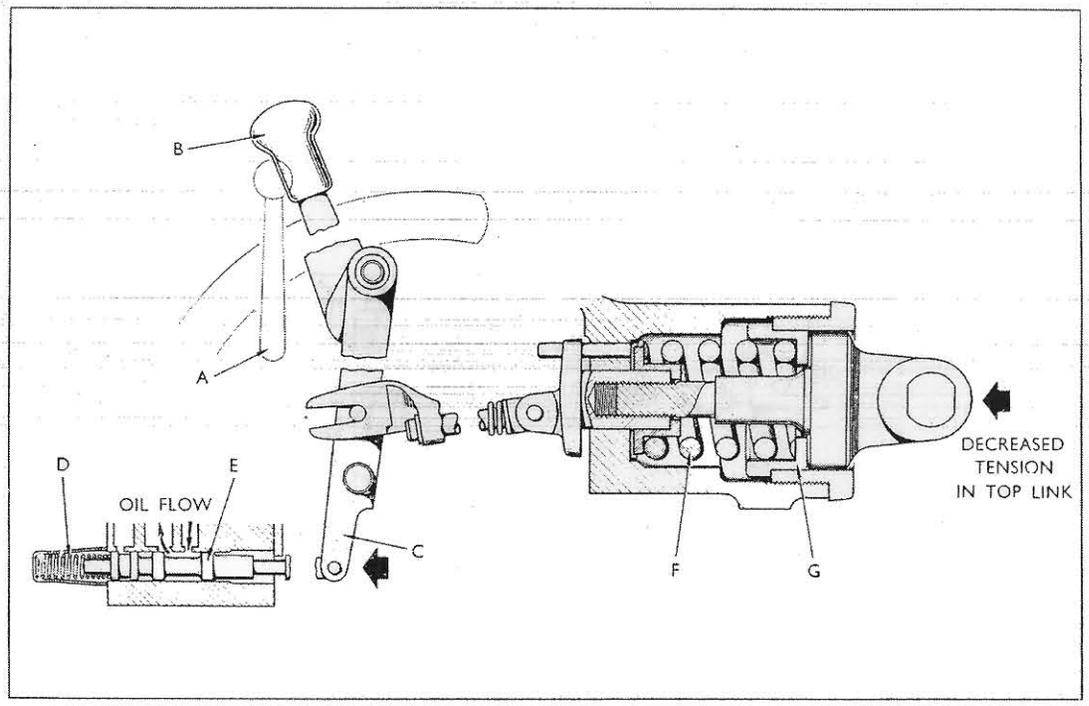


Fig. 56
Qualitrol—Raising In Work Due to Decrease in Top Link Tension

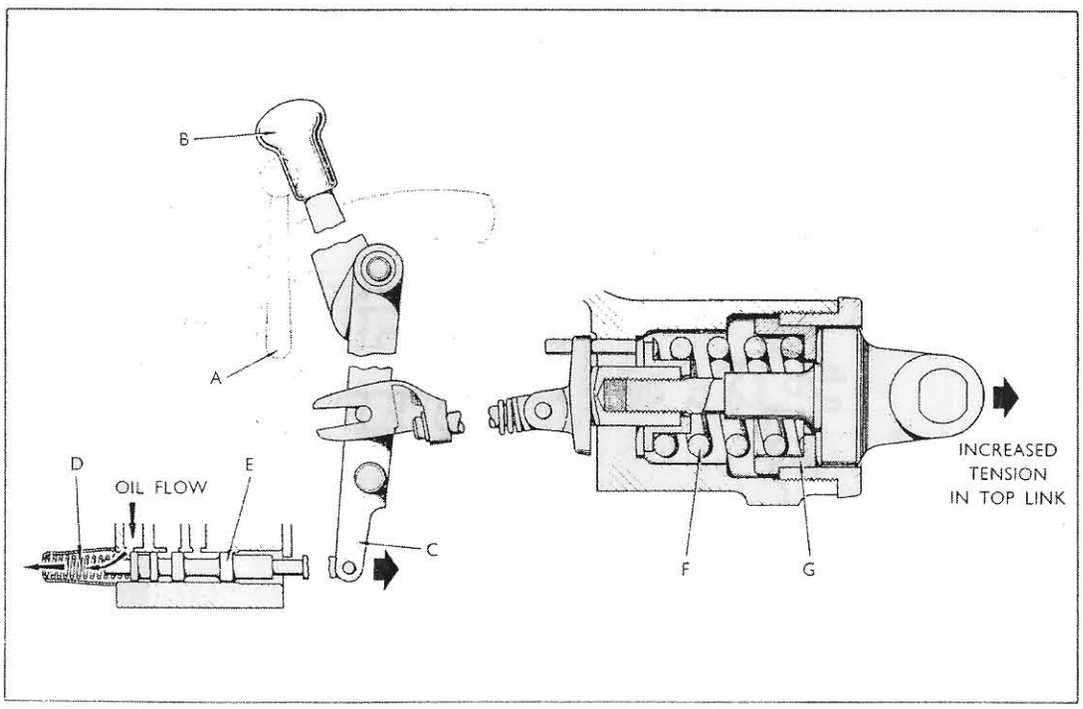


Fig. 57
Qualitrol—Lowering In Work Due to Increase in Top Link Tension

Lowering stops when the implement draft reduces the tension in the top link a sufficient amount for the main control spring to push the qualitrol plunger and hence the actuating lever forward, overcoming the rearward pressure of the control valve spring and moving the control valve into the neutral position.

Hydraulic Operation when Implement Draft is insufficient to produce Compression in the Top Link

When the implement draft is constant but is insufficient to overcome the weight of the implement the top link will be in tension and the main control spring compressed rearward against spring seat 'G.'

(*a*) *Increased Draft* (Fig. 56)

An increase in draft will now produce a **decrease** in tension in the top link allowing the main control spring 'F' to expand in a forward direction thus pushing the qualitrol linkage and actuating lever 'C' forward, moving the control valve 'E' into the raising position.

As the implement is raised the draft will decrease but the tension in the top link will **increase.** The qualitrol linkage will, therefore, be pulled rearwards away from the actuating lever, compressing the main control spring until the original draft is obtained. The control valve spring will then move the control valve into the neutral position.

(*b*) *Decreased Draft* (Fig. 57)

A decrease in draft will produce an **increase** in tension in the top link and the qualitrol linkage will be drawn rearwards away from the actuating lever, increasing the rearward compression of the main control spring and allowing the control valve spring to move the control valve into the lowering position.

As the implement runs deeper the draft will increase until such time as the original draft is obtained.

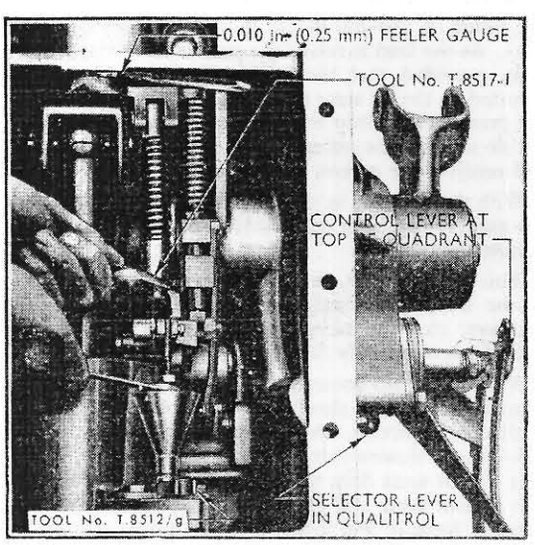


Fig. 58
Qualitrol Linkage Adjustment

Tension in the top link will decrease and the main control spring will then expand in a forward direction thus moving the qualitrol linkage and actuating lever forward and the control valve into the neutral position.

SETTING THE HYDRAULIC LINKAGE

The setting of the new hydraulic linkage differs from that necessary with the previous hydraulics and careful note should be made of the following procedure :—

Main Control Spring

To set the main control spring initially, first screw in the yoke until all free play is eliminated and then unscrew to the nearest position at which the pin holes in the yoke are horizontal. To obtain the correct setting it is necessary to carry out the functional check (see page 48).

Qualitrol Setting (Fig. 58)

1. Place the selector lever in qualitrol, i.e. upward position.

2. Insert a 0.010 in. (0.25 mm.) feeler blade between the qualitrol plunger and the rear inner face of the top cover.

3. Screw in the main control spring yoke fully to pull the qualitrol plunger against the housing and move the lift arms to the fully raised position so that the machined face on the rear of the ram arm contacts the qualitrol plunger, pushing it rearwards and trapping the feeler blade between the plunger and the cover.

4. Place the main control lever at the top of the quadrant, i.e. beyond the normal top stop.

5. Slacken the locknut on the position control rod and screw the rod fully rearwards, away from the control valve actuating lever.

6. Locate the thicker end of slip gauge, Tool No. T.8512/g, marked "Position Control," between the rear face of the ram cylinder housing and the adjacent shoulder of the control valve.

NOTE.—This gauge is double-ended and was used for setting the qualitrol and position control linkage of previous Super Major hydraulics. The "Qualitrol" end of the gauge is not used with the new hydraulics.

7. With slip gauge T.8512/g still in position check that there is a gap of 0.2 in. (5.08 mm.) between the front face of the qualitrol fork and the retaining circlip on the qualitrol rod.

A new gauge, Tool No. T.8517-1, has been produced to facilitate the checking of this gap. If necessary adjust the length of the control valve turnbuckle to obtain the correct gap.

Piston Knock-off Pin Setting

As previously described this pin is eccentric and must be so positioned that it is contacted by the piston when the lift arms reach the fully raised position. To set the pin proceed as follows :—

1. Remove the ram cylinder safety valve.

2. With gauge T.8517–1 and the 0.010 in. feeler blade in position and the lift arms fully raised, as when setting the qualitrol adjustment detailed above, slacken the locknut on the piston knock-off pin, and use a screwdriver to rotate the pin so that the smallest portion of the eccentric is adjacent to the piston bore in the ram cylinder housing.

3. Pass a length of suitably curved or flexible rod through the ram cylinder safety valve hole and force the piston fully rearwards, ensuring that the piston rod is correctly located in the centre of the piston.

4. Rotate the eccentric stop pin so that it contacts the piston and secure in this position by means of the locknut.

5. Refit the safety valve and sealing washer then remove the gauge and feeler blade.

6. Reset the main control spring yoke to its initial position.

Position Control Setting (Fig. 59)

This adjustment should only be carried out after the preceding checks and adjustments have been made.

1. Place the selector lever in the downward position and the control lever at the bottom of the quadrant.

2. Using Tool No. T.8517 set the lift arms in the lowered position.

3. Check the gap between the rear face of the ram cylinder housing and the adjacent shoulder on the control valve, using the thicker, " Position Control," end of slip gauge T.8512/g. Adjust the gap by screwing the rod into, or out of, the position control block as required. Tighten the locknut and recheck the setting.

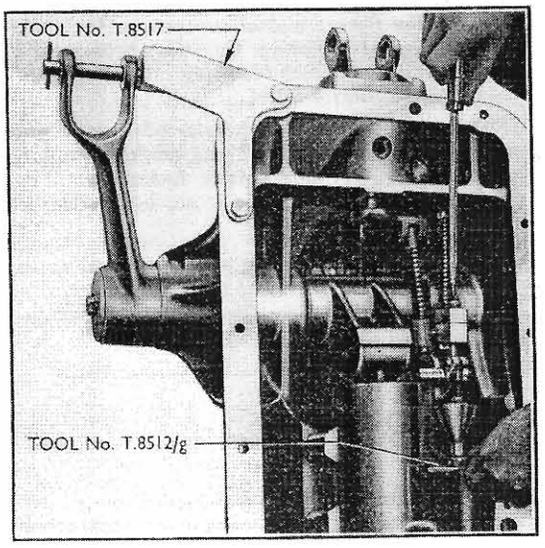


Fig. 59
Position Control Linkage Adjustment

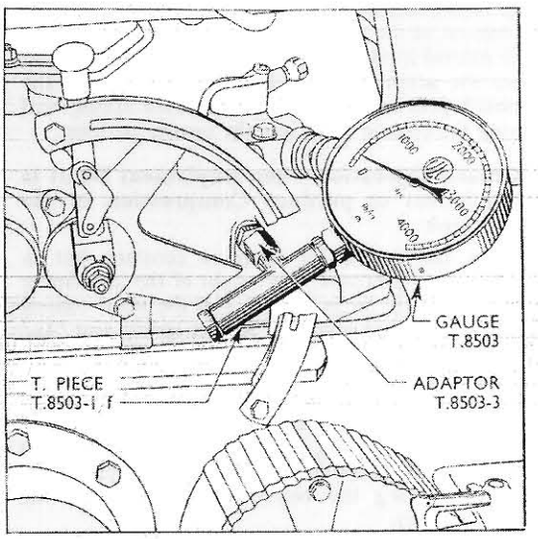


Fig. 60
Checking Eccentric Knock-Off Pin Setting

Functional Check

Assemble weights of 1,500 lbs. (681 kg.), or a suitable implement, to the lower links, start the engine and set it to run at 1,600 r.p.m.

With the selector lever in the Qualitrol position, move the main control lever up the quadrant to beyond the top stop and ensure that the piston moves the control valve into neutral when the lift arms reach the fully raised position.

An easy way of checking that this is happening satisfactorily is to fit a pressure gauge into the pressure testing point as shown in Fig. 60. Before commencing to lift the weight the pressure in the system will be in the region of 150–200 lb./sq. in. (10.55–14.06 kg./sq. cm.). As the load is raised the pressure will rise, and then, provided that the knock-off pin is correctly adjusted, as the lift arms reach the fully raised position the pressure will drop to its original level. If it does not do so it will be necessary to remove the lift cover and readjust the eccentric stop pin.

With the lift arms in the fully raised position check the number of height corrections that occur in a two minute period.

This can vary, but, bearing in mind the service age of the tractor, the weight supported, the oil temperature, etc., the acceptable maximum should not exceed approximately 30.

Move the main control lever to the bottom of the quadrant and then slowly move the lever upwards until a raise occurs. Move the control lever 1 in. (25.4 mm.) downwards from this point and check that the lift arms drop to the lowered position. With the control lever still at this position apply a compressive force of 250 lbs. (113.5 kg.) to the qualitrol yoke. This should produce a raise if the system is operating correctly.

To facilitate this test an extension, Tool No.

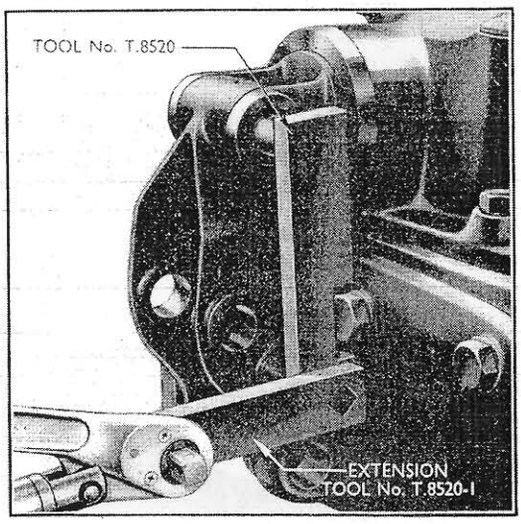


Fig. 61
Checking Main Control Spring Setting

T.8520–1, has been produced for use with the existing Main Control Spring Pre-load Tool No. T.8520, and a suitable torque wrench. This extension must be assembled at right-angles to the arm of the existing tool, connection being made to the square hole in the arm (see Fig. 61). The torque wrench is then applied to the outer end of the extension and an upward force of 80 lbs. ft. (11.06 kg.m.) applied. The leverage provided by the tool and extension multiplies this force to the required 250 lbs. (113.5 kg.) direct thrust on the spring.

OVERHAUL PROCEDURE

As the components of the new hydraulic lift cover assembly vary only in detail from those used on the previous hydraulics, dismantling procedure will be virtually identical with that previously detailed. The following information covers those items which are completely new in design :—

To Remove Drop Control and Restrictor

1. Remove the hydraulic lift top cover assembly from the tractor.
2. Remove the auxiliary service valve unit.
3. Remove the ram cylinder assembly.
4. Withdraw the restrictor from the front of the ram cylinder.
5. Drive out the pin securing the control knob to the drop control restrictor spindle.
6. Screw the spindle inwards through the top cover.
7. Remove and discard the seal from the counterbore in the front of the housing and the seal on the restrictor.

To Replace Drop Control and Restrictor

1. Fit a new seal to the front of the housing. This seal should be fitted with the lip facing outwards as its main function is to prevent ingress of dirt into the hydraulics and the rear transmission housing.
2. Screw the spindle into position from inside the top cover housing.
3. Locate the control knob on the spindle and secure in position with the appropriate pin.

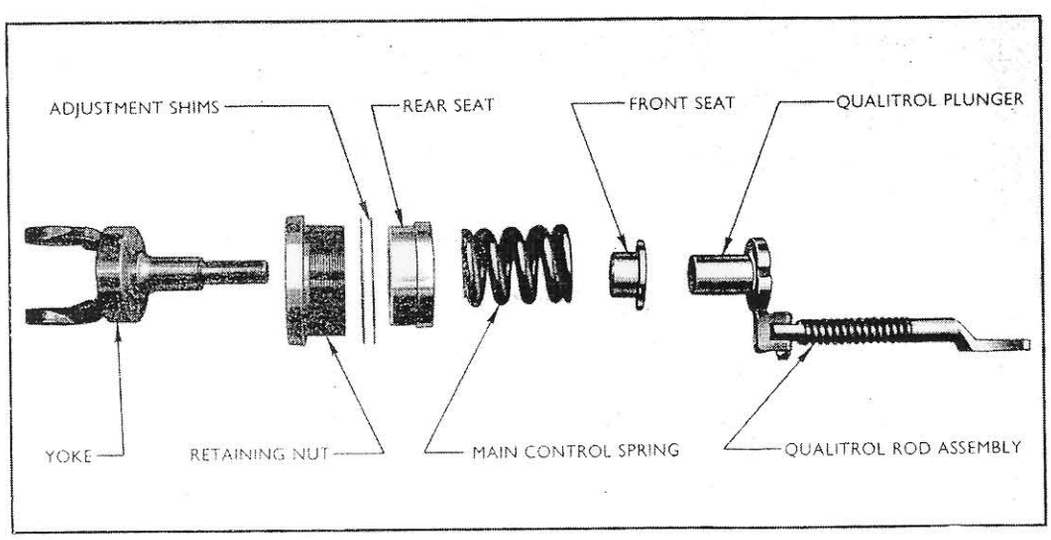


Fig. 62
Qualitrol Linkage Exploded

4. Fit a new ' O ' sealing ring to the restrictor and then locate the restrictor in its drilling in the ram cylinder housing. The restrictor must be fitted with its domed end facing outwards and the end with the small central cone facing into the housing.

5. Replace the ram cylinder assembly.

6. Replace the auxiliary service valve assembly.

7. Replace the top cover assembly on the tractor.

To Remove Main Control Spring and Spring Seats

It is unlikely that the spring, inner spring seat, or outer spring seat will require attention in service but should it be necessary to change any of these components the following procedure should be followed :

1. Disconnect the top link rocker from the yoke.

2. Unscrew and remove the yoke.

3. Using special adaptor, Tool No. T.8521, unscrew the spring rear seat retaining nut and remove the adjusting shims from the nut.

4. Withdraw the rear seat, spring and inner seat.

5. Clean, inspect and renew as necessary.

To Replace Main Control Spring and Spring Seats

1. Replace the spring inner seat and pack the spring chamber with approximately $\frac{1}{3}$ lb. (150 gms.) of general purpose grease.

2. Assemble the spring and rear seat.

3. If new parts have been fitted it will be necessary to check the gap between the spring rear seat retaining nut and the lift housing and to then select the appropriate thickness of shims in the following manner :

(*a*) Assemble the retaining nut without shims and tighten until the spring is just gripped between the seats.

(*b*) Using feeler blades check the gap between the nut and the housing then remove the nut and fit the same thickness of shim.

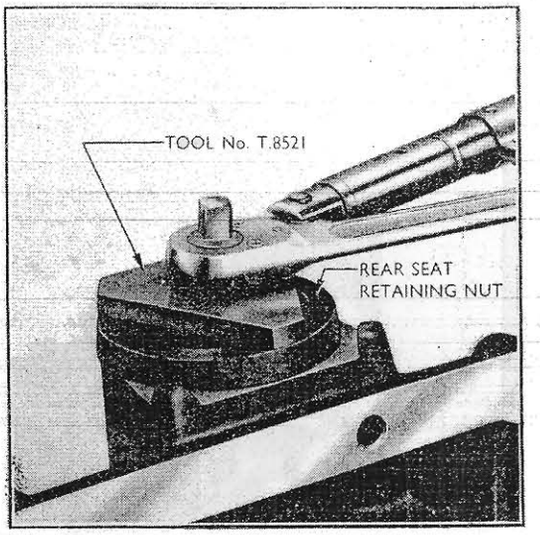


Fig. 63
Replacing Main Control Spring Rear Seat Retaining Nut

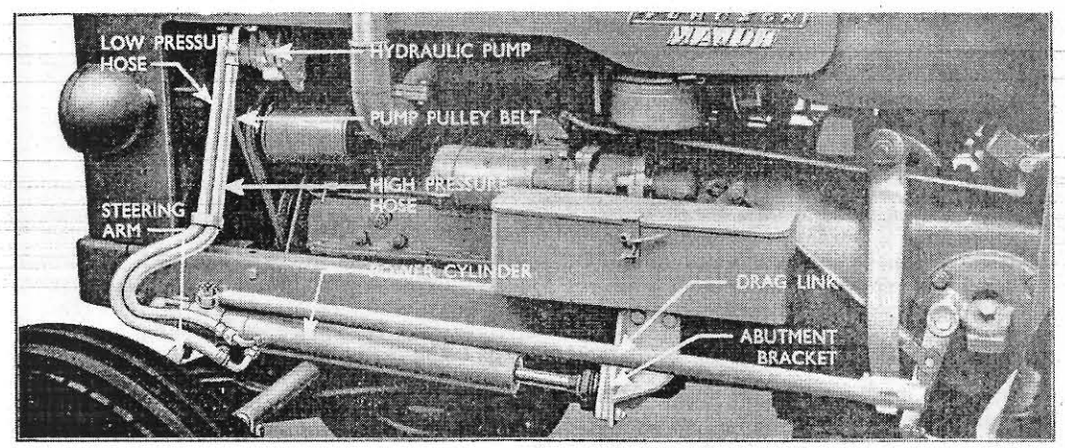
NOTE.—Each shim has a thickness of 0.008 to 0.012 in. (0.020 to 0.031 mm.) and in selecting the number to be used the total thickness must be as near as possible **below** the measured gap. It must not be greater than the gap.

(*c*) Replace the nut and shims and tighten to a torque of 80 85 lb. ft. (11.06 11.74 kg.m.) using special adaptor Tool No. T.8521, and a suitable torque wrench (see Fig. 63).

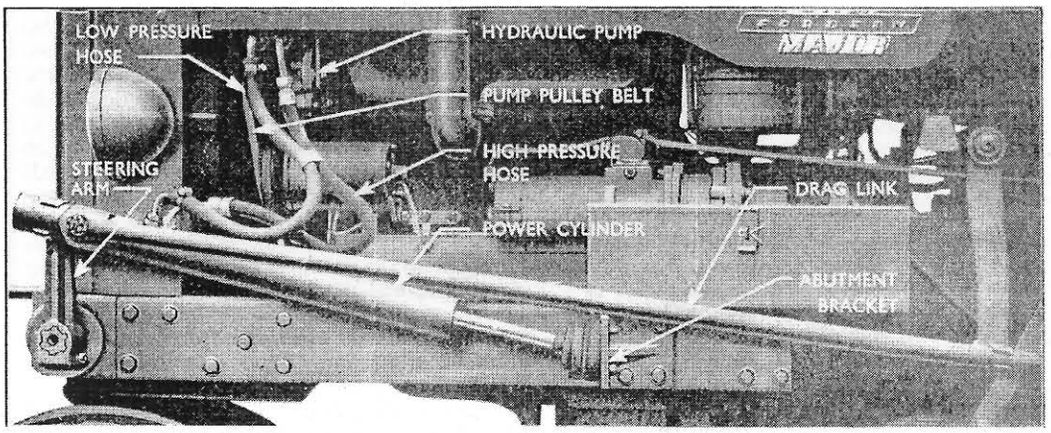
4. Screw in the yoke until the spring is just nipped (i.e. until free horizontal movement of the yoke is just eliminated) then unscrew to the nearest position at which the pin holes in the yoke are horizontal.

5. Reconnect the top link rocker to the yoke.

POWER ASSISTED STEERING



Four-wheeled Tractor



Tricycle Tractor

Fig. 1

Power Assisted Steering Installations

The power assisted steering installations used on standard four-wheeled models and tricycle versions of the present production Power Major tractor (see Fig. 1) are basically the same as those used previously on the same models of the New Fordson Major tractor. Certain improvements have, however, been effected on these installations since their initial introduction and the modifications are, in as far as they affect service procedure, detailed where they occur.

GENERAL DESCRIPTION

The power assisted steering installations for the four-wheeled and tricycle tractors operate on the same principal and consist essentially of a power cylinder, incorporating a control valve, coupled by flexible pipes to an engine driven hydraulic

pump as shown in Fig. 1. The system utilises the standard steering box and if for any reason there is a loss of power assistance the driver will be able to steer the tractor manually.

The pump, its method of attachment and drive are identical on four-wheeled and tricycle tractors, but some constructional differences exist within the power cylinders and these are described under the appropriate heading.

The Pump

The pump is driven by a separate V-belt from a special pulley fitted to the engine crankshaft and is mounted on a support bracket bolted to the front left-hand side of the cylinder head. (See Fig. 1.) Three elongated bolt boles in the pump support bracket, for securing the pump, provide a means of adjusting the pump drive belt tension.

The oil reservoir is mounted on the pump body and it contains a filter element through which oil is passed on its return from the power cylinder. The element is held in position by a spring-loaded cap which will lift and permit oil to by-pass the element should it become clogged. An oil level dip stick is attached to the reservoir filler cap and this should be used only when the steering is in the straight-ahead position as the oil level will vary between left and right lock.

The pump is of the eccentric bi-rotor type, the inner rotor which has six lobes being driven by the pump drive shaft. The drive shaft is supported by a pre-lubricated sealed ball bearing at the pulley end, and by bronze bushes in the pump body and cover. The outer rotor has seven lobes and is driven by the inner rotor. (See Fig. 2.) As the pump rotors turn the spaces formed between the rotor lobes increase and then decrease in volume with each revolution, propelling oil from the intake side of the pump to the outlet. (See solid arrows, Fig. 2.)

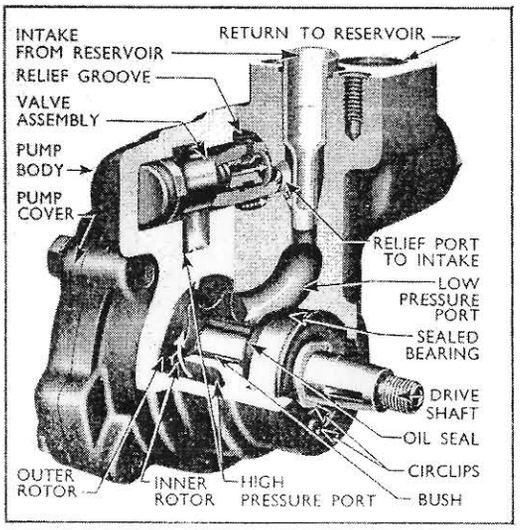


Fig. 2

Section Through Hydraulic Pump

When the engine is idling the pump is operating at its minimum output which is, however, sufficient to provide power assistance. To limit pump output at higher engine speeds, a spool type spring-loaded flow control valve is provided in the pump body. The valve which is hollow and closed at one end has two metering orifices drilled through its walls. A pressure relief valve, which is also spring-loaded, is contained inside the flow control valve and is retained in position by means of a circlip. The flow control and pressure relief valve assembly is retained in the pump body by the oil outlet adaptor. (See Figs. 2 and 3.)

The flow control valve limits the output of the pump to a maximum of approximately 2.75 Imp. galls. per minute (12.5 litres per minute) regardless of pump speed. This is accomplished in the following manner:—

Oil from the pressure side of the pump flows into the chamber containing the flow control valve. A flat ground on the land at the closed end of the valve allows the oil to flow behind it. The oil also flows to the inside of the valve through the two metering orifices and from here, through the pressure relief valve and the pump outlet to the power cylinder assembly. (See Figs. 2 and 3.) When the pump speed is increased, due to an increase in engine speed, the pump output tends to exceed 2.75 Imp, galls. per minute (12.5 litres per minute). This creates a pressure differential between the outside and inside of the flow control valve, due to the restricted flow through the metering orifices, and the pressure at the closed end of the flow control valve (via the flat) then exceeds the pressure on the spring-loaded end so that the entire valve assembly moves and compresses the flow control valve spring. This action uncovers passages in the pump body which allow excess oil to flow back to the reservoir and to the intake side of the pump. (See dotted arrows, Fig. 2.) Thus, the pump output is limited to 2.75 Imp. galls. per minute (12.5 litres per minute) regardless of pump speed.

The pump produces the oil pressure required in the system to meet all normal steering conditions, the pressure relief valve installed in the flow control valve limiting the pump pressure to 720–800 lbs. per sq. inch (50.6–56.2 kg. per sq. cm.). The two ends of the relief valve are of different diameters and the end having the greater area is fitted nearest the pump outlet and is acted upon by the pressure in the system. A pressure of 720–800 lbs. per sq. inch (50.6–56.2 kg. per sq. cm.) must be built up in the system before the relief valve spring is compressed and the valve is lifted. When the relief valve lifts, the

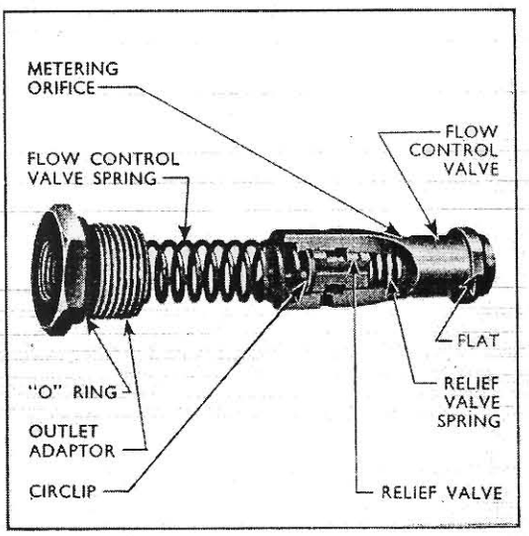


Fig. 3

Hydraulic Pump Valve Assembly—Flow Control and Relief Valves Shown Cut-away

movement uncovers ports in the flow control valve and allows sufficient oil to return to the reservoir and to the intake side of the pump to prevent further pressure build-up. (See Figs. 2 and 3.)

The relief valve action is the same regardless of the position of the flow control valve in its bore since the action of the flow control valve controls only the volume of oil delivered by the pump. For example, with the engine idling the flow control valve does not lift, as the output of the pump is below 2.75 Imp. galls. per minute (12.5 litres per minute). If the wheels are turned against the stops and the steering wheel inadvertently held hard over the pump builds up a high pressure, but the volume of oil delivered by the pump still does not exceed 2.75 Imp. galls. per minute (12.5 litres per minute). Under these conditions the flow control valve remains closed, but the pressure relief valve opens, regulating the maximum pressure within the desired limits, but because of the high pressures involved, the steering wheel must not in any circumstances be held hard over for more than 30 seconds with the front wheels contacting any object which completely prevents steering movement in the direction the steering wheel is turned. Operation at such pressures for longer than the period specified could cause damage to the system and in particular to the pump.

The Power Cylinder

The power cylinder for the tricycle tractor differs from that used on the four-wheeled tractor in that less power assistance is required for the tricycle version, and the cylinder bore is only $1\frac{3}{4}$ in. (44.45 mm.) compared with 2in. (50.80 mm.) for the four-wheeled tractor. The smaller diameter cylinder obviates the necessity for the locating collar fitted to the end of the valve body for power cylinders with the 2 in. (50.80 mm.) bore (see Fig. 9) and also makes the tricycle tractor power cylinder readily recognisable since its outer tube is the same outside diameter throughout its length, not stepped as is the power cylinder used with the four-wheeled tractor. (See Fig. 5.) In addition, the position of one of the grease nipples, with associated grease passages in the valve body, differs on the two types of power cylinder, but, despite the constructional variations mentioned, servicing procedure is virtually the same, with some parts directly interchangeable and both power cylinders operate on the same principle as descibed in the following.

Manual effort from the steering box is directed to the control valve spool by means of the manual ball pin, and power assistance from the ram is directed to the steered wheels by means of the power ball pin. (Fig. 5.) The control valve spool is held in the neutral (central) position by means of a pre-compressed spring and by the hydraulic forces acting on the reaction ring and washer. (See Figs. 4 and 9.)

As long as the steering wheel is not being turned and there is no side thrust acting on the front wheels, the spool remains central and the oil circulates freely on open circuit from the pump, through the control valve and back to the reservoir as shown in Fig. 4. There being no resistance to flow, no pressure build-up occurs.

A light effort only is required at the steering wheel to overcome the spring pre-load on the control valve when the spool will be displaced towards one end of the body, thus directing the oil to the appropriate side of the piston. The pressure quickly builds up until it is sufficient to overcome the resistance at the wheels, thus providing the required steering assistance. The flow of oil and the resulting movement of the cylinder is maintained, within the limits of the wheel travel, so long as the driver continues to turn the steering wheel to keep the spool displaced from its central position.

It is important to note that the driver always steers against a resistance which is derived from the spring pre-load, plus the pressure build-up on the reaction ring and washer. Since this pressure is dependent on the pressure of the oil pushing on the piston it is proportional to the required steering force, thereby giving the driver the necessary " feel of the road." (See Fig. 4.)

In the event of the steered wheels being subjected to a shock load the control valve spool is moved in the appropriate direction to direct the oil to that side of the piston which will resist movement. This blocking action is effective in

damping out the "kick back" normally felt at the steering wheel.

The system is so designed that should the hydraulic power fail for any reason, manual steering is still maintained. When steering manually the small relief valve in the valve body (see Fig. 9) permits free circulation of oil directly between both ends of the cylinder and the steering force is not appreciably increased over that required for the normal manual steering system.

OPERATION

To prevent any possibility of the front wheel contacting the power cylinder with the steering on full lock, it is recommended that tractors equipped with 6.00 × 19 front tyres are not operated with the front axle at the minimum track of 50.5 ins. (128 cm.) and that the next larger track setting of 54.5 ins. (138 cm.) be considered minimum; this does not apply to tractors equipped with 7.50 × 16 front tyres, as with these tyres the minimum track obtainable is 54 ins. (137 cm.).

Under no circumstances, whether operating, bleeding the system, testing, etc., must the steering wheel be held hard over FOR MORE THAN 30 SECONDS with the front wheels contacting any object which COMPLETELY prevents steering movement in the direction the steering wheel is turned. This applies throughout the full turning movement of the steering wheel, i.e. if the front wheels contact an object such as a high kerb which completely prevents steering movement of the front wheels in the required direction, and in addition when the steering wheel is held hard over on either full lock position with the front wheels contacting the steering stops.

It must be born in mind that it is not necessary to hold the steering wheel hard over when no further steering movement of the front wheels in the required direction is possible, and should this condition be encountered release the pressure from the steering wheel immediately. This will allow the control valve spool in the power cylinder to move into the central or neutral position so that the oil can then circulate freely on open circuit (see Fig. 4); the steering position of the front wheels will remain unaltered, i.e. they will remain in contact with whatever prevents further steering movement in the direction the steering wheel is turned.

Failure to observe the precaution of releasing the pressure from the steering wheel in the circumstances described will result in a high pressure being built-up in the system and although the pump relief valve will lift when the maximum permissible pressure for the system is reached, operation for more than 30 seconds at such pressures could cause damage to the system and in particular to the pump.

Straight Ahead Driving

When the tractor wheels are in the straight ahead position the control valve spool is held in the central or neutral position. In this position, oil from the pump flows past the valve spool lands and returns to the reservoir through the port in the control valve body. (See Fig. 4.)

Since only a small amount of back pressure exists in the system under this condition the pump delivers oil at a low pressure, which is transmitted to both sides of the power cylinder piston through the flexible pipes, so that a balanced condition exists.

Left Turn

When the steering wheel is first turned to the left the steering drag link exerts a force on the control valve spool which tends to move the spool forward. When the spool is in this position the oil passage leading to the rear of the power cylinder is closed to pump pressure, but is opened to the reservoir. The passage leading to the forward end of the cylinder is opened to pump pressure. As the oil from the pump flows into the power cylinder the pressure increases until it is sufficient to force the cylinder and steering arm forward, thus providing the power assistance for the turn. The oil displaced from the rear of the power cylinder flows back through the control valve to the reservoir. (See Fig. 4.)

When the operator stops the steering wheel at the desired position, thus removing the thrust against the control valve, movement of the steering arm by the cylinder will momentarily continue, moving the cylinder until the spool is in the central position, thereby stopping the power assistance.

Right Turn

When making a right turn the steering drag link moves the control valve spool rearward. The movement of the valve spool opens the oil pressure supply passage in the valve body, which leads to the rear end of the power cylinder. As the pressure in the system increases the cylinder and steering spindle arm move rearward, thus providing the power assistance for the right turn. The oil displaced from the front end of the power cylinder flows back through the control valve to the oil reservoir. (See Fig. 4.)

Operation Without Pressure Supply

If the pump fails to deliver oil pressure for any reason, the tractor may be steered manually. Under this condition the power steering system operates in the following manner:—

When the steering wheel is turned, the movement of the steering drag link transmits the manually applied force to the control valve spool. The spool moves approximately .045 in. (1.1 mm.) until it contacts its stop, then the full manual effort is transmitted mechanically to the steering linkage. With the valve spool in the off-centre position oil is directed directly to either end of the power cylinder through the small relief valve in the valve body. (See Fig. 9.) Thus, manual move-

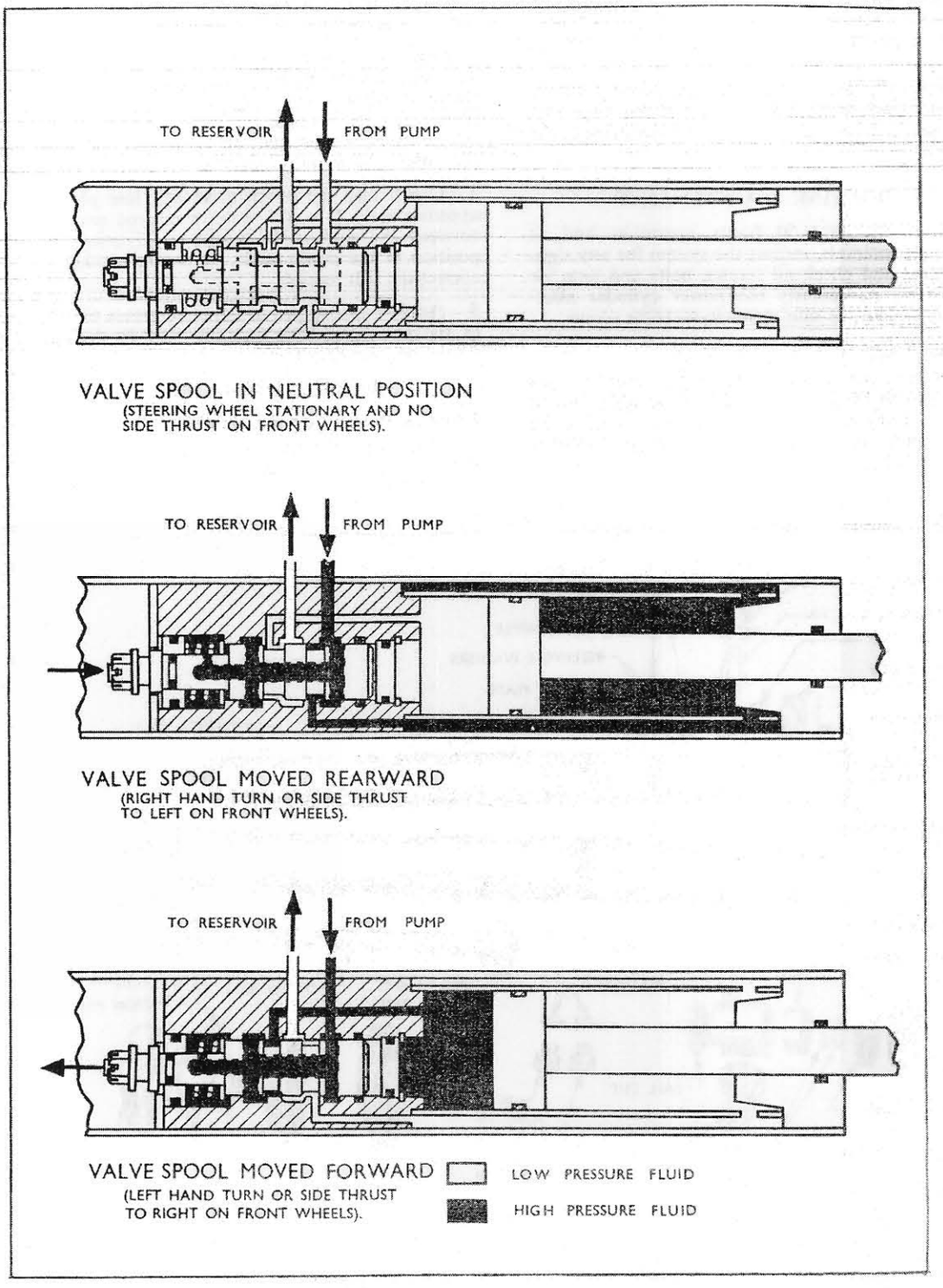


Fig. 4

Diagrammatic Illustration of Oil Flow in Power Cylinder

ment of the power cylinder is not restricted, and steering effort is not appreciably increased over that required for the normal manual steering system.

Note.—If there is no oil in the pump reservoir do not operate the tractor without first removing the pump drive belt, to disconnect the drive to the pump.

ROUTINE MAINTENANCE

After the first 50 hours operation and at periodic intervals, inspect the system for any signs of leaks and check all screws, bolts and nuts for tightness, particularly the power cylinder abutment bracket to side member securing screws.

After Every 50 Hours Operation

1. Check the oil level in the pump reservoir **with the wheels in the straight ahead position** and, if necessary top up to bring the oil to the level of the full mark on the dipstick, using a good quality S.A.E. 10 W oil (S.A.E. 5w where the temperature is consistently below 10° F. (—12° C.)).

Note.—The filter element in the pump reservoir and the oil in the system will only require changing when a major overhaul is carried out, providing care is taken to exclude dirt from the system: **always clean the top of the reservoir and the filler cap before removing the cap.**

2. Check that the pump drive belt free play is approximately 1 in. (25 mm.) measured midway between the pulleys, if necessary adjusting the position of the pump on its mounting bracket to correct the belt tension.

3. Apply a grease gun to the three grease nipples of the power cylinder assembly and to the one on the steering drag link.

REPAIR OPERATIONS

Removal of the Power Cylinder

1. Disconnect the two hoses from the adaptors

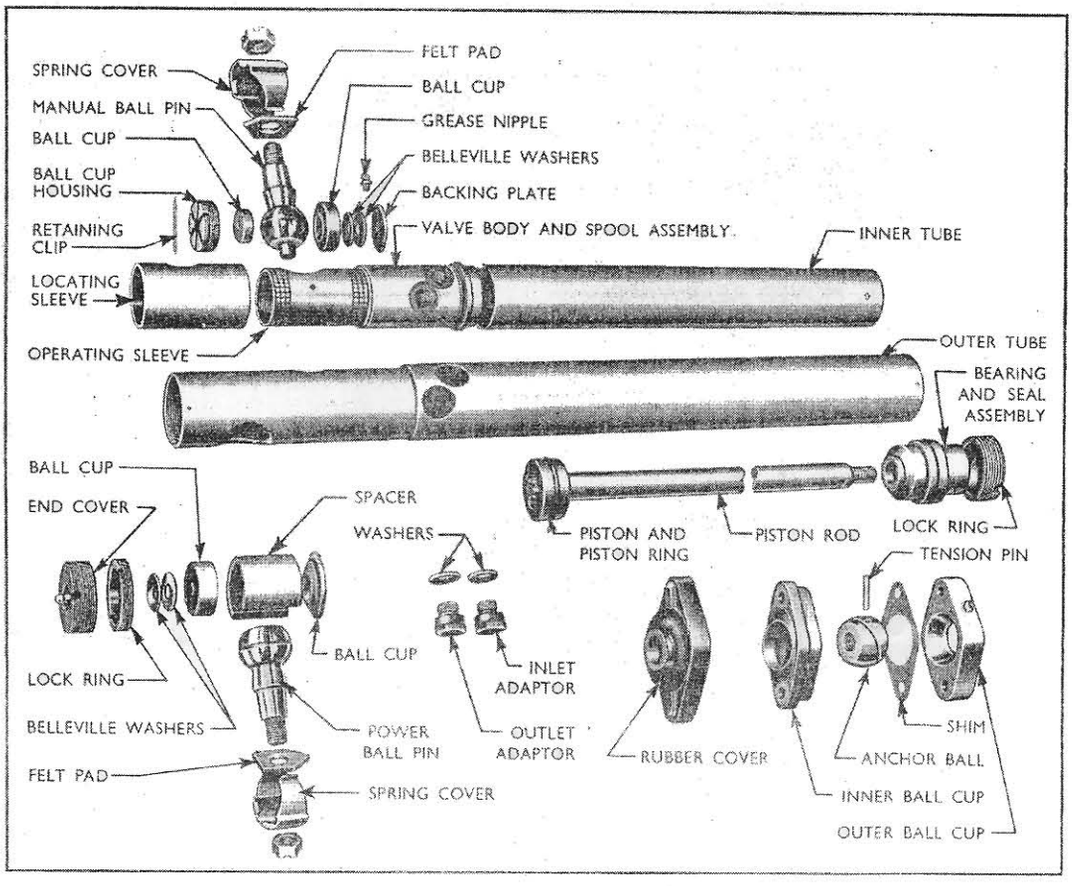


Fig. 5
Exploded View of Power Cylinder (four-wheeled tractor)

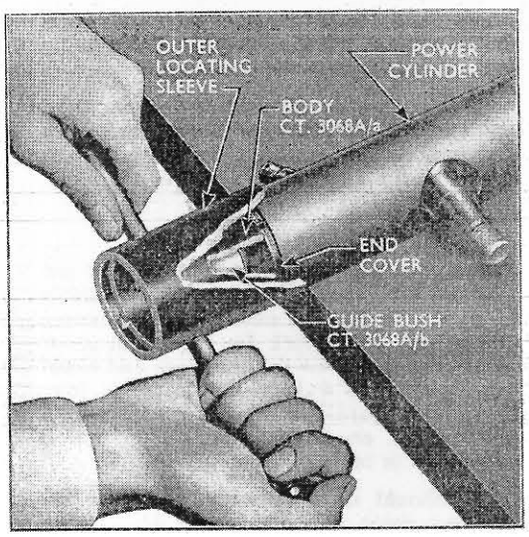


Fig. 6

Removing the End Cover from the Power Cylinder—Tool CT.3068A Shown Cut-away

at the power cylinder and secure above the pump reservoir level to prevent oil draining from the reservoir.

Note.—On previous power assisted steering installations a copper washer is installed inside each hose adaptor for sealing purposes.

2. Jack-up the front wheels clear of the ground and turn the front wheels from lock to lock several times to force all the oil from the assembly, then remove the jack.

3. Remove the split pin and castellated nut which secure the front end of the drag link to the ball pin and disconnect the drag link. Excessive force must **not** be used or the ball pin and ball cups may be damaged.

4. Remove the split pin and castellated nut which secure the power ball pin to the steering arm and lift the cylinder assembly away from the steering arm.

5. Remove the rubber abutment cover, followed by the two nuts and bolts securing the piston rod anchor ball cups to the abutment bracket, when the outer cup and shims will be free of the power cylinder (see Fig. 5), and lift the power cylinder from the tractor.

Dismantling the Power Cylinder

Due to detail changes in design of the power cylinder two additional tools have been added to the tool range (one for four-wheeled tractor units and the other for tricycle units), and some existing tools have been modified and improved, resulting in a new range of tool numbers being allocated to these items.

Note.—The following repair procedure for the power cylinders describes modifications on the cylinders since their introduction. At the time of printing, however, one or two of the later changes mentioned are not yet actually incorporated in either the four-wheeled or tricycle tractor power cylinders, or have been introduced on four-wheeled tractor power cylinders only. It is anticipated, however, that these particular changes will become effective on both four-wheeled and tricycle tractor power cylinders in due course.

1. Remove the two spring covers, with grease retaining pads, from the ball pins.

2. If required, unscrew the grease nipple from the end cover at the ball pin end of the unit. Extract the split pin securing the end cover and remove the end cover by unscrewing it with Tool CT.3068A with the outer locating sleeve of the tool assembled in position to pilot on the outer tube of the power cylinder. When carrying out this operation the power cylinder may, if so desired, be held in a vice equipped with soft jaws, but care must be taken to prevent any distortion of the unit.

Note.—Fig. 6 shows Tool CT.3068A being used to remove the end cover. This is an improved type, double ended tool which can be used with any previous type end cover or lock rings (with four slots) and with current ones (with two slots). Although corresponding previous type tools are not suitable for use with the current end cover and lock rings, Tool CT.3068 previously supplied can be brought into line with the latest type tool, which will be the only one supplied in future.

3. Extract the Belleville washers and the ball cup, then using Tool CT.3068A in the manner previously described unscrew the lock ring from the inside of the outer tube. Withdraw the spacer, power ball pin and the second ball cup.

4. Using a pair of long-nosed pliers extract the spring steel retaining clip securing the ball cup housing, unscrew the ball cup housing using Tool CT.3067A and withdraw the housing and ball cup. Extract the manual ball pin.

Previous Power Cylinders

Using a suitable Allen key remove the grub screw securing the manual ball pin outer cup and remove the ball cup, unscrewing it with Tool CT.3067A. Extract the manual ball pin.

Note.—Fig. 7 shows Tool CT.3067A being used to remove the ball cup housing. This is a modified tool which can be used on both previous and current power cylinders. It incorporates two pressed in pins and two screwed in pins, and when used on previous power cylinders the latter pins are removed to allow the others to locate in the holes in the ball cup; on current power cylinders the screwed in pins are left in position, all four pins then enter the slots of the ball cup housing.

Although corresponding previous type tools are not suitable for use on current power cylinders, Tool CT.3067 previously supplied can be modified to bring it into line with the latest type tool, which will be the only one supplied in future.

5. Remove the grease nipple and two hose adaptors, with washers, protruding from the outer tube of the power cylinder, by unscrewing them from the valve body.

6. Move the anchor ball cup on the piston rod away and drive out the tension pin securing the ball to the piston rod.

Previous Power Cylinders

Using an Allen key remove the grub screw securing the piston rod anchor ball.

Note.—On current power cylinders the improved method of securing the piston rod anchor ball, introduced in conjunction with an increase in size to the threaded bore of the ball and to the end of the piston rod, makes individual replacement of the ball or piston rod impracticable and these parts will, therefore, be serviced as an assembly. Should it be necessary to renew the piston rod or ball on previous power cylinders, where the ball is secured with the grub screw, the current type piston rod and ball assembly will have to be fitted when stocks of the early type piston rod and ball are exhausted.

7. Clamp the piston rod anchor ball firmly in a vice equipped with suitable soft jaws and remove the ball from the rod by applying a spanner to the flats on the piston rod. Slide off the anchor ball cup and rubber abutment cover from the piston rod.

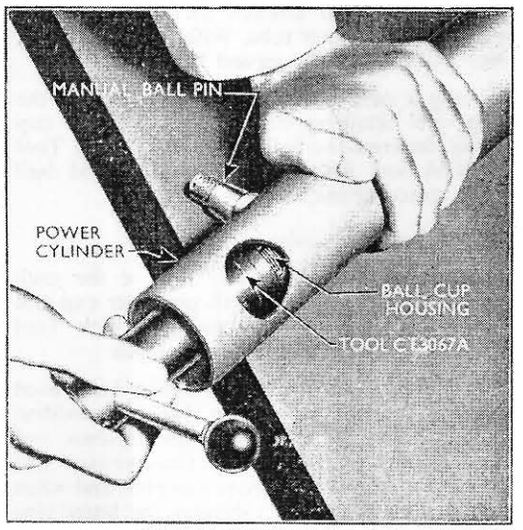


Fig. 7

Unscrewing the Ball Cup Housing

8. Extract the split spin securing the piston rod bearing lock ring and remove the lock ring with Tool CT.3068A. The outer locating sleeve of the tool should be removed for this operation to allow the guide bush CT.3068A/b to pilot on the piston rod.

Previous Power Cylinders

Extract the split pin securing the piston rod bearing assembly, unscrew the bearing assembly using Tool CT.3068A as described for removing the piston rod bearing lock ring on current power cylinders, then withdraw the piston rod and piston assembly, complete with bearing assembly from the cylinder. Separate the bearing assembly from the piston rod, ensuring the end of the rod is free from dirt or burrs.

Note.—Should it be necessary to renew the single piece piston rod bearing assembly used on previous power cylinders the piston rod bearing and lock ring fitted to current units will have to be used when existing stocks of the single piece type are exhausted. This change, however, does not affect the parts used in the bearing assembly for sealing purposes.

9. Insert a suitable piece of wood into the ball pin end of the power cylinder to contact the remaining ball cup and carefully tap the inner assembly (complete with piston, piston rod and bearing in the case of current power cylinders) from the outer tube, then withdraw the valve spool and operating sleeve assembly from the valve body.

10. To separate the valve body from the inner tube on current power cylinders, use a vice equipped with soft jaws and lightly clamp the valve body in the most suitable position to prevent distortion or damage, then pull the inner tube away from it, if necessary rocking the tube from side to side or in a circular direction at the piston rod bearing end. This rocking or rotating should be kept to an absolute minimum to prevent distortion of the tube. Extract the piston and rod assembly from the inner tube and bearing, ensuring that the end of the rod is free from dirt or burrs, then, using a suitable piece of wood inserted into the tube, drive the bearing out of position.

Previous Power Cylinders

To separate the valve body from the inner tube insert a suitable piece of wood into the inner tube and carefully tap the valve body out of position.

11. Withdraw the locating sleeve from the outer tube.

12. Remove the piston ring and separate the piston from the rod after removing the split pin, castellated nut and plain washer.

13. Remove the "O" ring from the outside of

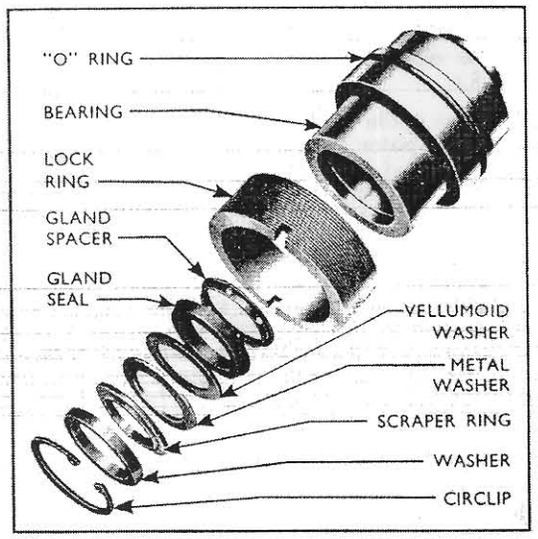


Fig. 8

Piston Rod Bearing, Seals and Lock Ring-Exploded View

the piston rod bearing, and from the bore of the bearing remove the circlip, washer, scraper ring, flat metal washer vellumoid washer, gland seal and gland spacer. (See Fig. 8.)

14. Extract the ball cup, Belleville washers and backing plate from the operating sleeve by tapping the end of the sleeve on a wooden block.

15. Remove the split pin, slotted nut and hardened steel washer securing the operating sleeve to the valve spool.

Previous Power Cylinders

Remove the self-locking nut and hardened steel washer securing the operating sleeve to the valve spool.

16. Remove the operating sleeve, collar and valve body spacer from the valve spool. Slide the reaction ring, spring and washer from the spool and remove the "O" rings from the reaction ring and valve spool. (See Fig. 9).

17. Remove the "O" ring from the outside of the valve body. Extract the circlip from the bore of the valve body, withdraw the end cover and remove the "O" rings from the end cover and bore of the valve body.

18. Unscrew the plug and pin from the valve body using the appropriate Allen key and extract the relief valve spring and ball.

19. If required remove the locating collar from the end of the valve body (see Fig. 9), and if damaged or loose remove the locating pins from the valve body and collar.

Note.—The locating collar is not fitted to power cylinders for tricycle tractors.

Inspection of the Power Cylinder

1. Thoroughly clean all the parts of the power cylinder and inspect for wear or damage.

2. Examine the valve spool and body for burrs and scoring. Burrs may be removed with a very fine emery cloth.

Caution.—Do not round off the sharp edges on the valve spool or the operation of the valve may be affected.

3. Insert the valve spool into the body and check its fit. With a light film of oil the spool should fall freely of its own weight into the body.

4. Inspect the mating surfaces of the operating sleeve and locating sleeve for wear or damage. The surfaces should be free from burrs and scores. Minor burrs and scores may be removed with a very fine emery cloth.

5. Check the fit of the operating sleeve in the locating sleeve. The operating sleeve should slide freely within the locating sleeve when lightly lubricated.

6. Examine the inner tube, piston, piston ring, piston rod and bearing for wear or scoring and renew if necessary.

7. Inspect the piston rod anchor ball and cups for signs of wear or hammering, and renew as necessary if the ball has end float when assembled between the cups with the shims removed.

8. Normally during an overhaul oil seals should be removed and discarded and new ones fitted on reassembly.

Reassembling the Power Cylinder

At assembly a good quality general purpose grease should be used at the locations where greasing is required, and components such as the valve spool, piston rod and inner tube, etc., should be smeared with a light film of oil.

1. If previously removed, fit new locating pegs to the locating collar (four-wheeled tractors only) and valve body, tapping them lightly into the holes provided, and install the locating collar on the valve body (see Fig. 9) by means of a small press or by a few light taps with a wooden or hide mallet, lining up the slot in the collar with the locating peg in the valve body.

2. Assemble the relief valve ball and spring to the valve body and, using a suitable Allen key, screw home the plug and pin, ensuring the ball and spring remain correctly located.

3. Fit a new "O" ring to both the bore of the valve body and to the valve body end cover, slide the end cover into the body and secure with

the circlip. Assemble the new "O" ring to the outside diameter of the valve body.

Caution.—Extreme care must be taken when fitting "O" rings to avoid damage which could cause subsequent leakage.

4. Assemble the valve body to the inner tube, tapping it lightly into position with a wooden or hile mallet, so that the locating peg engages with the slot in the tube.

5. Fit the gland spacer, flanged end first, to the bore of the piston rod bearing. Carefully install a new gland seal, flat face first, in the bore at the small end of CT.3055/a, the outer part of Tool CT.3055. Fit the inner part (CT.3055b) of the tool, insert the tool with seal into the bore of the bearing and press the seal onto the gland spacer. (See Fig.10.)

6. Install the scraper ring of the piston rod bearing on the piston rod, bevelled edge first, followed by the flat metal washer and vellumoid washer, making the assembly from the piston end of the rod. Carefully slide the piston rod bearing onto the same end of the piston rod, move it towards the anchorage end of the rod and press the vellumoid washer, metal washer and scraper ring fully into position in the bearing. Assemble the thick metal washer over the piston rod and into the bearing, then secure the sealing parts of the bearing with a circlip. Assemble a new "O" ring to the outside of the piston rod bearing. (See Fig. 8.)

7. Install the piston so that its flat face abuts the shoulder of the piston rod and secure with the flat washer, castellated nut and split pin, tightening the nut to a torque of 35 to 45 lbs. ft. (4.8 to 6.2 kg.m.). Do not overtighten the nut otherwise the piston may swell and bind in the cylinder. Fit the piston ring to the piston.

8. Compress the piston ring and slide the piston, rod and bearing assembly into the inner tube to fully locate the piston rod bearing in the end of the tube. On current power cylinders it may be necessary to carefully tap the bearing fully into position in the tube.

9. Fit new "O" rings to the valve spool and reaction ring. Assemble the reaction washer, spring and reaction ring to the spool in that order, both the reaction washer and ring being fitted with the chamfered edge of the bore first, then fit the small collar with its larger end adjacent to the reaction ring. Fit the valve body spacer to the collar so that it is correctly positioned for engagement with the valve body, i.e. so that it will locate by the dowel with its remaining hole in line with the hole in the valve body. Install the operating sleeve on the collar, fit the hardened steel washer, followed by the slotted nut, tighten-

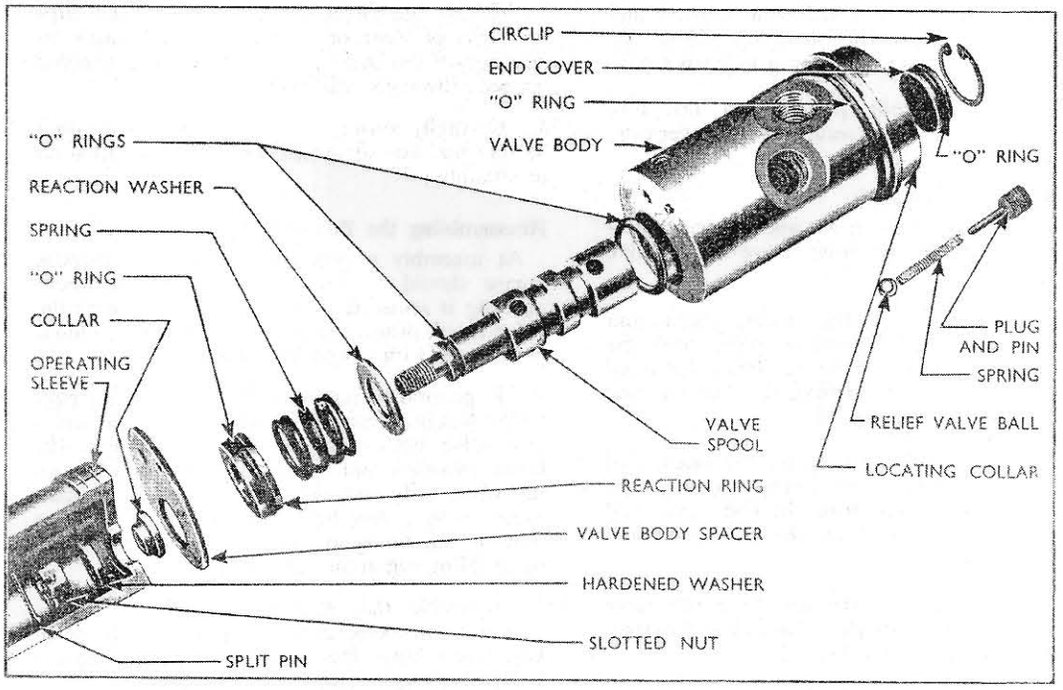


Fig. 9

Exploded View of Power Cylinder Control Valve (four-wheeled tractor)

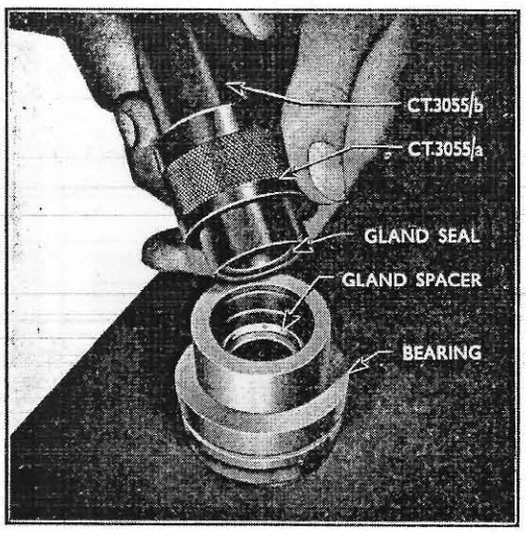


Fig. 10

Installing the Gland Seal in the Piston Rod Bearing with Tool CT.3055

ing it to a torque of 10 to 16.5 lbs. ft. (1.38 to 2.28 kg.m.). Secure the nut with a new split pin. (See Fig. 9.)

Note.—If a self-locking nut, previously fitted to the valve spool, was removed at the time of dismantling it is recommended that it is replaced with the current slotted type nut and split pin.

The current valve spool is of course drilled to accommodate a split pin and the current nut and split pin **must** be used with this spool. The current operating sleeve has a small aperture to facilitate fitting the split pin and in addition is made from a stronger material. It differs dimensionally only to allow easier removal and replacement of the manual ball pin and has two additional small holes to allow the use of the spring clip for retaining the ball cup housing on current power cylinders. This sleeve will be the only one supplied in service and may be fitted to current or previous power cylinders.

10. Slide the spool fully into the valve body, taking care not to damage the edges of the lands of the spool or the sealing rings, so that the spacer is positioned by the dowel against the valve body.

11. Install the backing plate in the bore of the operating sleeve, chamfered edge first, and ensure that it seats correctly. Place two Belleville washers back to back (convex faces together) in the recess of the appropriate ball cup and fit it to the operating sleeve with the Belleville washers adjacent to the backing plate—a smear of grease will help to maintain the washers in position.

12. Fit the ball cup to the threaded ball cup housing and screw the housing into the operating sleeve, a few threads only.

Previous Power Cylinders

Screw the threaded ball cup into the operating sleeve, a few threads only.

13. Grease the operating sleeve and slide the locating sleeve over it with the holes aligned.

14. On both current and previous type power cylinders the following operation should be carried out with the power cylinder suitably positioned to prevent the valve spool, etc. from falling out of position. In addition every precaution must be taken to ensure that the spacer remains against the valve body, located by the dowel, otherwise incorrect assembly may result.

With the sleeve protector installed in Tool T.3033 (for current power cylinders used with four-wheeled tractors) or Tool CT.3069 (for current power cylinders used with tricycle tractors), fit the tool to the anchorage end of the outer tube so that the wall of the tube locates in the recess between the sleeve and its adaptor, the sleeve then covering the thread in the bore of the tube. Remove the sleeve protector from the tool and slide the complete power cylinder inner assembly through the tool into the outer tube (see Fig. 11), ensuring the threaded hose ports in the valve body line-up radially with the ports in the outer tube and taking care to enter the piston rod bearing "O" ring carefully into the tool. It may be necessary to lightly tap the inner assembly into position but in such circumstances do not tap the end of the piston rod. When the hose ports in the valve body and outer tube are almost in line longitudinally withdraw the tool, fit the piston rod bearing lock ring and using Tool CT.3068A in the manner previously used for dismantling, screw down the lock ring until the hose ports are in line and a slot in the lock ring is in line with the split pin hole in the outer tube. Secure the lock ring with a new split pin.

Previous Power Cylinders

Slide the complete power cylinder inner assembly into the outer tube from the anchorage end, ensuring the threaded hose ports in the valve body line-up radially with the ports in the outer tube and taking care to enter the "O" ring of the piston rod bearing assembly carefully into the threaded bore of the outer tube.

Note.—Tools T.3033 and CT.3069 are only suitable for use with the current piston rod bearing and lock ring and cannot be used with the previous type single piece piston rod bearing assembly.

Using Tool CT.3068A, in the manner previously used for dismantling, screw the piston rod bearing assembly into the end of the outer tube until the ports in the valve body and outer tube line-up longitudinally and a slot in the bearing assembly

is in line with the split pin hole in the outer tube. Secure the bearing assembly with a new split pin.

15. Fit the hose adaptors, with sealing washers, and the grease nipple through the outer tube and screw them securely into the valve body.

Note.—Two types of hose adaptors are available through service, one to suit the previous type hoses with nipple type "V-swaged" end pipes and the other to suit the current hoses with "flared" end pipes. Care should be taken to ensure that the hose adaptors fitted are the correct ones for the hoses to be used. (See Fig. 12.)

16. Apply a liberal coating of grease to the spherical surface of the manual ball pin and assemble it through the holes in the outer tube, locating and operating sleeves, ensuring that the limit peg of the ball pin locates correctly in the slots provided in the sleeves.

17. Using Tool CT.3067A with all four pins in position as described for dismantling, screw the ball cup housing into the operating sleeve until fully tight. Back-off approximately one-quarter turn to provide the proper tension on the Belleville washers and fit the spring steel retaining clip so that it lays flat in one of the slots of the ball cup housing with its ends securely located in the holes provided in the operating sleeve.

Previous Power Cylinders

Remove the two screwed in pins from Tool CT.3067A and use the tool to screw the ball cup into the operating sleeve until fully tight, then back-off one-quarter turn to provide the proper tension on the Belleville washers. Using the appropriate Allen key, secure the ball cup with the grub screw but do not over-tighten.

18. Install the larger diameter ball cup in the outer tube, ensuring that it is fully located. Apply a liberal coating of grease to the power ball pin and assemble it through the hole in the outer tube.

19. Install the spacer in the outer tube, around the power ball pin, and locate it on the ball cup.

20. Using Tool CT.3068A with its outer locating sleeve piloting on the outer tube, screw the lock ring down against the spacer in the outer tube and fully tighten to ensure that the spacer, power ball pin inner cup, locating sleeve, valve body spacer, valve body and inner tube are clamped securely as one unit between the piston rod bearing assembly and the lock ring. Ensure the slot in the spacer and the hole in the locating sleeve are central with the power and manual ball pin holes in the outer tube respectively when the lock ring is tightened securely.

21. Place two Belleville washers back to back (convex faces together) in the recess provided in the power ball pin outer cup, and install the cup in the bore of the spacer in the outer tube.

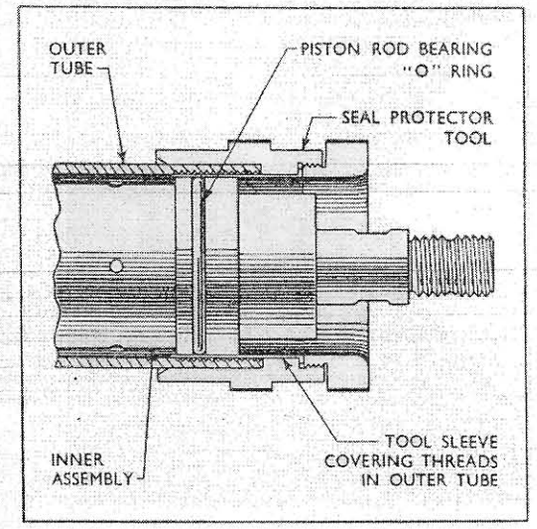


Fig. 11

Section Showing Application of Piston Rod Bearing "O" Ring Protector Tool

22. Fit and fully tighten the end cover in the outer tube, using Tool CT.3068A with the outer locating sleeve of the tool piloting on the outer tube, then back-off approximately a quarter turn to provide the proper tension on the Belleville washers, when a slot in the end cover must be in line with a split pin hole in the outer tube. Secure the end cover with a new split pin, and if previously removed screw the grease nipple securely into the end cover.

Note.—On previous power cylinders which incorporated an end cover with four slots, only one split pin hole was drilled in the outer tube and this allowed a sufficiently fine adjustment of the end cover to provide satisfactory tension on the Belleville washers. Although present production cylinders, where the end cover has only two slots, now have two split pin holes in the outer tube drilled at 90° to each other, thus providing the same degree of adjustment as previously, the current end cover (two slots) was initially introduced with only one split pin hole in the outer tube and in these instances a corresponding hole may have to be drilled at 90° to the existing one to obtain the required adjustment as detailed above. Should it be necessary to drill another split pin hole in the outer tube this operation should be carried out with the end cover partially installed in the outer tube so that the drill enters the end cover. This will prevent damage to the threaded bore of the tube and consequential difficulty in removing or replacing the end cover.

23. Install the spring covers, with grease pads assembled, over the two ball pin locations so that

the pointed ends of the covers are between the ball pins.

24. Slide the rubber abutment cover onto the piston rod, followed by the piston rod anchor ball cup.

25. Screw the anchor ball against the shoulder of the piston rod, slotted end outwards, so that the pin hole in the ball is in line with the one in the rod and secure by driving a tension pin firmly into position.

Previous Power Cylinders

Screw the anchor ball securely onto the shoulder of the piston rod, slotted end outwards, and secure with the grub screw.

Note.—To tighten the piston rod anchor ball clamp it tightly in a vice equipped with soft jaws and apply a spanner to the flats on the piston rod.

Replacement of the Power Cylinder

1. Fit the power cylinder to the abutment bracket on the tractor, attach to the steering arm and drag link, make the necessary hose connections, prime and bleed the system in the manner outlined within "FITTING INSTRUCTIONS."

Note.—If copper washers (E2—CH—9) were fitted previously to the threaded counterbore of the hose adaptors, for sealing purposes, do not omit them when reconnecting the hoses unless new hoses are fitted. The current hoses which are the only ones now supplied have "flared" end pipes instead of the nipple type "V-swaged" end pipes used on the previous type hoses, and if replacing the previous type hoses with the current ones the current hose adaptors must be fitted also to both the power cylinder and the pump. (See Fig. 12.)

Removal of the Pump

1. Disconnect the two hoses from the adaptors at the power cylinder and fasten the ends of the hoses above the level of the pump reservoir to prevent oil drainage. Temporarily cover the power cylinder hose adaptors to exclude dirt from the system.

Note.—On previous power assisted steering installations copper sealing washers are installed inside the hose adaptors of the power cylinder and the pump.

2. First loosen the pump to mounting bracket securing screws and remove the pump drive belt, then remove the screws, flat washers and spring washers and lift the pump away from the bracket.

Dismantling the Pump.

1. Remove the filler cap from the reservoir, drain off the oil, and clean the outside of the pump body and reservoir. Remove the hoses from the adaptors in the pump body but do not allow dirt to enter the adaptors.

2. Unscrew the reservoir cover securing screw, remove the cover and filter element retainer assembly, complete with cover securing screw. Remove the large sealing ring from the reservoir cover, and, if required, dismantle the cover and filter element retainer assembly by removing the clip from the cover securing screw.

3. Lift the filter element from the reservoir inlet stud, then using a suitable box spanner remove

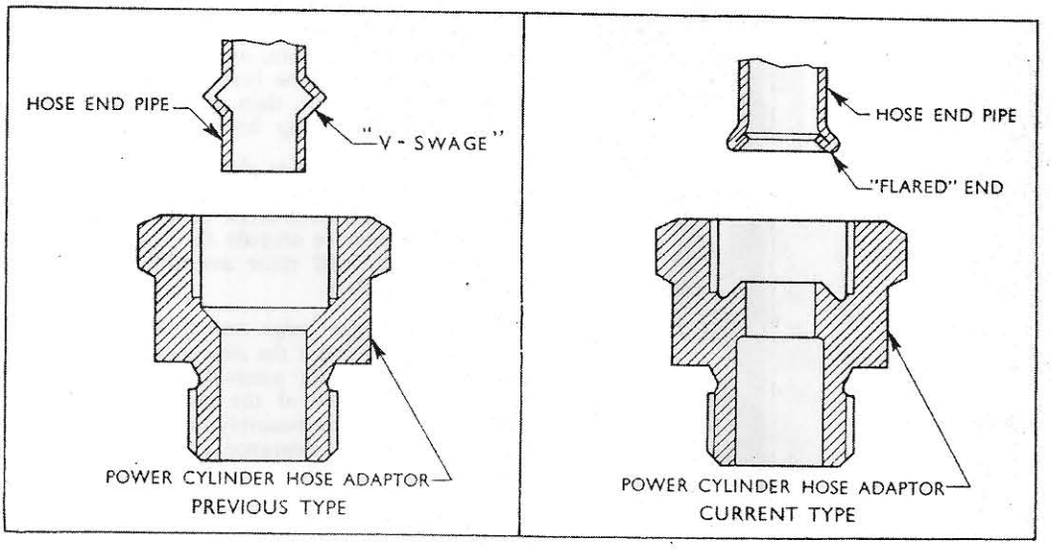


Fig. 12
Previous and Current Hoses and Adaptors in Section

the inlet stud. Remove the two reservoir securing screws and shakeproof washers, followed by the reinforcement plate and lift the reservoir from the pump body. Remove the four "O" rings fitted between the reservoir and pump body.

4. Remove the nut and shakeproof washer securing the pump pulley and using a suitable puller remove the pulley from the pump drive shaft. Extract the Woodruff key from the keyway of the drive shaft.

5. Remove the four screws, with spring washers, securing the pump cover to the pump body, lift the cover away and remove the two "O" rings from their locations in the pump body.

6. Remove the rotors and rotor drive key from the pump body and drive shaft.

Caution.—Handle the rotors, pump body and cover carefully as nicks, burrs, cracks or scratches may render them unfit for further service.

7. Remove the circlip from the pump body retaining the pump drive shaft and bearing assembly (see Fig. 2), then carefully press or tap the shaft and bearing assembly from the pump body.

8. Remove the circlip retaining the bearing to the drive shaft and carefully press or tap the shaft from the bearing. The bearing is of the pre-lubricated, sealed type, and it is recommended that it be renewed whenever a major overhaul is carried out.

9. Extract the pump drive shaft oil seal from the pump body.

10. Unscrew the outlet adaptor from the pump body, withdraw the flow control valve spring from its location and remove the "O" ring from the adaptor. (See Fig. 3.)

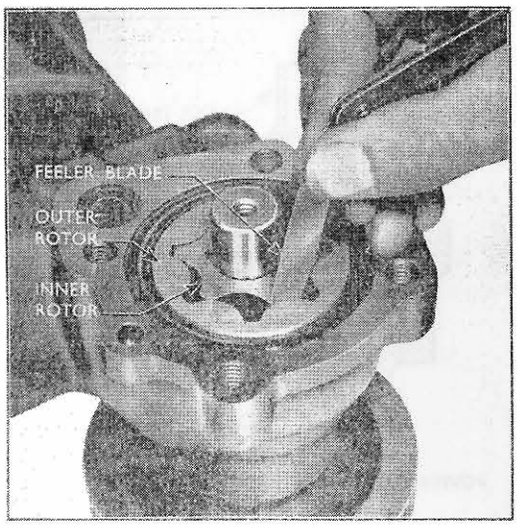


Fig. 13
Checking Clearance Between Rotors

11. Withdraw the valve assembly from the bore in the pump body, remove the circlip from the bore of the flow control valve and extract the relief valve and spring. (See Figs. 2 and 3.)

Caution.—The spring tension in the valve assembly necessitates that care be taken during dismantling, particularly when removing the circlip retaining the relief valve. **When dismantled handle the valves carefully to avoid damage.**

12. If required, remove the inlet adaptor, with fibre washer, from the pump body.

Inspection of the Pump

1. Using a suitable solvent thoroughly wash and clean all parts of the pump, except the pre-lubricated drive shaft bearing if for any reason it is to be refitted.

2. Inspect the pump body and cover for wear or damage and renew if necessary. Inspect the rotors for wear, cracks or scores, and if either rotor is worn or damaged renew the rotor assembly.

3. If the pump body and rotors appear to be in good condition check the fit of the rotors to the pump body and to each other. To do this it is necessary to start reassembling by installing a new bearing on the pump drive shaft, using a suitable adaptor which will locate against the inner race of the bearing to seat the bearing on the shoulder of the shaft. Fit a circlip to the shaft to retain the bearing.

4. Install the drive shaft and bearing assembly in the pump body so that the bearing seats against the shoulder of the bore, applying the pressure to the outer race of the bearing. Fit the rotor drive key to the shaft, then assemble the rotors to the shaft and pump body. (See Fig. 2.)

5. Check the maximum clearance which exists between each lobe of the inner rotor and the lobes of the outer rotor using feeler gauges. (See Fig. 13.) If the clearance exceeds .006 ins. (.15 mm.) the pump body and rotor assembly should be renewed as necessary.

6. Using a straight edge and feeler gauges as shown in Fig. 14 check the clearance between the end face of the rotor assembly and the pump cover mounting face of the pump body. The pump body and rotor assembly should be renewed as necessary if the clearance exceeds .0025 ins. (.06 mm.).

7. Again using feeler gauges check the clearance between the outer rotor and the insert in the pump body. (See Fig. 15.) Renew the pump body and rotor assembly as necessary if the clearance exceeds .006 ins. (.15 mm.).

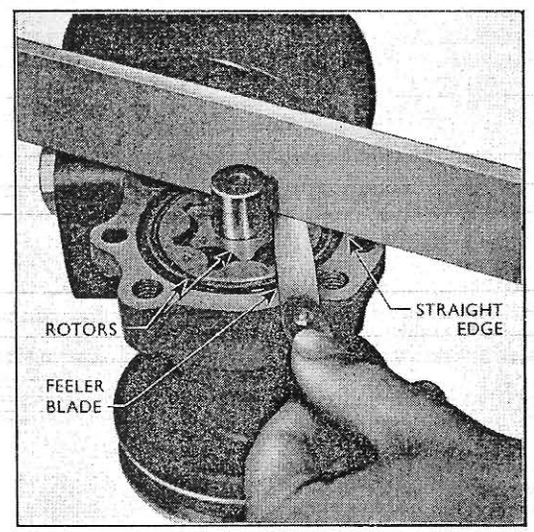


Fig. 14

Checking Rotor to Body End Clearance

8. Remove the rotors and rotor drive key from the pump body and driveshaft then press or tap the drive shaft and bearing assembly from the pump body, being careful not to damage the bearing or shaft.

9. Dry the pressure relief valve and flow control valve thoroughly. Check that the relief valve move freely in the bore of the flow control valve, if necessary removing any burrs with a very fine emery cloth.

10. Ensure the valve bore in the pump body is dry and check the flow control valve for free movement in the valve bore. A fine emery cloth can, if necessary, again be used to remove any burrs.

11. Check the tension of the flow control valve spring. The spring should exert a pressure of 16 to 18 lbs. (7.3 to 8.2 kg.) when compressed to a length of 1.2 ins. (30.5 mm.). If the spring tension is not within these limits renew the spring.

12. Check the tension of the pressure relief valve spring. The spring should exert a pressure of 23.5 to 24.5 lbs. (10.7 to 11.1 kg.) when compressed to a length of 1.18 in. (30 mm.). If the spring tension is not within these limits renew the spring.

Reassembling the Pump

At assembly lubricate the rotors, valves, bushes in the pump body and cover, with a light film of oil.

1. Install a new drive shaft oil seal, sealing lip first, in the bore in the pump body, so that it seats against the shoulder of the bore. (See Fig. 2.) A suitable adaptor which will bear on the outer edge of the seal should be used to drive the seal into position.

2. Ensure there are no burrs on the pump drive shaft, particularly around the location for the rotor drive key, then carefully tap the drive shaft and bearing assembly (previously assembled together for inspection purposes) into the pump body until the bearing seats against the shoulder of the bore; the pressure should be applied to the outer race of the bearing, and care should be taken not to damage the oil seal. Fit the circlip to the pump body to retain the shaft and bearing assembly.

3. Fit the rotor drive key to the drive shaft and then assemble the rotors to the shaft and pump body.

4. Fit new "O" rings to the groove and small counterbore at the pump cover mounting face of the pump body. Ensure the dowels for positioning the pump cover are not loose or damaged, and install the pump cover on the pump body. Secure the pump cover using four screws with spring washers, ensuring that the screws are tightened evenly until fully tight.

Important.—The pump drive shaft must rotate freely without binding. If the shaft does not rotate freely the pump must be dismantled to locate the cause.

5. Install the Woodruff key in the keyway of the pump drive shaft, tap the pump pulley into position on the shaft and secure with the shakeproof washer and nut, fully tightening the nut.

6. If previously removed screw the inlet adaptor,

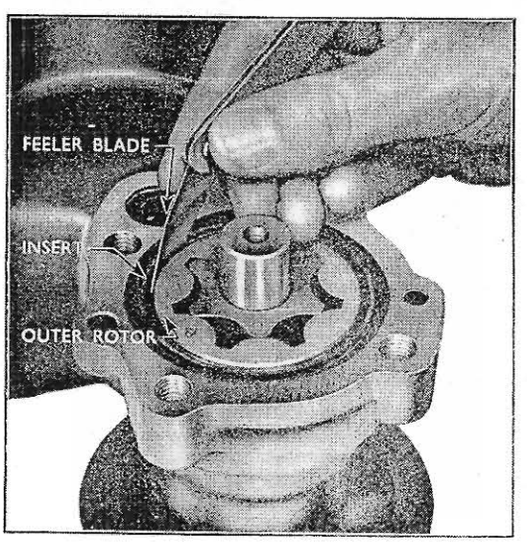


Fig. 15

Checking Clearance Between Outer Rotor and Insert in Pump Body

the shorter adaptor, with a fibre washer assembled, securely into the appropriate port in the pump body.

Note.—Two types of both the inlet and outlet hose adaptors are available through service, one to suit the previous types hoses with nipple type "V-swaged" end pipes and the other to suit the current hoses with "flared" end pipes. Care should be taken to ensure that the hose adaptors fitted are the correct ones for the hoses to be used.

7. Install the pressure relief valve spring and pressure relief valve in the bore of the flow control valve and retain with a circlip (See Fig. 3), then place the valve assembly in the bore of the pump body (See Fig. 2), being careful not to damage the valve lands or the bore of the body.

8. Fit a new "O" ring to the outlet adaptor, install the flow control valve spring and screw the outlet adaptor securely into the pump body to retain the valve assembly. (See Fig. 3.)

9. Fit the four new sealing rings to the locations provided at the reservoir mounting face of the pump body. Install the reservoir on the pump body and position the reinforcement plate in the reservoir, with the holes in the plate and reservoir alined with those in the pump body. Secure the plate and reservoir with two screws, fitted with shakeproof washers, and with the reservoir inlet stud. Ensure the screws and inlet stud are tightened fully.

10. If previously dismantled, reassemble the reservoir cover and filter element retainer assembly by first installing the flat washer on the reservoir cover securing screw, followed by a new seal, large end first. Insert the screw through the reservoir cover, fit the spring to the screw followed by the spring seat, recessed face first, and retain by fitting the clip securely to the screw. Fit a new large sealing ring to the reservoir cover.

11. Locate a new filter element on the reservoir inlet stud, then install the cover and filter element retained assembly on the reservoir and secure by tightening the cover screw firmly but not excessively.

12. If required replace the gasket in the filler cap with a new one, and fit the filler cap to the reservoir cover temporarily to prevent the entry of dirt whilst installing the pump on the tractor.

Replacement of the Pump

1. Attach the pump to the mounting bracket on the tractor, fit and adjust the pump drive belt, install the hoses, prime and bleed the system in the manner outlined within the following "FITTING INSTRUCTIONS."

Note.—If copper washers (E2—CH—9) were fitted previously to the threaded counterbore of the hose adaptors, for sealing purposes, do not omit them when reconnecting the hoses unless new hoses are fitted. The current hoses which are the only ones now supplied have "flared" end pipes instead of the nipple type "V-swaged" end pipes used on the previous type hoses and if replacing the previous type hoses with the current ones the current hose adaptors must be fitted also to both the power cylinder and the pump. (See Fig. 12.)

FITTING INSTRUCTIONS

In service, power assisted steering conversion kits are available for all standard four-wheeled Power Major and New Fordson Major tractors, except when the latter are fitted with a V.O. engine unless designed for operation between 5,000 and 10,000 feet, when the petrol engine cylinder head is fitted.

At Engine No. 1425097 the diesel and petrol engine cylinder heads were modified to incorporate a special mounting pad for the power assisted steering pump mounting bracket; this was not present on previous cylinder heads and therefore two kits of parts are available, E16—WR—9 effective with Engine No. 1425097 and E15—WR—9 prior to Engine No. 1425097. The method of fitting the pump mounting bracket for each kit is described in the following instructions.

Fitting Steering Pump Drive Pulley to Crankshaft Pulley

1. Remove the starting handle (if fitted), followed by the crankshaft ratchet and washer.

2. Fit the steering pump drive pulley to the crankshaft pulley so that the three welded strips of the pump drive pulley are between the rivet heads of the crankshaft pulley; install the new larger crankshaft ratchet washer and fit the crankshaft ratchet.

3. Turn the steering pump drive pulley anti-clockwise and hold in this position, with the welded strips of the pump drive pulley against the rivet heads of the crankshaft pulley, whilst tightening the crankshaft ratchet to a torque of 90 to 100 lbs. ft. (12.4 to 13.8 kg.m.). Refit the starting handle (if fitted) to the tractor.

Engine Water Pump Modification

1. Drain the cooling system, slacken the generator mounting bolts and adjustment locking screw, detach the fan belt, remove the fan and water pump pulley by removing the four securing screws and spring washers.

2. Disconnect the radiator hose at the water pump, remove the four screws and spring washers securing the water pump to the cylinder block and remove the water pump.

3. Position the water pump so that the pulley hub is in the bore of Main Tool CPT.8000, with the hub towards the tool centre screw. Fit the split adaptors CPT.8000-2/a to the tool and around the hub, install the centre screw adaptor

CPT.8000-3/d and press the hub from the water pump shaft.

4. Install the new water pump pulley on the spigot diameter at the long boss of the new pulley hub, with the holes aligned.

5. Fit the split adaptors T.7000-17/a to Main Tool T.7000 and install the new water pump pulley and hub assembly with the hub located centrally in the adaptors. Position the water pump in the tool so that the end of the pump shaft is located at the entrance to the bore of the pulley hub, fit the centre screw extension T.7000-17/b and press the shaft into the hub until the end of the shaft is $1\frac{3}{32}$ ins. (35.7 mm.) below the extreme front end of the hub.

6. Having installed the new water pump pulley and hub, check that the water pump shaft revolves freely and that the hub or pulley do not rub against the pump bearing or housing.

7. Using a new gasket, install the water pump and secure to the cylinder block with the four screws and spring washers, then reconnect the radiator hose to the water pump.

8. Install the fan belt, position the fan and fit the four new securing bolts through the fan, water pump hub and pulley and secure with spring washers and nuts.

9. Position the generator for correct fan belt tension ($\frac{1}{2}$ in. (12 mm.) free play mid-way between the generator and water pump pulleys) and tighten the generator mounting bolts and adjustment locking screw. Refill the radiator.

Installing the Steering Pump

1. *Kit No. E16—WR—9 (effective with Engine No.* 1420597).

Secure the steering pump mounting bracket to the mounting pad provided at the front, left-hand side of the cylinder head using three screws and spring washers.

Kit No. E15—WR—9 (prior to Engine No. 1425097).

Remove the two front, left-hand side cylinder head securing screws, followed by the exhaust manifold front securing screw and washer. Fit the steering pump mounting bracket securely at this location using the same manifold securing screw and washer together with the two longer cylinder head securing screws provided, tightening the latter to the correct torque of 85 to 90 lbs. ft. (11.74 to 12.44 kg.m.).

2. Position the Woodruff key in the keyway of the steering pump drive shaft, tap the pump pulley into position on the shaft and secure with a shake-proof washer and nut, fully tightening the nut. Remove the dust cap from the steering pump body and screw the inlet adaptor, with a fibre washer assembled, securely into the steering pump body.

3. Install the steering pump on the mounting bracket fitted to the tractor, using three screws, spring washers and flat washers, but do not tighten the screws. Fit the pump drive belt, adjust the position of the pump on its mounting bracket so that the belt has approximately 1 in. (25 mm.) free-play mid-way between the pulleys and fully tighten the screws fixing the pump to the mounting bracket.

Note.—After installing the steering pump on the tractor check that there is a minimum clearance of $\frac{1}{16}$ in. (2 mm.) between the pump reservoir and the radiator brace rod; if necessary reposition the brace rod to obtain the desired clearance, adjusting the brace rod retaining nuts as required.

Steering Linkage Modification

1. Remove the split pin and castellated nut securing the steering drag link to the drop arm and detach the drag link from the drop arm.

2. Jack-up the tractor, remove the left-hand front wheel and disconnect the track rod at the left-hand steering arm by removing the split pin and pin.

3. Support the left-hand wheel spindle to prevent it dropping from its location and remove the nut and clamp bolt securing the steering arm. Lift the steering arm from the spindle, with drag link attached, install the new steering arm provided in the correct position on the spindle and secure with a clamp bolt and self-locking nut, tightening the nut to a torque of 75 to 85 lbs. ft. (10.4 to 11.7 kg.m.).

Note.—From approximate Engine No. 1510131, modified front wheel spindles, having a slightly wider steering arm clamping bolt slot are being **gradually** introduced in production. The wider slot allows the steering arm to be clamped in a position on the spindle to give .002 in. to .007 in. (.05 to .18 mm.) clearance between the bottom face of the arm and the top face of the axle with the spindle held firmly up into the axle. With wheel spindles having the narrow slot this clearance is controlled by manufacture as the slot is of such width that the steering arm clamp bolt fits snugly into it.

When fitting a steering arm to a wheel spindle, therefore, always check first to see if the steering arm clamp bolt slot is the wider one, by fitting the steering arm and clamp bolt to the spindle and noting if there is movement of the arm up and down the spindle. If the spindle has the wider slot the steering arm must be clamped in a position on the spindle to give the clearance specified above, using feeler gauges to obtain the correct setting.

4. On tractors equipped with 6.00 × 19 in. front tyres check the front axle track setting and if necessary extend the front axle from the minimum track setting of 50.5 in. (128 cm.) to the

next larger setting of 54.5 in. (138 cm.) and adjust the track rod accordingly. (It is recommended that tractors equipped with power assisted steering and 6.00 × 19 in. front tyres are **not** operated at the minimum front axle track setting obtainable—see previous " OPERATION.")

5. Connect the track rod to the new steering arm, securing the pin with a new split pin, refit the wheel securely and remove the jack.

6. Attach the new steering drag link to the drop arm using a castellated nut tightened to a torque of 100 to 110 lbs. ft. (13.8 to 15.2 kg.m.) and secure with a new split pin.

Installing the Power Cylinder

Care should be taken at all times to ensure that when installed, the front end of the power cylinder will not, in service, foul the frame of any front mounted equipment which may be fitted to the tractor and cause damage to the end of the power cylinder and possible consequential difficulty should it be required to remove the power cylinder end cover.

1. At the left-hand side of the tractor remove the four side channel member to front transmission housing securing screws and spring washers. Secure the power cylinder abutment bracket at this location (see Fig. 1) using the four longer screws and spring washers supplied, tightening the screws to a torque of 65 to 70 lbs. ft. (9.0 to 9.7 kg.m.).

2. Assemble the piston rod anchor ball outer cup to the inner cup on the piston rod, interposing shims of suitable thickness to allow free movement of the piston rod anchor ball in the cups, without end float, when the power cylinder is secured to the abutment bracket. The grease nipple installed in the outer cup must be on the opposite side to the larger section of the semi-spherical projection raised on the front face of the inner cup. (See Fig. 5.)

Note.—The three thicknesses of shims available are .0025 in. (.06 mm.), .005 in. (.13 mm.) and .010 in. (.25 mm.).

3. Insert the two bolts through the inner and outer cups then position the power cylinder, grease nipple in outer cup facing outwards, with the bolts passing through the abutment bracket and secure with the two self-locking nuts, tightening the nuts to a torque of 60 to 65 lbs. ft. (8.3 to 9.0 kg.m.).

After securing the power cylinder to the abutment bracket ensure that the piston rod anchor ball moves freely in its cups without end float and also that the power cylinder has sufficient angular movement in the ball cups to allow operation with the front axle extended.

4. Connect the power cylinder to the steering arm and drag link at the power and manual ball pins respectively and secure with castellated nuts tightened to a torque of 100 to 110 lbs. ft. (13.8 to 15.2 kg.m.). Split pin both nuts securely, using new split pins.

5. Grease liberally with a good quality general purpose grease by means of a grease gun at the three nipples provided on the power cylinder assembly and the grease nipple on the steering drag link.

Installing the Hoses

1. Remove all dust caps and connect the hoses to the steering pump and power cylinder, screwing the union nuts of the hoses firmly into position. The high pressure hose, identifiable by the clinched end caps on the rubber hose, must be connected between the rearmost ports of the pump and cylinder.

2. Fasten the two hoses together with the strap provided.

Note.—To ensure satisfactory operation, care should always be taken to ensure that the hoses are not reversed, and also that when installed they will not, in service, rub against any part of the tractor, causing chafing and possible consequential leakage or failure.

Priming and Bleeding the System

Having correctly installed the power assisted steering equipment, prime and bleed the system in the following manner. This procedure must also be adopted if air is allowed to enter the system at any time either because of low oil level or the removal of a part.

Note.—Providing care is taken when filling, checking or topping-up the oil in the steering pump reservoir the filter in the reservoir will remove all foreign matter from the oil until such time as an overhaul is carried out. It is essential, therefore, to always thoroughly clean the outside of the reservoir and filler cap before removing the cap.

1. Jack-up the front wheels clear of the ground, or failing this ensure the front tyres are at the correct pressure and are on a smooth, hard surface such as concrete, then turn the tractor wheels to the right against the steering stops so that the piston is retracted into the cylinder.

2. Remove the reservoir filler cap. Fill the reservoir to the correct level, as indicated by the dipstick attached to the filler cap, using a good quality oil, S.A.E. 10W (S.A.E. 5W where the temperature is consistently below 10° F. (−12° C.) and replace the filler cap. Capacity is 2½ pints (1.4 litres).

3. Start the tractor engine and set it to run at a fast idling speed.

4. Turn the steering wheel gently from lock to lock.

Note.—Do not on any account hold the steering wheel hard on full lock when filling or testing the system for longer than 30 seconds otherwise damage may result.

5. Keep the reservoir topped-up and continue operating the steering wheel until the system is clear of air, indicated when the oil returned into the reservoir is free from turbulence and air bubbles.

6. Check the hose connections for any oil leaks and rectify as necessary.

Note.—Should any difficulty be experienced in obtaining a perfect seal at the hose unions with the previous type hose (nipple type "V-swaging" on the end pipes as shown in Fig. 12) this may possibly be overcome by disconnecting the hoses from the adaptors where necessary, fitting a copper washer (E2—CH—9) to the threaded counterbore of the adaptors and reconnecting the hoses securely.

7. With the wheels in the straight ahead position, stop the engine and fill the reservoir to the full mark on the dipstick. Replace the filler cap securely, and if necessary remove the jack.

FAULT FINDING

The following information is intended as a guide should any difficulty be encountered with the power assisted steering system, and for this purpose the standard equipment of the tractor, i.e. steering gear assembly etc. is assumed to be in good working order.

Loss of Power Assistance

A sequence for checking through the system to determine the cause of loss of power assistance is shown at Fig. 16 in the form of a fault finding chart.

Binding in the Steering

If binding or sticking is noticed at the initial turning movement of the steering wheel check the following items:—

(a) Manual ball pin movement.

Check the longitudinal movement of the manual ball pin for evidence of sticking or binding. Unsatisfactory movement may be caused by the operating sleeve binding in the locating sleeve, possibly due to inadequate lubrication or wear and in such circumstances the parts should be freed or if necessary renewed.

(b) Control valve spool movement.

Check that the control valve spool, together with reaction ring, etc., does not stick or bind and if necessary remove any burrs or renew the damaged part.

Excessive Free Play in the Steering

If excessive free play is noticed in the steering check the following items:—

(a) Manual ball pin adjustment.

Check for looseness of the manual ball pin caused by wear on the ball pin, ball cups, faulty Belleville washers or by maladjustment; readjust and renew worn parts as necessary.

(b) Power ball pin adjustment.

Check for looseness of the power ball pin and if necessary re-adjust, renewing worn ball cups, Belleville washers or by maladjustment; re-adjust ring inside the end cover at the ball pin end of the cylinder is tightened fully.

Heavy Steering

Heavy steering should not be confused with loss of power assistance or binding in the steering. The steering effort required is less than that necessary when there is no power assistance and the heaviness exists over the whole travel of the steer-the wheel, whilst binding occurs only at the initial turning movement of the steering wheel.

If the steering is heavy check the following items:—

(a) Pump delivery and pressure.

Ensure that the pump delivery and pressure is not low by first checking, and if necessary adjusting or renewing the pump drive belt. Check for leaks from the pump, hoses, hose connections (in particular the high pressure hose), etc.; if necessary renew faulty parts and tighten connections. Check the pump flow control and pressure relief valves and springs, renewing any parts required, then if necessary, check the pump body, cover, rotors, bushes, etc., and renew any worn or damaged parts.

(b) Power cylinder leakage.

Check for leaks from the power cylinder, particularly at the piston rod bearing assembly and renew seals as required. Examine the control valve spool, valve body (paying attention to the small relief valve shown in Fig. 9) and associated sealing rings for damage which could cause internal leakage, renewing any faulty parts, then if necessary check the inner tube, piston, piston ring, etc., and renew worn or damaged parts.

Note.—Excessive oil leakage from the small hole in the outer tube, directly opposite the hose adaptors can be indicative of internal leakage at the valve spool, valve body or associated sealing rings. This must not be confused with the normal slight leakage which may be evidenced at this hole, which is an air bleed from the back of the valve spool and will also act as an escape for any normal slight seepage of oil which may get behind the spool.

Should there be any oil leakage at the ball pin location or from the holes in the outer tube where

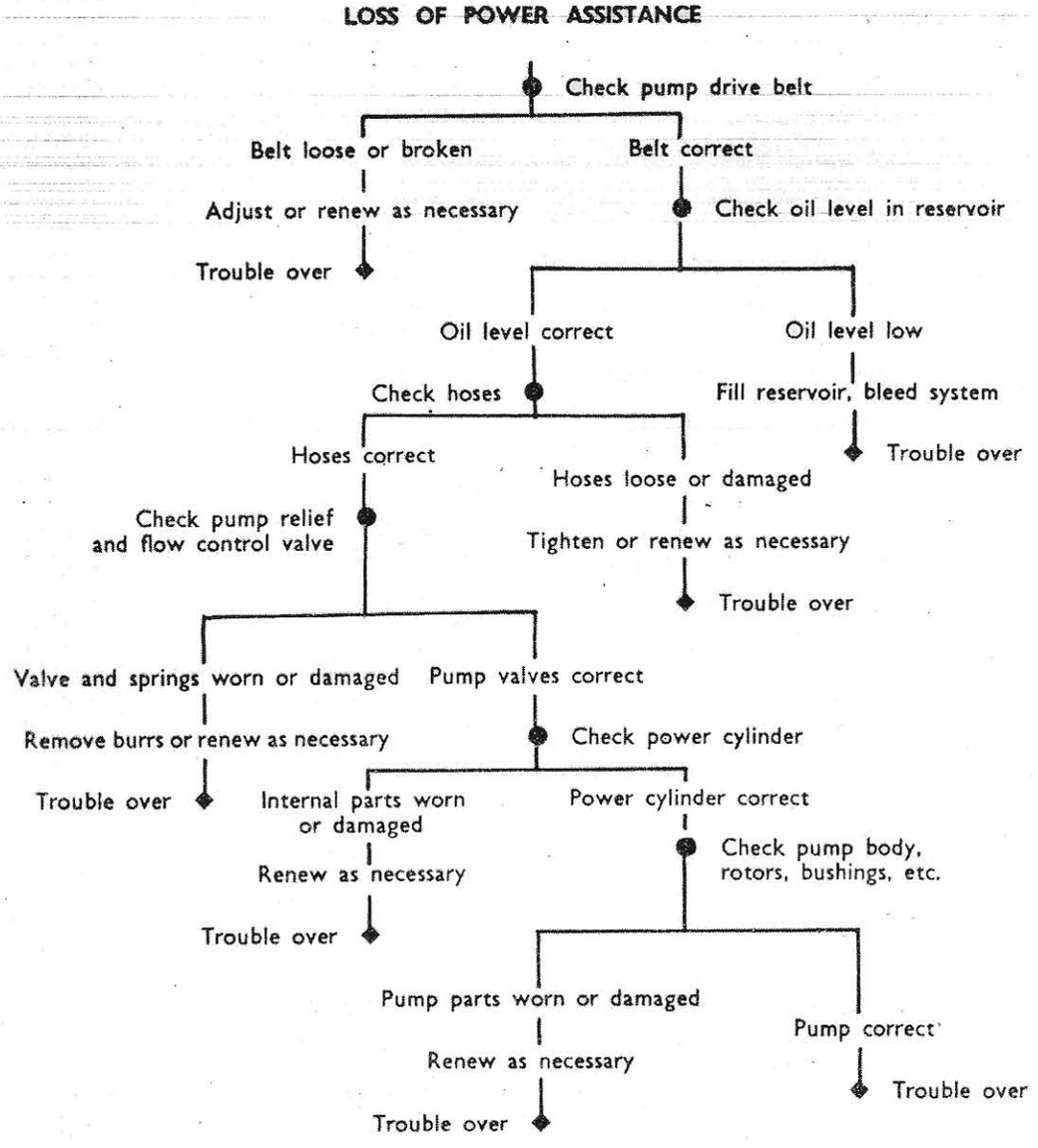


Fig. 16
Loss of Power Assistance—Fault Finding Chart

the hose adaptors are situated, this could again be due to faulty valve spool, valve body or associated sealing rings, and in the latter case could be particularly attributable to a damaged sealing ring on the outside diameter of the valve body. If this sealing ring is damaged oil may flow from the inner tube end of the valve body, along the outside diameter of the valve body and out through the holes in the outer tube which accommodate the hose adaptors. In the case of suspected leakage at the ball pin location it must be ensured that it is oil which is escaping, and not grease, as the ball pins and operating sleeve are greased by means of the grease nipples protruding from the outer tube.

Noisy Operation

If undue noise is noticeable in the system check the following items:—

(a) Pump reservoir oil level.

Check that the oil level in the pump reservoir is not low, allowing air to be drawn into the system, and if necessary add sufficient good quality oil of the correct specification to bring the oil to the correct level (do not forget to bleed the system). Ensure also that hose connections, etc., are secure.

(b) Pump drive belt tension.

Check that the pump drive belt is not too tight, which could cause pump noise, or too loose, which may result in squealing, and adjust if necessary.

(c) Pump wear.

Check the pump flow control and relief valves and springs, then if necessary examine the pump for wear; renew worn parts as required.

Steering Chatter

If steering chatter is evident check the following items:—

(a) Abutment bracket fixing.

Check that the abutment bracket is fixed securely to the side member of the tractor, with the securing screws tightened to the specified torque.

(b) Piston rod anchor ball end float.

Check that the piston rod anchor ball cups are secured to the abutment bracket with the bolts tightened to the specified torque and that the piston rod anchor ball is not loose in the cups. If necessary adjust the shims between the anchor ball cups to remove any end float and tighten the anchor ball cups to the specified torque.

(c) Power ball pin adjustment.

Check for looseness of the power ball pin caused by wear or maladjustment and renew worn parts or adjust as necessary, ensuring also that the lock ring inside the end cover at the ball pin end of the cylinder is secure.

FRONT AXLE AND STEERING

With the introduction of the Super Major, a number of minor modifications have been made to the front axle assembly and steering components and a heavier front cross-member has been introduced specifically for the Super Major.

The following differences should be noted :—

(*a*) Front Axle Trunnion Pin and Bush

A new front axle trunnion pin (larger in diameter, shorter in length and having a single hole drilling as against the two-hole drilling on the previous type) has been introduced with the Super Major. This trunnion pin is retained positively in position by a spring tension pin which passes through the drilling in the trunnion pin and locates in a cross-drilling in a new type front cross-member. (See Fig. 16.)

To accommodate the larger diameter trunnion pin a new hardened steel bush is used in the front axle centre beam, and this in turn necessitates a new centre beam with a larger diameter bush locating hole than was incorporated in the previous centre beam.

To remove and fit a new bush, use driver Tool No. T.3080 and the 550 handle (see Fig. 17).

(*b*) Radius Rod Pin and Bush

A new pin (longer and larger in diameter than previously used) locates the rear of the front axle radius rod to the engine sump. This pin is in turn retained by a spring tension pin locating in a cross-drilling in the sump. A thrust washer is now fitted between the rear of the radius rod and the sump.

To accommodate the change in pin diameter a new hardened steel bush is used, this necessitating a new radius rod, with a larger diameter bush locating hole than was incorporated in previous radius rods.

To remove and fit a new bush, use Tool No. T.3081 in conjunction with 550 handle. When fitting a new bush, assemble the small collar T.3081/b with the small spigoted diameter facing into the bush, then drive the bush into position until the tool is flush with the face of the radius rod.

(*c*) Front Cross-member

A new front cross-member, 40 lbs. (18.14 kg.) heavier than previously used but having the same fixing location, is used on the Super Major. This cross-member incorporates a larger diameter trunnion pin hole and a cross-drilling to locate the trunnion pin retaining tension pin.

(*d*) Front Axle Spindles

On the Super Major a rubber dust seal replaces the felt seal previously used. At the same time, the clearance between the front axle extension and the steering arm has been changed from .002 to .007 in. (.05 to .18 mm.) to .025 to .035 in. (.63 to .89 mm.). Whilst the felt and rubber seals are interchangeable, it is important that the previous clearance is maintained when a felt seal is fitted and the current clearance with the rubber seal.

(*e*) Steering Drop Arm

To prevent a foul condition between the steering drop arm and the new clutch pedal the steering drop arm has been redesigned. The new arm can be used for service on previous tractors but the previous arm is not suitable for use on the Super Major.

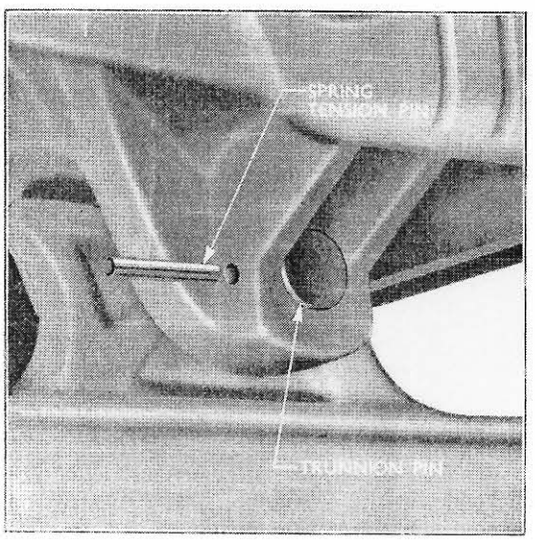


Fig. 16
Trunnion Pin Retention

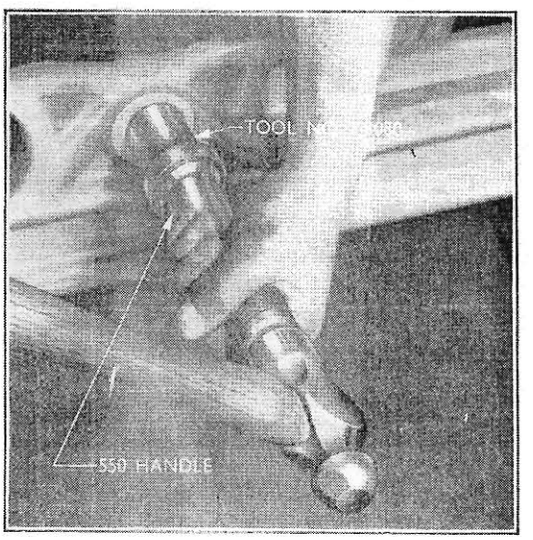


Fig. 17
Removing Trunnion Pin Bush

TRAILER VACUUM BRAKING EQUIPMENT

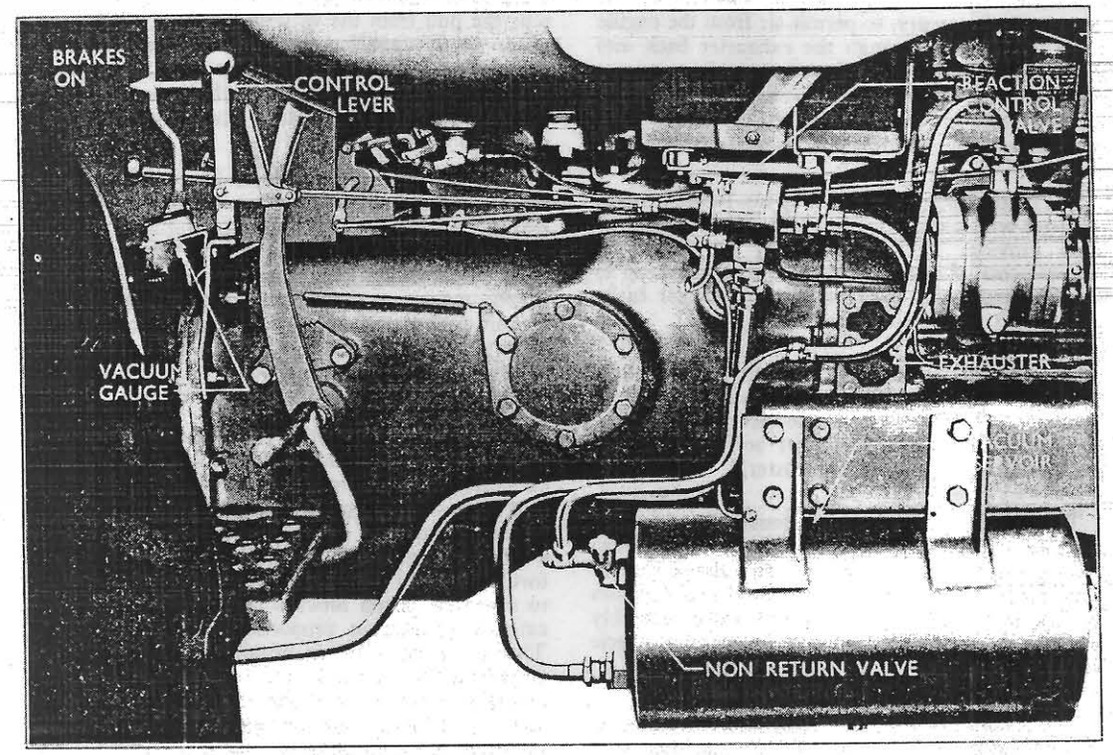


Fig. 1
Vacuum Braking Equipment

Vacuum braking equipment can be fitted in production, on request, to all Fordson Major Diesel Agricultural and Commercial Tractors or supplied as an accessory kit under Part No. E60–Z–9.

The kit comprises a rotary exhauster, vacuum reservoir, reaction valve, control lever, vacuum gauge, quickly detachable coupling and the necessary connecting pipes and brackets. To install this equipment it is necessary to modify the fuel injection pump by fitting a new cambox and camshaft to enable the exhauster to be driven from the rear of the camshaft. The parts necessary for the modification of the fuel injection pump are also included in the kit.

The rotary exhauster is mounted behind the fuel injection pump and driven at half engine speed by the pump camshaft. It consists of a body in which a rotor is supported by heavy duty ball bearings. The rotor has six sliding vanes or plates, which are held in contact with the internal bore of the body by cam rings. The ends of the bore of the body for the rotor are sealed by spring-loaded plates which bear against the ends of the rotor vanes, a seal being made between the end plates and the internal bore by piston rings.

The method of operation of the rotary exhauster is as follows :—

The rotor is supported eccentric to the internal bore of the body, being closer to the body at the bottom than at the top. The vanes and end sealing plates make six separate compartments and as the rotor is supported eccentric to the internal bore, these compartments will be of a larger volume towards the top of the exhauster than at the bottom.

As the rotor commences to rotate in a clockwise direction, when viewed from the front of the engine, so the sliding vanes will move in and out of the rotor as their position moves from bottom to top of the exhauster body. Air is drawn from the vacuum reservoir, into the exhauster body at the point where the compartments are increasing in size, and expelled through the outlet (on the side where the compartments are decreasing) into the engine sump. The intake and outlet pressures of the air will obviously vary depending on the amount of vacuum existing in the reservoir at any time.

A spring-loaded ball valve is fitted between the inlet and outlet passages of the exhauster, to prevent the exhauster being overloaded. This valve opens, when the vacuum in the reservoir exceeds 25 ins. (63.5 cm.) of mercury, to permit air from the engine sump to circulate through the exhauster back into the engine sump thus by-passing the vacuum reservoir. At this time a non-return valve in the vacuum reservoir drops back on to its seat and prevents air from entering the vacuum reservoir.

The vacuum reservoir tank is 29 ins. long × 10 ins. diameter with a total capacity of 1,570 cubic inches. This provides sufficient capacity to meet the requirements of any suitably equipped trailer up to 10-tons gross, and will provide for several brake applications with the engine stopped.

The exhauster is connected to the reservoir tank through a non-return valve which allows air to be drawn off. A gauze filter is also incorporated in the non-return valve to prevent dirt or foreign matter from being drawn into the exhauster.

The reaction control valve assembly consists of a cylinder having connecting ports to trailer brake cylinders and vacuum reservoir, and also a vent to atmosphere. Operating in the cylinder is a piston having at its centre a combined valve assembly which acts at its rearward end as an atmospheric valve and at its forward end as a vacuum valve.

The piston is spring loaded and directly connected to the operating lever through the medium of a control rod, extension rod and fork (see Figs. 1 and 2).

In the normal " brakes off " position (Fig. 2) the return spring holds the piston fully forward in the cylinder, the vacuum end of the combined valve being held firmly on its seat by the vacuum spring plus the pull from the vacuum reservoir. With the piston in this position the length of the combined valve is such that the rear end is clear of the seat, thus the forward portion of the reaction valve cylinder and also the trailer brake cylinders, are vented to the atmosphere.

When the driver's hand lever is operated, movement is transmitted to the piston assembly pulling it rearward against the return spring. Initial movement first closes the atmospheric end of the combined valve, the vacuum end remaining seated, but continuing movement opens the vacuum end while still sealing the atmospheric end (Fig. 2). Air is drawn from the forward part of the reaction valve cylinder and from the trailer brake cylinders into the vacuum reservoir, and brake application commences.

A small spring is fitted between the end of the control rod extension and the operating lever connecting fork (see inset Fig. 1). This allows small fluctuations of the piston assembly independent of the operating lever. When the combined valve opens at the vacuum end a depression is formed in the forward part of the reaction valve cylinder, tending to draw the piston forward against the control rod extension spring in proportion to the depression. Thus, in order to obtain heavier braking power the combined valve must be moved further off its seat at the vacuum end and the effort at the operating lever to achieve such movement is progressively increased in proportion to the depression in the forward part of the cylinder.

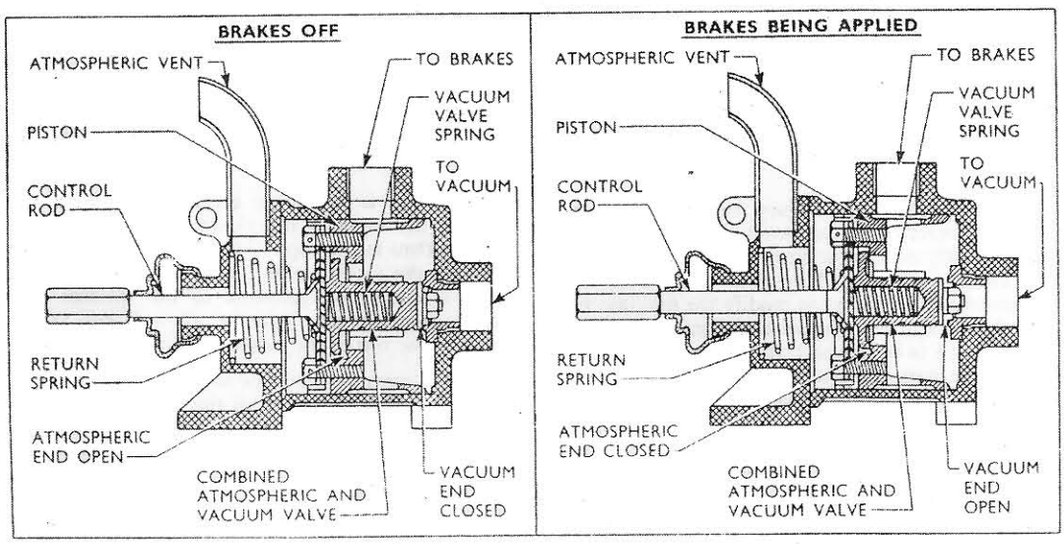


Fig. 2
Operation of Reaction Valve

This characteristic provides the operator with a "sense of feel" enabling him to apply the trailer brakes with perfect control and absolute safety.

Should it be desired to partially apply the brakes and hold them in a definite position, the piston will move forward against the control rod extension spring until a position of balance is achieved, when both the armospheric end *and* the vacuum end of the valve will be seated : the depression in the reaction valve cylinder and the trailer brake cylinders being proportional to the pull on the operating lever.

Any decrease in pull on the operating lever during brake application allows the piston return spring to move the piston further forward, opening the atmospheric end of the combined valve and reducing the depression in the reaction valve cylinder and the trailer brake cylinders, until such time as pull on the operating lever is either again held or increased.

It will be seen that the degree of vacuum applied to the trailer brake cylinders is always proportional to the effort applied to the hand lever.

The quick detachable coupling used is the standard type of unit in general use and provides a simple and speedy method of connecting the trailer brake system. The male portion is the part of the trailer equipment fitted on the end of the trailer flexible connection hose. A dummy plug is provided with the coupling and should always be inserted as the trailer hose is disconnected, to prevent dirt entering the coupling.

Should the trailed vehicle accidentally break away, the coupling will then be released so that no damage can be done to the trailer hose connection.

If a pull of 85 lbs. (38.855 kg.) or more is put on the coupling it will then disconnect.

Periodic Attentions

As a certain amount of condensation will collect in the vacuum reservoir tank, the drain plug should be removed every 200 hours to allow this accumulation of water to drain off.

It is advisable that pipe connections be checked and tightened at 200 hour intervals to ensure that no leak can occur.

Ensure that the leather gaiter on the control valve is intact as this prevents dirt from entering the valve when the brakes are released.

The rubber washer fitted to the coupling should be examined in case of it having become damaged or perished.

Lubrication

Exhauster lubrication is by intermittent oil feed from number four camshaft journal at approximately 30 lbs. per sq. in. (2.1 kg. per sq. cm.) pressure.

The oil lubricates all working parts of the exhauster and is expelled with the air through the exhaust port to the engine sump.

FITTING INSTRUCTIONS

Fitting the Vacuum Reservoir Assembly

1. Remove the two rear bolts from the right-hand side member.
2. Locate the rear bracket of the vacuum reservoir in this position and secure it with the two existing bolts.
3. The side member on early Major tractors were not drilled to accept the exhauster front mounting bracket bolts and it will then be necessary to use the front support bracket as a template and drill two $\frac{1}{2}$ in. holes in the side member at this location.
4. Secure the front bracket to the side member with two $\frac{1}{2}$ in. $\times$ $1\frac{1}{8}$ in. bolts, nuts and spring washers.

Fitting the Control Lever and Gauge Assembly

1. Remove the two top right-hand bolts from the rear axle to gearbox coupling flange.
2. Locate the lever and gauge assembly in position and secure with two $\frac{7}{16}$ in. $\times$ $2\frac{1}{8}$ in. bolts, nuts and spring washers (see Fig. 3).

The Quick Detachable Coupling

This is located on top of the right-hand rear axle housing and is so designed that should the trailer be accidentally detached, the coupling will be released so that no damage is done to the trailer hose con-

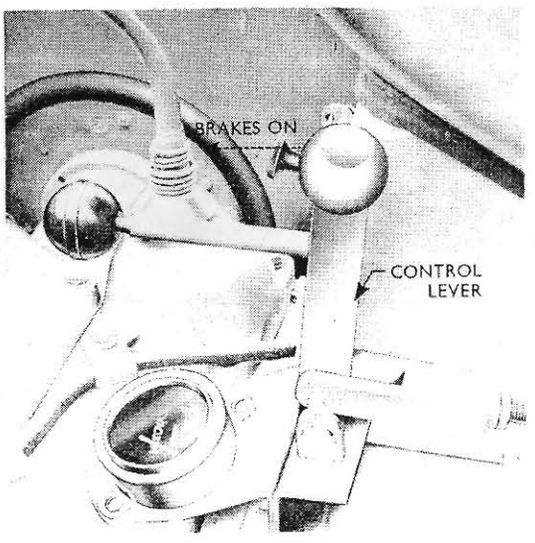


Fig. 3
Control Lever and Vacuum Gauge

nection. A dummy plug is provided with the coupling to be inserted whenever the trailer hose is disconnected.

Fitting the Quick Detachable Coupling (Fig. 4)

1. Remove the brass caps from the two inner tapped holes on top of the right-hand rear axle housing.
2. Locate the coupling bracket in this position and secure it to the axle housing with two $\frac{5}{8}$ in. × $1\frac{1}{4}$ in. bolts and spring washers.
3. Secure the coupling and pipe adaptor to the bracket with two $\frac{1}{2}$ in. × $1\frac{1}{8}$ in. bolts, nuts and spring washers.

The Reaction Valve (Fig. 3)

The reaction valve is mounted on a suitable bracket located beneath the battery carrier. The valve is so designed that its reaction characteristics produce a "sense of feel" enabling the driver to apply the trailer brakes with perfect control.

Fitting the Reaction Valve Assembly (Fig. 5)

1. Disconnect and remove the battery.
2. The necessary mounting holes are already drilled on current production tractors but if an early tractor is being handled it will be necessary to drill a $\frac{3}{8}$ in. (9.53 mm.) hole $1\frac{3}{4}$ ins. (44.45 mm.) from the rear inside edge and $\frac{5}{8}$ in. (15.88 mm.) from the side of the battery carrier. Drill a second $\frac{3}{8}$ in. (9.53 mm.) hole $5\frac{9}{16}$ ins. (14.13 mm.) from the centre of the first one, $1\frac{1}{8}$ ins. (28.58 mm.) from the inside edge of the battery carrier.
3. Locate the bracket below the battery carrier with the distance pieces between the carrier and bracket.
4. Secure the bracket in position with two $\frac{5}{16}$ in. × $1\frac{3}{8}$ in. bolts, nuts and spring washers.

   NOTE.—The two holes for securing the reaction valve must be towards the rear of the bracket.
5. Secure the reaction valve to the bracket with two $\frac{5}{16}$ in. × $\frac{3}{4}$ in. bolts, nuts and spring washers.
6. Connect the control lever to the reaction valve by means of the adjustable rod. Adjust the rod so that the lever is vertical when in the off position (forward).

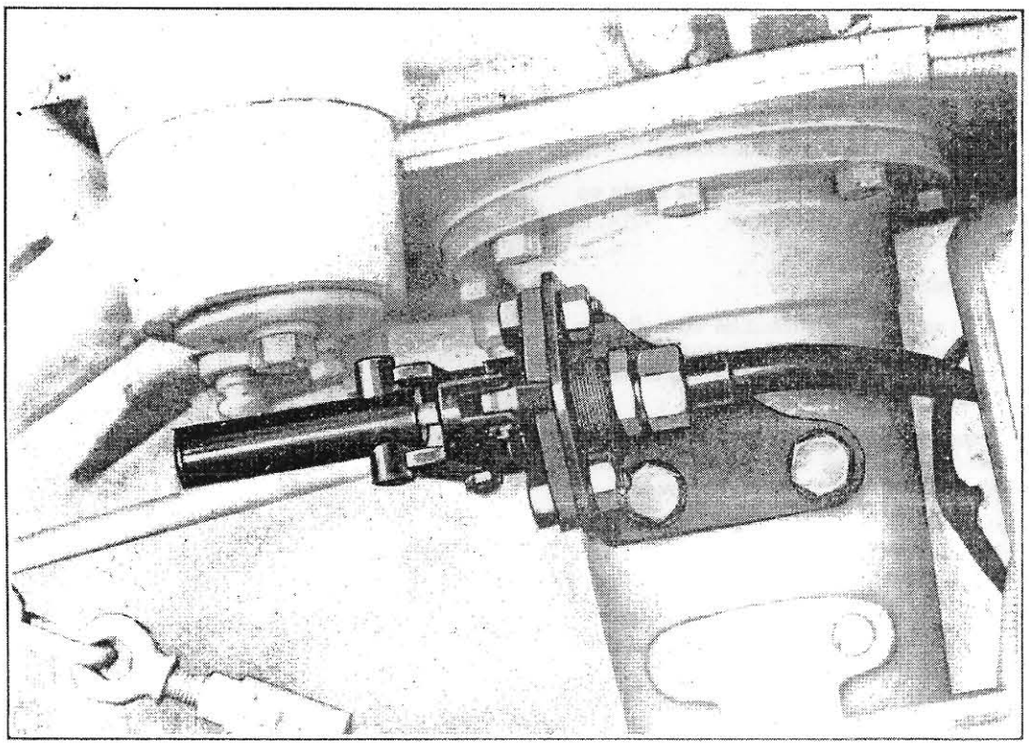


Fig. 4
Quick Detachable Coupling

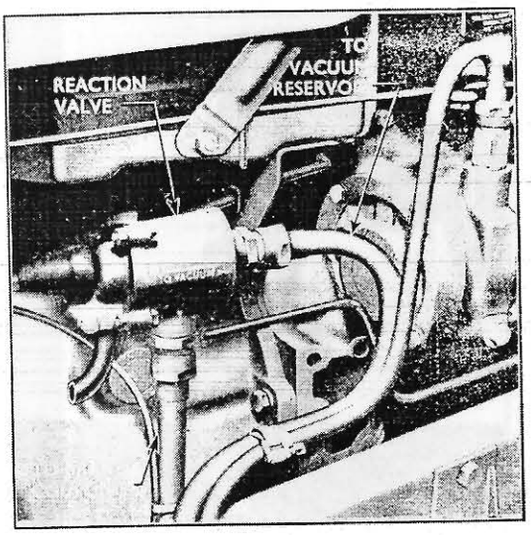


Fig. 5
Reaction Control Valve Assembly

Fuel Injection Pump

The fuel injection pump must be suitably modified to enable the rotary exhauster to be driven from the rear of the injection pump camshaft. A new fuel lift pump is then mounted on the injection pump cambox and is driven by the pump camshaft.

Modifying the Fuel Injection Pump

1. Remove the injection pump and completely dismantle same.
2. Remove the camshaft bearings and shims from the pump camshaft and fit them to the new camshaft.

   NOTE.—Each bearing, race and cup must be kept as an assembly and renewed if unserviceable.
3. Fit the new camshaft to the cambox (taper toward the front) and secure the front cover and timing plate in place with the four bolts and spring washers.
4. Remove the rear camshaft bearing cup from the original end cover.
5. Fit the small oil seal, baffle and bearing cup to the new end cover.
6. Fit the end cover to the cambox with four countersunk screws and shakeproof washers. Use Tool No. CT.9020 to prevent damage to the oil seal.
7. Check the camshaft end-float and adjust if necessary.
8. Completely assemble, phase and calibrate the fuel injection pump.
9. Locate the lift pump gasket on the cambox studs, fit the lift pump in position and secure it with two nuts and spring washers.
10. Put one-sixth of a pint of engine oil in the pump cambox.
11. Fit the coupling (less driving dogs) to the injection pump camshaft and secure in place with the cotter bolt, nut and spring washer.
12. Refit and time the injection pump.

The Exhauster

The exhauster is driven from the rear of the fuel injection pump camshaft and is located on two suitable pads machined on the cylinder block. It is secured to the lift pump mounting flange and tappet chamber side cover.

Fitting the Exhauster

1. Turn off the fuel, remove the tank to lift pump pipe and remove the fuel lift pump.
2. Remove the rear bolt from the tappet chamber side cover.
3. Fit the copper washer to the special hexagon headed bolt (longer head than normal and drilled and tapped to accommodate exhauster mounting top bolt) and fit this bolt in the place of the one removed.
4. Remove the grub screw from the front mounting pad for the exhauster and locate the small rubber oil seal in the recess.
5. Loosely fit the coupling complete with driving dogs, and fibre pad to the exhauster shaft.
6. Locate the gasket on the mounting flange and fit the exhauster to the tractor.
7. Enter the two bolts in the mounting flange and the one in the top mounting bracket. Tighten these bolts evenly.
8. Rotate the engine until it is possible to locate the driving dogs in the fibre pad and injection pump coupling. Fit the dogs in position and secure them with the self-locking nuts.
9. Insert a .025 in. (.63 mm.) feeler blade between the fibre pad and metal half of the coupling. Push the exhauster coupling towards the injection pump and securely tighten the coupling bolt. Remove the feeler blade. This will ensure that there is a permissible end-float of .020 to .030 in. (.51 to .76 mm.) on the shaft.

Worn bearings should obviously be replaced when carrying out any overhaul of this nature. If premature failure has occurred, this may have been caused by the rotor shaft being exposed to end thrust or possibly a shortage of oil.

A certain amount of wear on the rotor blades is permissible but should the inner edges become appreciably " stepped " where they contact the cam ring, the blades should be replaced.

The piston rings should only be removed from the sealing plates when the rings or the plates need replacing. It is normally found that the rings will last a lifetime on the exhauster if handled with care. Wear on the faces of the sealing plates may necessitate their renewal especially where excessive scoring has occurred. The locating pegs are rivetted to the sealing plates and are supplied together as an assembly.

It is advisable to replace all oil seals and gaskets when reassembling an exhauster.

1. Refit the front oil seal cover plate then install the oil seal in the front cover, using adaptor CT.6068, with 550 handle (see Fig. 7), with the lip of the seal towards the inside.
2. Reassemble the rotor assembly if previously dismantled by fitting the cam rings on the rotor shaft, refit the bearings and drive on the front oil seal collar up to the bearing, using Tool No. CT.6067. (See Fig. 8) then refit the vanes.
3. Refit the sealing rings to the end sealing plate and pass the sealing plates over the bearings locating them on the cam ring spigot.
4. Fit the rotor assembly into the exhauster body

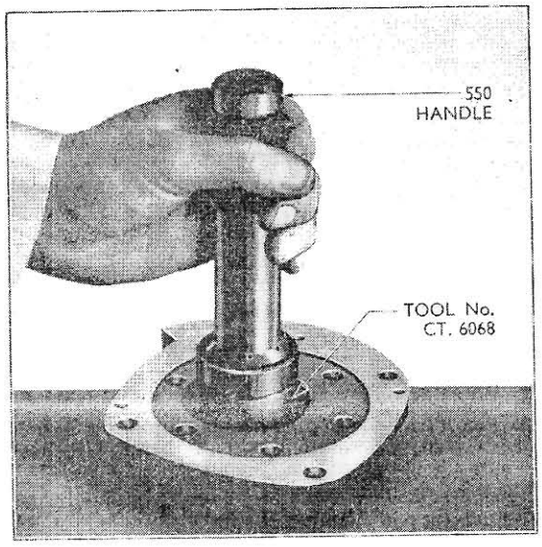


Fig. 7
Replacing End Cover Oil Seal

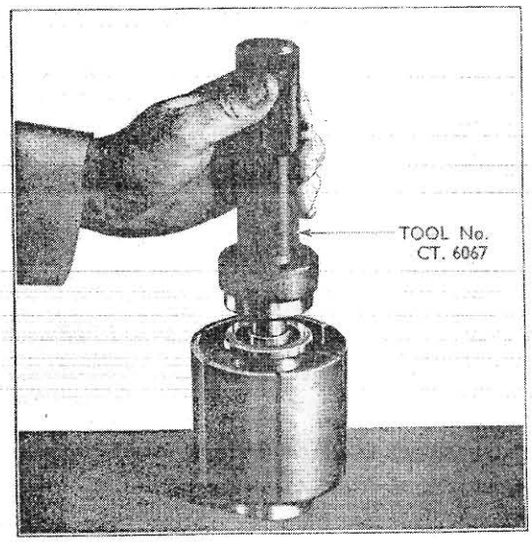


Fig. 8
Replacing Rotor Shaft Bearing

ensuring that the sealing rings enter the bore of the body completely to allow the end covers to seat correctly.

5. Replace the end sealing plate springs in their recesses in the end covers, a smear of grease will locate them during assembly.
6. Smear the new end plate gaskets with grease and stick them to the end plates. Locate the oil seal rear plate in the recess in the drive end cover making sure that it drops to the bottom of the ball race seat.
7. Fit the blank end plate opposite to the drive end of the exhauster and retain in position with the four bolts and spring washers.
8. Fit the seal guide (Tool No. CT.6066) over the end of the exhauster shaft to protect the seal and fit the drive end plate in position. (See Fig. 9.)
9. Replace the snifter valve ball on its seating and locate the larger diameter of the coil spring in the retaining plug. Ensure that the sealing washer is in good condition before refitting it and screw in the retaining plug.

To Replace

1. Fit a new sealing ring in the oil feed recess in the cylinder block then follow operations 5 to 9 of section headed " Fitting the Exhauster " on page 5.
2. Replace the pipe from the exhauster to the vacuum tank and ensure that all union nuts are tightened securely.

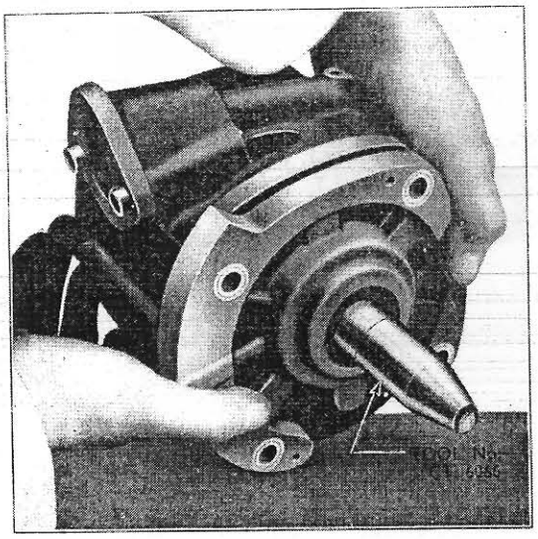


Fig. 9
Replacing Drive End Plate

Testing

Run the engine until the vacuum gauge reading is 25 ins. (63.5 cm.) Hg. Stop the engine and observe the gauge for rate of fall of the pointer. The rate of fall must not exceed 1 in. (2.54 cm.) in three minutes. If the rate of fall is greater than this, check connections on all pipe assemblies (except control valve to coupling). Tighten unions and nuts as necessary and check the snifter valve in the vacuum tank for correct seating.

Ensure that the dummy plug is firmly inserted in the coupling and repeat the above test with the control lever pulled back. After the initial drop, when the lever is operated, the gauge pointer should remain steady and the consequent drop should not exceed 1 in. (2.54 cm.) in three minutes. If the leak rate is greater than this, check the connections on the pipe between the control valve and coupling, tighten as necessary.

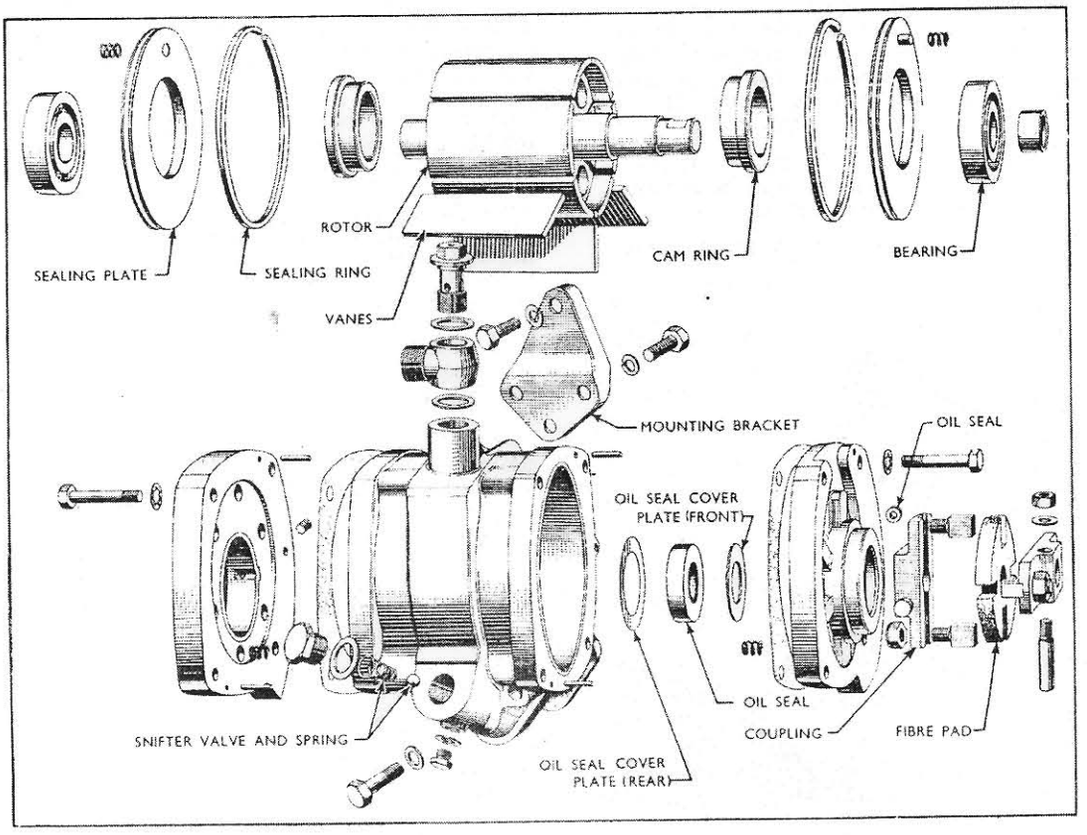


Fig. 10
Exploded View of Exhauster

Worn bearings should obviously be replaced when carrying out any overhaul of this nature. If premature failure has occurred, this may have been caused by the rotor shaft being exposed to end thrust or possibly a shortage of oil.

A certain amount of wear on the rotor blades is permissible but should the inner edges become appreciably "stepped" where they contact the cam ring, the blades should be replaced.

The piston rings should only be removed from the sealing plates when the rings or the plates need replacing. It is normally found that the rings will last a lifetime on the exhauster if handled with care. Wear on the faces of the sealing plates may necessitate their renewal especially where excessive scoring has occurred. The locating pegs are rivetted to the sealing plates and are supplied together as an assembly.

It is advisable to replace all oil seals and gaskets when reassembling an exhauster.

1. Refit the front oil seal cover plate then install the oil seal in the front cover, using adaptor CT.6068, with 550 handle (see Fig. 7), with the lip of the seal towards the inside.
2. Reassemble the rotor assembly if previously dismantled by fitting the cam rings on the rotor shaft, refit the bearings and drive on the front oil seal collar up to the bearing, using Tool No. CT.6067. (See Fig. 8) then refit the vanes.
3. Refit the sealing rings to the end sealing plate and pass the sealing plates over the bearings locating them on the cam ring spigot.
4. Fit the rotor assembly into the exhauster body ensuring that the sealing rings enter the bore of the body completely to allow the end covers to seat correctly.

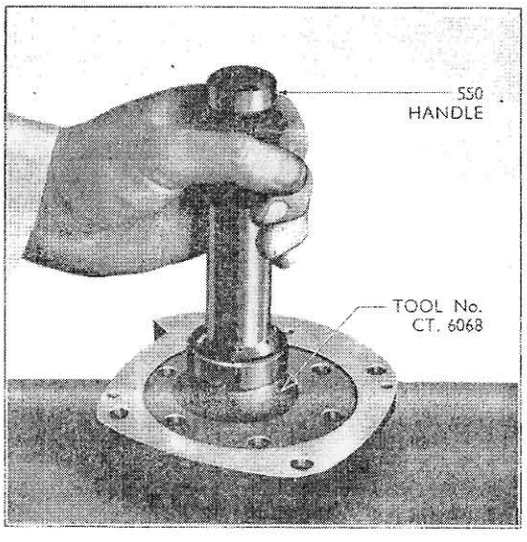


Fig. 7
Replacing End Cover Oil Seal

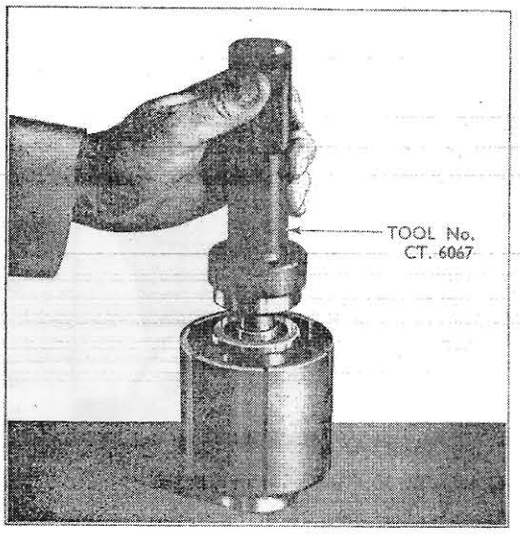


Fig. 8
Replacing Rotor Shaft Bearing

5. Replace the end sealing plate springs in their recesses in the end covers, a smear of grease will locate them during assembly.
6. Smear the new end plate gaskets with grease and stick them to the end plates. Locate the oil seal rear plate in the recess in the drive end cover making sure that it drops to the bottom of the ball race seat.
7. Fit the blank end plate opposite to the drive end of the exhauster and retain in position with the four bolts and spring washers.
8. Fit the seal guide (Tool No. CT.6066) over the end of the exhauster shaft to protect the seal and fit the drive end plate in position. (See Fig. 9.)
9. Replace the snifter valve ball on its seating and locate the larger diameter of the coil spring in the retaining plug. Ensure that the sealing washer is in good condition before refitting it and screw in the retaining plug.

To Replace

1. Fit a new sealing ring in the oil feed recess in the cylinder block then follow operations 5 to 9 of section headed "Fitting the Exhauster" on page 5.
2. Replace the pipe from the exhauster to the vacuum tank and ensure that all union nuts are tightened securely.

DISC BRAKES

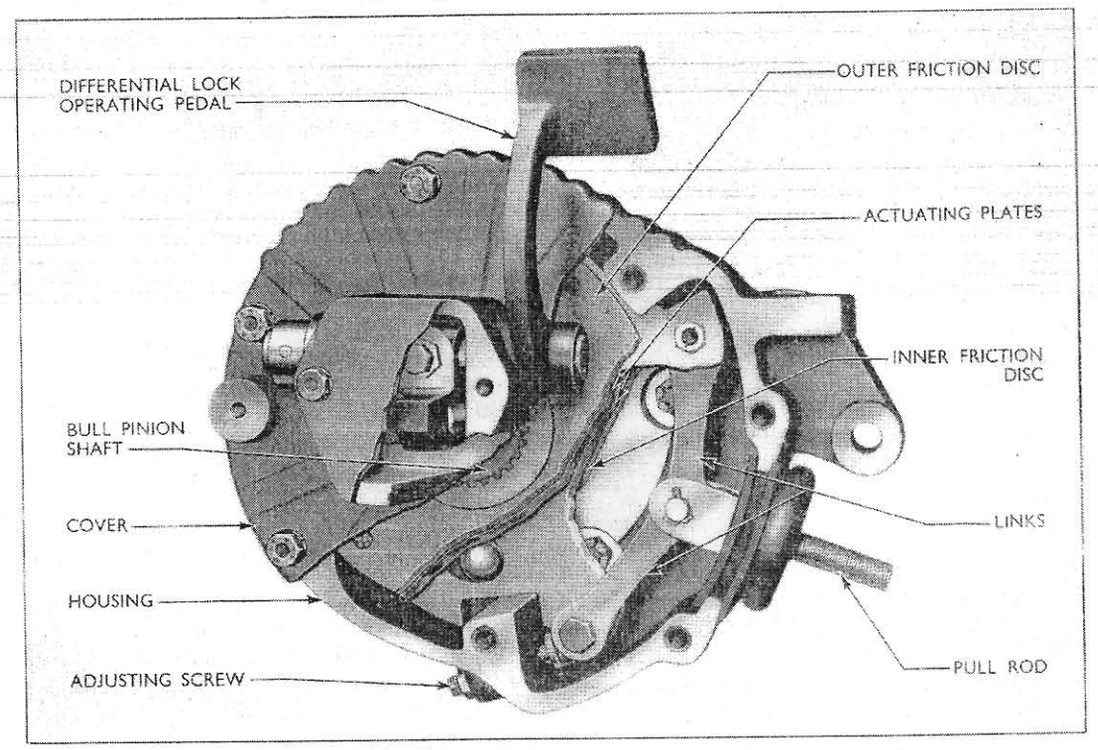


Fig. 11
The Disc Brake

With the Super Major an entirely new braking system has been introduced, the expanding shoe and drum brakes fitted for many years having been superseded by disc brakes (see Fig. 11).

Although braking is still effected at the bull pinion shafts, the brake extension housing is no longer employed, the brake assembly being bolted directly to the rear transmission housing.

The disc brakes are self-energising, totally enclosed, with double rotating friction discs. The two friction discs, which are splined to the bull pinion shafts, are located one on each side of an actuating plate assembly. The actuating plate assembly consists of two pressure plates having five ramped pockets in their inner faces in each of which is a steel ball. Three short helical springs are employed to hold the two actuating plates in contact with the balls and to act as actuating plate return springs.

Movement at the brake pedal is transferred by a pull rod and links to the actuating plates. The resultant rotation of the actuating plates in opposing directions causes the balls to ride up the ramps thus producing an axial movement of the plates, which introduces a braking effect by compressing the friction discs against the brake housing and cover (see Fig. 12).

When braking commences, the actuating plates tend to rotate under the action of the friction discs, but movement of one of the plates (depending upon the direction of rotation) will be limited by a stop within the brake housing. The other plate, however, will continue to rotate causing the balls to ride further up the ramps, thus increasing the braking effect.

Upon releasing the pressure on the brake pedal, the actuating plates return to their original position with the balls at the bottom of the ramps under the action of the actuating plate return springs. The friction discs are then free to rotate.

To ensure even braking when both brakes are applied, a compensating spring is provided in the operating linkage to each pedal.

In order that the radial movement of the actuating plate is maintained at a practical minimum to avoid distortion of the actuating linkage when braking commences, the lower stop within the brake housing is provided with a means of adjustment.

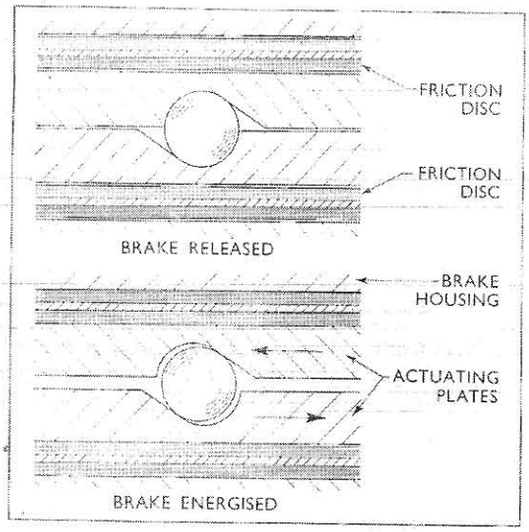


Fig. 12
Actuating Plate Operation

To Adjust the Brakes

1. Slacken the lock nut on the lower stop and tighten the adjusting screw (see Fig. 13) until the brake is fully locked.
2. Slacken off the screw one and a half turns and tighten the lock nut.
3. With the pedal return spring removed, adjust the pull rod nut (see Fig. 14) until the pedal just contacts the pedal upper stop. Slacken off the pull rod nut one and a half turns. This will give a pedal-free travel of 1.5 in. (38.1 mm) at the pedal pad or .81 in. (20.57 mm) at the pedal upper stop.
4. Connect the pedal return spring.
5. Operate the pedal and re-check the free travel, making further adjustment if necessary.
6. Repeat this operation for the other brake.

To Dismantle the Disc Brakes

1. Remove the bolts securing the platform to the platform support bracket and brake housing and remove the platform. Note that in the case of the left-hand brake it is also necessary to remove the clutch pedal retracting spring before removing the platform.
2. Disconnect the brake actuating levers by removing the split pins and clevis pins from both ends of the levers. Remove the levers.
3. Remove the seven bolts securing the brake housing cover to the brake housing and remove the cover.

   In the case of the right-hand brake, the brake housing cover and differential lock operating pedal are removed as an assembly. Further dismantling of this assembly will normally be necessary only if it is required to renew any part of the differential lock operating pedal assembly.
4. Withdraw the outer friction disc from the brake housing.
5. Remove the actuating plate assembly complete with links, operating rod and dust cover.
6. Withdraw the inner friction disc from the brake housing.
7. If necessary remove the brake housing taking care not to disturb the bull pinion housing and shims whilst carrying out this operation.

To Dismantle the Brake Actuating Plates Assembly

1. Remove the rubber dust cover and remove the bolts securing the links to the actuating plates. Note that the nuts are staked to these bolts during initial assembly.
2. Remove the three actuating plate return springs and separate the actuating plates. Remove the five steel balls.

To Reassemble the Brake Actuating Plates Assembly

1. Thoroughly clean and inspect all parts and renew any parts which may be damaged or worn.

   NOTE: DO NOT LUBRICATE EITHER THE STEEL BALLS OR THEIR SEATINGS IN THE ACTUATING PLATE.
2. Lay one actuating plate with its inner face uppermost on the bench and locate the five steel balls in their seatings.

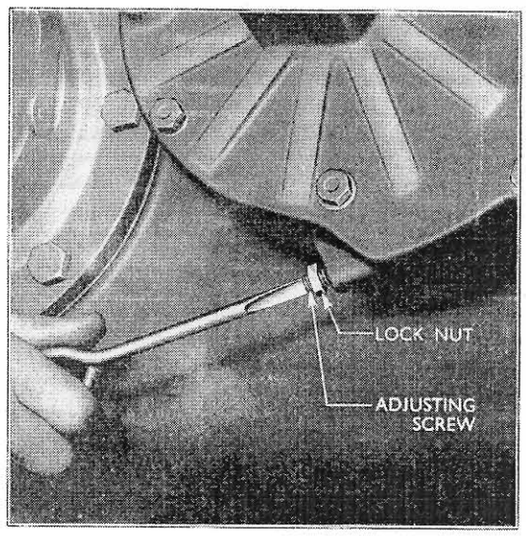


Fig. 13
Adjusting the Disc Brake

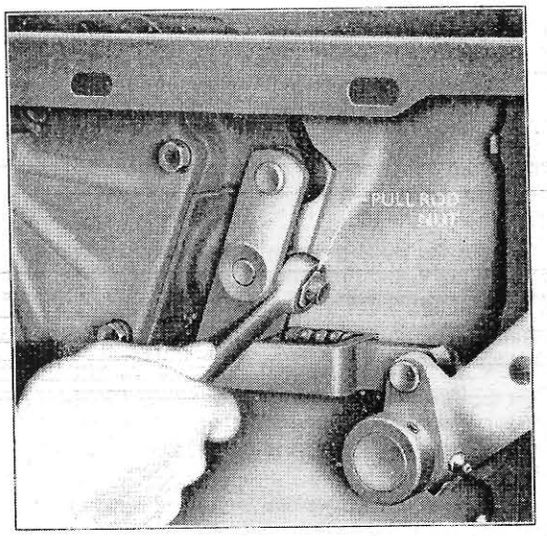


Fig. 14
Adjusting Pedal Free Movement

3. Locate the other actuating plate on top of the steel balls.

4. Fit the three actuating plate return springs ensuring that they are correctly located on the lugs on the inner edge of the actuating plates otherwise they may foul the bull pinion shaft when the assembly is refitted.

5. Replace the links and pull rod. Stake the nuts and bolts securing the links to the actuating plates.

To Reassemble the Disc Brakes

1. Check the oil seal in the brake housing for damage. If necessary replace the oil seal using Tool No. T.4085 with the 550 handle.

2. Replace the brake housing ensuring that the holes in the shims behind the flange of the bull pinion housing are in alignment with the holes in the rear transmission and bull pinion housings. Replacement of the brake housing is facilitated by using the bull pinion housing locating studs Tool No. PT.4063. Replace the six bolts to secure the housing in position and tighten to a torque of 55-65 lb./ft. (7.61-8.99 kg.m.).

3. Check the friction linings for excessive wear, scoring, cracking or loose rivets. Also check the brake discs for distortion, cracking and worn or damaged splines. Replace the inner friction disc.

4. Replace the actuating plate and pull rod assembly and fit the rubber dust cover, ensuring that the cover fits correctly into the recess in the housing.

5. Replace the outer friction disc.

6. Replace the brake housing cover ensuring that the rubber dust cover fits tightly against the cover. In the case of a right-hand brake, the cover and differential lock pedal are replaced as an assembly.

7. Connect the brake actuating lever to the brake housing and to the compensating spring yoke by replacing the clevis pins and split pins at both ends of the levers.

8. Replace the platform and in the case of the left-hand brake, the clutch pedal return spring.

9. Adjust the brakes as previously described.

To Remove and Dismantle the Brake Operating Linkage

1. Remove the split pin and clevis pin connecting the compensating spring rod to the brake pedal, or to the brake lever in the case of the left-hand brake.

2. Remove the split pin and clevis pin connecting the compensating spring yoke to the brake actuating levers and remove the rod and the yoke assembly.

3. Remove the pull rod nut and the split pin and clevis pin connecting the brake actuating levers to the brake housing. Remove the brake actuating levers and block.

4. Dismantle the compensating spring rod and yoke assembly by removing the self-locking nut and withdrawing the rod from the yoke, thus releasing the washer, compensating spring and sleeve.

To Reassemble and Replace the Brake Operating Linkage

1. Insert the compensating spring rod in the yoke and replace the sleeve, compensating spring and washer on the rod. Fit the self-locking nut and tighten to the point where the overall length of the compensating spring is 1.17 in. (29.72 mm).

2. Fit the block and pull rod nut to the pull rod and fit the actuating levers to the block.

3. Connect the actuating levers to the brake housing by fitting the clevis pin and a new split pin.

4. Connect the compensating spring rod and yoke assembly to the brake actuating levers and the brake pedal by fitting the clevis pins and new split pins.

5. Adjust the brakes as previously described.

To Remove and Dismantle the Brake Pedal Cross-Shaft

1. Drain the oil from the rear transmission housing or lower the oil level until it is below the brake cross-shaft.

2. Jack up the rear of the tractor and remove the right-hand rear wheel.

3. Disconnect the balance lever to clutch pedal rod at the clutch pedal end. Disconnect the compensating spring rod from the brake operating lever. Remove the clutch pedal return spring and stop bracket.

4. Remove the cotter securing the left-hand brake operating lever to the cross-shaft and remove the clutch pedal, brake operating lever and thrust washer from the cross-shaft.

5. Remove the split pin and clevis pin securing the brake locking catch pawl to the brake pedal stop bracket. Remove the brake pedal stop bracket.

6. Disconnect the brake pedal return springs and remove the pin connecting the brake pedal to the right-hand brake compensating spring rod and yoke assembly.

7. Remove the pin, retaining collar and washer and pull off the right-hand brake pedal. Remove the spacer washer which separates the inner and outer brake pedals.

8. Slacken the clamp bolt and remove the inner brake pedal. Extract the " Woodruff " key from the shaft and remove the thrust washer.

. Remove the brake cross-shaft withdrawing it towards the right-hand side. If worn or damaged, the cross-shaft oil seals should be removed and new seals fitted using Tool No. T.2004. Note that if necessary these seals may be replaced without removing the brake cross-shaft.

To Reassemble and Replace the Brake Pedal Cross-Shaft

1. Replace the brake cross-shaft making the assembly from the right-hand side.

2. Fit the thrust washer, clutch pedal and brake lever to the left-hand end of the cross-shaft and replace the cotter to secure the brake lever to the shaft.

3. Connect the clutch lever to balance lever rod to the clutch pedal, and the compensating spring rod to the brake operating lever.

4. Replace the clutch pedal return spring and the pedal stop bracket.

5. Fit the thrust washer and " Woodruff " key to the right-hand end of the cross-shaft and replace the inner brake pedal. Tighten the brake pedal clamp bolt.

6. Replace the spacer washer, outer brake pedal, washer and retaining collar. Fit the pin to secure the retaining collar. Check that there is not less than .015 in. (.38 mm) clearance between the inner thrust washer and the rear transmission housing to allow free movement of the pedals.

7. Replace the brake pedal return springs and the pedal stop bracket.

8. Replace the clevis pin and the split pin to secure the brake locking catch pawl.

9. Connect the compensating spring rod and yoke assembly to the pedal and adjust the brakes as previously described.

10. Replace the wheel and fill the rear transmission housing to the required level with the appropriate grade of oil.

ELECTRICAL SYSTEM

Basic principles of the electrical system on Major diesel tractors are fully covered in the Fordson Major Repair Manual but detail changes have occurred since the inception of the model and therefore this section will summarise the more important items affected.

BATTERIES

In 1956 two significant changes were made.

(a) Twin 6-volt batteries were fitted in place of the previous single 12-volt unit with the purpose of making handling easier. The total capacity of the battery unit was unchanged, but detail changes were made to the battery support and tray assembly. The change produced no problems from a service point of view apart from ensuring that the connections were correct, i.e., with the twin batteries the negative terminal on the right-hand battery is connected to the positive terminal on the left-hand battery, whilst the negative terminal of the left-hand battery is connected to the starter solonoid and the positive terminal of the right-hand battery to earth.

(b) Dry charged batteries were introduced for service.

Service instructions for this type of battery are contained on the battery label and have been fully covered in Service Letters on this subject. For convenience however these are repeated and particular attention is drawn to the instruction that these batteries should not be allowed to stand for more than two days after filling without receiving a charge.

Filling a Dry Charged Battery *(as used on Diesel Tractors)*

1. Fill each cell with electrolyte of the correct specific gravity (see Table 1) until the electrolyte is $\frac{5}{8}$ in. (15.8 mm.) above the tops of the separators. The electrolyte should be at a temperature preferably between 70° and 90°F. (21° and 32°C.).

The level in each cell will fall rapidly during the first few minutes following filling, and thereafter progressively at a much lower rate.

Allow the battery to stand for approximately ten minutes, then add electrolyte of the same specific gravity to bring it up to the correct level.

2. Approximately fifteen minutes after initial filling the battery should be ready for service.

Prolonged or unsuitable storage, also low ambient and battery temperatures may result in a longer standing period (up to two hours) being required to ensure sufficient output from the battery for starting a cold or stiff engine. Before installation and if the necessary time and facilities exist, it is beneficial to give a freshening charge for about four hours at the normal charging rate of 10 amps. and then check that all cells are gassing freely. The specific gravity should now approach that of a fully charged battery (see Table 1).

NOTE—If the battery is put into service after the date shown on the label, it should be dealt with as in paragraph 1 above, but a special charge must then be given at the normal charging rate prior to installation in the tractor. This charge should be continued until the voltage and specific gravity of all cells remain constant for five successive hourly readings with all cells gassing freely. The specific gravity of a normal fully charged battery is shown in Table 1.

3. If, owing to unforeseen circumstances, the battery is not put into service immediately after filling, the battery should not be allowed to stand for more than two days before receiving a charge

	Temperate Climates	*Tropical Climates*
Specific gravity of electrolyte for filling new batteries	1.260 (30° Baumé)	1.230 (27° Baumé)
Specific gravity of electrolyte at end of charge ...	1.270 to 1.285 (31° to 32° Baumé)	1.240 to 1.255 (28° to 29.5° Baumé)
Maximum permissible temperature of electrolyte during charge	110F°. (43.3°C.)	125°F. (51.7°C.)

Table 1

on or off a tractor. Before charging the battery check the electrolyte level in each cell.

4. The electrolyte levels and specific gravity should again be checked within a few days of going into service, and if necessary, the electrolyte levels topped-up.

General

After dry charged batteries have been initially filled and charged, it is possible they may remain idle. If so, they should receive a bench charge, preferably once per month, especially in hot climates.

It is important that a battery which has been processed for full dry charge shall be given a charge either on or off a tractor within two days after initial filling. Since there may be a delay in getting the battery into service after it has been filled with electrolyte, it is most desirable that the personnel responsible for filling arrange for the battery to be given a short charge of about four hours' duration in every case before despatch, as indicated on the label attached to each battery.

The dry charged characteristics of batteries slowly fall off with time; hence the limiting date stamped on the label. Such falling off in dry charge characteristics does not mean that a battery which has remained in stock after the expiry of the period given on the label will not have a perfectly normal life in service providing that it is given a sufficient charge before being fitted. It is, however, very much to the Dealer's advantage to see that dry charged batteries are taken from his stock in proper rotation, so that no batteries are kept in stock for excessive periods, and the need to give a lengthy charge before sending a battery out is avoided.

STARTER MOTOR

To facilitate service of the starter motor drive pinion and clutch assembly, all the detail parts of the assembly have been released for service and are available if the pinion and clutch assembly requires attention. This obviates the necessity for replacing the complete pinion and clutch assembly as required previously.

The multi-plate clutch in the pinion and clutch assembly is interposed between the armature shaft and the pinion and protects the starter motor from damage due to overloading should the engine backfire. The clutch is set to slip at a pre-set torque figure which is approximately three times the normal full starting torque of the starter motor.

The clutch also only allows torque to be transmitted from the starter motor pinion to the flywheel ring gear, and therefore, should the pinion be inadvertently held in mesh with the ring gear when the engine is running and the

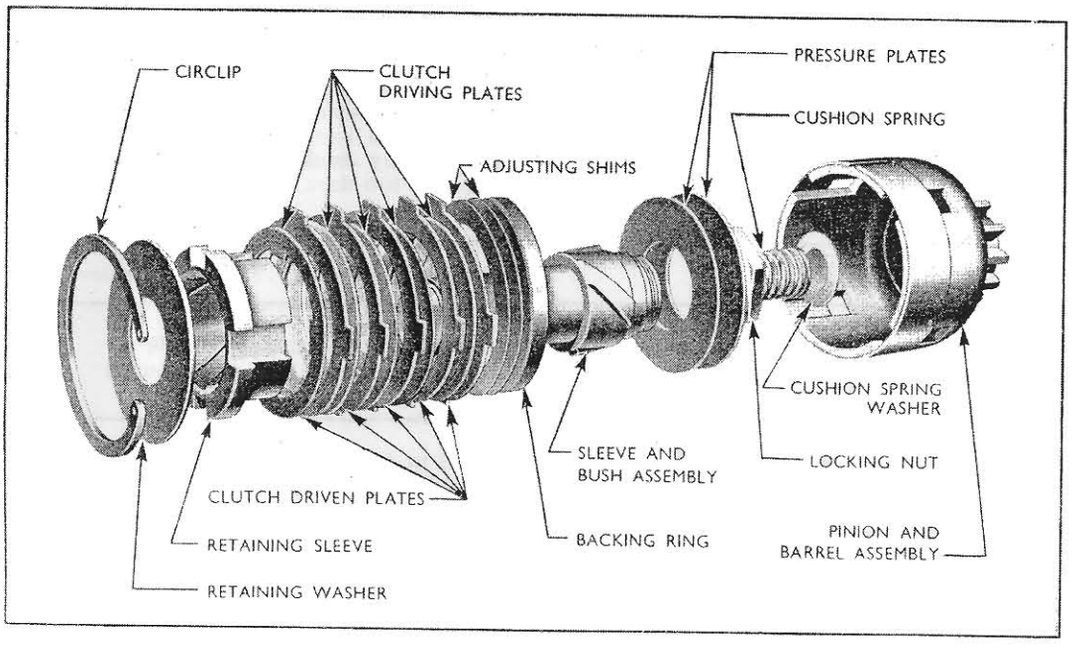


Fig. 1. Exploded View Pinion and Clutch Assembly

engine is tending to drive the starter motor, the clutch will "free-wheel" and no damage will occur to the starter motor

The clutch slipping torque is adjustable by means of shims interposed between the backing ring and the clutch plates (see Fig. 1), and after the clutch and pinion assembly has been overhauled, the slipping torque has to be re-set as detailed in subsequent paragraphs.

To Remove and Dismantle the Pinion and Clutch Assembly

1. Disconnect the battery lead from the negative post of the battery and the starter cable from the field terminal on the starter motor.

2. Disconnect the two leads from the starter relay switch.

3. Remove the split pin and clevis pin securing the operating rod to the starter actuating lever.

4. Unscrew the three starter motor securing bolts evenly and detach the starter motor.

5 Remove the four dowelled screws securing the relay switch bracket to the starter motor body and remove the bracket and cover.

6. Release the ends of the actuating lever return spring from under the flange in the drive housing.

7. Unscrew the nut from the actuating lever pivot bolt and remove the bolt.

8. Remove the return spring, two spacers and the two halves of the actuating lever from the drive housing, and reassemble them together to ensure correct positioning when reassembling the starter motor.

9. Remove the two through bolts securing the starter motor drive housing to the starter motor body and remove the drive housing.

10. Remove the thrust washer and slide the pinion and clutch assembly off the armature shaft.

11. Open the retaining cup securing the lock ring on the pinion and clutch assembly. (See Fig. 2.)

12. Depress the brake plate and remove the lock ring and retaining cup.

13. Remove the brake plate, operating bush and tension spring.

14. Remove the large internal circlip from the pinion and barrel assembly, and withdraw the sleeve and bush assembly complete with the clutch unit.

15. Remove the cushion spring and thrust washer from inside the pinion and barrel assembly.

16. The clutch unit can be completely dismantled by removing the retaining washer, retaining sleeve, clutch plates, adjusting shims and backing ring.

17. The nut retaining the two pressure plates is secured by peening and it should only be removed if the plates require renewing.

18. Clean all parts and inspect the pinion teeth and clutch plates for wear. Ensure that the clutch plates are free to move in their respective engagement splines. Check the cushion spring and tension spring for any signs of weakness.

Renew any parts that are worn or damaged in any way.

To Reassemble and Replace the Pinion and Clutch Assembly

1. If they have been removed, replace the pressure plates, fit the locking nut and secure by peening.

2. Replace the clutch plates on the retaining sleeve and refit this assembly with the adjusting shims and backing ring onto the sleeve and bush assembly. Care should be taken to ensure that the clutch plates are in the correct order (see Fig. 1) and that the ground face on the backing ring is adjacent to the adjusting shims. The clutch plates and helices on the inside of the retaining sleeve should be smeared with a thin coating of high melting point grease before assembly.

3. Fit the flat washer and cushion spring inside the pinion and barrel assembly so that they are positioned centrally over the pinion bearing bush.

4. Instal the clutch unit in the pinion and barrel assembly, fit the retaining washer and secure in position with an internal circlip.

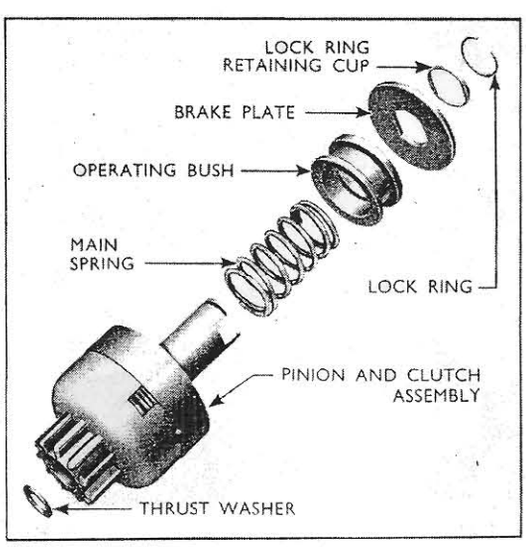


Fig. 2. Starter Motor Drive

5. Position the pinion and clutch assembly in a vice so that the pinion is securely clamped in soft metal vice jaws and the assembly is upright.

6. Using the special socket (Tool No. CT.9513) and a suitable torque wrench apply an anti-clockwise torque to the central sleeve of the assembly. (See Fig. 3.) The clutch should not slip until the torque applied is between 65 and 80 lbs. ft. (8.983 to 11.056 kg.m.).

7. If the clutch slips at below the minimum slip torque, dismantle the pinion and clutch assembly and add shims until the correct slip torque is obtained.

If the clutch slips at above the upper torque limit, dismantle the clutch and remove shims until the correct slip torque is obtained.

There are three thicknesses of shims available in thicknesses of .004 in. (.102 mm.), .005 in. (.127 mm.) and .006 in. (.152 mm.).

8. Replace the tension spring, operating bush and brake plate over the sleeve and bush assembly, and compress the tension spring.

9. Position a new lock ring retaining cup on the shaft and fit a new lock ring.

10. Release the pressure compressing the spring and close the outer edge of the retaining cup inwards over the lock ring.

11. Refit the pinion and clutch assembly to the armature shaft and refit the thrust washer.

12. Replace the starter motor drive housing, ensuring that the dowel is correctly located. Enter the two through bolts and spring washers and securely tighten.

13. Locate the lower half of the actuating lever in the groove in the operating bush with the thrust

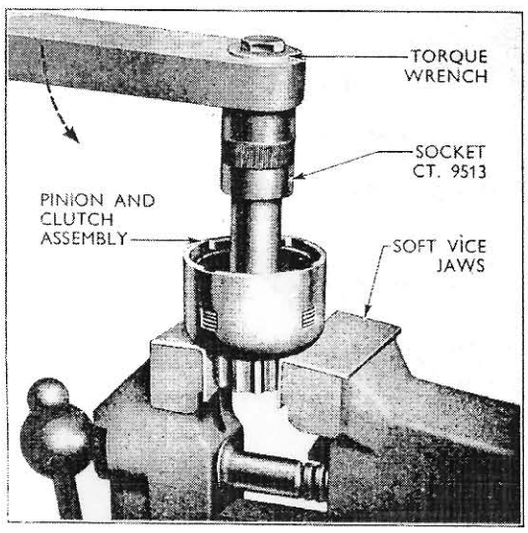


Fig. 3 Checking Slip Torque

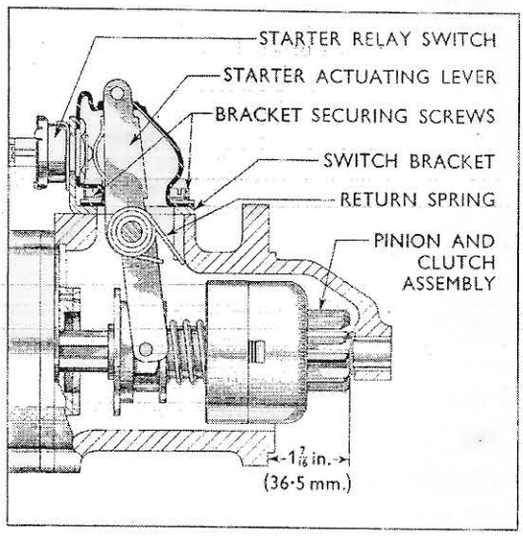


Fig. 4. Diesel Starter Actuating Mechanism in the Operating Position

shoes offset away from the pinion. Fit the upper half of the actuating lever with the plain face towards the pinion. Refit the return spring and two spacers with the loop in the spring downwards and away from the starter body, and enter the lever pivot bolt. Locate the spring ends in the housing behind the flange. The lever pivot bolt should be lightly smeared with high melting point grease before assembly in the housing.

14. Refit the spring washer and nut to the pivot bolt and tighten securely.

15. Refit the relay switch cover and switch bracket assembly, and enter the four dowelled screws.

16. Depress the actuating lever until the distance from the rear face of the pinion teeth to the starter motor mounting flange is $1\frac{7}{16}$ ins. (36.5 mm.) as shown in Fig. 4.

Adjust the relay switch plate until the contacts are just closed with the pinion at this setting. Securely tighten the retaining screws. Check that the contacts are closed by means of a battery and bulb.

17. Pass the drive end of the starter motor into the clutch housing aperture. Replace the three starter motor securing bolts and spring washers, and tighten evenly.

18. Refit the clevis pin and split pin securing the operating rod to the starter actuating lever.

19. Reconnect the two leads to the relay switch.

20. Reconnect the starter cable to the field terminal on the starter motor and the battery lead to the negative post on the battery.

VOLTAGE CONTROL REGULATOR

The regulator incorporates a combined cut-out and voltage regulator. Normally this regulator requires very little attention in service.

Should, however, it be suspected that it is not functioning correctly, tests should be made to ensure that the rest of the electrical circuits are in good condition and are not affecting the operation of the regulator.

Effective after approximate Engine No. 1426221 the design of the regulator was changed and although functionally identical the procedure for adjustment differs in detail. The latest adjustment figures for both types will therefore be covered in this section.

With the introduction of the Power Major the regulator was made more accessible by moving it from behind the control box to a mounting on the air cleaner bracket. (See Fig. 5.) At the same time it was enclosed in a separate metal dust cover.

PRELIMINARY CHECKS

Important points which can give a false indication of a regulator fault are given below, and should be carefully checked before attempting to effect any replacements.

Fan Belt

Make certain that the generator support brackets are securely tightened in position. Check the fan belt and ensure that it is adjusted correctly without the slightest suspicion of belt "slip." A slipping belt may cause an erratic or low charging rate. Ensure that the fan belt is correctly aligned and that the pulleys are not damaged.

Battery

Check the battery and test with a hydrometer and high rate discharge test-meter. Top up if necessary. Clean off any corrosion from the battery lugs and cable ends and make certain that the top of the battery is dry.

A sulphated battery or corroded lugs will cause a low output even though the open circuit setting of the regulator may be correct. Both these conditions will probably result in unsatisfactory starter motor operation.

If a battery has a short-circuited cell, or the top of the battery has become soaked with acid, or is in a poor condition due to abuse or prolonged service, it will cause a high output.

Check the earth connections from the battery to the body, and from the regulator, to ensure that they are tight and in good condition, as a poor earth will cause a rise in voltage.

Generator and Connections

Check that the generator is functioning satisfactorily and ensure that the leads "D" and "F" are not crossed either at the regulator or generator. If the leads are crossed, the regulator points will have 'welded together" the moment the engine was started. Make sure that the leads are not broken or damaged and that the connections are tight.

To Test the Generator

1. Disconnect the leads from the regulator terminals marked "D" and "F" respectively and connect them together. Attach the negative lead of a moving-coil type voltmeter, calibrated to at least 30 volts, to these leads and the positive lead to a good earth.

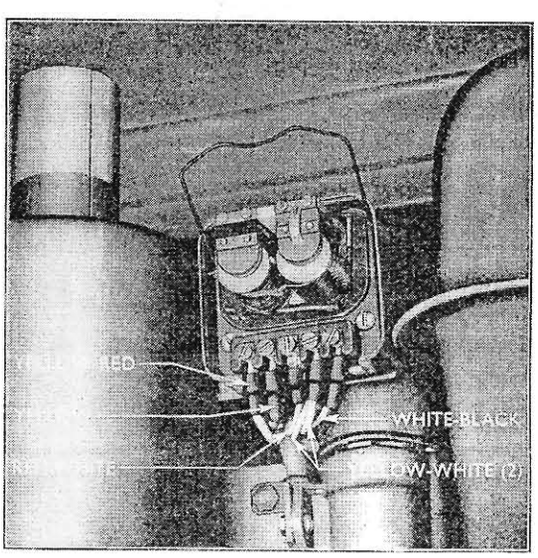


Fig. 5
Voltage Control Regulator (Current Type)

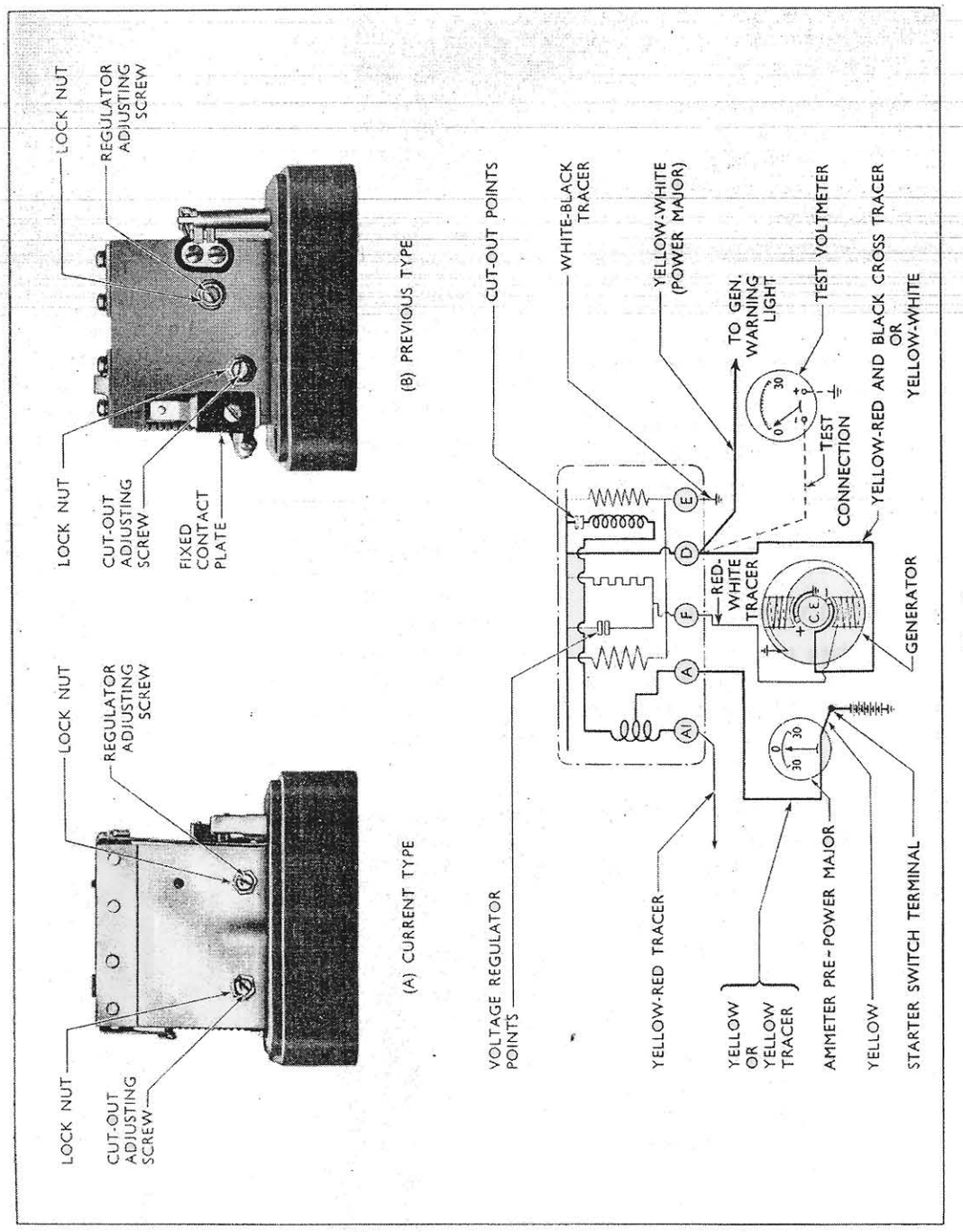


Fig. 6
Regulators and Wiring Diagram

2. Start the engine and gradually increase the speed to a fast idle (approximately 1,000 r.p.m.), when the voltmeter reading should rapidly rise without fluctuation above 24 volts. DO NOT increase the engine speed above a fast idle in an endeavour to obtain this voltage as this will give a false reading.

If there is a low or no reading, first check the generator leads. If the leads are in good condition, carefully check over the generator and effect any repairs that may be required in line with the usual procedure. It may be that the generator has become demagnetised, possibly due to the leads having been crossed (regulator points will be " welded " together in this case).

After checking that the generator is in good order, proceed to test the regulator. This should only be carried out by an experienced electrician who is thoroughly acquainted with the correct method to be adopted.

3. Reconnect the leads " D " and " F " from the generator to the terminals " D " and " F " on the regulator.

TESTING AND ADJUSTING THE REGULATOR

1. Insulate the cut-out points with a thin strip of mica or withdraw the cables from the terminals marked "A" and"A1" (see Fig. 6) and join them together.

2. Connect the negative lead of the test voltmeter to terminal " D " on the regulator and the positive lead to a good earth ,or the " E " terminal.

3. Adjustment must be made with the regulator cold, i.e. immediately on starting the engine the atmospheric temperature should be noted by means of a thermometer.

4. Start the engine and gradually increase the speed until the voltmeter needle " flicks " and then steadies (approx. 1,500 generator r.p.m.). This should occur at a voltmeter reading between the limits given below for the approximate temperature of the regulator unit.

Regulator Setting

Atmospheric Temperature	*Volts*	
	Current Type	*Previous Type*
50°F. (10°C.)	15.7 to 16.1	15.9 to 16.5
68°F. (20°C.)	15.6 to 16	15.6 to 16.2
86°F. (30°C.)	15.5 to 15.9	15.3 to 15.9
104°F. (40°C.)	15.4 to 15.8	15 to 15.6

If the reading is not between these limits the regulator is in need of adjustment.

5. Increase the speed gradually to maximum speed when the voltmeter needle should not rise more than half a volt above the tabulated readings.

If the voltmeter reading continues to rise as the engine speed is increased, possibly swinging the needle right over, it is indicative that either the regulator points are not opening or there is a poor or no earth between the regulator and the body.

If the points are not opening, the regulator should be renewed, as it is probable that they are " welded " or shorted, or there is an open circuit in the shunt coil.

6. If the voltage at which the reading becomes steady occurs outside these limits the regulator must be adjusted.

Shut off the engine and remove the cover. Slacken the lock-nut of the regulator adjusting screw (see Fig. 6), and turn the screw in a clockwise direction to raise the setting or in an anti-clockwise direction to lower the setting. Turn the screw only a fraction of a turn at a time and then tighten the locknut. Again run up the engine and repeat as above until the correct setting is obtained.

Adjustment of regulator open-circuit voltage should be completed within 30 seconds, otherwise heating of the shunt winding will cause false settings to be made.

A generator run at high speed on open circuit will build up a high voltage. Therefore, when adjusting the regulator, increase engine speed **slowly** until the regulator operates, otherwise a false setting may be made.

7. Reconnect the wires to terminals "A" and "A1 " or remove the insulation from the cut-out points.

Ampere Output Test

1. Connect a test ammeter in series with the lead "A" and terminal "A."

2. Speed up the engine and observe the changing rate. This will vary according to the state of charge of the battery.

To Clean the Regulator Points *(Current Type)*

These must be removed for cleaning, and this should be carried out as follows:—

1. Slacken the locknut securing the fixed contact and screw to its bracket. Unscrew and remove the fixed contact and screw.

2. Remove the two armature screws and locknuts (refer to Fig. 7) and detach the metal strip.

3. Move the fixed contact mounting over slightly, enabling the moving contact bracket to be lifted out. Take care not to lose the insulating strips positioned on either side of the fixed contact mounting strip.

4. Clean the contact points with a suitable cleaning fluid or carborundum paper operated in a circular movement. Carefully wipe away all traces of dirt or other foreign matter. Finally, wipe both points with methylated spirits (denatured alcohol).

5. Replace the points in the reverse sequence to that described above in paragraphs (1)to (3).

In the event of the regulator not functioning correctly after adjustment, re-examine the regulator contacts. Any pitting or dirt must be removed as a clean smooth surface is essential.

It is also possible that the control voltage will not be steady until the points have " bedded in " properly and the air gaps may require adjustment as described below.

To Clean the Regulator Points *(Previous Type)*

1. Remove the screws securing the plate carrying the fixed contact to render the regulator contacts accessible for cleaning. (See " B " Fig. 6.)

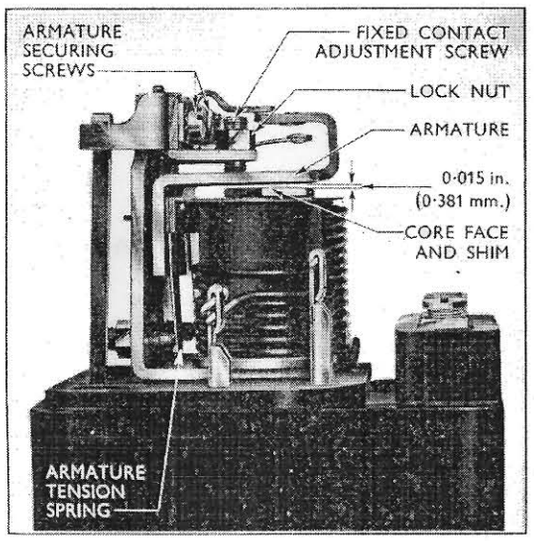


Fig. 7

Voltage Regulator Coils *(Current type)*

The plate was secured by two screws on early units of this type, but on later units the upper screw was replaced by a peg.

2. Remove the moving contact. (Two screws.)

3. Clean the contact points with carbon tetrachloride or carborundum paper operated in a circular movement. Carefully wipe away all traces of dirt or other foreign matter.

4. Wipe both points with alcohol, assemble the fixed contact and tighten the screw or screws securely and then replace the moving contact.

Resetting the Regulator Armature

The armature or moving contacts should not normally be removed, as the air gaps between the core and the frame are accurately set and are of great importance to the satisfactory operation of the regulator. If, for any reason, however, the armature has been removed or its setting altered, it should be reset as follows:—

Current Type Regulator

1. Disconnect the battery.

2. Slacken the fixed contact screw locknut and unscrew the contact screw until it is clear of the armature moving contact. (Refer to Fig. 7.)

3. Slacken the regulator adjusting screw locknut and unscrew the adjusting screw until it is completely clear of the armature tension spring.

4. Slacken the two armature assembly securing screws. Using a 0.015 in. (0.381 mm.) feeler blade, wide enough to cover the complete core face, insert the blade between the armature and core shim, taking care not to damage or burr the edge of the shim.

5. Press the armature **squarely** down against the blade and, holding it firmly, retighten the two armature assembly securing screws.

6. With the blade and armature still in the above position, screw the adjustable contact down until it just touches the armature contact. Re-tighten the locking nut.

7. Reset the regulator adjusting screw as described in " Testing and Adjusting the Regulator."

8. Reconnect the battery.

If the contact points are found to be badly worn, replace the regulator.

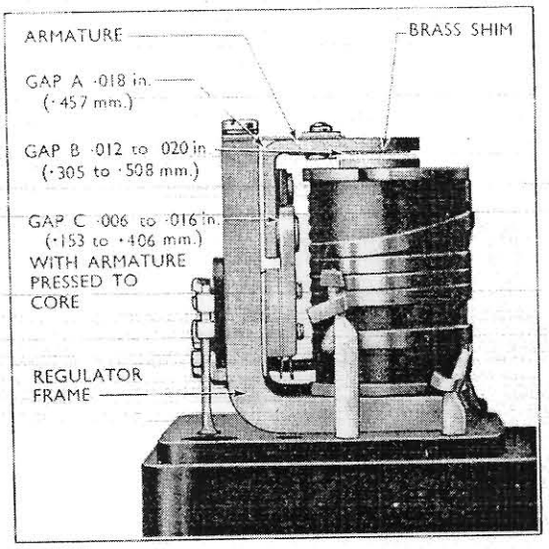


Fig. 8
Voltage Regulator Coils *(Previous Type)*

Previous Type Regulator

1. Slacken the two screws securing the armature to the regulator frame.

2. Insert an 0.018 in. (.457 mm.) feeler gauge between the armature and the frame (gap A, Fig. 8) and an 0.020 in. (.508 mm.) feeler gauge between the armature and the core of the bobbin (gap B, 0.012 in. to 0.020 in.). Press the armature firmly against both gauges and tighten the two screws securing the armature to the regulator frame.

3. Remove the gauges, press down the armature on to the core and check the gap C of the contact points.

This should be between 0.006 and 0.016 in. (.153 and .406 mm.) and may be adjusted either by increasing or decreasing the number of .005 in. (.127 mm.) thick shims located between the contacts and the packing plate. Do not allow the shims to "short" to the back frame.

4. Tighten the screws securing the fixed contact after making any shim adjustment and re-check the gap.

THE CUT-OUT

Examine the cut-out points and, if necessary, clean with carbon tetrachloride or carborundum paper. Ensure that the points are meeting correctly.

To Test and Adjust the Cut-out

1. Connect the voltmeter between the "D" terminal and a good earth, or the "E" terminal.

2. Speed up the engine slowly and note the voltage immediately before the points close.

This voltage should be 12.7 to 13.3 volts. The voltage may be adjusted by slackening the locknut and turning the cut-out adjusting screw (see Fig. 6), in an anti-clockwise direction to decrease the voltage and vice versa. Turn the adjusting screw a little at a time, tighten the locknut and re-test as above.

Resetting the Cut-out Armature *(Current Type)*

It is suspected that the above setting is incorrect and the cut-out points setting has been disturbed, proceed as follows :—

1. Slacken the adjusting screw locknut and unscrew the cut-out adjusting screw until it is clear of the armature tension spring.

2. Slacken the two armature securing screws.

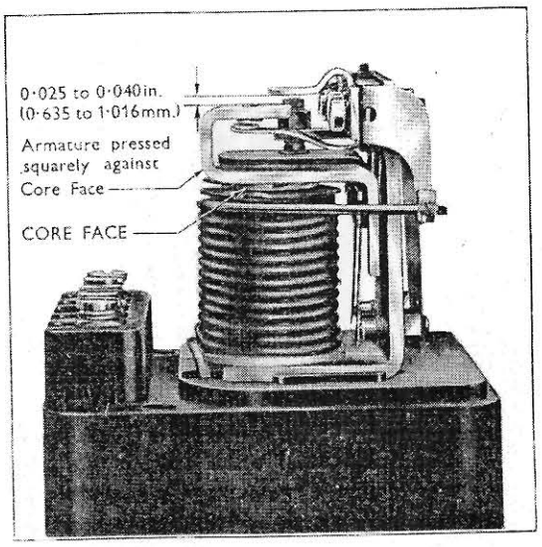


Fig. 9
Cut-out Points *(Current Type)*
(Setting Armature Stop Arm)

3. Press the armature down **squarely** against the copper-coated core face and, holding it there, retighten the armature securing screws.

4. Still holding the armature down against the core, bend the armature stop arm so that a gap of 0.025 to 0.040 in. (0.635 to 1.016 mm.) exists between it and the armature tongue (see Fig. 9).

5. Insert the end of a 0.010 to 0.020 in. (0.254 to 0.508 mm.) feeler blade between the outer end of the armature and core face, and set the fixed contact, by bending the arm, so that the points are **just** touching (see Fig. 10).

6. Reset the cut-out adjusting screw as described in "To Test and Adjust the Cut-out."

Resetting the Cut-out Armature *(Previous Type)*

For general setting purposes, slacken off the cut-out adjusting screw (see Fig. 6) fully and the two screws on the regulator frame. Place a feeler in gap "A" (0.011 in. – 0.015 in. : .28 – .381 mm. and gap "C" (0.014 in. : .356 mm.). Refer to Fig. 11. Press the armature on both feeler gauges and tighten the two regulator frame screws.

Remove the feeler from gap "C" and with the feeler in gap "A" still in position, press down the armature and adjust gaps "B" and "D" (0.030 in. – 0.034 in. : .772 – .863 mm. and 0.002 in. – 0.006 in. : .051 – .152 mm. respectively). Remove the gauges and readjust the voltage as described in "To Test and Adjust the Cut-out".

Ensure that the points close before the armature touches the core of the bobbin.

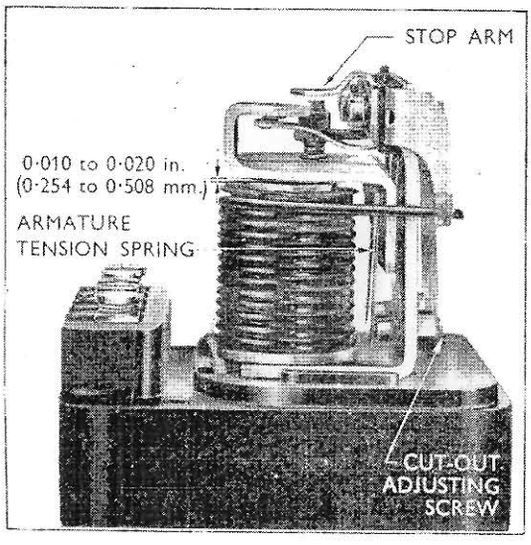


Fig. 10
Cut-out Point *(Current Type)*
(Setting the Fixed Contact)

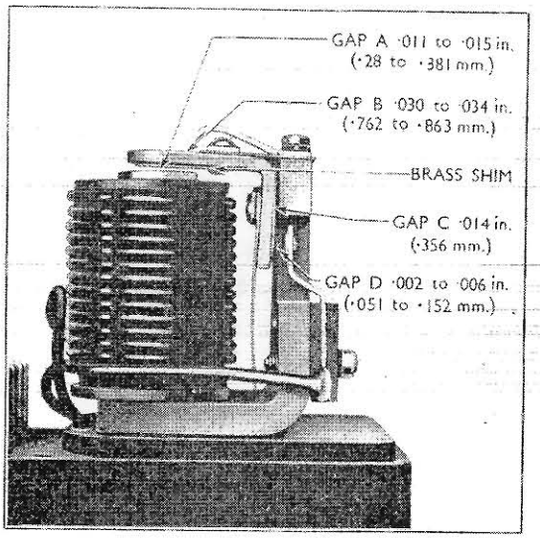


Fig. 11
Voltage Control Regulator Cut-out Coils
(Previous Type)

POWER MAJOR INSTRUMENT LAYOUT

With the introduction of the Power Major the ammeter and oil pressure gauge where deleted in favour of warning lights for generator charging and engine oil pressure. These lights are incorporated, together with a water temperature gauge, in a combined instrument situated in a new design of panel located directly below the steering wheel.

Changes were also made at this time to the main wiring loom which was re-routed from the right to the left-hand side of the engine.

To Replace a Warning Light Bulb

1. Remove the steering wheel and throttle control lever and extract the grease nipple from the top end of the steering column.

2. Remove the three screws retaining the instrument panel assembly to the steering column bracket.

3. Lift the panel assembly and release the two thumb screws retaining the temperature and warning light gauge to the panel.

4. Draw the gauge upwards away from the panel and extract the warning lights and holders from the rear of the gauge.

5. Remove the bulbs and renew as necessary.

6. Reverse the dismantling procedure to effect replacement.

AUTOMATIC PICK-UP HITCH

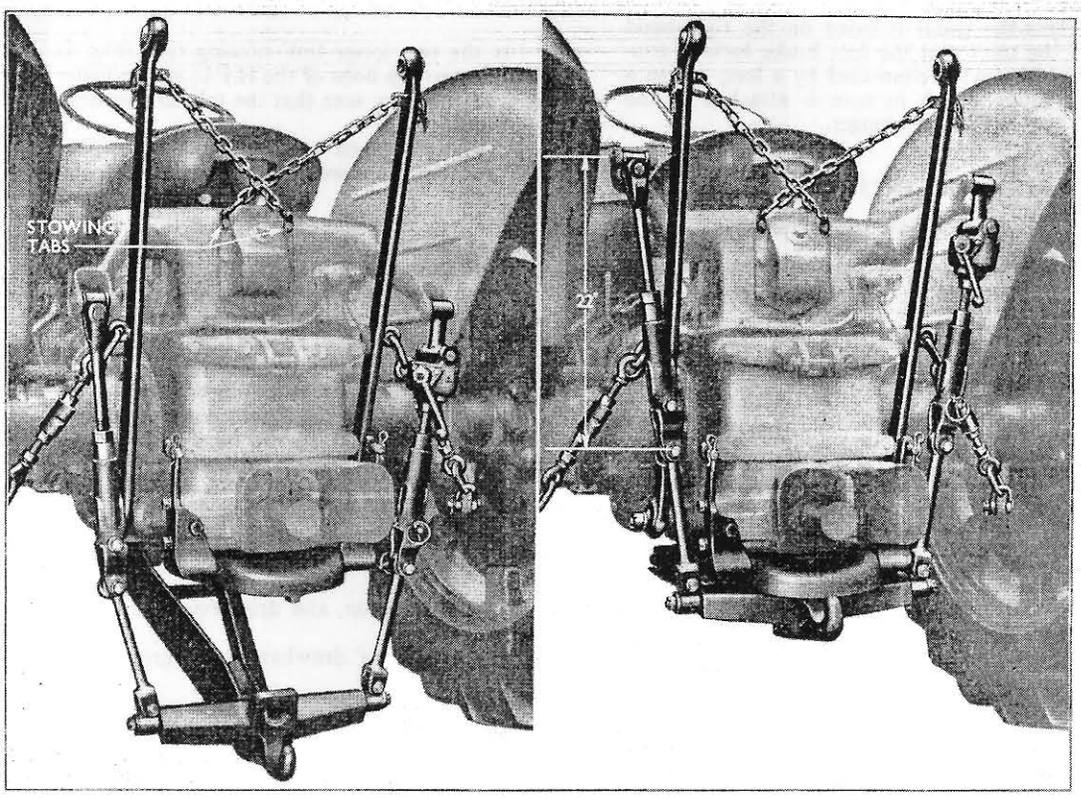


Fig. 1
Hitch in Lowered Position

Fig. 2
Hitch Locked in Raised Position

A hydraulically-operated pick-up hitch installation is available as optional equipment on current production Power Major Tractors with H.P.L. (hydraulic power lift) and may also be fitted as an accessory to earlier 4 cyl. O.H.V. Fordson Major tractors.

The existing drawbar and upper link must be removed before the hitch can be fitted, but all other equipment remains on the tractor, provision being made for stowage of the H.P.L. lower links. If so desired the P.T.O. (power take-off) or raised P.T.O. may still be used, although a new P.T.O. idler gear shifter lever will be required for the raised P.T.O. if the pick-up hitch is fitted to early models.

In the operating position (i.e. with trailer attached) the hitch hook is retained in position by a spring-loaded plunger which is connected by suitable linkage to a foot pedal, the operation of which withdraws the plunger when it is desired to uncouple the trailer.

COMPONENT PARTS

The pick-up hitch installation consists of three sub-assemblies. (See Fig. 6.)

1. The hitch housing and supporting bracket sub-assembly:—right- and left-hand supporting brackets are used which are dowelled to the hitch housing and bolted to the rear lower corners of the transmission housing. The hitch housing contains the spring-loaded locking plunger.

2. The hitch frame and hook sub-assembly:—the frame is of triangulated construction and is bolted to the hitch hook. The assembly is connected through the medium of hitch lift rods to the normal H.P.L. lift rods, and is pivoted at the front end on the existing drawbar anchor bracket.

3. The foot pedal and operating linkage assembly:—the pedal is fitted on the right-hand side of the tractor at the foot brake locking control location and is connected by a long rod to a pivoted lever, which in turn is attached to the spring-loaded locking plunger.

FITTING INSTRUCTIONS

To build up the sub-assemblies

Hitch Housing and Supporting Bracket Sub-Assembly

1. Locate the two supporting brackets with their locating dowels in the appropriate drillings in the hitch housing assembly.

Note—The brackets are "handed" and must be assembled with the hitch lift rod stowing pins facing away from the plunger locking device. (See Fig. 4.)

Hitch Frame and Hook Sub-Assembly

1. Bolt the frame assembly to the hook assembly using two bolts (45812-S), two spring washers (34813-S) and two nuts (34674-S), ensuring the hook assembly is fitted the correct way round. (See Fig. 6.)

2. Assemble the lift rod knuckles to the link pins at either end of the hook assembly and secure with flat washers (118326-ES7) and slotted nuts (33987-S). Fully tighten nuts and retain with split pin ($\frac{1}{8}$ in. by $1\frac{3}{8}$ in.).

3. Fix the hitch lift rods to each of these knuckles using clevis pins (74039-S7/S8), retained by split pins ($\frac{1}{8}$ in. by 1 in.).

Hitch Foot Pedal and Operating Linkage Assembly

1. Assemble the foot pedal to its bracket, using the swivel pin. (See Fig. 6.) Retain the pedal to the swivel pin with groove pin (72275-S).

2. Attach the fixed clevis of the rod and yoke assembly to the foot pedal with clevis pin (73919-S). Secure with a split pin ($\frac{1}{8}$ in. by $\frac{3}{4}$ in.).

3. Adjust the length of the rod and yoke assembly, by loosening the locknut and turning the clevis to give a measurement of $22\frac{1}{8}$ .ins. between the centres of the clevis eyes.

4. Tighten up the locknut.

Fitting Pick-up Hitch

1. Disconnect upper link of three-point linkage, by removing the linch pin.

2. Adjust H.P.L. lift rods to equal lengths (22 ins.) ensuring that the lift rods are in the fixed position.

3. Fix the two lower link stowing tabs (Fig. 1) under the two top bolts of the H.P.L. ram cylinder rear cover, making sure that the tabs are vertical.

4. Remove the linch pins retaining the H.P.L. lifting rods to the lower links of the three-point linkage.

5. Cross the two lower link safety chains and attach them to the stowing tabs. (See Fig. 1.) Adjust the check chains so that the safety chains hold the lower links tightly in position, and provide clearance for the H.P.L. lift arms to operate.

Where heavy duty check chains are fitted it will be necessary to move the inner ends of the check chains from the outer to the inner holes in the lower links.

6. Remove the screw and retaining plate holding the drawbar fulcrum pin to the drawbar front anchor bracket.

7. Support drawbar, and drive out fulcrum pin.

8. Lower front of drawbar to the ground.

9. Remove the drawbar guide bracket linch pins, and lower the drawbar to the ground.

10. Remove the drawbar guide brackets, by withdrawing the four securing bolts.

11. Extract the blanking plugs that protect the two threaded holes, at the bottom rear face of the rear transmission housing.

12. Fix the hitch housing and supporting bracket sub-assembly to the rear transmission housing, locating four bolts (21062-S) in the tapped holes used for the drawbar guide brackets, and two larger bolts (45754-S) in the two tapped holes previously protected by the blanking plugs.

13. Offer up the hitch frame and hook sub-assembly to the tractor, and secure the open end of the frame to the drawbar anchor bracket, using the same fulcrum pin as was previously used on the drawbar.

Fit the fulcrum pin retaining plate, securing screw and spring washer.

Note.—In a case where the drawbar attachment has not been fitted as original equipment, it will be necessary to fit a drawbar anchor bracket. Enter the drawbar anchor bracket dowel in its location at the bottom of the rear transmission housing. Locate the drawbar anchor bracket on this dowel and secure with four bolts (21062-S) and spring washers (34810-S).

14. Lift the hook assembly, and secure the lift rods to their appropriate H.P.L. lift rods with the two linch pins normally used to hold the lower links in position on the H.P.L. lift rods.

15. Remove the nut that secures the brake pedal locking control to the transmission case. To remove the securing bolts it will be necessary to disconnect the brake pedal locking control from the brake pedal pawl by removing the retaining split pin. If a transmission hand-brake is fitted, the hand-brake sector will also have to be removed.

16. Install the pick-up hitch release pedal and operating linkage assembly as shown in Fig. 3, using a long bolt (20547-S) in the top locating hole and a shorter bolt (20543-S) in the lower. Both bolts must be entered from the front, to ensure that they do not foul the foot pedal locking control, and are secured by the same size nuts (34671-ES).

17. Attach the rod and yoke assembly to the locking plunger release lever, using clevis pin (73919-S).

18. Secure the clevis pin with an appropriate size split pin.

To Change from Automatic Pick-up Hitch to Three-Point Linkage

1. With the hook assembly locked to the housing assembly, i.e. fully raised position, remove the hitch lifting rod linch pins and disconnect the rods. Stow the rods on their appropriate pegs on the hitch housing bracket assemblies using the "hair pin" clips provided to retain them in position. (See Fig. 4.)

2. Loosen the lower link check chains, and remove the safety chains from their stowing tabs.

3. Attach the lower links to the H.P.L. lift rods with the linch pins previously used to retain the pick-up hitch lift rods. Where heavy duty check chains are fitted move the inner end to the outer holes in the lower links.

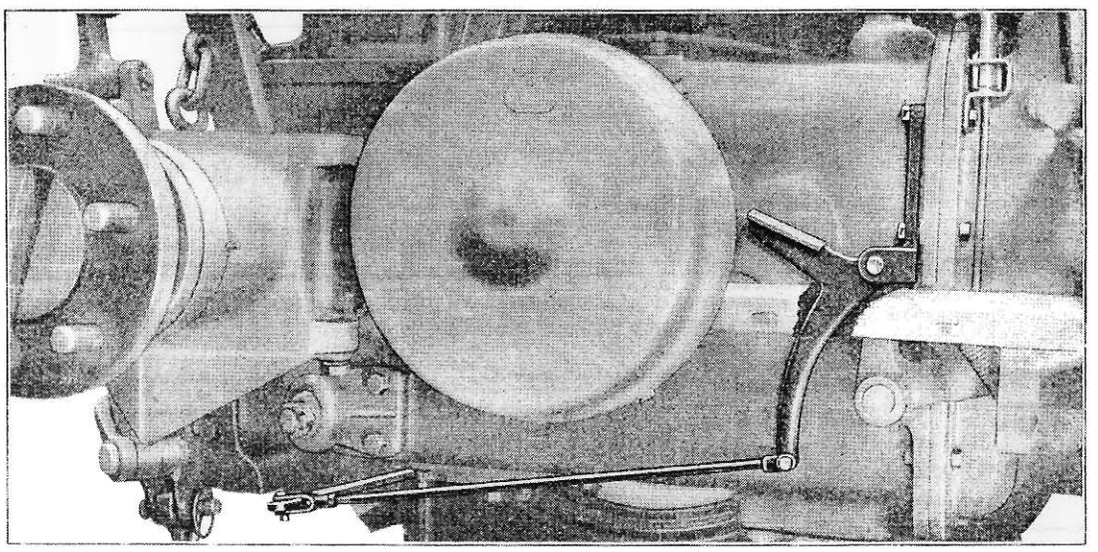


Fig. 3
Hitch Foot Pedal, Bracket and Operating Linkage

HITCH HOUSING

Dismantling the Locking Plunger (see Fig. 5)

1. Insert a suitable wedge in front of the plunger to relieve the spring load on the clevis pin (release lever to plunger).

Remove the clevis pin and release the wedge.

2. Unscrew the two retaining screws (20345-S) and lift off plunger sleeve retaining plate.

3. The plunger sleeve, plunger and spring can now be removed from the housing assembly.

4. Thoroughly clean all the component parts and renew if necessary.

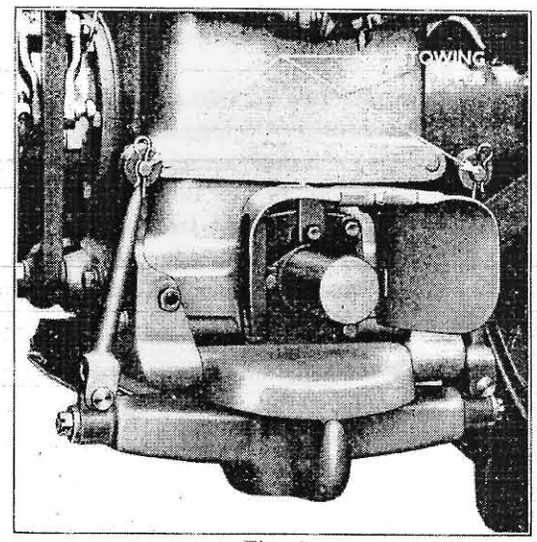


Fig. 4
Lift Rods in Stowed Position

Assembling the Locking Plunger

1. Fit the locking plunger and spring in the bore, and pack with grease.

2. Press in the plunger sleeve and fit the retaining plate. Secure with two screws and spring washers.

3. Compress the plunger spring, place the release lever in the plunger slot and insert the clevis pin. Retain the clevis pin with a split pin.

Maintenance

There is a grease nipple on the underside of the plunger housing assembly through which grease should be added every 200 hours.

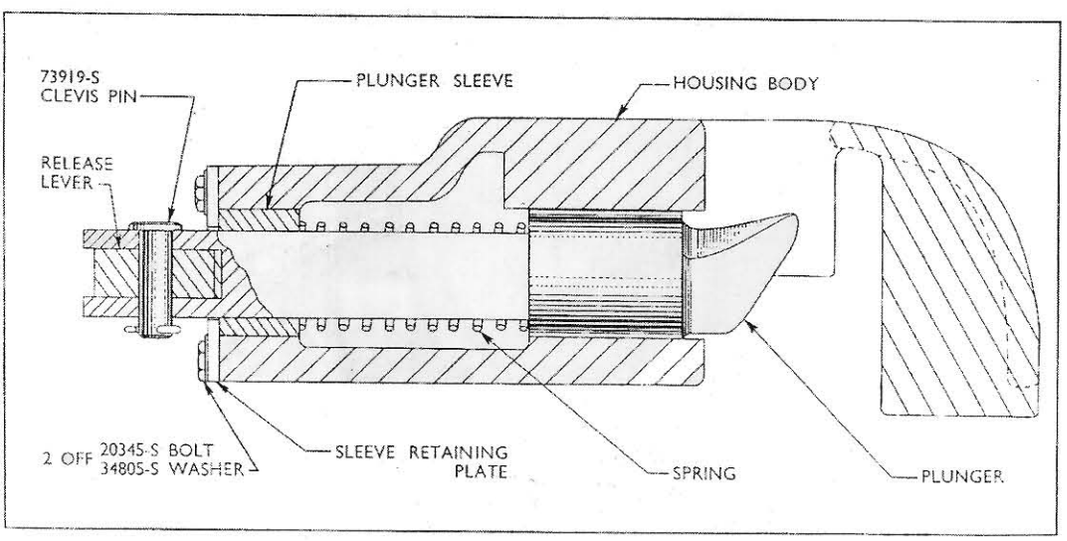


Fig. 5
Sectioned View of Locking Plunger

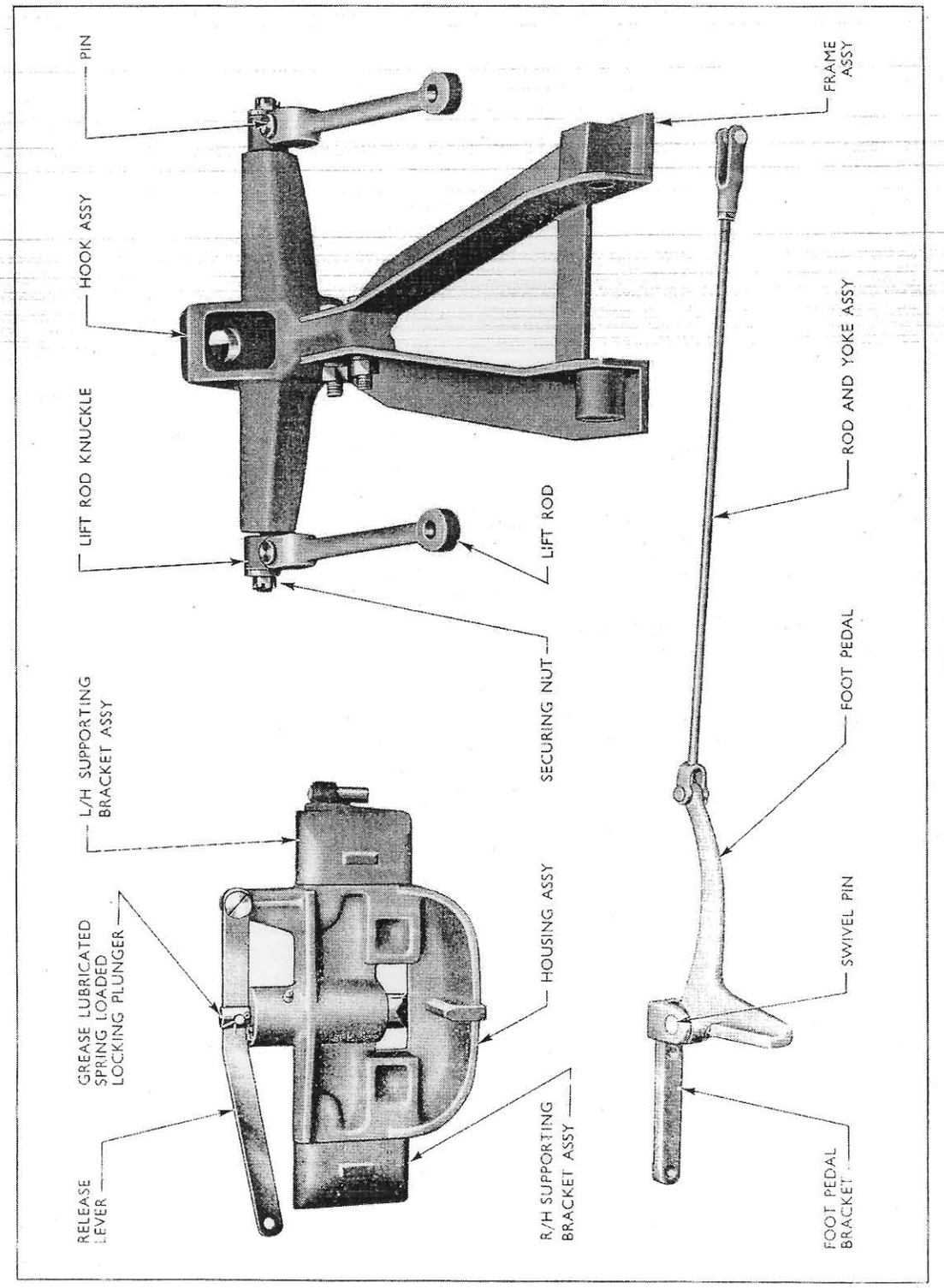


Fig. 6
View of Main Components

LIST OF TOOLS USED IN THE FORDSON MAJOR REPAIR MANUAL SUPPLEMENT

Current Number	Previous Number	DESCRIPTION
Diesel Engine		
Tr/NMD 27	Tr/NMD 27	Tractor dismantling stand (Field service kit)
200A	200	Engine stand
335	335	Connecting rod alignment arbor
336	335 F1	Connecting rod alignment arbor adaptors
512	512	Piston pull scale
550	550	Oil seal driver handle
T. 3007	Tr2/NMD 3004	Front axle wedge tool
CT. 6003	TTr/D 6004	Engine lifting brackets
CT. 6005	TTr/D 6005	Engine bracket
CT. 6006	—	Engine bracket
CT. 6024	TTr/DDK 6153	Piston ring squeezer
CPT. 6040	ATTr/MVMD 6306A	Crankshaft gear remover
CT. 6069	TTr/D 6306B	Crankshaft gear replacer
CT. 6070	TTr2/D 6312A	Crankshaft pulley remover
CT. 6071	TTr/D 6319	Engine turning bar
CT. 6072	TTr2/D 6362B	Crankshaft front oil seal replacer
CT. 6073	TTr/D 6510AB	Valve guide remover and replacer
CT. 6073-1	TTr/D 6510AB (details 1, 4, 7, 8, 17, 18 & 19 only)	Valve guide remover and replacer (adaptors)
CT. 6074	TTr/D 6513	Valve spring compressor
CT. 6075	TTr2/D 6055A	Cylinder sleeve remover
CT. 6076	TTr/MD 6050	Cylinder head locating studs
CT. 6085	TTr3/D 66608AB	Auxiliary drive shaft bearings remover and replacer (Main Tool)
CT. 6085-3	TTr3/DD 66608AB	Auxiliary drive shaft bearings remover and replacer (adaptors)
CT. 6086	TTr2/D 66610B	Auxiliary drive shaft oil seal replacer
T. 7000	Tr/D 7006	Bearing remover and replacer (Main Tool) — For use on tractors with power assisted steering
T. 7000-17	—	Water pump overhaul kit (adaptors) — For use on tractors with power assisted steering
T. 7024	Tr/D 7563	Clutch plate locator
CPT. 7061	AT2/U 7600B	Clutch pilot bearing replacer
7600	7600	Clutch pilot bearing remover (Main Tool)
CPT. 7600-3	AT4/U 7600A	Collet for use with 7600 Main Tool
CPT. 8000	ATTr/DHT 8501	Water pump overhaul tool (Main Tool)

Current Number	Previous Number	DESCRIPTION
CPT. 8000-2	ATTr/DHT 8501 Codes 1, 2, 3	Water pump overhaul adaptors
CPT. 8000-3	ATTr/DHT 8501 Codes 4, 5 & 6	Water pump overhaul adaptors
Fuel System		
550	550	Oil seal driver handle
7065-D	7065-D	Circlip pliers
CT. 6085	TTr3/D 66608AB	Pump camshaft bearing remover and replacer (Main Tool)
CT. 6085-1	TTr/DD 993203AB1	Pump camshaft bearing remover and replacer (adaptors)
CT. 9001	Tr4/DD 993100	Fuel pump cleaning pipe
CT. 9004	Replaces TTr/DD 993187A	Pump flange remover
CT. 9008	TTr2/DD 993228	Delivery valve holder wrench
CT. 9009	TTr2/DD 993191	Nozzle nut socket
CT. 9014	TTr3/DD 993157	Fuel injector cleaning kit
CT. 9015	TTr/DD 993817	Pump coupling flange holding wrench
CT. 9017	Supersedes TTr/D 993201	Camshaft end float gauge and anvil
CT. 9017-1	—	Camshaft end float gauge (adaptors)
CT. 9018	TTr/DD 993203A2	Pump camshaft bearing cup remover
CT. 9019	TTr/DD 993203B2	Pump camshaft bearing cup replacer
CT. 9021	TTr/DD 993211	Fuel pump control rod setting gauge
CT. 9022	TTr/DD 993227A	Delivery valve guide remover
CT. 9023	TTr/DD 993228	Pump spill pipe
CT. 9024	TTr/DD 993149	Nozzle reverse flush adaptor
T. 9047	—	Governor hub remover } Mechanically governed fuel injection pumps only
T. 9048	—	Camshaft nut wrench } Mechanically governed fuel injection pumps only
T. 9049	—	Governor spring adjuster } Mechanically governed fuel injection pumps only
NOTE—If CT. 9000 (TTr/DD 993100) calibrating machine is used, the following adaptors are required for use on mechanically governed fuel injection pumps.		
CT. 9000-2	—	Universal coupling
CT. 9000-4	—	Coupling and shaft assembly
"Live" Power Take-off		
CT. 6076	TTr/MD 6050	Locating studs
T. 7000	Tr/D 7006	Bearing remover and replacer (Main Tool)
T. 7000-6	Tr2/D 7006-6	Live P.T.O. input shaft bearing and oil seal replacer (adaptors)
T. 7000-7	Tr2/D 7006-7	Live P.T.O. main drive shaft spigot bearing replacer (adaptors)

Current Number	Previous Number	DESCRIPTION
T. 7000-8	Tr2/D 7006-8	Live P.T.O. input shaft bearing and oil seal remover (adaptors)
T. 7000-27	—	P.T.O. idler gear needle roller bearing replacer
T. 7015	Tr/D 7118A1	Transmission shaft small bearing cone remover (Main Tool)
T. 7015-1	Tr/D 7118A1	Transmission shaft small bearing cone remover (adaptors)
T. 7015-2	Tr2/D 7118A1	Primary lower shaft bearing inner race remover (adaptors)
T. 7016	Tr/D 7118A2	Transmission shaft small bearing cup remover
T. 7017	Tr/D 7118B2	Transmission shaft small bearing cup replacer
T. 7026	Tr/D 77012	Dummy end plate
T. 7028	Tr/D 77105	Primary upper shaft dog-nut wrench
T. 7030	Tr/D 85GA	Primary upper shaft gear locking nut wrench
T. 7031	Tr/D 89GE	Live P.T.O. input shaft oil seal replacer
T. 7502	7502	Double clutch assembly fixture
T. 7502-1	7502-1	Double clutch spring compressor
T. 7502-2	Tr/D 7502	12 in. double clutch adaptors
T. 7094	—	Live P.T.O. transmission main drive shaft oil seal replacer
Rear Axle		
T. 4062	Tr/MD 4235	Drive pinion bearing pre-load gauge
PT. 4063	Tr/MD 4301	Bull pinion housing locator studs (pairs)
T. 4065	Tr/NMD 4612	Final reduction gear nut wrench
Hydraulics		
T. 8503	Tr1/MD 994675	Pressure gauge
T. 8503-1	—	Hydraulic pressure testing equipment (used with T.8503)
Power Assisted Steering		
T. 3033	—	Piston rod bearing "O" ring protector (four-wheeled tractors)
CT. 3055	—	Piston rod bearing gland seal replacer
CT. 3067A	—	Ball cup spanner (CT.3067 can be converted)
CT. 3068A	—	End cover and lock rings spanner (CT.3068 can be converted)
CT. 3069	—	Piston rod bearing "O" ring protector (tricycle tractors).
Vacuum Braking Equipment		
CPT. 4000	F4221	Exhauster rotor shaft bearing remover (Main Tool)
CT. 4000-21	TTr2/DD 43FGA	Exhauster rotor shaft bearing remover (adaptors)

Current Number	Previous Number	DESCRIPTION
CT. 6066	TTr/D 41FGB	Exhauster rotor shaft collar oil seal guide
CT. 6067	TTr/DD 43FGB	Rotor shaft support bearing replacer
CT. 6068	TTr/D 58FGB	End cover oil seal replacer
CT. 9020	TTr/DD 993207	Fuel pump end cover protecting sleeve
Electrical		
CT. 9513	—	Starter motor driving sleeve socket