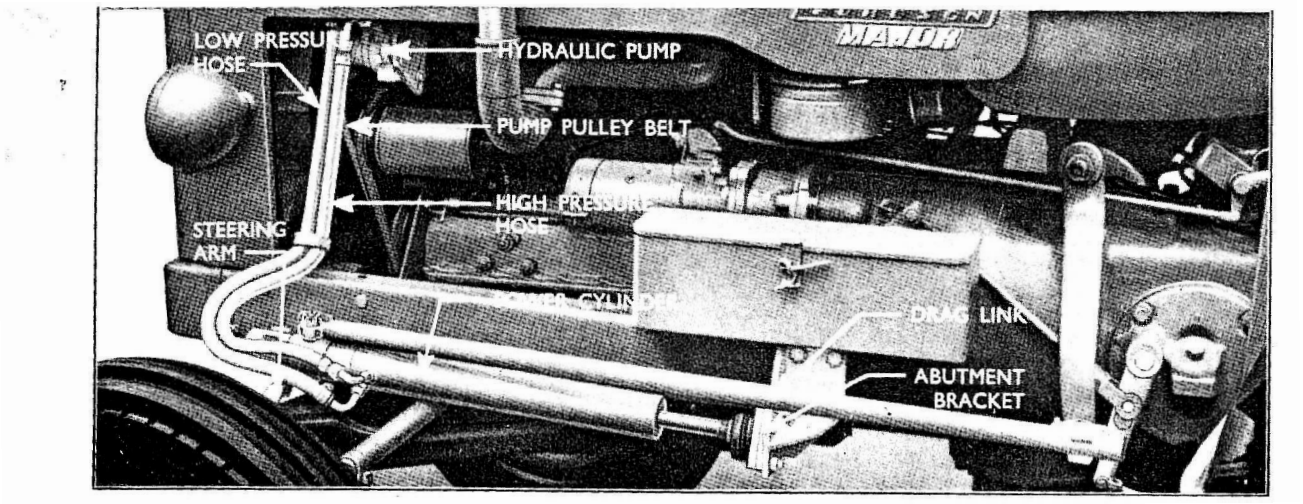
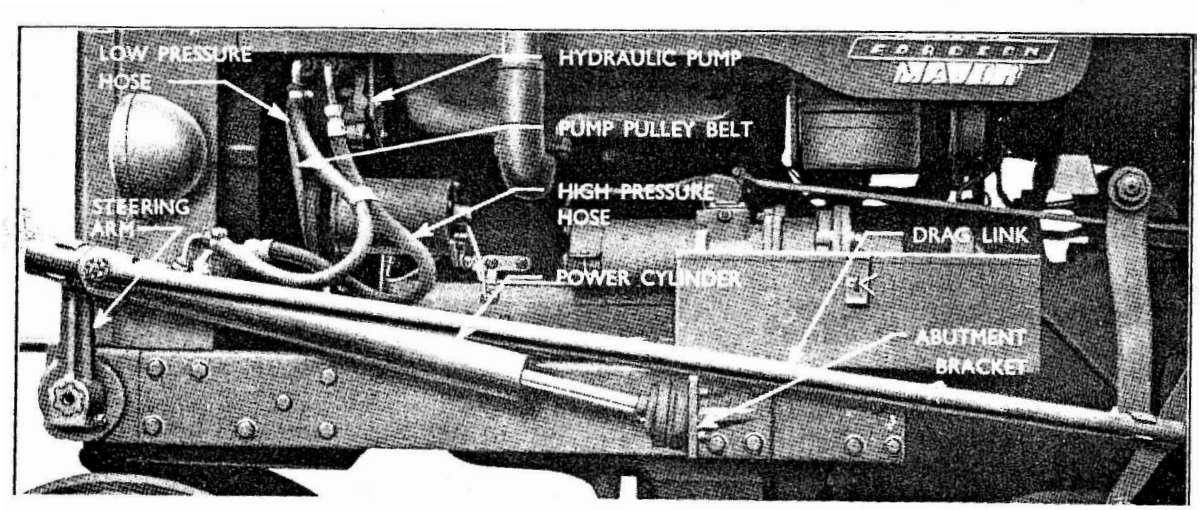
POWER ASSISTED STEERING



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 principle 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 holes 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.)

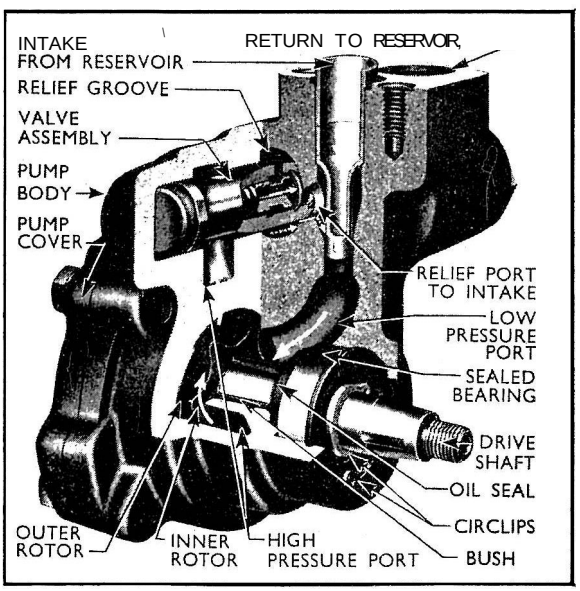


Fig. 2

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 Ibs. 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 Ibs. 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

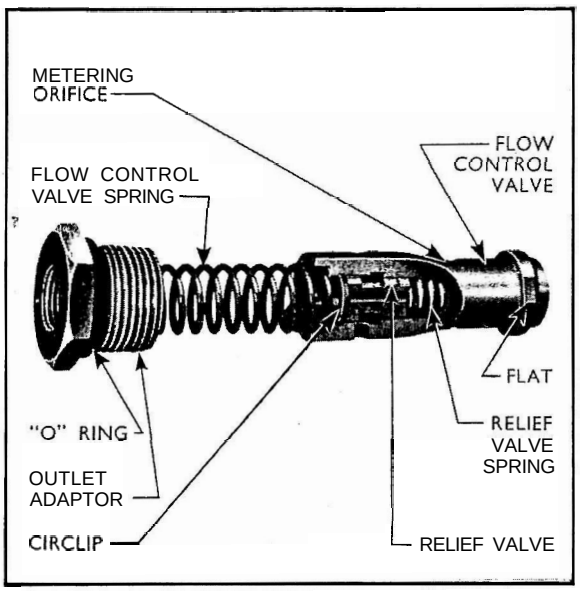


Fig. 3

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 1¾ 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 X 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 X 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-

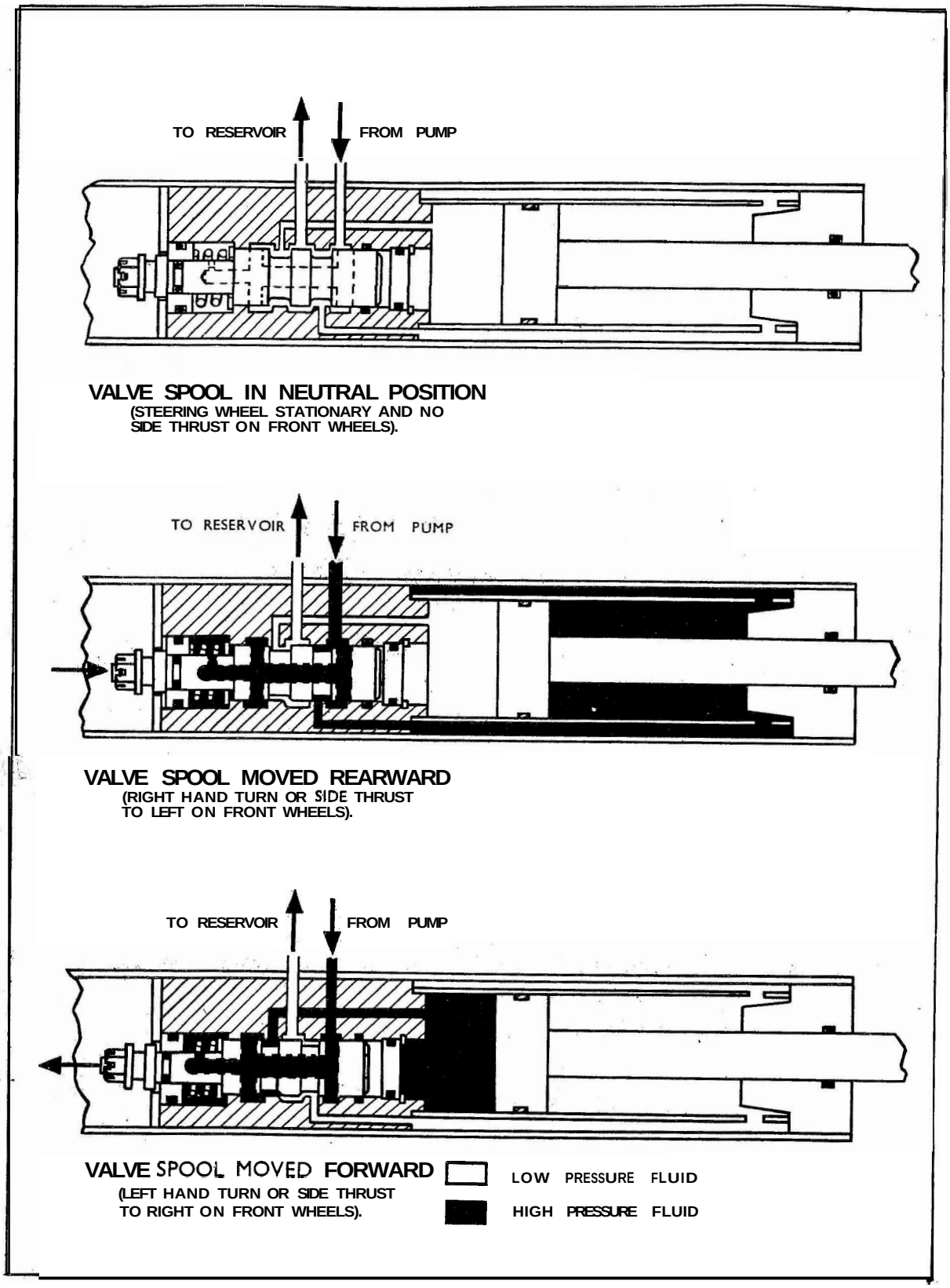


Fig. 4

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 OPER TIONS

Removal of the Power Cylinder

1. Disconnect the two hoses from the adaptors

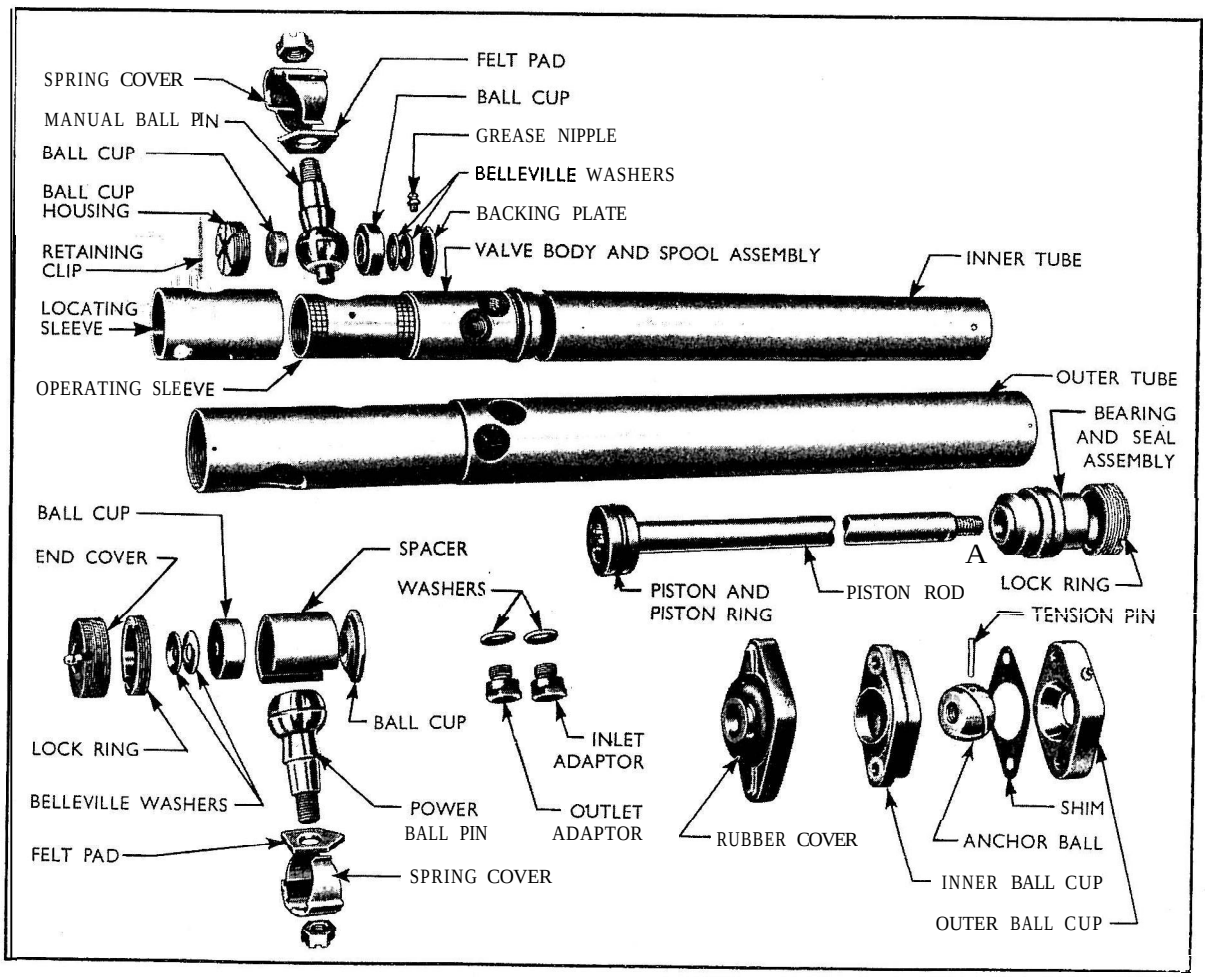


Fig. 5
Exploded View of Power Cylinder (four-wheeled tractor)

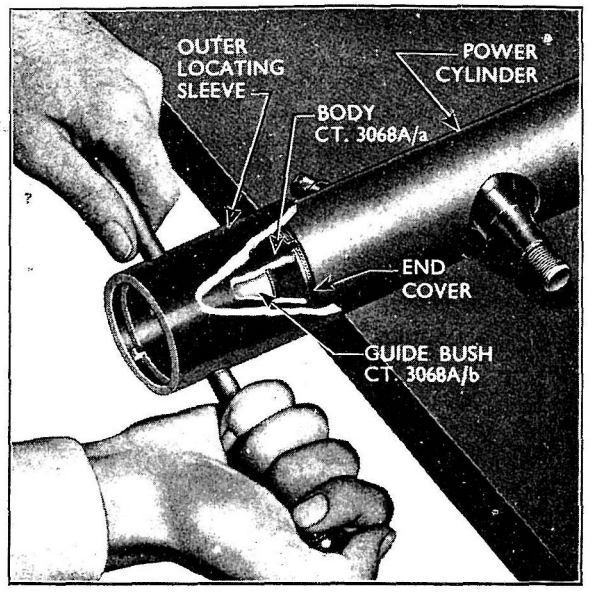


Fig. 6

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 bali 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 cylinder\ 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 kev 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 away the anchor ball cup on the piston rod 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.

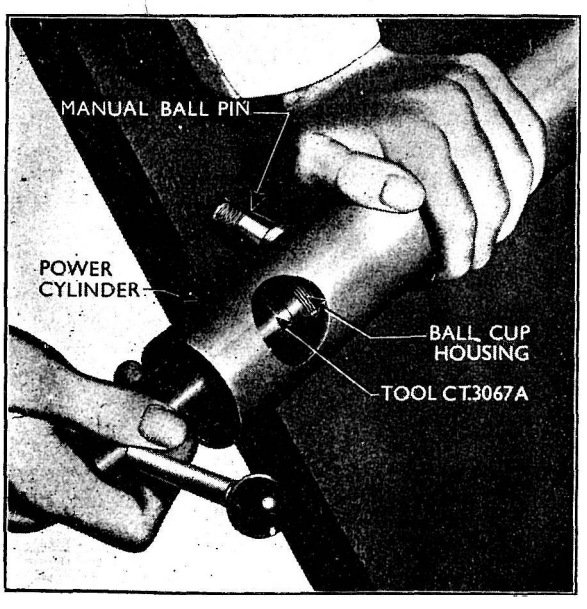


Fig. 7
Unscrewing **the Ball Cup** Housing

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.

l I. 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

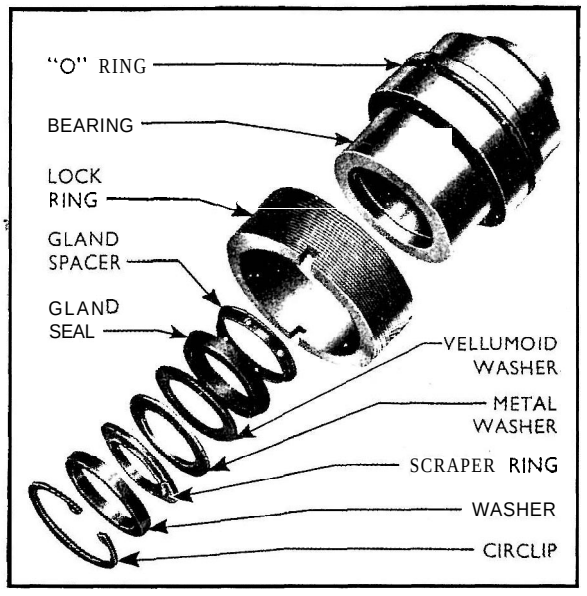


Fig. 8

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-

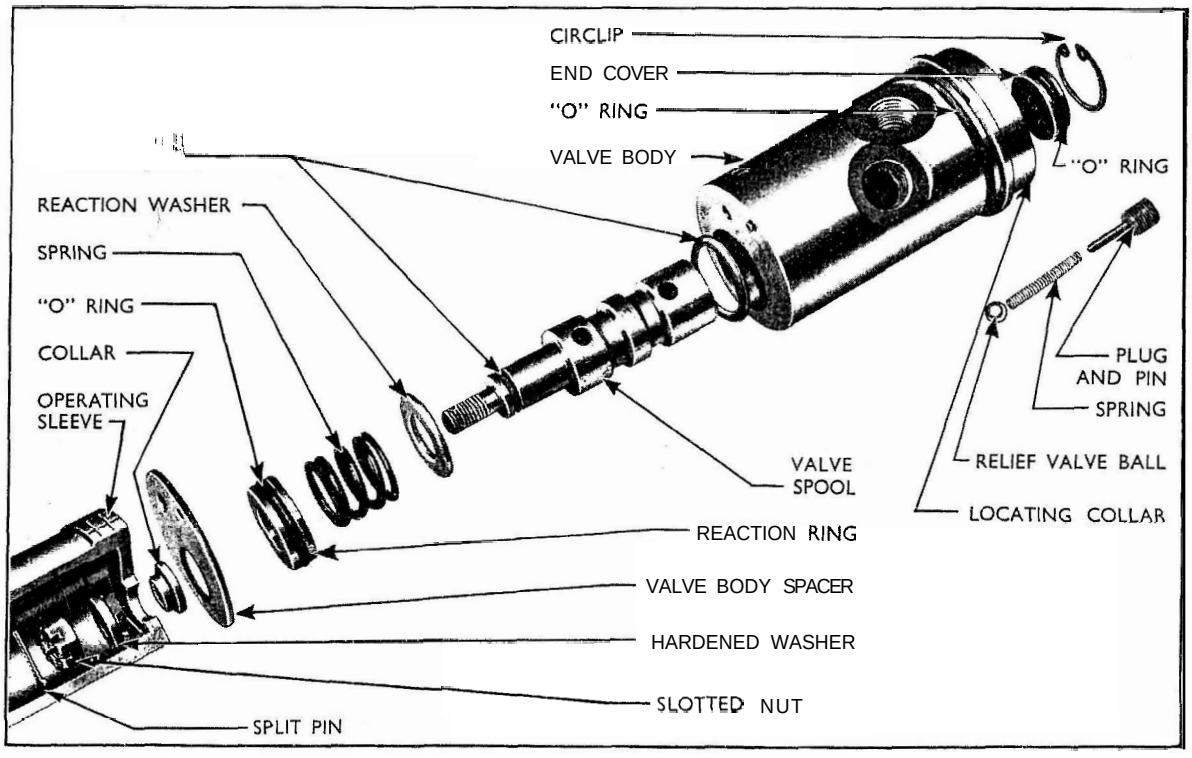


Fig. 9

Exploded View of Power Cylinder Control Valve (four-wheeled tractor)

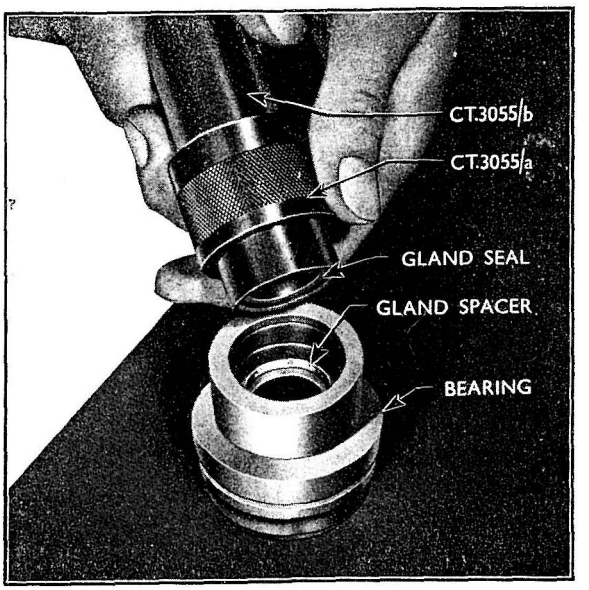


Fig. 10

Installing the Gland Seal in **the** Piston **Rod** Bearing **with** Tool CT.3055

ing it to a torque of 10 to 16.5 Ibs. 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.

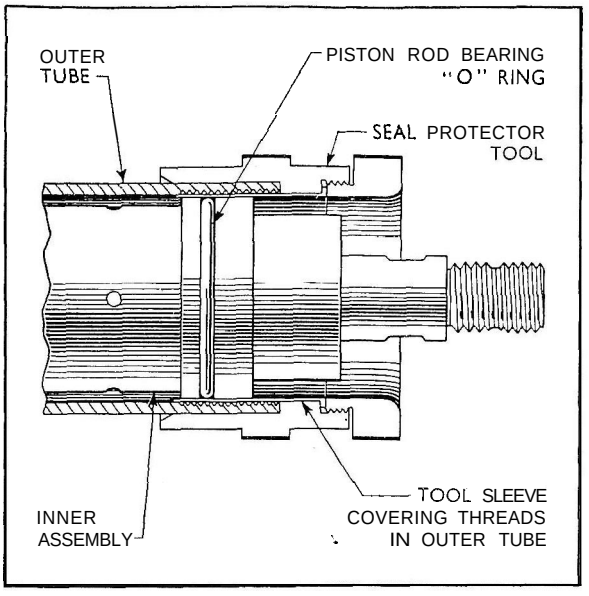


Fig. 11

Section Showing Application of Piston Rod Bearing **"O"** Wing 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.

73. 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 Pouer 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

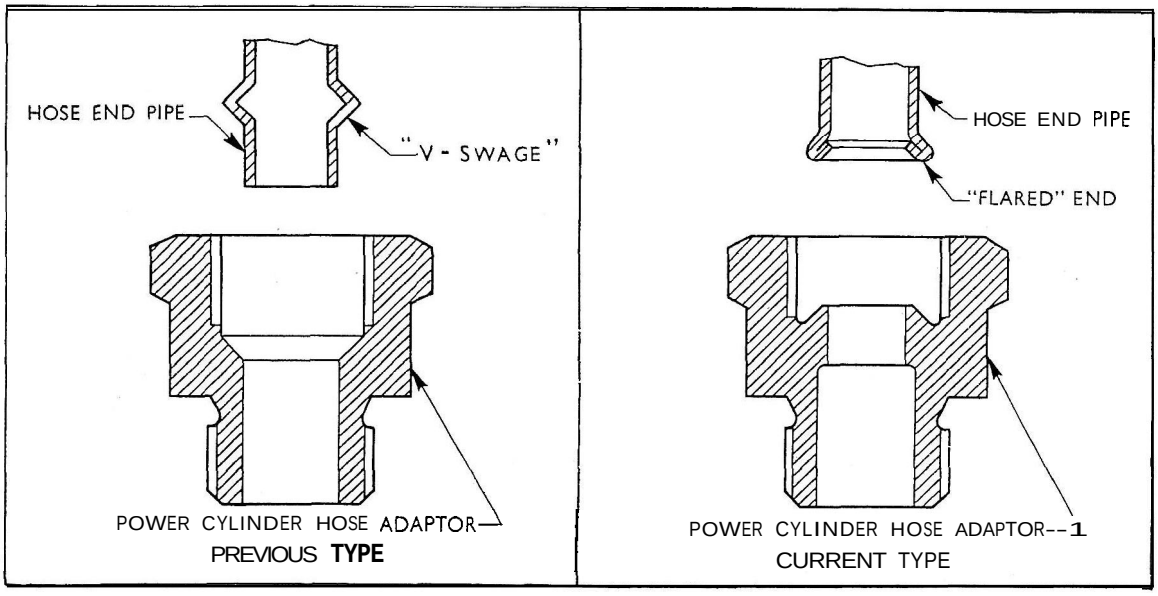


Fig. 12
Previous and Current Hoses
and **Adaptors** in Section

the inlet stud. Remove the two reservoir securing screws ahd 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.)

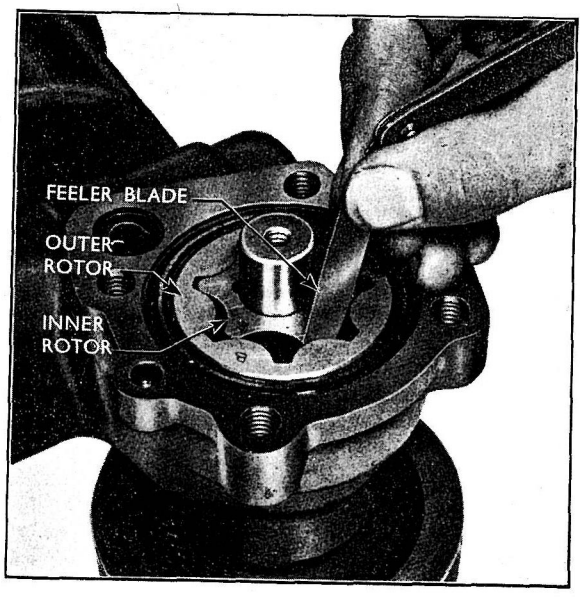


Fig. 13

Checking Clearance Between Rotors

11. Withdraw the valve assembiy 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 anh rotor assembly as necessary if the clearance exceeds .006 ins. (.15 mm.).

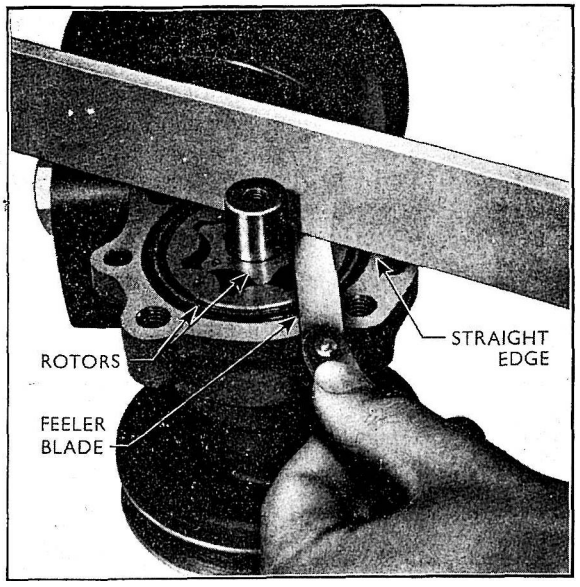


Fig. 14

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 Ibs. (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,

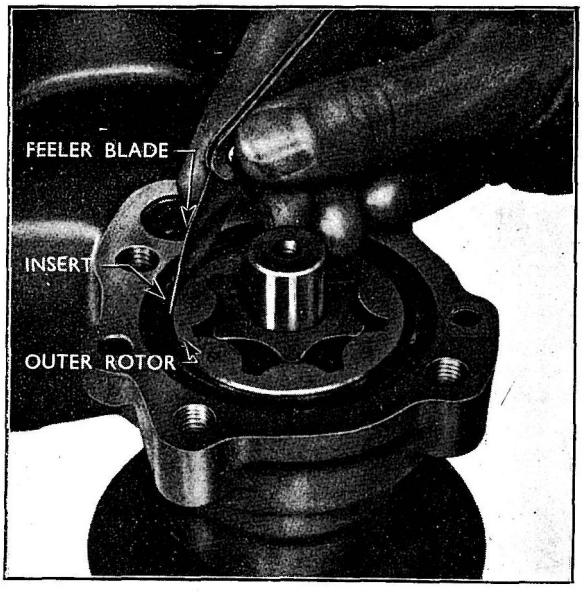


Fig. 15

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 tit the filler cap to the reservoir cover temporarily to prevent the entry of dirt whilst installing the punip 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 punip. (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 niounting 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.

7. 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 tit the crankshaft ratchet.

3. Turn the steering pump drive pulley anti-clockwise and hold in this position. with the welded strips of the punip drive pulley against the rivet heads of the crankshaft pulley, whilst tightening the crankshaft ratchet to a torque of 90 to 100 lbs. ft. (11.4 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, reniove the fan and water punip 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 punip.

3. Position the water punip 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 shakeproof 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 X 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 X 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 Ibs. ft. (13.8 to 15.3 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 Ibs. ft. (9.0 to 9.7 kg.m.).

3. 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 Ibs. 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 15.3 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 chating 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 tilling, 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 tiller 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 tiller cap, using a good quality oil, S.A.E. IOW (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 washer etc. ensuring that the lock 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 steering 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

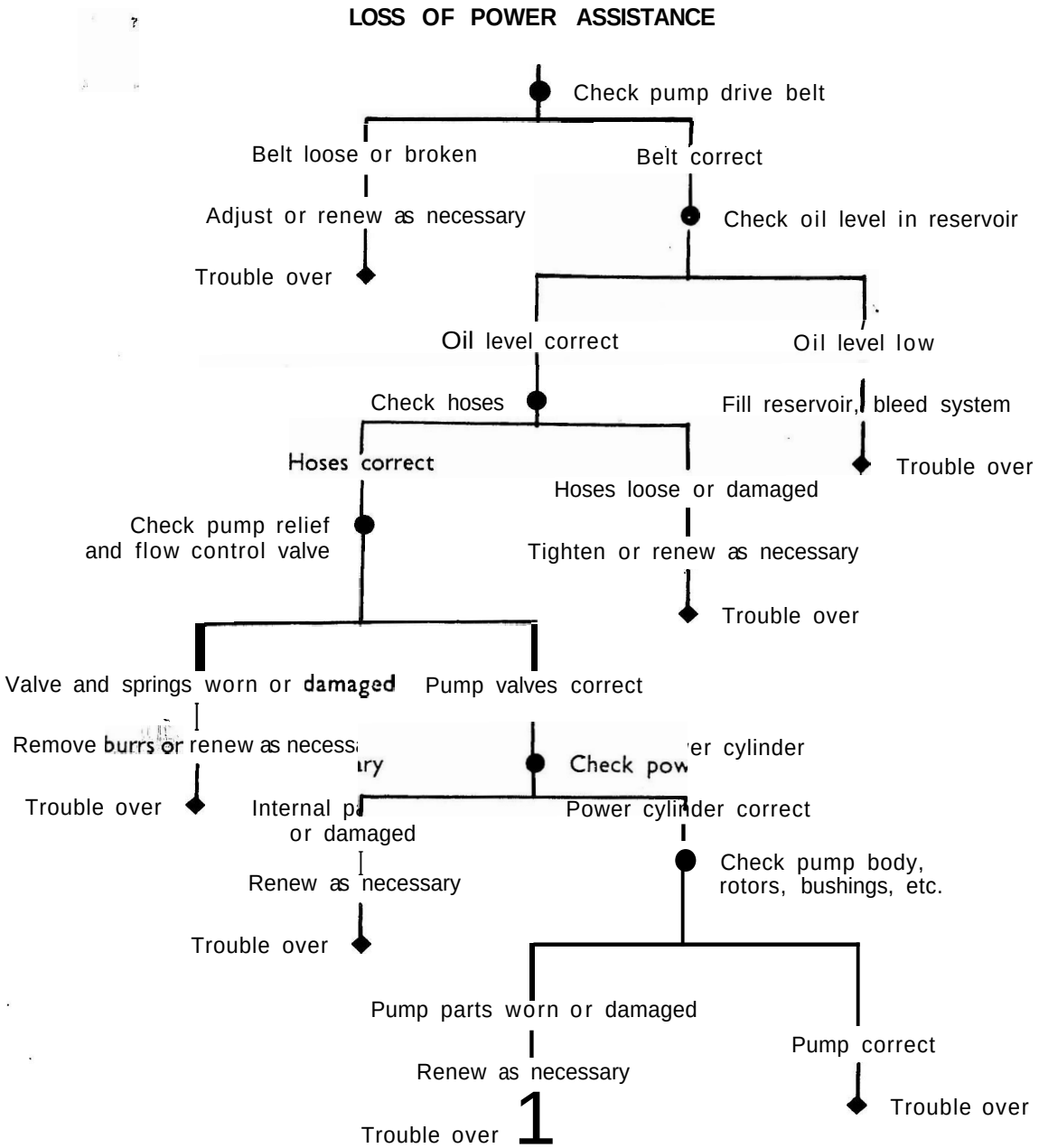


Fig. 16
Loss of Power Assistance—Fault Finding Chart

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.

(h) 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.

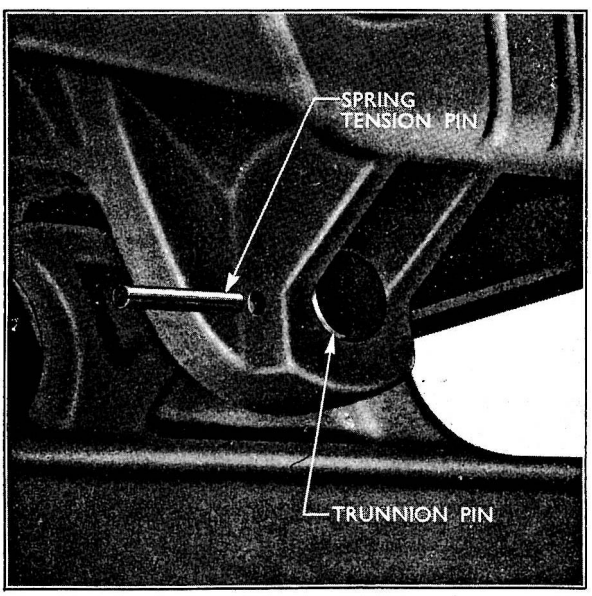


Fig. 16
Trunnion Pin Retention

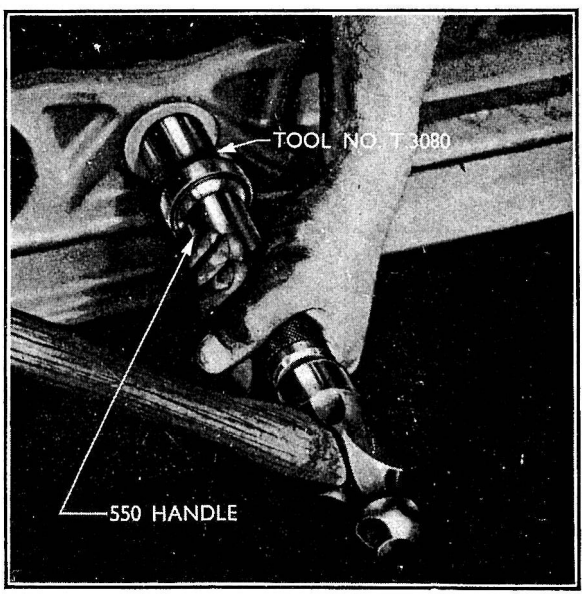


Fig. 17
Removing Trunnion Pin Bush