POWER-ASSISTED STEERING

TRACTOR MODELS

850 - 880 - 950 - 990

LE IN 850/950 F AIR MANUAL

CONTENTS

DAVID BROWN TRACTORS LIMITED
MELTHAM · HUDDERSFIELD · YORKSHIRE
Telephone Meltham 485
Telegrams: Farming, Meltham

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OPERATION OF THE SYSTEM

The Pump Unit

The pump is driven from the engine crankshaft by gears, or driving belt, and may be of the bi-rotor or roller type.

The bi-rotor type pump has a six lobe inner rotor driving a seven lobed outer rotor and as the rotors turn the spaces formed between the inner and outer lobes increase and then decrease with each revolution. The change in volume thus produces a pumping action by passing oil from the inlet to the outlet side of the pump.

The roller type pump has a slotted carrier fitted with six rollers revolving inside a cam ring and as the carrier revolves the rollers are held against the cam ring by centrifugal force. The rollers therefore follow the shape of the cam ring, and a pumping action is produced as the spaces between adjacent rollers increase and then decrease with each revolution of the carrier.

Since the pump output must be sufficient to operate the steering at low engine speeds the output at high speeds is in excess of requirements. A flow control valve is therefore incorporated in the pump to maintain a constant output irrespective of pump speed.

The pump also incorporates a pressure relief valve to prevent any possibility of damage being caused by the pump building up excessive pressure should any obstruction prevent the tractor wheels from being turned.

Control Valve (Bi-rotor Pump)

The flow control valve is in the form of a hollow spool, this is spring loaded at one end and subjected to full pump output at the other. Oil flow from the closed end passes through two metering orifices in the spool to the open end and then into the outlet connection.

At low pump speed therefore, the oil pressure at both ends of the spool is equal, due to the full pump output being able to pass through the metering orifices. As the pump speed increases however, the flow of oil to the closed end of the spool is greater than the flow that can pass through the metering holes. This causes the pressure to build up at the closed end of the spool and the spool is therefore pushed against the spring. Movement of the spool against the spring then uncovers an annular groove in the housing and allows oil to pass to the inlet side of the pump until the pressure balance is restored.

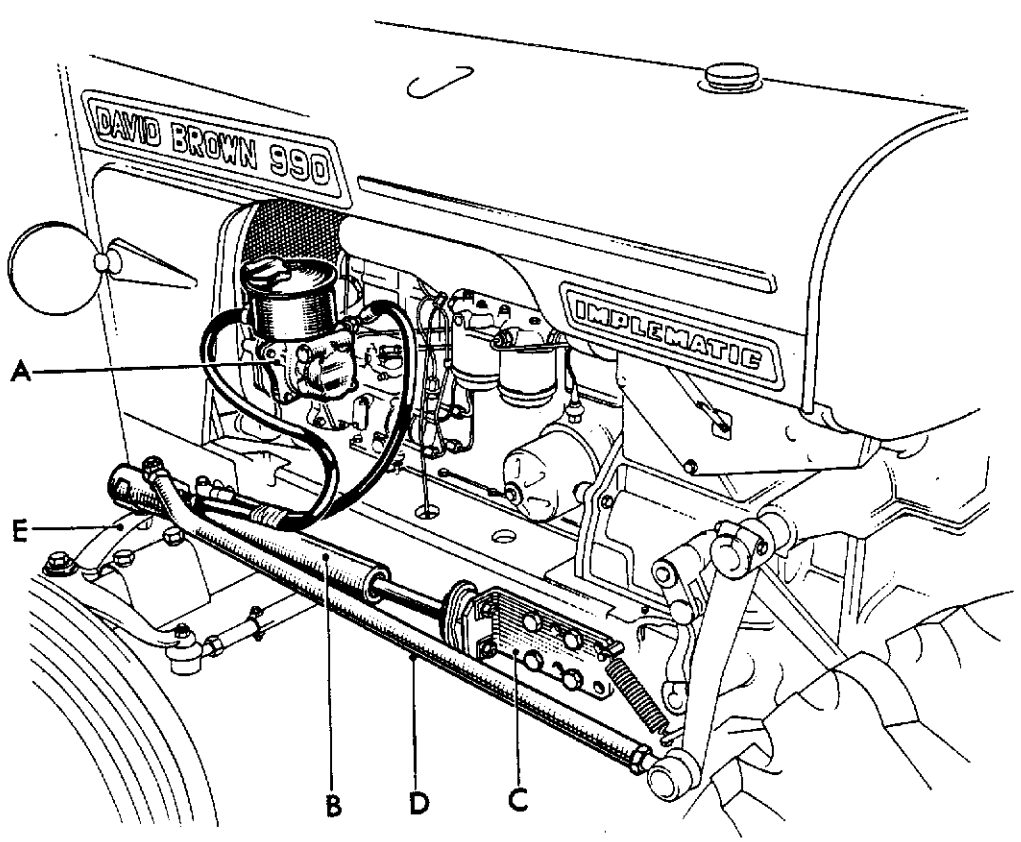

Figure 1. 990 TRACTOR WITH POWER-ASSISTED STEERING

A. Pump Unit and Reservoir
B. Hydraulic Ram
C. Ram Anchorage
D. Side Steering Rod
E. Steering Arm

NOTE—Minimum track setting on power-assisted steering is 56 in. (142 cm.)

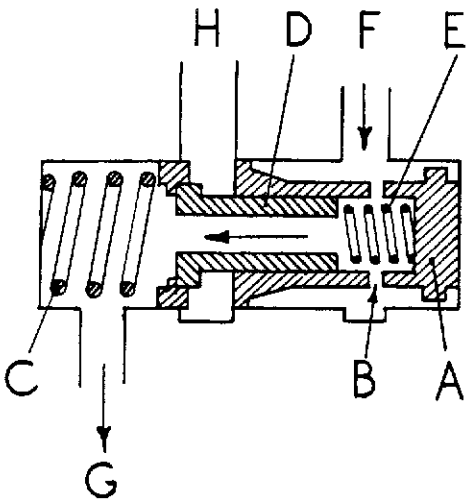

Figure 2

BI-ROTOR PUMP CONTROL VALVE

A. Flow Control Valve
B. Restricting Orifice
C. Flow Control Spring
D. Pressure Control Valve
E. Pressure Control Spring
F. Oil Inlet from Pump
G. Oil Supply to Ram
H. Relief Port to Pump Inlet

To prevent excessive pressure build up in the system a pressure relief valve is fitted inside the flow control valve spool. This valve operates entirely independently of the flow control valve and consists of a tube having a larger diameter at one end. When the pressure in the system exceeds its set maximum the pressure acting against the larger end of the valve is sufficient to move the valve against its spring and uncover a port to allow oil to pass to the inlet side of the pump.

Control Valve (Roller Pump)

The flow control valve is in the form of a hollow spool, which is spring loaded at one end and subjected to full pump output at the other. At low pump speeds the pressure in the spring chamber is equal to the pressure in the pump outlet port, due to the spring chamber being connected to the outlet connection. The spring therefore holds the plunger in the closed position and full pump output is available. As pump speed increases however the increased pump output cannot pass through the restricting orifice and back pressure commences to build up in the pump outlet port. Since the spring chamber is not subjected to the back pressure, as the chamber feed is from the outlet side of the restricting orifice, the increased pressure in the pump outlet port pushes the spool against the spring until the relief port is uncovered and surplus pump output is returned to the inlet side of the pump.

The pressure relief valve is inside the flow control valve spool and causes the spool to operate when maximum pressure is reached regardless of flow. When the pressure in the outlet connection, and therefore the spring chamber, reaches its set maximum the relief valve ball is pushed off its seat and oil escapes to the relief port via the drilling through the spool. This reduces the pressure in the spring chamber and allows the higher pressure in the pump outlet port to push the spool against its spring and uncover the relief port in exactly the same manner as occurs under flow control conditions.

Pump Control Valve Settings

Pump Number	Maximum Pressure	Maximum Flow
902356	720 lb/sq. in. (50·6 kg/sq. cm.)	2·5 gal/min. (11·4 litres/min)
904511	900 lb/sq. in. (63·3 kg/sq. cm.)	2·2 gal/min. (10 litres/min.)
913625	700 lb/sq. in. (49·2 kg/sq. cm.)	2·2 gal/min. (10 litres/min.)
915578	600 lb/sq. in. (42·2 kg/sq. cm.)	2·2 gal/min. (10 litres/min.)

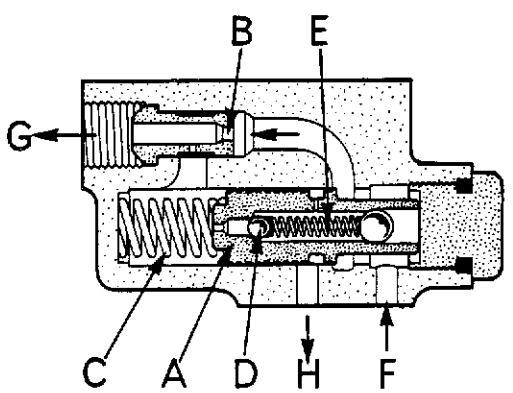

Figure 3

ROLLER PUMP CONTROL VALVE

A. Valve Spool
B. Restricting Orifice
C. Flow Control Spring
D. Pressure Control Valve
E. Pressure Control Spring
F. Pump Outlet Port
G. Oil Outlet to Ram
H. Relief Port to Pump Inlet

The Hydraulic Ram

Manual effort from the steering box is directed to the manual ball pin on the ram by means of the side steering rod. The manual ball pin is not fixed rigidly to the ram case, but is free to move and attached to the valve spool.

The valve spool is normally held in the central, or neutral, position by means of a spring. In this position the flow of oil from the pump is circulated freely back to the reservoir and the ram is inoperative.

When the steering effort applied to the wheel is very low the effort at the manual ball is insufficient to overcome the tension of the spool spring and the ram therefore moves with the ball pin, resulting in no power assistance being supplied and the steering remaining manual.

For steering efforts greater than that required to compress the spool spring the ram remains stationary initially and the ball pin moves the spool in its housing. This directs the pump output to the appropriate side of the piston, allowing a rapid build up of pressure until it is sufficient to overcome the resistance of the wheels and provide the amount of assistance required. The flow of oil and resulting movement of the ram is maintained, within the limits of the wheel travel, so long as the steering wheel is turned enough to keep the spool displaced from its centre position.

When the spool is displaced from its central position, oil from the pressure side of the piston is directed to the spool spring chamber by means of the drilling through the spool. This chamber is fitted with washers at each end and any pressure inside it tends to return the spool into the central position, this has to be balanced by a slight increase in effort from the steering wheel thereby giving the driver the 'feel' of the steering when power assistance is in operation.

In the event of the front wheels being subjected to a shock load, such as is encountered when travelling over rough ground, the spool remains stationary but the ram, and therefore spool housing is displaced, this directs oil to the appropriate side of the ram piston so that the steering movement is damped and the front wheels are returned to their original position.

If the pump fails to deliver oil pressure for any reason the tractor may be steered manually. If this occurs movement of the valve spool will not result in any power assistance but when the manual ball pin reaches the end of its travel further movement will move the ram manually. Oil then passing from one side of the piston to the other by means of the relief in the spool housing. Under this condition the ram offers very little resistance to movement and the steering effort required is not appreciably increased over that required for the manual steering system.

When the wheels are in the straight ahead position the control valve spool spring holds the spool in the central position. Oil then flows past the spool lands and returns to the reservoir. Since only a small amount of back pressure then exists in the system the pump delivers oil at low pressure to both sides of the piston and a balanced condition exists.

Fault Finding

Whilst the system has been designed to provide long and trouble free service faulty operation may be experienced if units become maladjusted or receive damage due to neglect or abuse. The following information is therefore provided to assist in quickly locating any difficulties that may be encountered.

1. Loss of Power Assistance.

Loss of power assistance may be caused by any of the following:

(a) Low oil level—Refill and bleed system.
(b) Failure of pump drive.
(c) Leaking pipe connections.
(d) Pump valve assembly—Remove and check.
(e) Pump rotors worn—Remove and examine.
(f) Power cylinder faulty—Strip and examine.

2. Binding.

If binding occurs when the steering wheel is turned, check the following:

(a) Movement of the manual ball pin.
The operating sleeve may be binding in the locating sleeve, probably due to inadequate lubrication. These parts should be removed and freed, or if necessary renewed.

(b) Control Valve Spool.
Check the operation of the spool in the valve housing. If it is binding inspect for damage, renew the spool and housing if necessary.

3. Excessive free play in Steering.

If excessive free play is experienced, and the steering box and joints are in good condition, check the following:

(a) Manual ball pin cups.
Check for excessive clearance between the ball pin and cups, check for wear or faulty Belleville washers, and replace as required.

(b) Loose locating sleeve.
If the locating sleeve is loose, remove the split pin from the ball pin end, remove the end cover and tighten the lock ring. Replace the end cover, tightening fully then releasing one quarter turn, to provide the correct tension on the Belleville washers, before replacing the split pin.

These checks should be made with the engine running. Movement of the manual ball pin is necessary to operate the valve and this movement is particularly evident when the engine is stationary. Under this condition no oil is being supplied to the ram and steering is only obtained after the valve has been moved to the end of its travel.

4. Heavy Steering.

Heavy steering should not be confused with binding. Heavy steering is experienced over the full range of travel of the front wheels, but binding is normally experienced over only a portion of the travel. If heavy steering is experienced, check the following:

(a) Low pump output.
Check the pump drive. If it is suspected that the pump output is low, first check the pressure relief valve and spring, and if correct strip the pump and examine the rotors, etc.

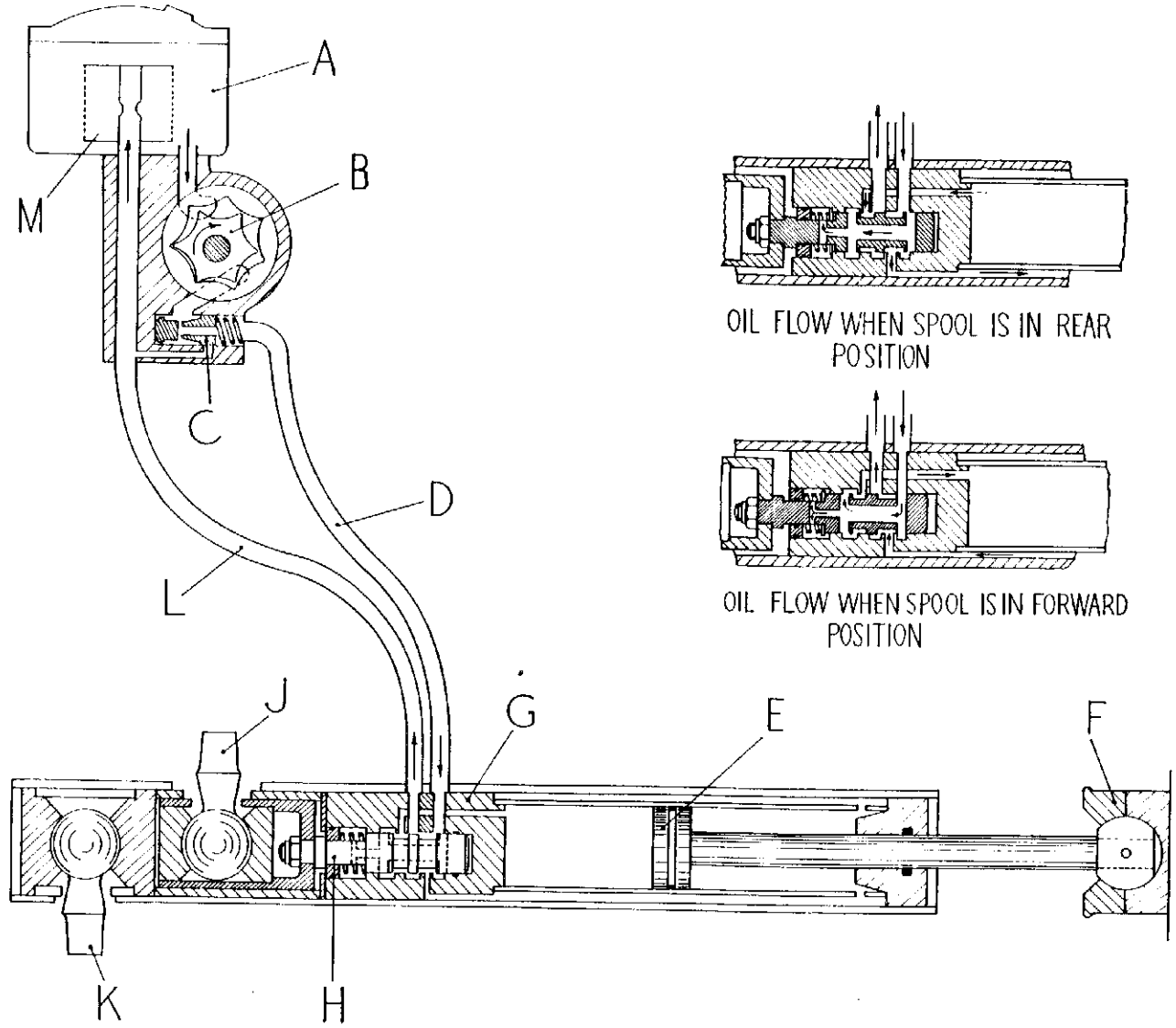

Figure 4. DIAGRAMMATIC ARRANGEMENT OF HYDRAULIC SYSTEM

A. Reservoir
B. Pump Rotors
C. Control Valves
D. Ram Supply Pipe
E. Piston
F. Anchorage
G. Valve Housing
H. Valve Spool
J. Manual Ball Pin
K. Power Ball Pin
L. Oil Return Pipe
M. Filter Element

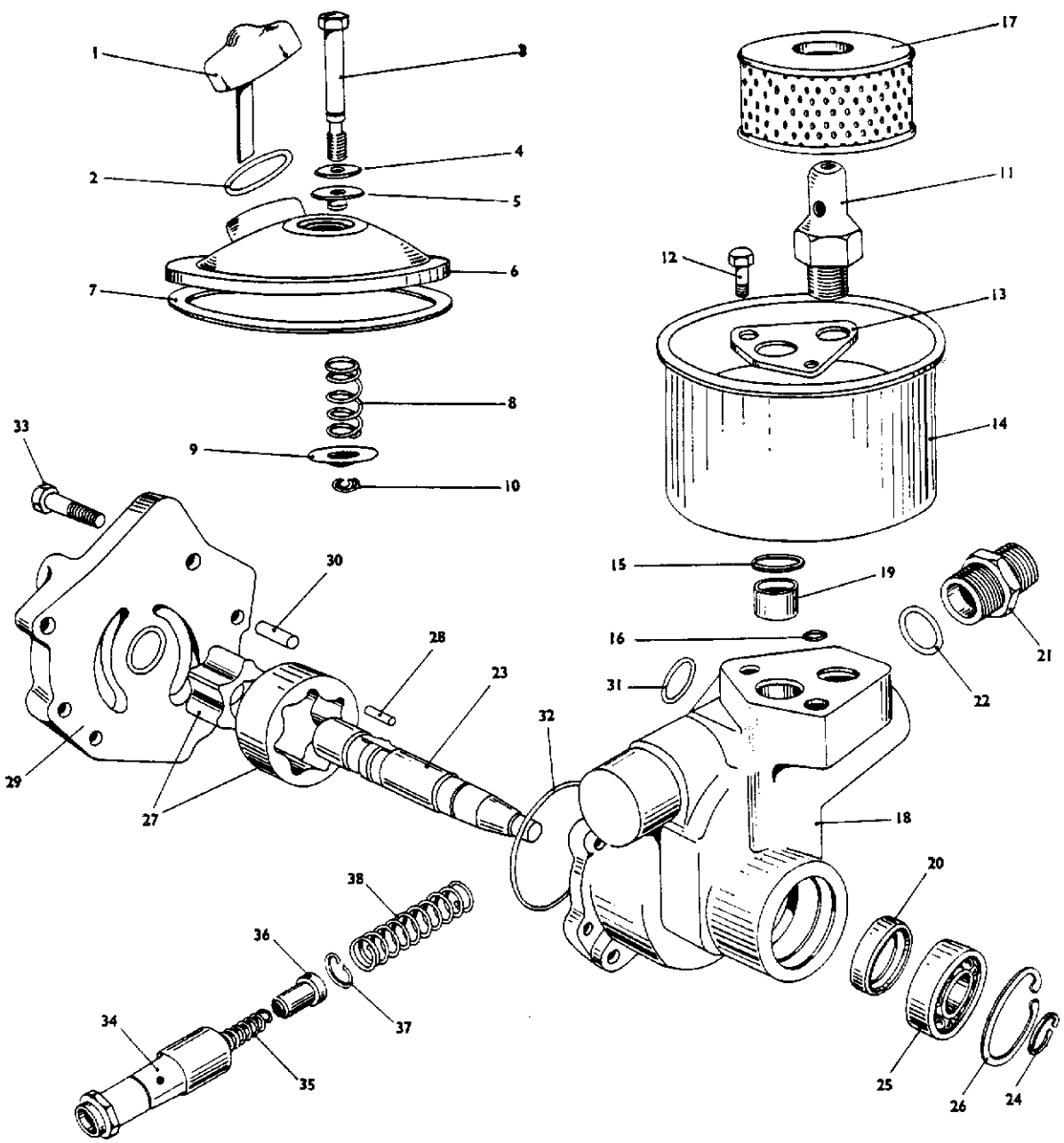

Figure 5. HYDRAULIC PUMP ASSEMBLY 902356

HYDRAULIC PUMP ASSEMBLY

FIG. REF.	PART NO.	DESCRIPTION	QTY.	REMARKS
	902356	**Pump and Reservoir** (Complete) ... ... Comprising:	1	
	960839	**Reservoir Assembly**	1	
	960840	**Reservoir Cover Assembly**	1	
1	**960841**	**Filler Cap Assembly**	1	960841
2	**960843**	**Gasket**—(Filler Cap)	1	
3	**960721**	**Bolt**—(Cover)	1	
4	**960722**	**Washer**—Cover Bolt	1	
5	**960723**	**Gasket**—Cover Bolt	1	960840
6	**960842**	**Cover**—Reservoir	1	960839
7	**960725**	**Gasket**—Cover	1	
8	**960726**	**Spring**—Filter Cap	1	
9	**960727**	**Cap**—Filter	1	
10	**960728**	**Circlip**—Cover Bolt	1	
11	**960729**	**Stud**—Reservoir	1	
12	**960844**	**Setscrew**—Reservoir Body	2	
13	**960731**	**Reinforcement Plate**	1	
14	**960845**	**Reservoir**	1	
15	**960733**	**Gasket**—Large	2	
16	**960734**	**Gasket**—Small	2	
17	**902187**	**Filter Element**	1	
	960836	**Body Assembly**		
18	**960837**	**Body**—With Bushes (not supplied separately) ...	1	960836
19	**960838**	**Gasket Retainer**	1	
20	**960740**	**Oil Seal**	1	
21	**960854**	**Adaptor**—Pump Outlet	1	
22	**960748**	**'O' Ring**—Adaptor	1	
	960847	**Shaft Assembly**		
23	**960848**	**Shaft**	1	960847
24	**960849**	**Circlip**—Rotor Shaft...	1	
25	**960754**	**Bearing**	1	
26	**960735**	**Circlip**—Bearing Retainer	1	
27	**960850**	**Rotor Assembly**—Inner and Outer	1	Not Supplied separately
28	**960738**	**Drive Pin**—Rotor	1	
29	**960846**	**Cover**—With Bush	1	Not Supplied separately
30	**960737**	**Dowel**—Body-Cover	2	
31	**960856**	**'O' Ring**—Small	1	
32	**960755**	**'O' Ring**—Large	1	
33	**960855**	**Bolt**—Cover	4	
	960851	**Valve Assembly**		
34	**960853**	**Valve**—Flow Control	1	960851
35	**960852**	**Spring**—Pressure Relief	1	
36	**960744**	**Valve**—Pressure Relief	1	
37	**960746**	**Circlip**	1	
38	**960747**	**Spring**—Flow Control	1	

(b) Hydraulic Ram.
If the steering is heavy after checking the pump, dismantle the ram assembly and inspect the valve spool and bore. Deep scoring or scratches will allow internal leaks, resulting in heavy steering. If the valve assembly is in good condition the trouble may be due to excessive leakage in the power cylinder. In this case the inner tube and piston should be examined.

5. **Noisy Operation.**
(a) Reservoir oil level.
Check the oil and top up to the correct level with the recommended grade of oil. If the oil level is low, the pump is probably drawing air into the system.
(b) Pump Drive Belt.
Examine the drive belt and adjust or renew as required. If the belt is run tight pump noise may result, if it is run slack the belt may squeal.

6. **Steering Chatter.**
If the steering joints are in good condition, check the piston rod anchorage, the ball may be loose on the piston rod or slack in its housing. Also check the anchor bracket bolts, these may be loose, permitting the bracket to move on the main frame.

MAINTENANCE AND SERVICE

The pump and ram components operate with very small clearances and it is therefore essential that only very clean oil is used in the system. The presence of dirt or foreign matter in the oil will cause scoring and rapid wear of the pump rotors and valve spool, resulting in unsatisfactory operation.

When filling, or topping up the oil reservoir therefore, always clean the cover before removing the filler cap and ensure that all containers, funnels, etc., are clean.

The oils recommended for use in the power steering are as follows:—

Amoco	DL10 Hydraulic Oil.
B.P.	Auto Hydraulic 65.
Castrol	Hyspin 70.
Esso	Esso Automatic Transmission Fluid.
Mobil	Mobilfluid 200 or Mobil DTE Oil Light.
Shell	Tellus 27.

Vegetable oils, such as brake and shock absorber fluid, **must not be used.**

MAINTENANCE

When carrying out the tractor weekly maintenance the following points should receive attention.

1. Lubricate the two steering ball pins and the ram anchorage by means of the three nipples provided.
2. Check the level of oil in the reservoir; top up to the high mark on the dipstick, with a recommended grade of oil, if required.
3. Check the drive belt, this should have $\frac{3}{4}$ in. free play and may be adjusted by releasing the pump mounting bolts and moving the pump in the slotted mounting holes.
4. Examine the hoses and connections for any signs of oil leakage, and check the ram anchor bracket bolts for tightness.

It should be noted that the oil reservoir contains a filter element, this may be lifted out after removing the reservoir cover and should be replaced annually. Do not attempt to clean the element.

DISMANTLING THE BI-ROTOR PUMP UNIT

1. Remove the pump assembly from the tractor and clean the outside of the pump and reservoir. Do not allow dirt to enter the pipe connections.
2. Release the reservoir cover stud and remove the cover, spring and filter assembly. Remove the reservoir securing screws and stud, lift out the reinforcement plate and remove the reservoir from the pump housing. Remove the 'O' rings from their locations in the pump housing.
3. Remove the pulley securing nut and, using a suitable extractor, remove the pulley from the drive shaft.
4. Remove the bolts securing the pump cover to the pump body. Remove the 'O' rings from their grooves in the pump body.
5. Remove the pump rotors and the rotor drive key from the drive shaft.

CAUTION.
Handle the rotors, pump body and cover very carefully as nicks, burrs, cracks or scratches may render them unfit for futher service.

6. Clamp the pump body in a vice, fitted with soft jaw grips, then remove the rotor shaft bearing circlip from the body. Press the rotor shaft and bearing from the housing, taking care not to damage the shaft or bearing. The bearing is of the sealed type and should always be renewed when carrying out a major overhaul, or if the bearing shows any signs of roughness. Press the bearing off the shaft, using a suitable adaptor which bears against the inner track of the bearing.
7. Inspect the rotor shaft oil seal, if the seal is damaged or shows signs of wear, remove it from the pump body with a hammer and drift.
8. Remove the outlet adaptor from the pump body and remove the flow control valve spring from its location. Using a piece of hooked wire, carefully pull the flow control valve out of the pump housing.

CAUTION.
Handle the valve carefully to avoid damage.

9. Remove the circlip securing the pressure relief valve inside the flow control valve, then withdraw the relief valve and spring.

INSPECTION

Wash all parts except the rotor shaft bearing in a suitable solvent. Do not soak the bearing in solvent as the lubricant in the bearing may then become diluted. Inspect the pump body and cover for signs of wear caused by the rotation of the rotors, and check the bushings in the body for wear or scores. If the cover or the bushing in the cover is worn, replace the cover assembly. Inspect the drive and driven rotors for wear, cracks or scores. If either rotor is unserviceable, replace the pump body and rotor assembly. If the rotors are serviceable proceed as follows:—

1. Press the rotor shaft bearing on to the shaft, using a suitable adaptor, until the bearing is seated against the shoulder on the shaft. Press the shaft and bearing into the pump body until the bearing seats against the shoulder in the body.

NOTE.

When pressing the bearing into the pump body apply pressure against the outer track only.

2. Install the drive rotor and pin on the rotor shaft then install the driven rotor. Check the clearance between the rotors by means of a feeler gauge. If the clearance exceeds 0·006 in. (0·15 mm.), in any position, replace the pump body and rotor assembly.
3. Check the clearance between the side of the rotors and the pump body, using a straight edge and feeler gauge. If the clearance exceeds 0·0025 in. (0·06 mm.) replace the pump body and rotor assembly.
4. Check the clearance between the outside diameter of the driven rotor and the insert in the pump body. If the clearance exceeds 0·006 in. (0·15mm.) replace the pump body and rotor assembly. If all clearances are within the figures specified, remove the rotors, shaft and bearing from the pump body.
5. Thoroughly dry the pressure relief valve and the bore in the flow control valve. Insert the relief valve into the flow control valve, then shake the valve. If the valve does not move freely in its bore, remove it and check for burrs. Check the flow control valve for free movement in the bore in the cover, removing any burrs with fine emery cloth.

ASSEMBLING THE BI-ROTOR PUMP

Fit the rotor shaft oil seal into the pump body. Positioned so that the lip of the seal is towards the pump rotors and pressing into the housing until it contacts the shoulder in the body.

NOTE.

When pressing the oil seal into the body, use an adaptor that contacts the outer diameter of the seal.

2. Ensure that there are no burrs on the rotor shaft, particularly round the key-way, then press the shaft and bearing into the body until the bearing seats against the shoulder. Fit the bearing circlip into the groove in the pump body.
3. Fit the drive rotor and pin on to the rotor shaft and fit the driven rotor after smearing with a thin film of oil.
4. Position the pressure relief valve and spring inside the flow control valve and fit the retaining circlip.
5. Place the flow control valve in the bore of the pump body, taking care not to damage the valve lands or the bore of the chamber. Fit the valve spring and screw the adaptor into the body after fitting a new 'O' ring.
6. Position new 'O' rings in the recesses in the pump body then carefully fit the cover. Ensure the 'O' rings are not displaced when fitting the cover and tighten the bolts evenly.
7. Check the rotor shaft for free operation. The shaft should rotate freely without binding. If the shaft does not rotate freely, dismantle the pump and locate the cause.
8. Fit the drive pulley, after positioning the key in the shaft.
9. Place two new 'O' rings into the recesses in the top of the pump body and fit the oil reservoir. Placing the reinforcement plate in position and securing with the screws and stud.
10. Install new gaskets in the reservoir cover and filler cap. Place the new filter element in position and attach the reservoir cover stud firmly, but do not tighten excessively.

DISMANTLING THE ROLLER PUMP

After disconnecting the inlet and outlet pipes, remove the bolts and setscrews attaching the pump to the engine and withdraw the pump rearwards until it is clear of the timing case.

Plug the open ends of the pipes and the connections on the pump, to prevent the entry of dirt, then thoroughly clean the outside of the pump and reservoir.

Clamp the pump body in a vice and remove the bolt from the centre of the reservoir cover. Remove the cover, spring, filter cap and element.

Using a suitable box spanner, remove the hexagonal mounting stud from the base of the tank.

Remove the gasket from the recess in the pump cover and withdraw the gasket retainer. The venturi is pressed into the cover and should not be removed.

Remove the driving gear from the pump shaft after removing the centre setscrew. Remove the four socket screws and separate the support from the cover.

Remove the six socket screws attaching the cover to the body and lay the pump down so that the cover and body can be separated vertically, thus preventing the rollers from falling out.

Extract the drive pin from the shaft and remove the shaft and bearing assembly by tapping the shaft gently forwards from the body end.

Lift the rollers and carrier from the body, followed by the cam ring and locking peg.

Remove the valve cap, withdraw the valve and spring from the body placing the parts where they will not be subject to damage or contamination.

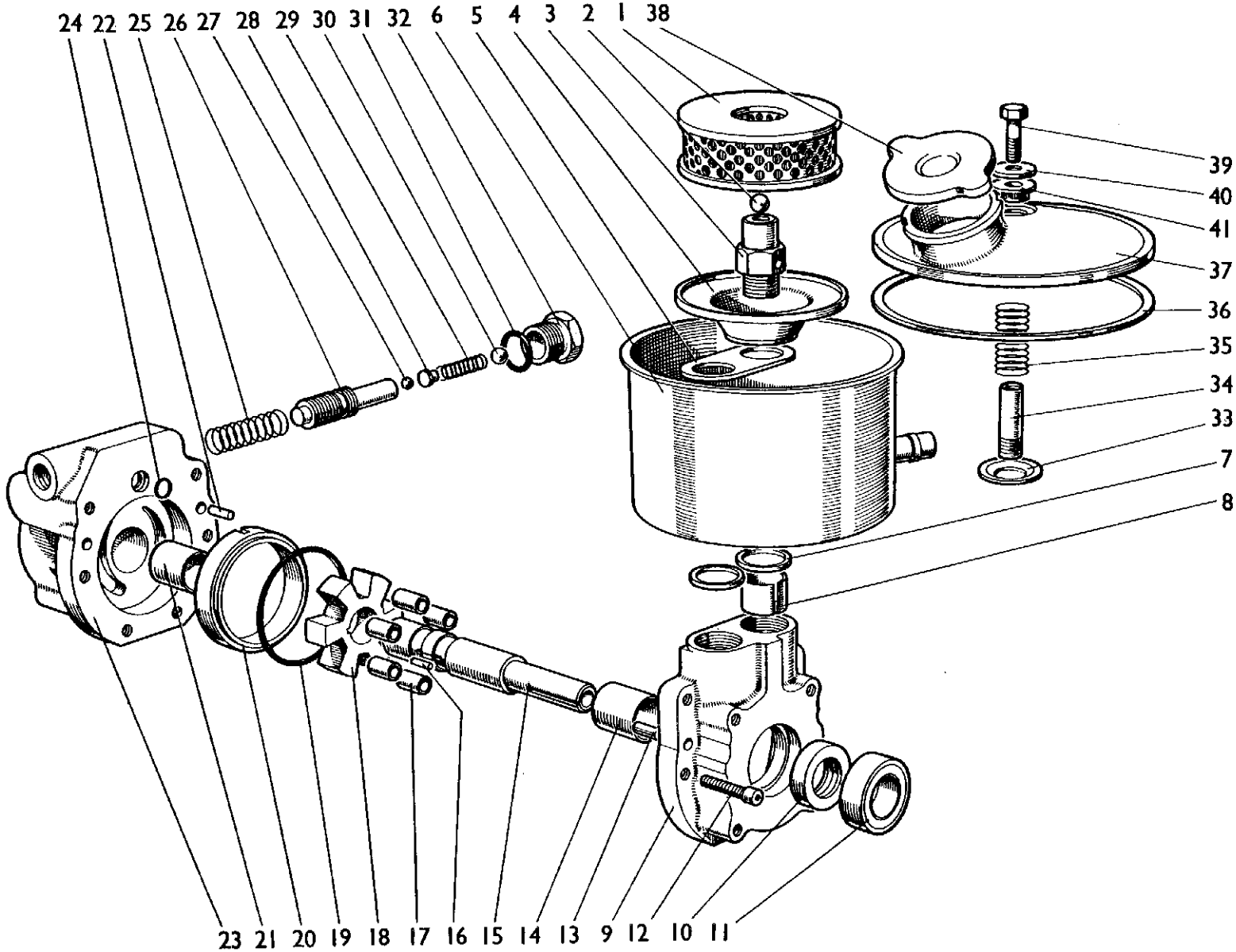

Figure 6. HYDRAULIC PUMP ASSEMBLY 904511

POWER-ASSISTED STEERING PUMP

FIG. REF.	PART NO.	DESCRIPTION	QTY.	REMARKS
	904511	**Pump and Reservoir** (Complete) ... ... Comprising:	1	
1	**902187**	**Filter Element**	1	
2	**961117**	**Ball**	1	
3	**961116**	**Mounting Stud**—Reservoir	1	
4	**961118**	**Support**	1	
5	**961120**	**Reinforcement Plate**	1	
6	**961110**	**Reservoir Assembly** (Complete with Cover) ...	1	
7	**960733**	**Gasket**...	2	
8	**961121**	**Retainer**—Gasket	1	
9	**961094**	**Cover** (with Venturi)	1	
10	**961093**	**Oil Seal**	1	
11	**960754**	**Bearing**	1	
12	**961108**	**Screw and Lockwasher**—Cover to Body ...	6	
13	**961096**	**Dowel Pin** (part of 961094)...	2	
14	**961092**	**Bush**	1	
15	**961109**	**Shaft**	1	
16	**960738**	**Drive Pin**—Carrier	1	
17	**961104**	**Roller** (supplied with Cam)...	6	
18	**961104**	**Carrier** (supplied with Cam)	1	
19	**961103**	**'O' Ring**	1	
20	**961104**	**Cam, Carrier and Rollers**	1	
21	**961092**	**Bush** (part of 961090)	2	
22	**961101**	**Lock Peg**—Cam	1	
23	**961090**	**Body** (with Orifice Tube and Bush)	1	
24	**961102**	**'O' Ring**	1	
25	**961098**	**Spring**—Flow Control	1	
26	**961097**	**Valve**—Flow Control and Pressure Relief... ...	1	
27	**961097**	**Ball**—Pressure Relief Valve	1	Not supplied separately
28	**961097**	**Ball Seat**	1	
29	**961097**	**Spring**	1	
30	**961097**	**Retaining Ball**	1	
31	**960857**	**'O' Ring**	1	
32	**961099**	**Cap**—Valve	1	
33	**961114**	**Filter Cap**	1	
34	**961115**	**Stud**—Cover	1	
35	**961113**	**Spring**—Reservoir	1	
36	**960725**	**Gasket**—Reservoir to Cover	1	
37	**961111**	**Reservoir Cover Assembly**	1	Central Reservoir
	961836	**Reservoir Cover Assembly**	1	Offset Reservoir
38	**961112**	**Filler Cap**	1	
39	**961122**	**Screw**—Reservoir Cover	1	
40	**960722**	**Washer**	1	
41	**960723**	**Sealing Washer**	1	

ASSEMBLING THE ROLLER PUMP

After washing all parts in a suitable solvent and drying by air, or a lint-free cloth, place the parts in a clean, covered container. Great care should be taken to prevent any foreign matter from entering the pump during assembly. All components must be clean and lightly oiled.

Examine the pump body and cover for any signs of wear. Renew either part if the faces or bushes are worn. Press a new oil seal into the pump cover, ensuring that the seal lip is not damaged and that it faces inwards.

Place the cam locking peg in the hole in the body pocket. Inspect the cam ring and renew if worn or damaged. Place the cam in the pocket, ensuring that it seats on the pocket face and that the slot in the cam locates on the peg in the body.

Inspect the carrier and place in the cam ring, ensuring that the angled faces are towards the direction of rotation (see figure 7). Inspect the rollers, paying particular attention to the finish of the ends. Renew if scored, damaged, or out of round. After fitting the rollers place a straight edge across the face of the cam ring and check the end clearance of the carrier and rollers with a feeler gauge. If the clearance exceeds 0·002 in. (0·05 mm) renew the carrier and rollers.

Examine the shaft and bearing. If the bearing shows any signs of roughness, or if excessive grease has seeped out of the bearing, it should be renewed. Smear the inside of the seal with grease and insert the shaft and bearing through the front of cover, ensuring that there are no sharp edges on the shaft which may cut the seal lip.

Fit the drive key into the shaft and a new 'O' ring in the body face. Insert the shaft into the carrier and body bush. Replace the six socket screws and tighten evenly to 18 lb ft (2·5 kg metres). After fully tightening the screws, check that the shaft can be turned without binding.

Refit the mounting plate, using a new gasket, and replace the drive gear key. Fit the drive gear with the boss towards the pump and secure with the setscrew and special washer.

Check the flow control valve spring tension, this should be 8 to 9 lb (3·5 to 4·0 kg) at 0·82 in. (20·8 mm) length and if outside this limit should be renewed. Replace the spring in the body bore, followed by the valve—exposed ball end outwards—'O' ring and cap. Tighten the cap to 30 lb ft. (4·0 kg metres).

The pressure control valve is housed inside the flow control valve and limits the maximum pump output pressure to a safe figure (see page 3). The valve is not adjustable and should be replaced if faulty operation is suspected.

Replace the gasket retainer in the pump body. Fit the two 'O' rings and replace the reservoir, reinforcement plate and filter support. Replace the centre stud and tighten to 30 lb ft. (4·0 kg metres).

Fit a new filter element. Replace the cap, spring and cover. Fit a new 'O' ring between the reservoir and cover and tighten the cover retaining bolt to 5 lb ft (0·7 kg metres).

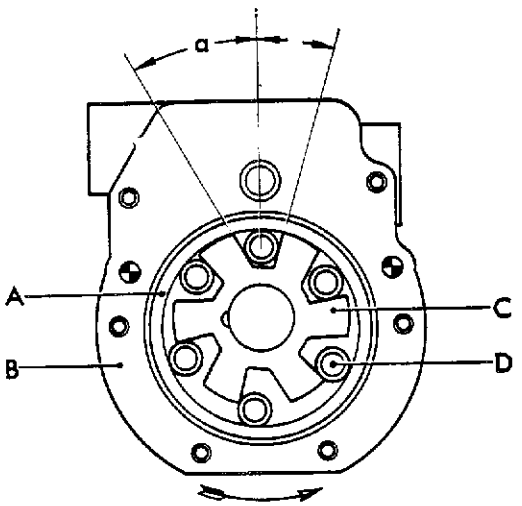

Figure 7

ROLLER PUMP CARRIER

A. Cam Ring B. Pump Body
C. Carrier D. Roller

Carrier must be fitted so that the greater angle "a" is towards the direction of rotation

DISMANTLING THE POWER CYLINDER

Remove the cylinder from the tractor, by releasing the two ball pins, disconnecting the oil pipes and removing the two bolts attaching the ball housing to the anchor bracket.

Before commencing to dismantle the cylinder, first drain the oil by moving the piston rod in and out several times from one extreme end of its travel to the other. The ram may be held in a vice by gently gripping at the valve body location.

1. Remove the spring covers and grease retaining pads from the ball pins. Remove the two grease nipples and the split pins from the ends of the unit.
2. Unscrew the end cover from the ball pin end and remove the two Belleville washers and ball cup.
3. Unscrew the lock rings immediately below the ball cup and remove the spacer, power ball pin and second ball cup.
4. Remove the grub screws or locking clip, from the manual ball cup, then unscrew the ball cup and remove the manual ball pin.
5. Unscrew the bearing assembly from the piston rod end of the cylinder and withdraw the piston and rod from the cylinder.
6. Remove the split pin, castellated nut and steel washer securing the piston to the rod. Remove the piston and slide the bearing assembly off the shaft from the piston end of the rod.

NOTE.

Do not grip the piston rod in a vice when removing the piston nut but hold the rod by applying a spanner to the two flats on the rod.

7. Remove the circlip from inside the piston rod bearing and withdraw the washer, scraper ring, flat metal washer, vellumoid washer, gland seal and gland spacer.
8. The valve body, spool and inner tube assembly may now be removed by a few light blows on a wooden block inserted in the ball pin end and resting against the ball cup.
9. Remove the inner tube from the valve body. This is a light press fit on the body and should be removed by holding and turning the inner tube whilst tapping the valve body on the edge of a wooden block.
10. Slide out the spool assembly and remove the locating sleeve. Extract the ball cup, Belleville washers and backing plate by tapping the end of the sleeve on a wooden block.
11. Remove the circlip from the valve body and slide out the end cover. Remove the 'O' rings from the end cover and the valve body bore.
12. Unscrew the plug from the end of the valve body, using a suitable Allen key, and remove the cylinder relief valve ball and spring.
13. Unscrew the nut from the spool and remove the steel washer. The operating sleeve, spacer and collar may then be removed. Slide off the reaction ring and remove the 'O' ring from its outer diameter.

INSPECTION

1. After thoroughly cleaning all parts, examine the spool and body for burrs or scoring. Remove any burrs with 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.

2. With all the 'O' rings removed insert the spool into the valve body and check its fit. With a light film of oil the spool should pass freely through the body.
3. Inspect the mating surfaces of the operating sleeve and the locating sleeve for wear or damage. The surfaces should be free from burrs and scores.
4. Check the fit of the operating sleeve in the locating sleeve. When lightly lubricated the operating sleeve should slide freely inside the locating sleeve.
5. Examine the inner tube, piston rod and bearing for wear or scoring and renew if necessary.
6. Inspect the piston rod anchor ball and socket for signs of wear or hammering. Renew if required.

ASSEMBLING THE POWER CYLINDER

1. Assemble the cylinder relief valve ball and spring into the valve body and screw home the plug and pin.
2. If any of the valve body locating pegs are loose or damaged, replace with new pegs tapped lightly into the holes in the body.
3. Assemble new 'O' rings into the valve body and on to the end cover, slide the end cover into the valve body and secure with the circlip. Assemble a new 'O' ring on to the outside diameter of the body.

CAUTION:
When fitting 'O' rings, extreme care must be taken to prevent damage which may cause subsequent leakage. All 'O' rings removed during dismantling should be discarded and new rings fitted during re-assembly.

4. Assemble the inner tube on to the valve body. This is a light press fit and should be assembled carefully by means of a few light taps with a wooden mallet, lining up the slot in the tube with the locating peg.

NOTE:
Under no circumstances must either the inner or outer tubes be gripped in a vice, as this may distort the tubes and render them useless. The assembled ram may be held in a vice by gently gripping at the valve body location.

5. Fit new 'O' rings on to the valve spool and reaction ring. Assemble the reaction washer, spring and reaction ring to the spool. Both the reaction ring and washer should be fitted with the chamfered side first.
6. Assemble the collar on to the threaded portion of the spool and assemble the spacer to locate round the collar. Positioning the spacer so that the holes in it line up with the corresponding holes in the valve body. Assemble the operating sleeve on to the collar. Fit the steel washer and locking nut and securely tighten.
7. Grease the operating sleeve then slide inside the locating sleeve.
8. Chamfer the edge of the piston rod shoulder, so that the seals will not be damaged during fitting. Fit the ball cup housing and rubber cover on to the piston rod then wipe the rod clean and smear with light oil. Slide the lip scraper on to the rod, positioned so that the inner lip is towards the anchorage end, followed by the circlip, seal and housing, flat washer and vellumoid washer.
9. Insert the gland seal spacer, lip outwards, into the recess in the piston rod bearing then carefully fit the gland seal, ensuring that this is positioned with the lip against the spacer and fits snugly into the recess in the bearing.
10. Assemble a new 'O' ring on to the outer diameter of the bearing then slide the bearing assembly on to the piston rod. Ensuring that the locking ring is first placed in position on the housing. When the bearing assembly has been pushed down towards the anchorage end of the rod, press the vellumoid washer, metal washer and seal housing into the recess in the bearing. Secure the assembly by replacing the circlip, then fit the lip scraper.

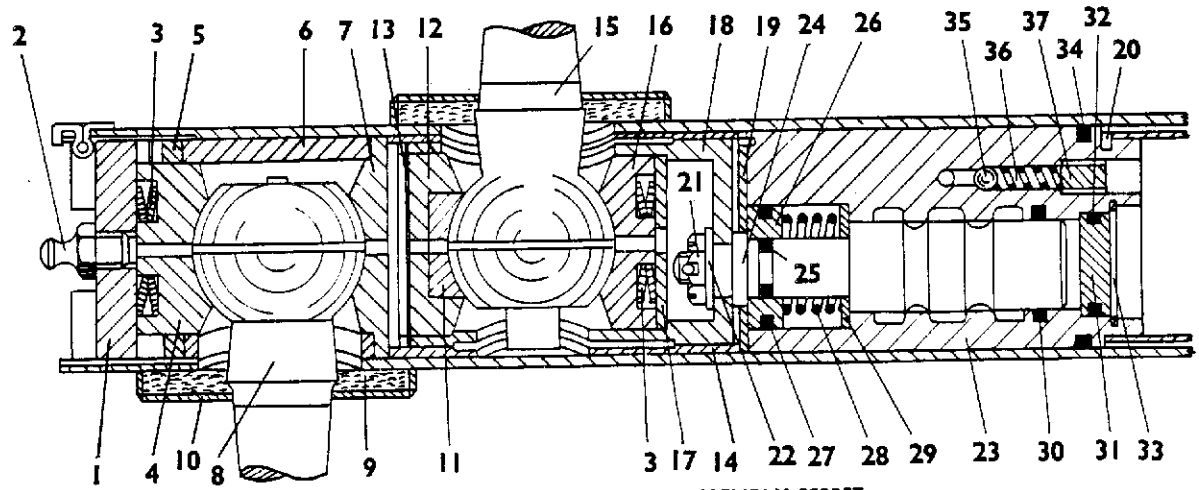

Figure 8A. HYDRAULIC RAM ASSEMBLY 902357

FIG. REF.	PART NO.	DESCRIPTION	QTY.	REMARKS
1	960796	**End Cover**	1	
2	960797	**Grease Nipple**	2	
	960799	**Split Pin**	2	
3	960785	**Belleville Washers**	4	
4	960794	**Ball Cup**—Outer	1	
5	960795	**Lock Ring**	1	
6	960793	**Spacer**—Ball Cups	1	
7	960791	**Ball Cup**—Inner	1	
8	960792	**Ball Pin**—Power	1	
	960825	**Nut**—Ball Pin	2	
9	960801	**Grease Pad**	2	
10	960800	**Spring Cover**	2	
	960788	**Ball Cup**	1	} Early type units only
	960789	**Grub Screw**—Ball Cup Locking	2	
11	960858	**Ball Cup**	1	} Later type units
12	960859	**Ball Cup Holder**	1	
13	960860	**Spring Clip**—Ball Cup Locking	1	
14	960790	**Locating Sleeve**	1	
15	960787	**Ball Pin**—Manual	1	
16	960786	**Ball Cup**	1	
17	970784	**Backing Washer**	1	
18	960783	**Operating Sleeve**	1	
19	960779	**Spacer**	1	
20	960773	**Locating Pin**	2	
21	960782	**Nut**—Valve Spool	1	
	960861	**Split Pin**—Spool Nut	1	
22	960781	**Hardened Washer**—Spool	1	
23	960759	**Valve Body and Spool**	1	Not supplied separately
24	960780	**Collar**—Spool	1	
25	960774	**'O' Ring**—Spool	1	
26	960777	**Reaction Ring**	1	
27	960778	**'O' Ring**—Reaction Ring	1	
28	960776	**Reaction Spring**	1	
29	960775	**Reaction Washer**	1	
30	960768	**'O' Ring**—Valve Body	1	
31	960770	**End Cover**—Valve Body	1	
32	960769	**'O' Ring**—End Cover	1	
33	960771	**Circlip**—Valve Body	1	
34	960772	**'O' Ring**—Valve Body	1	
35	960765	**Ball**—Relief Valve	1	
36	960766	**Spring**—Relief Valve	1	
37	960767	**Plug**—Valve Housing...	1	

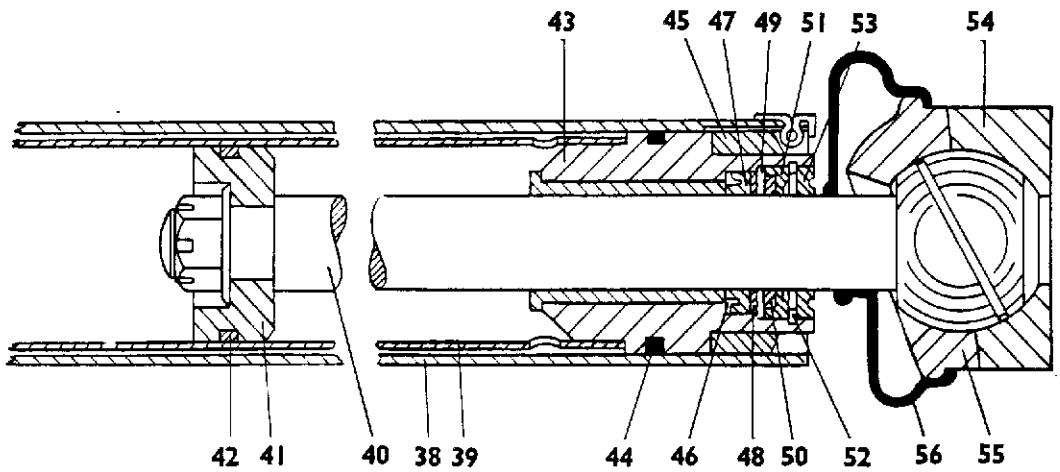

Figure 8B. HYDRAULIC RAM ASSEMBLY 902357

FIG. REF.	PART NO.	DESCRIPTION	QTY.	REMARKS
38	960798	**Outer Tube**	1	
39	960826	**Inner Tube**	1	
40	960827	**Piston Rod and Ball**	1	Not supplied separately
41	960816	**Piston**	1	
42	960817	**Piston Ring**	1	
	960818	**Washer**—Piston Rod	1	
	960819	**Nut**—Piston Rod	1	
	960820	**Split Pin**—Piston Nut	1	
43	960803	**Bearing and Bush**	1	Not supplied separately
44	960806	**'O' Ring**—Bearing	1	
45	960807	**Locking Ring**...	1	
	960799	**Split Pin**	1	
46	960808	**Gland Spacer**	1	
47	960809	**Gland Ring**	1	
48	960810	**Vellumoid Washer**	1	
49	960811	**Metal Washer**	1	
50	960862	**Scraper Ring**	1	
51	960863	**Housing**—Scraper Ring	1	
52	960814	**Circlip**—Bearing Housing	1	
53	960864	**Lip Scraper**	1	
54	960831	**Ball Cup**—Outer	1	
55	960832	**Ball Cup**—Inner	1	
	960833	**Shim**—Ball Cups		As required
	960834	**Grease Nipple**—Ball Housing	1	
56	960835	**Rubber Cover**	1	

NOTE:

The piston rod seals on early units consisted of a gland ring, vullumoid washer, metal washer, brass scraper and scraper ring. On later units however the scraper ring and brass scraper have been replaced by a square section rubber seal and an external lip scraper.

The parts listed on page 15 are all of the latest type and units originally fitted with early type seals should be converted to the new arrangement when stripped for servicing.

11. Assemble the piston ring on to the piston then fit the piston to the piston rod, positioned so that the flat face of the piston is towards the anchor end of the rod. Fit the flat washer and castellated nut to secure the piston to the rod, tighten the nut to 40 lb. ft. (5·95 kg.). Do not overtighten the nut as this may cause the piston to distort and bind in the tube.

12. Thoroughly clean the inner tube and apply a thin coating of oil to the inside. Compress the piston ring and slide the piston and rod inside the tube until the end of the tube locates in the recess in the piston rod bearing.

13. Thoroughly clean the spool assembly and smear with oil, then slide the spool into the valve body, taking care to prevent damage to the spool sealing edges. Position the assembly so that hole in the spacer locates on the dowel in the valve body.

14. Place the backing plate, chamfered side first, in the bore of the operating sleeve. Fit the two Belleville washers into the recess in the ball cup, then after ensuring that the backing plate is seated correctly, place the ball cup against the backing plate. The Belleville washers should be placed back to back and with their inner diameters together. Smearing the washers with grease will assist assembly.

15. Holding the inner tube assembly horizontal to prevent the spool falling out, slide the complete assembly into the anchorage end of the outer tube, positioning the hose ports in the valve body in alignment with the holes in the outer tube. Screw the end bearing locking ring into the outer tube until the hose ports coincide with the holes in the outer tube, inserting a banjo bolt in one of the hose ports to locate the spool valve body.

NOTE:

When fitting the piston rod bearing into the outer tube, take special care to prevent cutting the 'O' ring on the tube threads. A coat of thick grease on the 'O' ring and threads will assist assembly.

16. Apply a liberal coating of grease to the spherical surfaces of the manual ball pin and assemble through the holes in the outer tube and sleeve, ensuring that the limit peg is located in the elongated holes. Fit the outer ball cup, screwing home tight then releasing one quarter turn before locking with the two grub screws, or spring clip.

17. Fit the larger of the two power ball pin cups, ensuring that this seats squarely against the locating sleeve then fit the power ball pin after smearing with grease. Fit the power ball pin spacer then screw the lock ring in to the end of the tube. After ensuring that the spacer is in the correct radial position and the hose ports are positioned centrally in the holes in the outer tube, firmly tighten the lock ring and also the lock ring at the anchorage end of the ram. Lock the anchorage end lock ring with a split pin.

18. Fit the outer ball cup, then place the two Belleville washers, back to back, and inner diameters together, in the recess in the ball cup and screw the end cover into position. Fully tighten the end cover then release quarter of a turn and lock with the split pin.

19. Fit the grease nipples and apply a grease gun. Fit the grease retaining pads and spring covers to the ball pins.

20. Refit the cylinder to the tractor, firmly tightening and split pinning the ball pin nuts and tightening the two ball anchorage bolts to 45 lb. ft. (6·2 kgm).

21. After fitting the hoses, fill the oil reservoir with a recommended grade of oil then lift the front wheels clear of the ground. Start the engine and turn the steering wheels from lock to lock several times to expell all air from the system. Top up the oil reservoir and lower the front wheels.

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DAVID BROWN TRACTORS

STEERING PUMP WITH TANK TYPE A23-17331

1. DESCRIPTION

This unit is a high performance gear pump of 'sandwich' construction incorporating pressure balanced bearings. The pump rear cover houses a high pressure relief valve and the integral reservoir incorporates return line filtration.

2. INSTALLATION

The pump will give excellent performance provided that care is taken during its installation and maintenance. The following points should be noted in order to ensure maximum efficiency.

a) One of the following grades of oil should be used
Shell - Tellus 27
BP - Energol HLP65
Esso - Automatic Transmission fluid or NUTO H144
Castrol - Hyspin AWS32 of Agricastrol ATF
Mobil - Mobilfluid 200
Initial fill oil capacity 4.25 pints (2.4 litres) maximum
Refill capacity being approximately 2.5 pints(1.4 litres).

b) The level of the oil should be maintained to the upper edge of the inclined filler plug hole with the tractor in the full right hand lock.

c) The filter should be changed initially at 500 hours and thereafter at 1000 hours or annually which ever occurs first.

d) Access for the removal of the power steering pump may be obtained after removing the AC fuel lift pump. It is important that the power steering pump is removed prior to changing the filter. Assembly of the new filter should be carried out with the pump in the vertical position on the bench.

3. DISMANTLING

IMPORTANT - Always dismantle hydraulic equipment at a clean work bench after thoroughly cleaning the exterior. Cleaning solvents likely to attack the synthetic rubber seals must not be used. Do not use fibrous rags or cotton waste.

1) After detaching the pump from its mounting remove the external drive gear, using a suitable extractor and remove the woodruff key from the drive shaft.

2) Unscrew retaining bolt and remove reservoir and filter.

/continued.....

3) Unscrew relief valve assembly from rear cover of pump.

4) Unscrew rear cover retaining bolts and remove pump rear cover.

5) Remove the gears and bearings from the pump body. It is suggested that the bearings and body are lightly marked with pencil to facilitate correct re-assembly.

6) Separate the flange from the body by gently tapping with a soft faced mallet.

4. INSPECTION AND SERVICING

Sealing Rings

Inspect sealing rings for imperfections. These may be used again if undamaged but it is recommended that they are replaced if they have been in service for more than six months.

Bolts

Clean or replace if damaged.

Bearings

Examine the bearings for wear on the face and in the bores. Pay particular attention to the condition of the lubricating scrolls and the portion of the face between bores known as the seal bridge. Score marks or damage across the seal bridge can cause high internal leakage losses.
At this stage of major overhaul the bearings should be renewed but, if not badly worn, may be salvaged by polishing as follows:-

1) Place a sheet of 'O' grade emery paper lubricated with paraffin on a truly flat surface and polish the bearings face using a light rotary motion.

2) The outer diameters may be lightly polished to obtain free movement in the body bore.

Pump Body

Visually inspect the pump body for external damage and cracks. Examine bore for wear and damage, it is normal for the gears to cut a light track on the inlet side of the body bore. The depth of track should not exceed 0.004 in if the body is to be considered for use again.

The only re-working advisable is to remove burrs at the edge of the gear track with 'O' grade emery paper.

/continued.....

Gears.

Inspect the gears for scored or worn faces or journals, damaged teeth and surface scratches.

Slight wear and scoring on the journals may be removed by polishing between lathe centres using '0' grade emery paper lubricated with paraffin.

Slightly scored gear faces may be renovated by sandwiching emery paper between the gear face and a scrap bearing.

Whilst servicing the gears particular attention should be paid to the following:-

1) Gear widths of drive and driven gear must be within 0.0002 in of each other to ensure satisfactory efficiency. Spare gears are only supplied in matched pairs.

2) Journals of any gear must be within 0.0005 in of each other.

3) Gear faces must be flat. This feature may be checked by blueing a bearing face and rotating against the gear - this will also reveal any sharp edges on the teeth.

Flange and Cover

Visually inspect for any damage or cracks and check the flatness of the sealing faces with a straight edge.

Relief Valve Cartridge.

Grip the relief valve seat, reduced diameter end of the valve, in a vice fitted with soft jaws and loosen from the main body. Remove from the vice and unscrew with seat uppermost to prevent the valve head, seal, guide pin, shim and spring falling out.

Examine the blue cone and its seat to ensure there is a satisfactory seal and lightly lap if necessary using metal polish, thoroughly flushing afterwards.

Examine the guide pin and P.T.F.E. damper in the valve head ensuring that contaminant is not embedded in the P.T.F.E. material.

The only re-working advised is lightly lapping the valve cone on its seat and cleaning. Should this fail to cure the relief valve fault then the cartridge assembly complete should be replaced.

Reservoir and Filter

Examine the reservoir for damage and distortion particularly the 'O' ring sealing face and the return port joint. Discard the filter element.

/continued.....

UNSERVICABLE PARTS

In the event of components not cleaning up as detailed, the advisable course is to clean out the hydraulic system and replace the complete pump unit. Worn components can, in an emergency, be replaced but the following points should be noted.

Under working conditions hydraulic pressure within the pump loads the gears towards the inlet side of the body thus cutting the running track. If the bearings or gear journals wear, the gears move over and deepen the track.

Therefore if the running track is worn past or to the limit for re-use, the fitting of a new bearing may not improve pump efficiency as the new bearing will hold the gears and prevent them from bottoming in the running track.

6. RE-ASSEMBLY

Using a lithium - based high melting point grease pack the cavity between the lips of the shaft seal, grease all replacement seals and fit to their respective positions.

Lightly lubricate all internal surfaces with clean hydraulic oil.

1) Place flange, inner face uppermost over the open jaws of a vice with the heart shape of the sealing rings pointing towards you.

2) Locate body dowels onto flange and gently tap faces together with a soft faced mallet.

3) Slide one bearing to bottom of body bore, face uppermost and with relieved radii away from you.

4) Cover drive gear shaft key way with adhesive tape to protect seal. Insert drive gear, drive taper downward, through the bearing and flange and insert drive gear.

5) Insert other bearing in body bore, face downward and relieved radii away from you.

6) Assemble relief valve cartridge to pump rear cover, tighten to 3.4 - 4.5 N.M (30-40 lbs. ft.), and place cover assembly, face down, on pump body with the heart shape of the sealing rings pointing towards you.

7) Insert pump retaining bolts and tighten to 2.8 - 4.2 N.M (25-37 lbs. ft).

8) Place filter element on cover cone, locate lug on inside of reservoir lip with recess on pump body and push reservoir fully home over body spigot.

9) Insert reservoir retaining bolt and screw in until head engages washer and then rotate a further 3/4 to 1 turn. Care should be taken not to overtighten and distort the reservoir.