



# ***TRACTOR SHOP MANUAL***

## **SUPPLEMENT**

- **POWER STEERING  
600—800 TRACTORS**

*Prepared By*

**TRACTOR AND IMPLEMENT DIVISION  
FORD MOTOR COMPANY**

# FOREWORD

This supplementary shop manual contains all of the information necessary for servicing power steering on Ford Series 600 and 800 Tractors.

The manual contains information on the construction, operation, overhaul, maintenance and trouble shooting of the power steering system. Wherever possible, the step-by-step service procedures are accompanied by disassembled views and servicing illustrations.

Keep this supplement with your copy of the Tractor Shop Manual, and in a location where it will be readily available for use at all times.

**TRACTOR AND IMPLEMENT DIVISION  
FORD MOTOR COMPANY  
SERVICE DEPARTMENT**

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## STEERING, FRONT AXLE, BRAKES, WHEELS AND TIRES

## Chapter IB

**Power Steering (600—800 Tractors)**

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The Ford Power Steering System used on Series 600 and 800 Tractors is an adaptation of the "integral hydraulic gear" type of power steering in which the control valve is packaged with the steering gear while two power cylinders are attached to the steering linkage. Hydraulic power is used to assist all steering operations, but in the event of hydraulic failure, the system provides a mechanical steering control which enables the operator to exercise complete control of the steering system at all times.

A detailed description of each of the power steering components and its operation is given under the heading "1. Construction and Operation." The servicing procedures for the components are given under the headings "2. Overhaul - Pump Assembly," "3. Overhaul - Control Valve and Steering Gear Assembly," and "4. Overhaul - Power Cylinders."

Information regarding maintenance and trouble shooting is presented under the headings "6. Maintenance," and "7. Trouble Shooting."

**I. CONSTRUCTION AND OPERATION**

The Ford Power Steering System consists of a pump and reservoir assembly with a combined flow control and relief valve located in the pump body; a control valve assembly combined integrally with the steering shaft and gear assembly; two double acting cylinders attached to the steering drag links; a two groove pulley, the connecting hydraulic tubing; and drag link and radius rod assemblies. These assemblies are shown in Figure 1.

The construction and operation of the power steering unit is explained under headings which indicate the unit or condition involved.

**A. Pump Assembly**

A hollow sleeve type pump is used on the power steering system. The pump

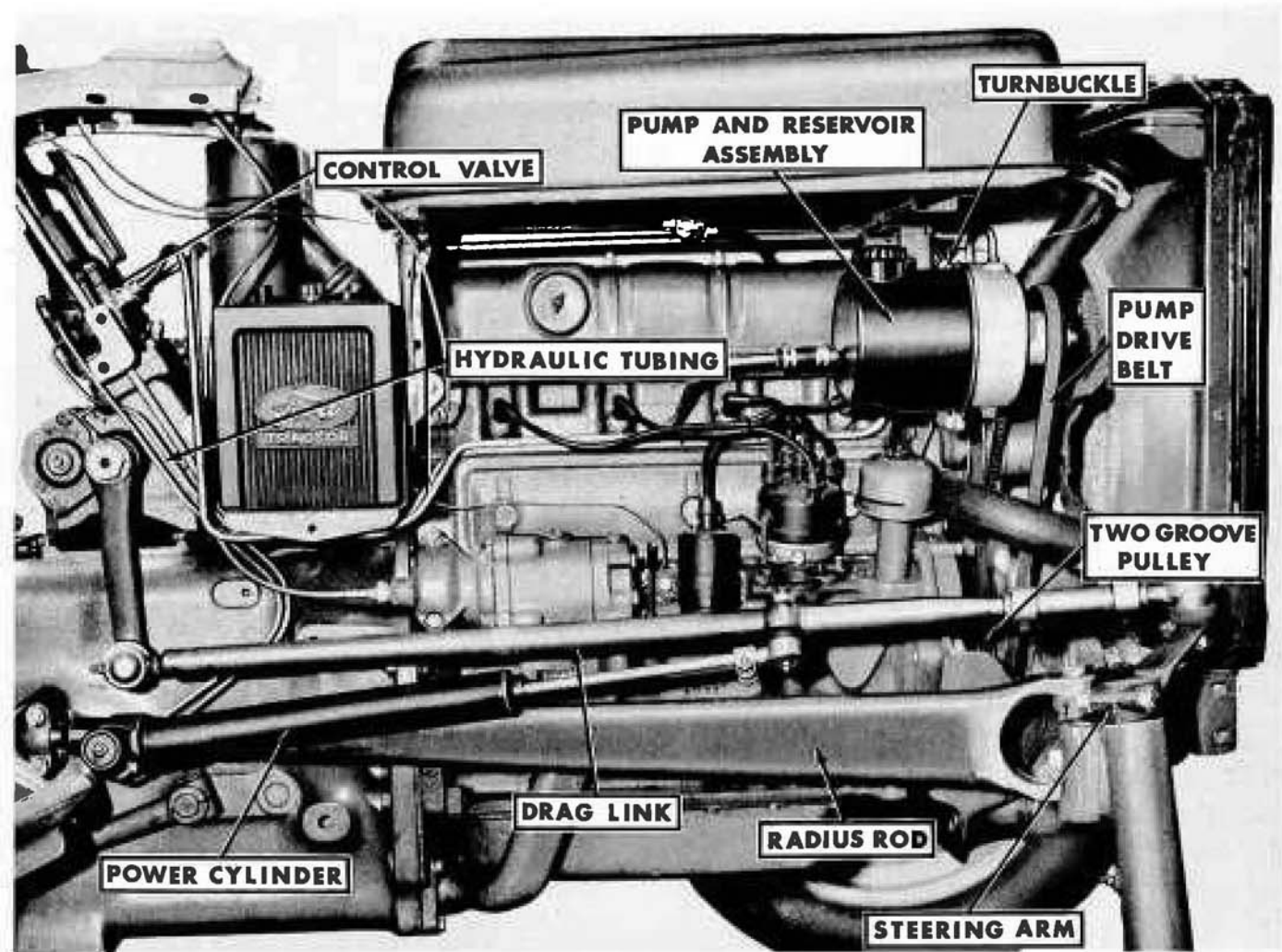


Figure 1 - Components of Power Steering System

body is attached to the tractor by means of a mounting bracket located between the fuel tank bracket and the water pump outlet. A turnbuckle between the top of the fuel tank bracket and the pump body provides the means for adjusting the pump belt tension. The pump is driven by a single V-belt from the two groove crankshaft pulley.

The oil reservoir is attached to the rear of the pump body in such a way that the pump body is submerged in the reservoir. The reservoir is held in place by a clamp ring and a rubber seal is installed between the reservoir and the pump body to prevent leakage. A replaceable filter element is installed on the return line inside of the reservoir. A spring loaded ball type relief valve is installed in the return line to permit oil to bypass the filter in the event the filter becomes clogged.

Correct oil level in the reservoir is indicated by a dipstick attached to the filler cap. A neoprene gasket is installed in the top of the filler cap to prevent

oil leakage from the reservoir and dirt entry into the reservoir. During operation, oil flows from the return line, through the filter element, into the reservoir. The oil then enters the pump through the pump inlet which is submerged in the reservoir.

The pump body contains a drive cylinder block and a driven cylinder block each containing nine holes. The two cylinder blocks are at an angle to each other in the pump body and nine bent hollow sleeves connect each hole in each cylinder block. The drive block is splined to the pump shaft and the mechanical connection of the nine bent sleeves transmits the rotation of the drive block to the driven block. The drive shaft is supported at the pulley end by a sealed ball bearing assembly which is a slip fit in the bearing cap and is held in place by a snap ring. A lip type spring loaded oil seal is installed behind the bearing. The inner end of the drive shaft is supported by a bronze bushing pressed into the bearing cap.

Because of the angle between the cylinder blocks the effective lengths of the holes (which are connected by the bent sleeves) are longer at one point in their rotation than they are 180° from that point. Oil is allowed to pass into the holes at the point in rotation of the cylinder blocks where this effective length is the longest. As the rotation of the blocks shortens this effective length, the volumes of the holes are reduced and oil is forced out the discharge side of the pump. The output of the pump must be high enough to provide the necessary power assist when the tractor is being turned with the engine idling. When the engine is at idle speed, the pump is operating at its minimum output which is great enough to provide the hydraulic assist for turning.

To limit pump output at higher engine speeds, a spool type, spring loaded flow control valve is provided in a bore in the pump body.

The flow control valve, which is hollow and closed at one end has one small metering orifice drilled through its wall. A spring loaded ball type pressure relief valve is installed inside the flow control valve spool. The pressure relief ball and spring are held in place by a threaded valve seat which contains a small metering hole in its center. The flow control valve spool and spring are retained in the pump body by a hex head fitting. A neoprene "O" ring is installed around the spring retaining fitting to prevent leakage from the bore of the pump body.

The flow control valve limits the output of the pump as follows:

Flow at 1250 R. P. M. 4.75 to 5.25 G. P. M. at 600 P. S. I.

Flow at 3000 R. P. M. 5.50 to 6.50 G. P. M. at 100 P. S. I.

Flow at 700 R. P. M. 2.80 G. P. M. Min. at 600 P. S. I.

700 to 800 P. S. I. Shut-Off Pressure

Oil Temperature 155° F.

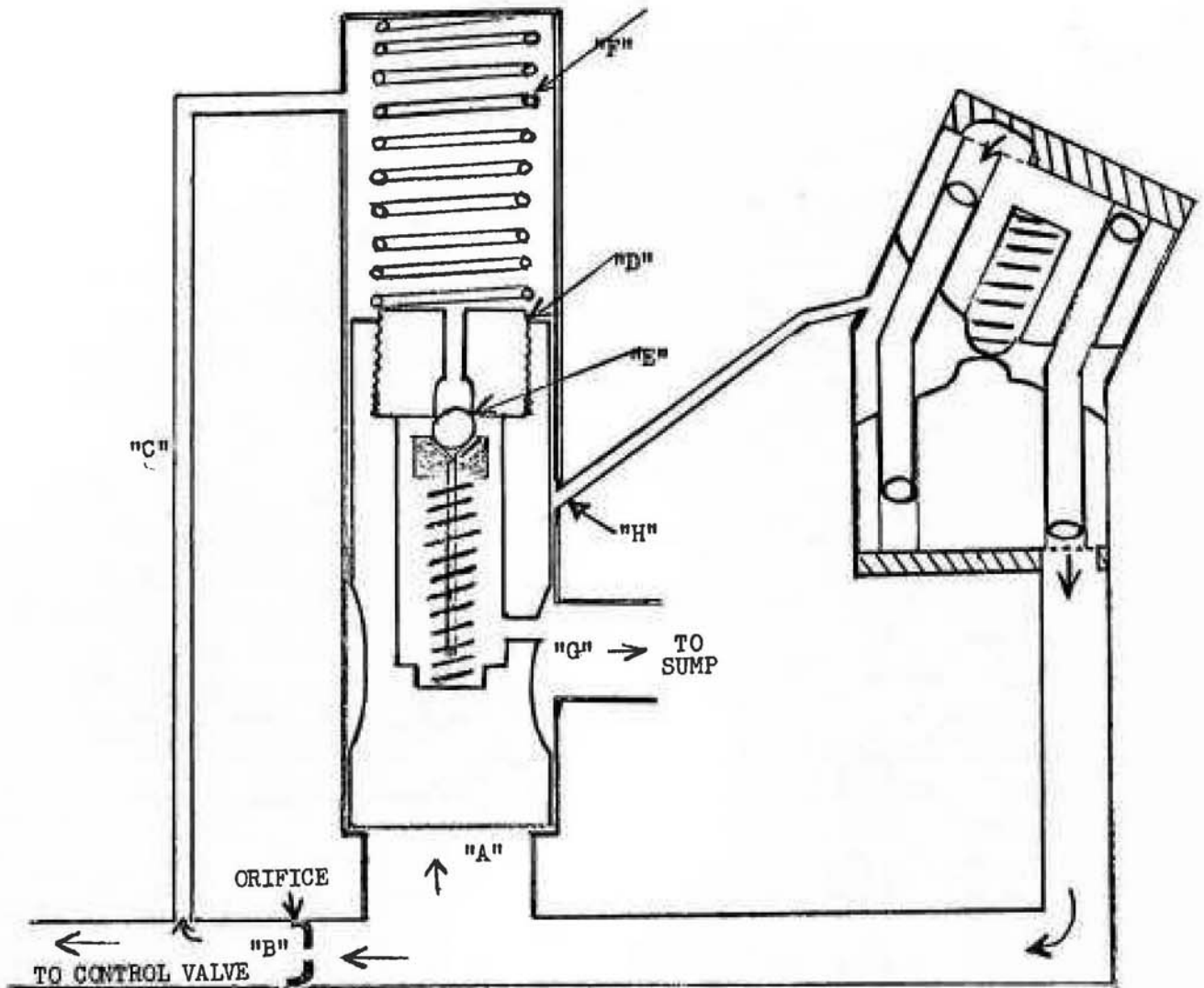


Figure 2 - Flow Diagram - Power Steering Pump

This is accomplished in the following manner. Oil from the pressure side of the pump flows past the closed end of the flow control valve spool and pump pressure is exerted against the closed end of the spool at "A" Figure 2.

Another passage "C" directs oil from beyond the metering orifice "B" in the discharge port to the opposite end of the flow control valve spool and this pump pressure at "D" plus the action of the flow control valve spring tends to keep the flow control valve closed.

When the pump speed is increased, due to an increase in engine speed, the pump output tends to exceed the specified flow. This creates a pressure differential between the outside and the inside of the flow control valve, due to the flow through the metering orifice "B" in the pump discharge port. Since the pressure

on the closed end of the flow control valve spool at "A" exceeds the pressure on the spring loaded end at "D" (due to a pressure drop after oil passes through the metering orifice in the pump discharge port), the entire valve assembly overcomes the spring pressure and moves toward the spring. This action uncovers a port in the pump body at "G" which permits excess oil to flow out of the pump body and back into the reservoir. Thus the pump output is limited to a maximum flow as specified in the chart on page 6 regardless of pump or engine speed.

The pump produces the oil pressure required in the system to meet all normal steering conditions. The amount of oil pressure produced depends on the pressure required to operate the power cylinders. The pressure relief valve installed in the flow control valve limits pump pressure to 800 P.S.I. The pressure relief valve operates as follows:

The relief valve is designed so that when pressure in the system exceeds the relief valve setting of 700 to 800 P.S.I., the pressure is transmitted through the passage "C," and the ball "E" in the relief valve will unseat, thereby relieving the pressure exerted at the spring loaded end of the flow control valve spool "D." A small quantity of oil flows through the relief valve within the flow spool, and passes out through the small orifice in the spool and returns to the reservoir. When the pressure is relieved at the spring loaded end of the spool, pressure acting at the closed end of the flow control valve "A" causes the spool to move toward the spring and oil is returned to the reservoir in the same manner as when the flow control valve is operating to limit flow only. The operation of the relief valve in conjunction with the flow control valve limits the maximum pressure obtainable in the system to 800 P.S.I.

## B. Control Valve and Steering Gear Assembly

The steering gear used on Series 600 and 800 Tractors is a recirculating ball bearing, worm and nut type. A spool type control valve is mounted over the steering shaft and bolted to the upper end of the steering gear housing. In the manual gear the worm is mounted in tapered roller bearings which confine the worm endwise as well as radially. In the hydraulic gear these bearings are replaced with needle bearings which allow endwise movement of the shaft. Ball-thrust bearings are located at either end of the valve. The worm shoulder is pulled against the inner bearing, valve and outer bearing by means of a nut. The races of the thrust bearings at the ends of the valve can move into counterbores in the end faces of the valve housing, permitting a slight axial movement of the worm, the valve, and the steering shaft. The dimensions are such that when the valve is at the midpoint of the allowable axial play, the valve is in the neutral position.

The valve is held in neutral position by six plungers and three springs in the valve housing which bear against the inner races of the ball-thrust bearing and at the same time on the adapter assembly and the cover and tube assembly above and below the valve housing.



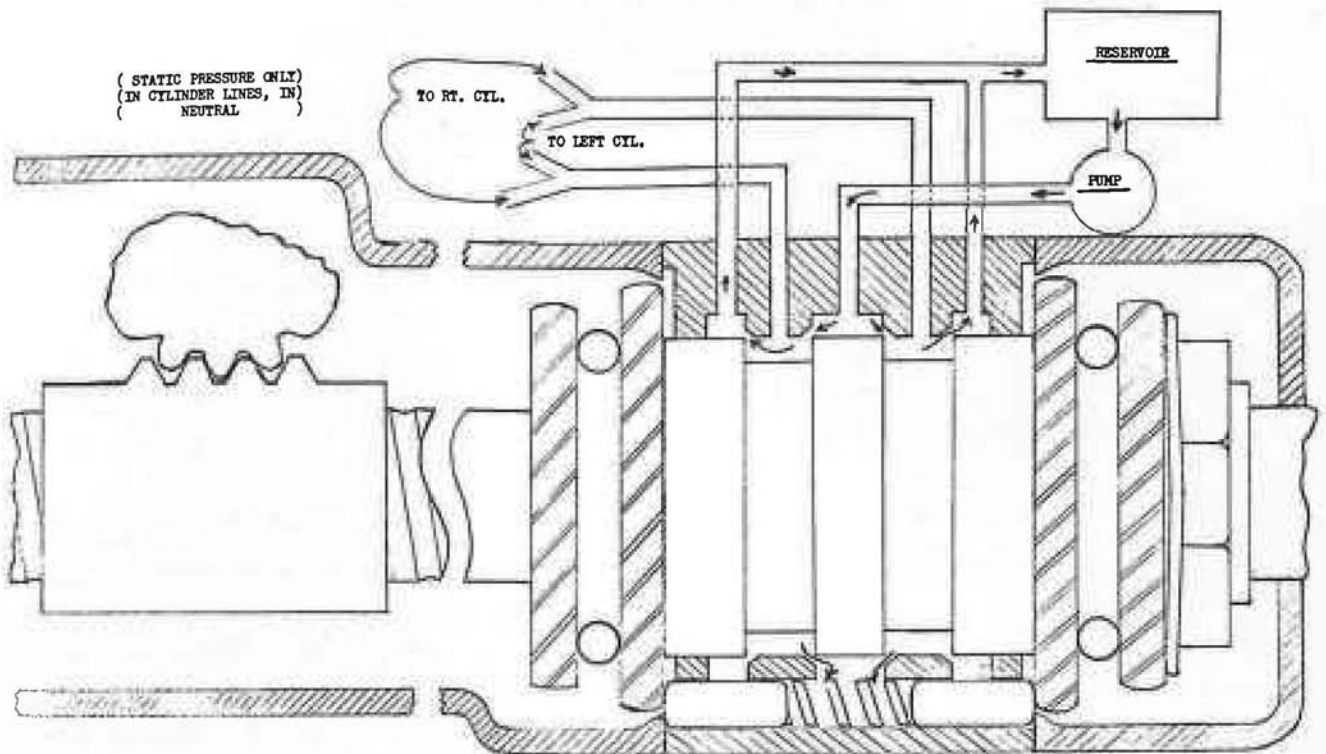


Figure 3 - Oil Flow in Neutral

A ball check or anti-cavitation valve assembly is threaded into the valve housing port through which fluid is returned to the reservoir. Two additional reaction plungers and anti-cavitation valves are located in a bore parallel to those which contain the centering springs and plungers. These anti-cavitation valves allow the return of hydraulic fluid to the reservoir when the system is operated manually without pump pressure. In addition to the reservoir port, the control valve housing has one port which admits fluid from the pump and two ports for each of the two double acting power cylinders.

In operation, oil pressure is delivered from the pump to the control valve through hydraulic tubing. When the steering wheel is turned the worm will tend to move up or down depending on the direction the wheel is being turned, because the position of the ball nut engaged in the sector shaft is fixed. This axial movement of the worm and shaft assembly is transmitted to the control valve and movement of the valve directs oil pressure to the appropriate end of each power cylinder. The movement of the valve within the valve housing is limited by the inner race of one of the thrust bearings engaging the valve housing itself which acts as a positive stop. The maximum movement of the valve is 0.070 inch (.030 to .035 inch either side of neutral).

When the operator stops the steering wheel at the desired position, the thrust is removed from the steering shaft and the action of the centering springs returns the valve to the center or neutral position.

### C. Power Cylinders

The power cylinders are double acting hydraulic cylinders. A cylinder is mounted at the rear of each radius rod and the piston rod of each cylinder is secured to the forward part of each drag link. Two hydraulic tubing connections are located at the rear of each cylinder.

The control valve directs fluid to the cylinders in such a way that the cylinders operate in opposite directions from each other.

### D. Straight Ahead Driving

When the tractor wheels are in the straight ahead position, the control valve spool is held in the center or neutral position by the centering springs. In this position, oil from the pump flows by the valve and returns to the reservoir through the port in the control valve housing. The pump output will simply be recirculated in the system without doing any work. Figure 3 illustrates the oil flow when the valve is in neutral.

### E. Left Turn

When the steering wheel is turned to the left, a thrust will be developed between the sector gear shaft and the ball nut. Thrust increases as the effort at the steering wheel increases. As it becomes increasingly difficult to move the nut, it reaches the point where the axial force exerted by the worm overcomes the centering springs in the control valve body. The worm shifts upward and along with it, the valve moves and directs the flow of oil to the rear of the left hand power cylinder and to the front of the right hand power cylinder, thereby adding hydraulic force to the manual effort of the driver to move the front wheels to the left as required. Oil from the opposite side of each piston is directed back through the valve body to the pump reservoir. In addition, oil pressure is directed against the valve centering plungers to supplement spring force in trying to center the valve. This causes the force required to turn the wheel to increase as the front wheels become more difficult to turn, thereby giving the driver a natural feel of steering. Figure 4 illustrates the flow of oil during a left turn.

### F. Right Turn

The system operates in the same manner for a right turn except that the worm and valve assembly tend to move downward and the oil flow is directed to the opposite side of each power cylinder causing the front wheels to steer to the right.

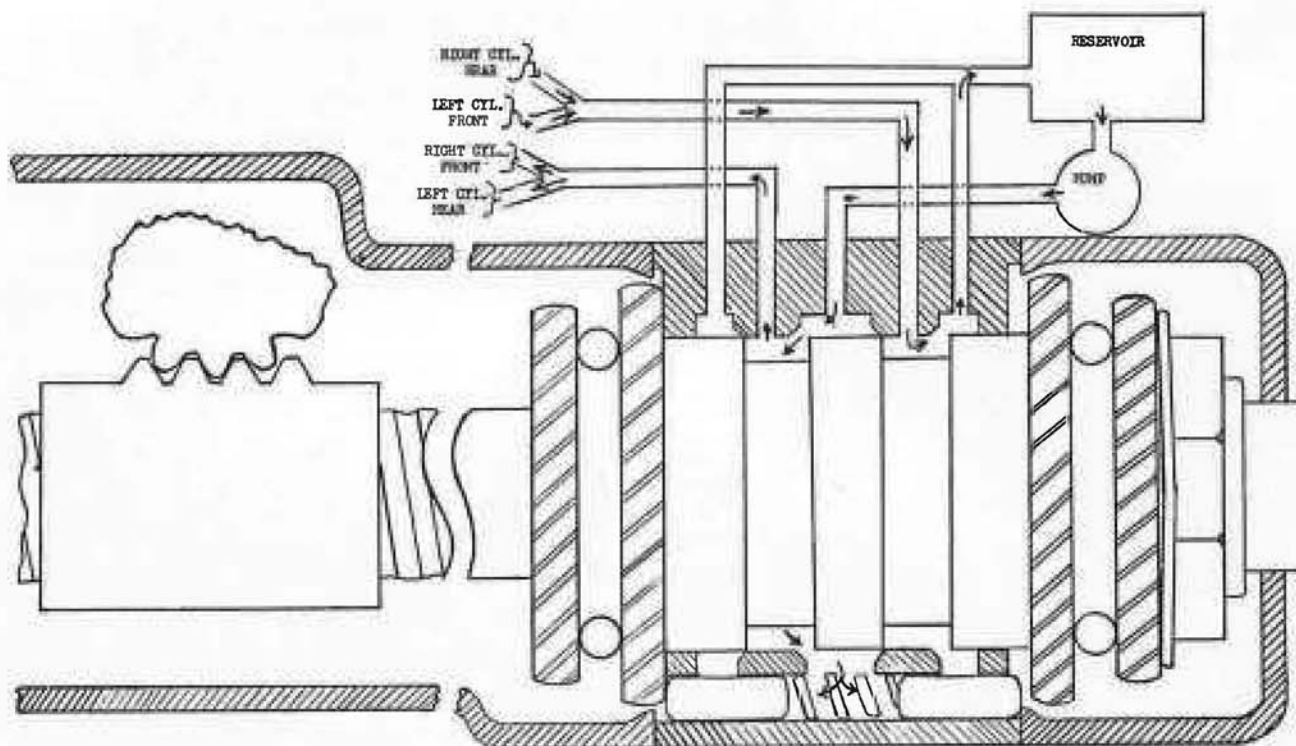


Figure 4 - Oil Flow During Left Turn

### G. Operation Without Pressure Supply

If the pump fails to deliver oil for any reason, the tractor may be steered manually through the regular steering linkage. The cross-over provisions in both the return port of the control valve and in the valve housing itself allow oil to be directed to either end of the power cylinders as required. Manual movement of the power cylinders is not restricted by the necessity of forcing oil back through the pump and steering effort is not appreciably increased over that required for the manual steering system. Figure 5 shows the check valves and cross-over provisions.

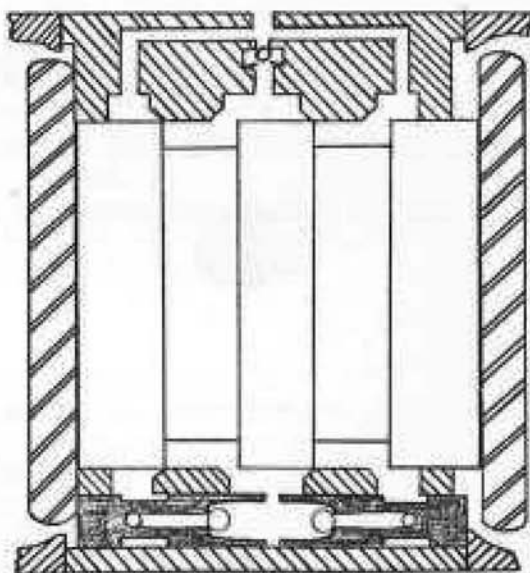


Figure 5 - Valve Housing Showing Reaction Plungers and Anti-Cavitation Valves

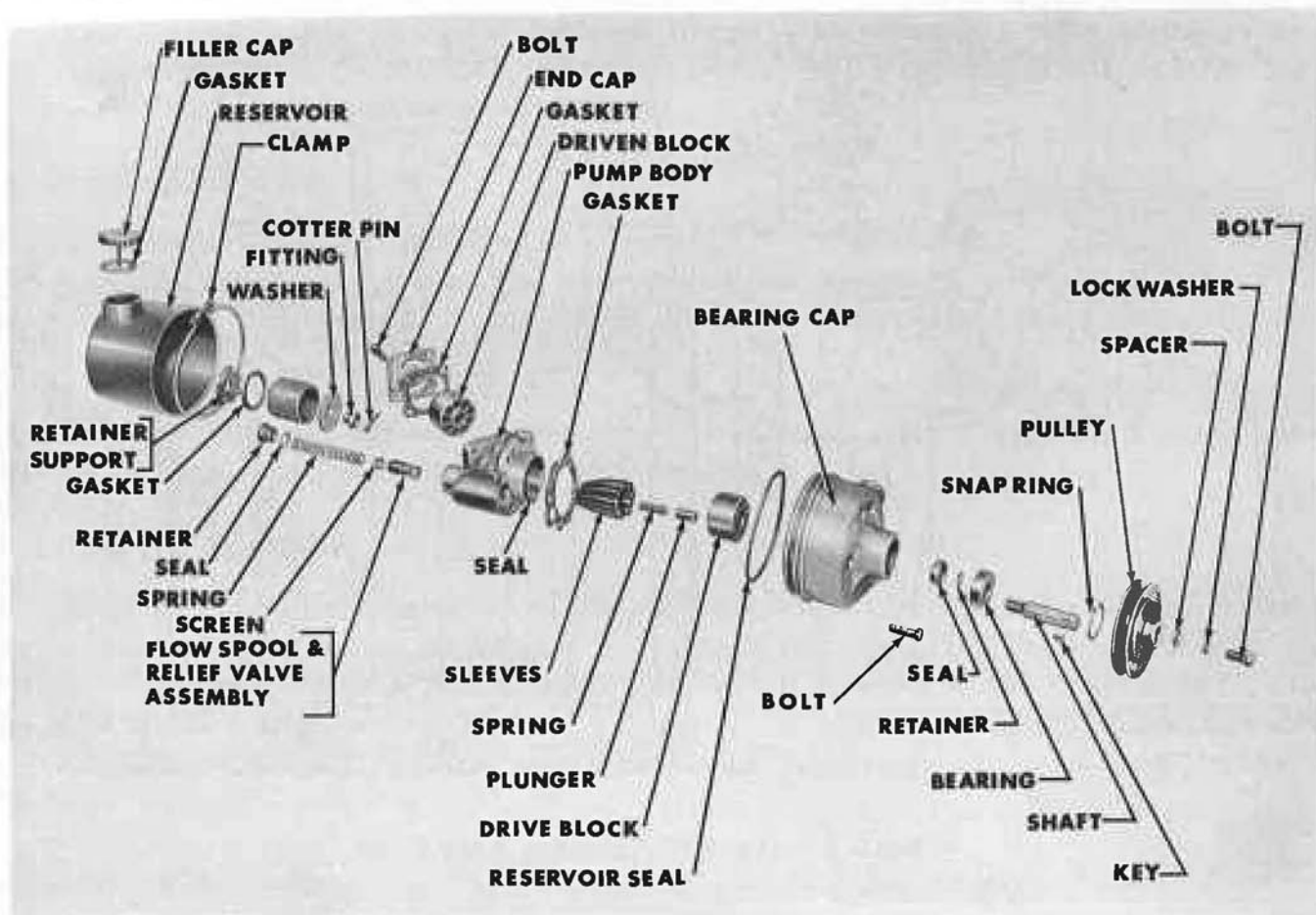


Figure 6 - Power Steering Pump (Disassembled View)

## 2. OVERHAUL - PUMP ASSEMBLY

### A. Removal

1. Remove the pump discharge line from the top of the pump body.
2. Remove the pump return line from the rear of the reservoir and cap the pump reservoir inlet.
3. Loosen the turnbuckle to relieve the belt tension and remove the drive belt. Remove the cotter pin and clevis pin from the turnbuckle and pump.
4. Remove the bolt from the pump mounting bracket.
5. Remove the pump from the tractor.

### B. Disassembly

Figure 6 shows an exploded view of the pump assembly and should be referred to for parts identification.

1. Drain the oil from the pump and reservoir.

2. Cover the discharge and return line fittings with protective closures to exclude dirt from the pump. Thoroughly clean the exterior of the pump.

**NOTE:** The pump must be disassembled in clean surroundings. Clean the bench area to be used for disassembly and cover with clean paper.

3. Remove the reservoir clamp ring.
4. Remove the reservoir from the pump body.
5. Remove the pump drive pulley retaining bolt from the end of the pump shaft.
6. Remove the pulley from the shaft with a suitable puller. Use a shaft protector to protect the end of the shaft.

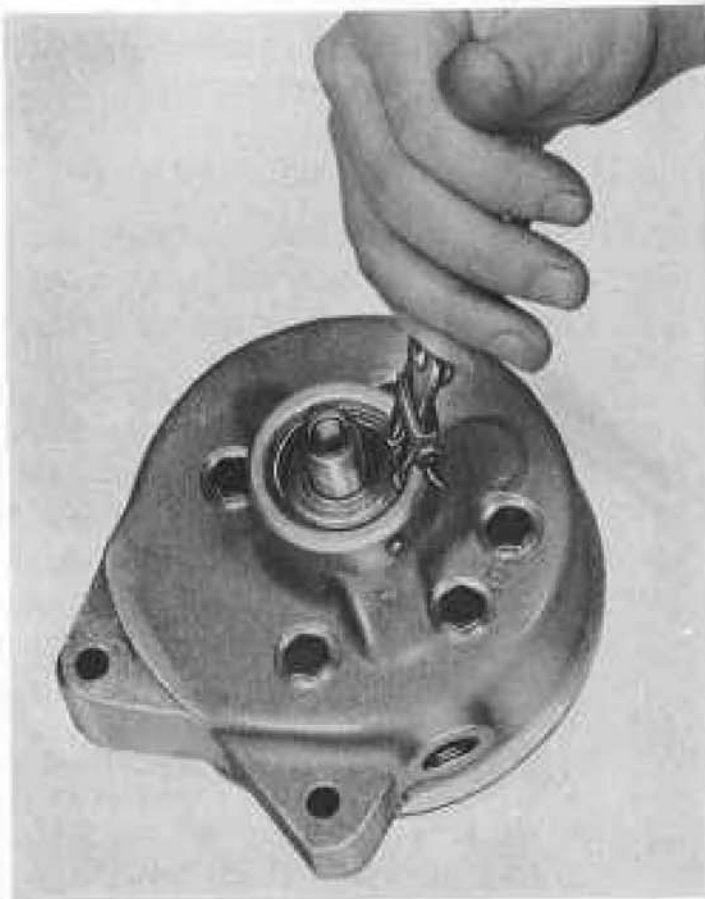


Figure 7 - Removing or Installing Snap Ring and Bearing and Shaft Assembly

**CAUTION:** Take care not to lose the Woodruff key from the pump shaft.

7. Mount the pump in a vise gripping the pump at the bearing hub. Loosen the four hex head bolts at the inlet end cap.
8. Remove the flow valve fitting from the end of the flow spool housing. Take care to prevent the flow valve spring and fitting from flying out.
9. Grip the pump in a vise at the inlet end and remove the five hex head bolts from the bearing cap.
10. Remove the pump from the vise and disassemble both end caps from the pump body. The cylinder blocks will push out of the body slightly due to the pressure of the plunger spring between the blocks.
11. Remove the cylinder blocks and the nine sleeves from the pump body as well as the cylinder plunger and plunger spring.
12. Remove the snap ring from the bearing end cap with Tru-Arc No. 3 snap ring pliers as shown in Figure 7.
13. Push the bearing and shaft sub-assembly from the bearing cap.
14. Remove the cotter pin and hex head fitting from the top of the filter assembly in the reservoir.

15. Remove the filter retainer, filter, gasket retainer, and rubber gasket from the reservoir.

### C. Cleaning, Inspection and Repair

1. Wipe the bearing and shaft assembly with a clean, lint-free cloth. Do not soak in cleaning solvent, as the lubricants sealed into the ball bearing may become diluted by the solvent.
2. Inspect the shaft for wear and check the ball bearing for roughness or noisy operation. If the bearing must be replaced, push the bearing from the shaft away from the splined end of the shaft. Examine the retaining ring in the groove on the shaft and replace the ring if it is worn or distorted. Install a new ball bearing with the trade marked side toward the pulley end of the shaft by supporting the bearing on the inner bearing race and press the shaft through the bearing until the retaining ring stops against the inner race of the bearing. The retaining ring must always be located between the bearing and splined end of the pump shaft.
3. Check the fit of the sleeves in the cylinder block bores. The sleeves must slide freely. Examine the mating surfaces of the sleeves and the bores. Heavy scoring, if present, can impair pumping efficiency. Either cylinder blocks or sleeves showing such signs of scoring should be replaced.
4. Examine the flow valve and valve liner. Slight hair line scratches are permissible. If burrs or scratches which may cause the flow valve to stick are found, the flow valve should be replaced.
5. Insert the flow valve in the valve liner. Move the valve back and forth and rotate the valve slightly in the liner with a pencil or other such rod that will not mar the I.D. of the liner. The valve must slide freely. If the valve sticks or drags, remove it from the liner and remove any dirt, nicks or burrs from the valve or liner.
6. Examine the shaft seal in the bearing cap. If it is worn or damaged, remove the seal with a suitable puller. When installing a new seal, the lips of the seal must point toward the casting. Press the seal into its bore until the shoulder of the seal stops against the bearing cap casting. Care must be taken to see that the seal is started straight.
7. Examine the running surfaces of the bearing cap (Figure 11) and the inlet end cap. If heavy scratches or gouging are present or if the port edges are damaged, the part should be replaced.
8. Examine the pump body for signs of unusual wear or damage. Small scratches or burrs can be removed with fine emory paper. If it is badly scored or damaged, a new pump body should be used.
9. Examine the filter assembly. Filters can normally be reused after cleaning with a suitable solvent. If the filter is cracked or shows signs of being



Figure 8 - Driven Cylinder Block and Assembly Fixture, Tool No. N310776



Figure 9 - Assembling Sleeves in Driven Block

plugged after it is cleaned, replace the element.

10. Examine the rubber gasket below the filter. Replace the gasket if signs of wear or distortion are noted.

#### D. Assembly

All parts must be thoroughly clean and assembly procedures should be conducted in a clean work place.

1. Press the drive shaft and bearing sub-assembly into the bearing cap using an arbor press and a sleeve which bears on the outer race of the ball bearing. Make certain that the shaft and bearing are properly aligned when being pressed into place, otherwise the shaft may push the bronze bushing out of the bearing cap or may scratch or mar the I.D. of the bushing. Install the snap ring. Check the rotation of the shaft to make certain that it turns freely.
2. Place the driven cylinder block (without spline) on the assembly fixture, Tool No. N310776, and insert the plunger spring and the plunger. See Figure 8.
3. Note which two pads on the assembly fixture are the shortest and insert seven sleeves in all the holes in the cylinder block except these two as shown in Figure 9. For ease of assembly, the sleeves should be lubricated with clean light oil.
4. Place the pump body, square end down, over the cylinder block, positioning the end of the pump body on the locating pins of the fixture.
5. Insert the two remaining sleeves in the cylinder block. Position the nine sleeves to a uniform spacing.

6. Position the drive block (with spline) over the sleeves, sighting through the bores in the block for alignment. Using a pointed probe slightly smaller in diameter than the sleeve bores, correct the alignment of the sleeves while guiding the cylinder block downward as shown in Figure 10. Continue this procedure until all of the sleeves are engaged and the block may be pushed home. Do not force the cylinder block at any time as proper alignment of the block and sleeves will allow the block to be pushed smoothly into place.



Figure 10 - Aligning the Drive Block and Sleeves

7. Install a new "O" ring in the counter bore at the flow valve liner in the valve body.
8. Install a new bearing cap gasket and assemble the bearing cap to the valve body. Make sure the locating pin on the bearing cap engages the locating hole in the pump body. Holding the bearing cap down, tighten the five hex head bolts finger tight.
9. Remove the body and cylinder block assembly from the fixture using care to see that the blocks are not forced out of the body by the plunger spring.
10. Install a new inlet end cap gasket and assemble the inlet end cap to the valve body bringing the hex head bolts down finger tight.
11. Grip the end of the pump shaft in a vise and rotate the pump applying force on the O.D. of the bearing cap. The pump should rotate freely with no binding or catching. If the pump rotates freely, tighten the hex head bolts uniformly on each end of the pump, one end at a time, to 15 to 20 ft. lbs. torque. Check the pump again for rotation.
12. Mount the pump in a vise in a vertical position gripping on the bearing hub.
13. Install the flow valve in its bore with the slotted end up.
14. Install a new "O" ring in the groove on the hex head flow valve fitting.
15. Insert the flow spool spring with the filter screen end down.
16. Install the threaded hex head flow valve fitting over the spring and tighten until the "O" ring is seated.



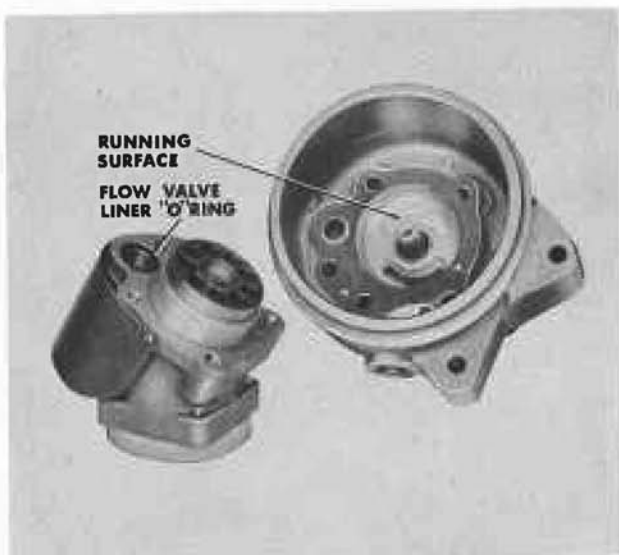


Figure 11 - Assembling the Bearing Cap to the Pump Body

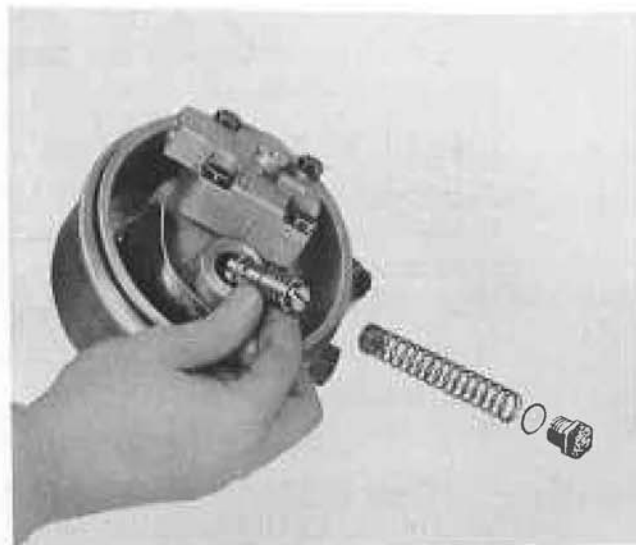


Figure 12 - Installing the Flow Valve, Spring and Retainer Fitting

17. Reinstall the filter in the reservoir. Fit the filter gasket retainer, the rubber gasket, and the filter over the reservoir return fitting in that order. Place the filter retainer on top of the filter and secure with the hex head fitting. Secure the fitting with a cotter pin.
18. Install a new reservoir seal on the groove provided on the O.D. of the bearing cap. Be sure that this seal is not twisted in its groove. Lubricate the seal to facilitate assembly of the reservoir.
19. Position the reservoir clamp ring over the reservoir. Position the reservoir so that the filler cap will be vertical when the pump is mounted. Press the reservoir into place and secure with the reservoir clamp ring.
20. Replace the gasket in the reservoir filler neck cap if necessary.
21. Position the Woodruff key on the pump shaft and align the pump pulley with the key. Position the spacer and lockwasher on the shaft and draw the pulley

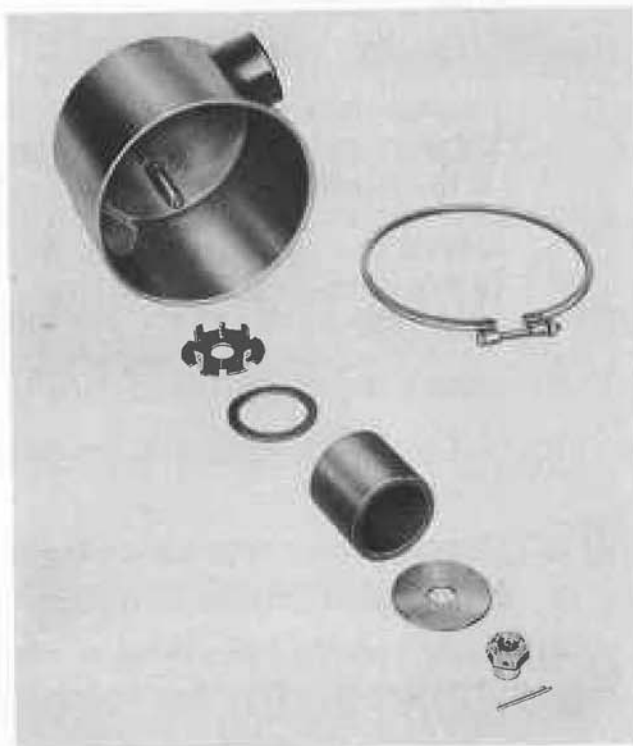


Figure 13 - Reservoir Filter Assembly Disassembled View

into position with the hex head bolt that threads onto the end of the pump shaft.

**CAUTION:** Do not draw the pulley so far onto the shaft that it bears against the ball bearing. If this is done, the bearing will tend to explode when the pump is operated.

### E. Installation

1. Position the lower pump mounting flange in the bracket between the tractor engine and water pump outlet. Install the bolt in the mounting bracket.
2. Position the pump drive belt on the pump pulley.
3. Secure the turnbuckle to the upper pump mounting flange with a clevis pin and cotter pin.
4. Adjust the belt tension to approximately 1/2" deflection between the pulleys by means of the turnbuckle.
5. Install the pump pressure line in the port on the top of the pump body.
6. Install the pump return line on the rear of the pump reservoir.
7. Refill the reservoir to the proper level with Automatic Transmission Fluid Type A.
8. Operate the system with the engine operating at idle speed in order to bleed air from the system.
9. After turning the steering wheel through its complete operating range several times, stop the engine and fill the reservoir to the full mark on the dipstick.

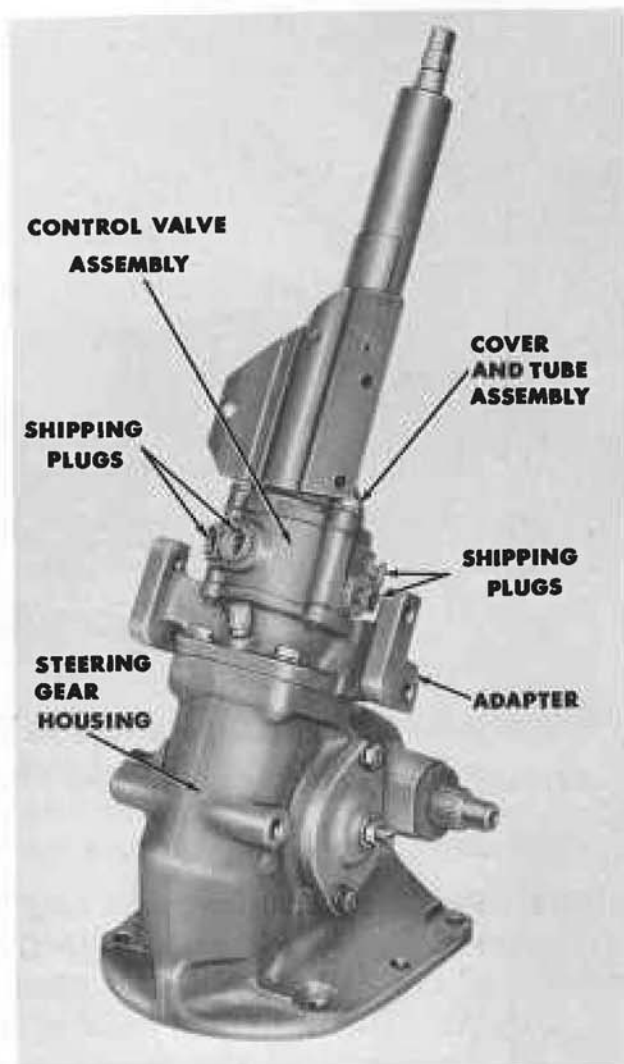


Figure 14 - Steering Gear and Control Valve Assembly

### 3. OVERHAUL - CONTROL VALVE AND STEERING GEAR ASSEMBLY

#### A. Removal

1. Remove the steering wheel nut and washer and remove the steering wheel. If necessary, use a steering wheel puller or any other commercially available tool that is adaptable.
2. Remove the spring, felt packing and spring seat from the top of the steering column.
3. Disconnect the throttle rod link from the throttle arm and disconnect the throttle lever from the throttle lever bracket.
4. Disconnect the throttle arm from the throttle lever and remove the lever.
5. Disconnect the hood side panels from the instrument panel and the lower rear hood panel. Pivot the hood assembly forward.
6. Disconnect the Proof-Meter cable at the instrument panel, if the tractor is so equipped.
7. Disconnect the battery carrier from the steering gear housing.
8. Disconnect the battery ground cable from the battery.
9. Disconnect the ammeter wire from the junction block.
10. Disconnect the generator regulator from the mounting pad on the steering column.
11. Disconnect the junction block from the mounting pad on the steering column.
12. Remove the temperature gauge and oil pressure gauge lines from the clip on the rear fuel tank support.
13. Disconnect the instrument panel from the lower rear hood panel. Slide the instrument panel over the top of the steering housing and set it on top of the fuel tank.
14. Remove the headlight switch from the hood rear lower panel assembly if the tractor is so equipped.
15. Remove the (2) hex head bolts securing the hood rear lower panel to the steering gear housing and remove the rear lower panel assembly from the tractor.
16. Remove the tail light wire from the clip on the steering gear housing if the tractor is so equipped.
17. Remove the hydraulic connections to the control valve. Two connections to the pump and two connections to each power cylinder. Cover or plug the exposed tubes and ports to prevent dirt entry in the hydraulic system.

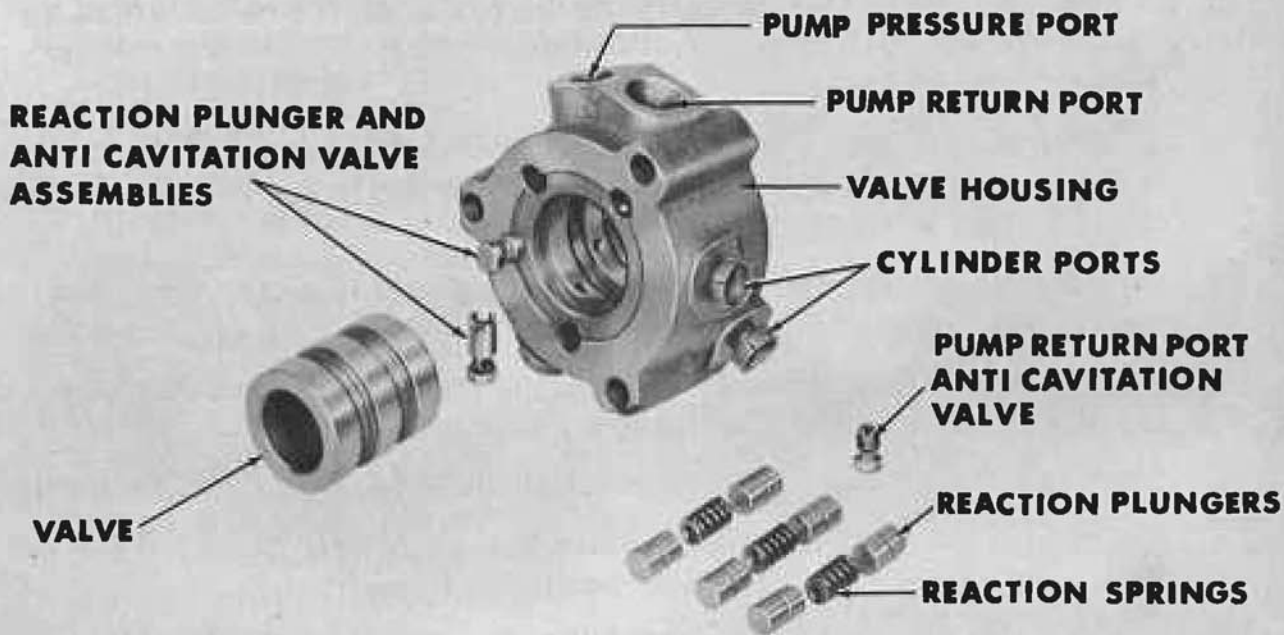


Figure 15 - Control Valve Assembly - Disassembled View

18. Remove the cotter pins and castellated nuts from the drag link pitman arm connections and remove the drag links from the pitman arms using a suitable puller.
19. Remove the (4) hex head bolts securing the steering gear housing to the transmission housing and remove the steering gear housing and control valve assembly from the tractor and place it on a bench.

#### B. Disassembly of Steering Column Components

1. Scribe a mark on the valve cover, valve body, valve adapter, and steering gear housing to insure the proper positioning of parts on reassembly.
2. Remove the (3) bolts and lockwashers that secure the valve cover to the valve body. Remove the valve cover and tube assembly from the steering shaft.
3. The control valve worm bearing nut is staked to a groove provided in the steering shaft. Cut out the staked area being careful not to damage the threads on the shaft, remove and discard the nut.
4. Remove the valve spool preload spring.
5. Remove the small bearing race, the bearing, and the large bearing race. Keep these parts together as an assembly so that the same three pieces will be installed together on reassembly.

6. Remove the valve housing and valve as an assembly being careful not to lose the plungers, springs, and check valve assemblies from the valve housing. Place the parts on a clean piece of paper to protect them from foreign material.
7. Remove the lower large bearing race, bearing, and small bearing race, keeping these three parts together as an assembly.
8. Remove the (4) bolts and lockwashers that secure the adapter to the steering gear housing. Remove the adapter from the steering shaft.

#### C. Control Valve Disassembly and Inspection

1. Remove the six plungers and three springs from their bores.
2. Remove the two reaction plunger assemblies from their bore. Note the bore from which these were removed to assure reassembly in the proper bore. Take care not to lose the steel balls from each reaction plunger assembly.
3. Remove the valve from the valve housing, noting which end of the valve has a groove on the I.D.
4. Unscrew the check valve assembly from the pump return port in the valve body.
5. Inspect the brass tubing seats located in the ports in the valve body for damage. Replace if necessary.
6. Inspect the valve and valve housing bore for signs of damage. If these parts are damaged, the valve body and valve must be replaced as an assembly.
7. Inspect the centering springs for damage or distortion. Replace if necessary.
8. Inspect the plungers for nicks or scratches. Replace if necessary.
9. Inspect the reaction plungers and plunger balls for wear or damage. Replace if necessary.
10. Inspect the thrust bearings and thrust bearing races for freedom of movement and signs of damage. Replace bearings or races as necessary.

#### D. Control Valve Assembly

1. Coat the plungers, check valves and valve with lubriplate or white petroleum jelly.
2. Install the valve in the valve body with the groove on the I.D. of the valve at the same end in relation to the valve body as was noted upon removal. **DO NOT FORCE THE VALVE INTO THE VALVE BODY.** When the valve

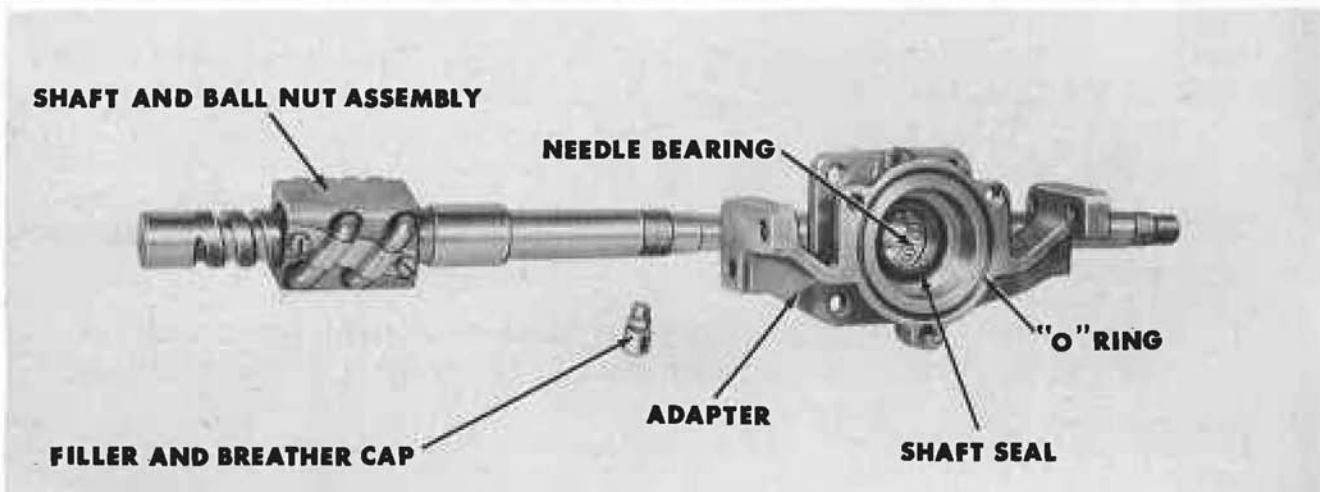


Figure 16 - Adapter Assembly - Showing Bearing and Seals

is properly aligned it will drop into place. Forcing the valve will damage both the valve and the valve bore.

3. Reinstall the check valve assembly in the pump return port of the control valve housing.
4. Install the two control valve reaction plungers and two plunger balls in the bore from which they were removed. Install the balls and plungers with the balls toward the center of the bore.
5. Install a centering spring in each of the remaining three bores.
6. Install a plunger at each end of the three centering springs.

#### E. Seal Inspection and Replacement in Adapter and Cover Assemblies

1. Inspect the seal in the shaft bore of the cover and tube, Figure 20, for nicks, scratches or signs of hardening of the lip. If necessary, remove the seal with an offset screwdriver and replace with a new seal that has been well coated with lubriplate. Press the seal into place with a proper sized socket, taking care not to damage the seal lip.
2. Remove and replace the "O" ring on the face of the cover assembly casting.
3. Inspect the needle bearing in the bottom of the adapter. The needle bearing rollers should be smooth, highly polished, and free to turn in their retainers. If the bearing shows signs of wear, remove the bearing using Owatonna Pilot Bearing Puller No. 956. Press a new bearing into the bore with the trade marked side out. The bearing should be pressed in until the outside face is just below the surface of the casting. **DO NOT PRESS THE BEARING IN SO FAR THAT THE BOTTOM OF THE BEARING CONTACTS THE SHOULDER OF THE CASTING.**

4. Inspect the seal in the shaft bore of the adapter for nicks, scratches or signs of hardening of the lip.
5. If necessary, remove the seal with an offset screwdriver and replace with a new seal that has been well coated with lubriplate. Press the seal into place with a proper sized socket, taking care not to damage the seal lip.
6. Remove and replace the "O" ring on the face of the adapter casting.

#### F. Steering Gear Disassembly

1. Drain the oil from the steering gear housing.
2. Secure the assembly in a vise and remove the pitman arms using a suitable puller.
3. Remove the felt seals.
4. Remove the right sector shaft side cover hex head bolts, lockwashers, and side cover. The sector shaft is easily removed from the side cover by turning the adjusting screw clockwise.
5. Remove the left sector shaft side cover and sector shaft in the same manner.
6. Remove the steering shaft and ball nut assembly.

#### G. Steering Gear Cleaning, Inspection and Repair

1. Remove the seals from the sector shaft bores in the steering gear housing.
2. Inspect the needle bearing in the bottom of the steering gear housing for wear and signs of damage. The needle bearing rollers should be smooth, highly polished, and free to turn in their retainers. If the bearing is damaged, remove it from the top using Owatonna Pilot Bearing Puller No. 956 with No. 955-14 jaws and a slide hammer.
3. Replace the needle bearing in its bore with the trademark facing upward. Press the bearing into place until it is just below the chamfer in the bore. (DO NOT PRESS THE BEARING IN SO FAR THAT IT BOTTOMS ON THE SHOULDER IN THE CASTING BELOW THE BEARING.)
4. Inspect the steering gear housing for cracks or damage to the adapter mounting pad. Replace if necessary.
5. Inspect the sector shaft bushings in the steering gear housing and in the side covers for excessive wear.
6. If it is necessary to replace the sector shaft bushings, remove them from the housing and side covers using a press or suitable puller.  
**CAUTION:** Driving the bushings out with a punch and hammer may cause

damage to the housing or side covers.

7. Use a press to install new bushings in the steering gear housing and side covers.
8. Install new sector shaft packing in the sector shaft bores of the housing.
9. Inspect the sector shafts and sector gear teeth for signs of wear. Replace if necessary.
10. Inspect the steering shaft for nicks, scratches and signs of wear on the ball nut rack teeth. Replace the shaft and ball nut assembly if necessary.

#### H. Steering Gear Assembly

1. Install new "O" ring seals on the sector shaft side covers.
2. Install Shim No. 8N-33544-A-B-C or D over the threaded end of each sector shaft adjusting screw to obtain a maximum clearance of .000 to .002 inch between the head of the screw and the bottom of the T-slot.
3. Use the adjusting screw in each side cover as a screw jack to pull the sector shafts into the side covers.
4. Center the ball nut assembly on the steering shaft and insert the bottom of the shaft into the needle bearing at the bottom of the steering gear housing. If the ball nut is centered correctly, the ball race grooves on the worm, showing on each side of the ball nut, will be equal.
5. Position the left sector shaft and side cover assembly (sector shaft with block tooth) into the housing first. Check to be sure that the ball nut is centered on the worm as outlined in Step 4. With the block tooth in the upper-most position, the middle tooth must mate with the middle groove on the steering shaft rack. Install the hex head bolts and lockwashers and tighten them to 25-30 ft. lbs. torque.
6. Install the right sector shaft and side cover assembly so that the fourth tooth meshes with the fourth groove on the left sector shaft. Tighten the

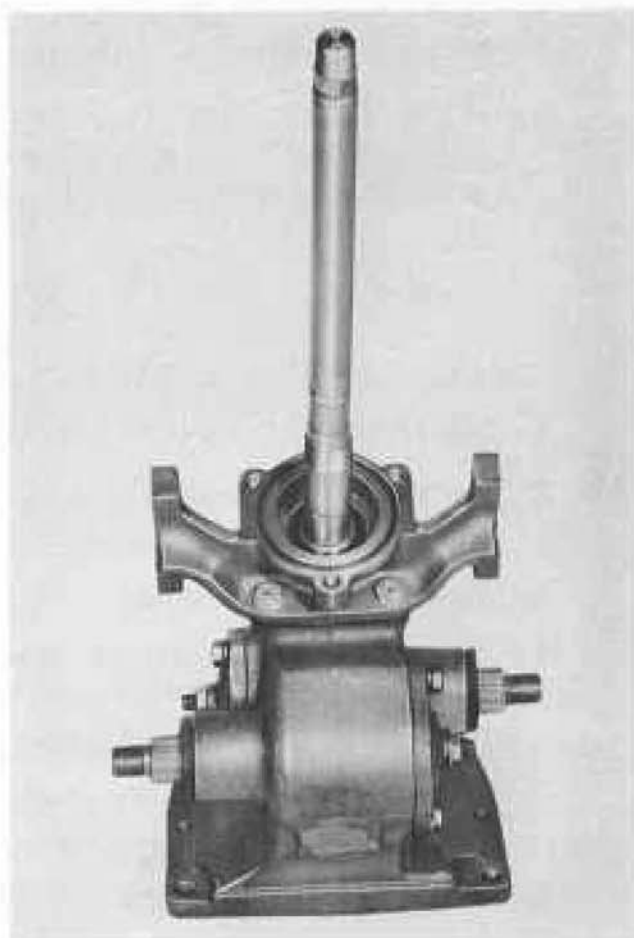


Figure 17 - Adapter Installed on Steering Gear Housing



hex head bolts and lockwashers to 25-30 ft. lbs. torque.

7. Position felt seals over the ends of both sector shafts and install the pitman arms, lockwashers, and nuts.

### I. Assembly of Components

1. Position the gasket on top of the steering gear housing.
2. Position the adapter assembly over the steering shaft and secure the adapter to the steering gear housing with the four hex head bolts and lockwashers. Take care not to damage the seal in the adapter when inserting the adapter on the shaft. Make sure the filler plug opening on the adapter faces forward. Torque the four hex head bolts to 20-25 ft. lbs.
3. Install the valve assembly on the adapter as follows:
  - a. Position a small bearing race on the bench with the groove up.
  - b. Position the ball bearing in the groove and position a large bearing race, groove down, on top of the bearing.
  - c. Keeping these parts together as an assembly, hold them with the back of the large bearing race against the bottom of the valve assembly.

~~NOTE:- The embossed markings on the valve ports are on the top side of the valve.~~ *Markings Down*

  - d. Carefully lower the valve assembly and the bearing races and bearings over the steering shaft and lower them into position on the adapter. Take care not to lose any of the plungers or reaction plungers from the valve body.
  - e. Position the valve so that the two pump ports are positioned just to the right of center.

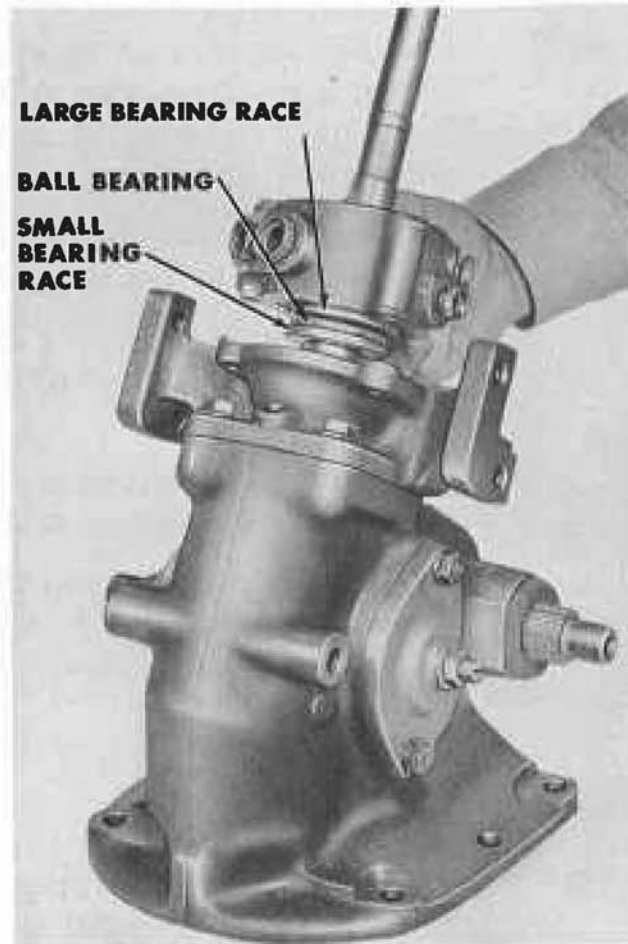


Figure 18 - Installing the Valve Assembly on the Shaft

- f. Install a large bearing race, groove up, a ball bearing, and a small bearing race, groove down, on top of the valve.
4. Install the preload spring, convex side up on top of the valve.
5. Install a new bearing lock nut on the threaded portion of the steering shaft.
6. Install the steering wheel temporarily on the steering shaft.
7. Install the three hex head bolts through the holes in the valve body and run them loosely into the threaded portion of the adapter to prevent the valve body from turning.

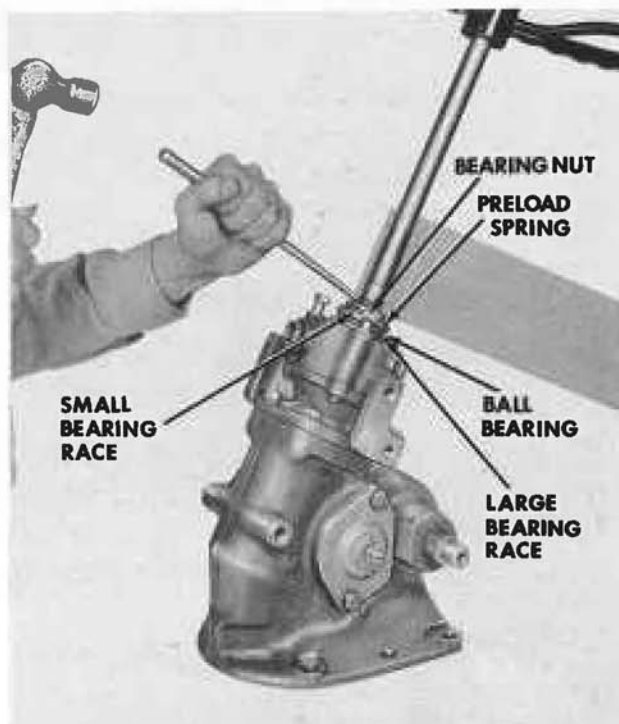


Figure 19 - Staking the Thrust Nut to the Steering Shaft

8. Grip the steering wheel to prevent the shaft from turning and tighten the lock nut until it seats firmly against the valve spool. Back the nut off about 1/6 turn and stake the nut to the groove in the shaft. Support the shaft from the opposite side of the groove as shown in Figure 19 while staking the nut in order to prevent damage to the shaft.
9. Remove the steering wheel and the three hex head bolts.
10. Cover the splined end of the shaft and the sharp shoulder of the shaft with masking tape to prevent damage to the cover assembly seal during installation.
11. Install the cover and tube assembly over the shaft, being very careful not to damage the seal in the cover assembly. The regulator mounting pad on the tube should face forward.
12. Secure the cover assembly and valve housing assemblies to the adapter with the three hex head bolts and lockwashers. Tighten the bolts to 20 ft. lbs. maximum torque.
13. Fill the steering gear housing to the level plug with extreme pressure gear lubricant SAE 90 in summer and SAE 80 in winter. Install the filler plug and breather assembly.

## J. Installation of the Control Valve and Steering Gear Assembly

1. Position the steering gear housing on the transmission housing. Install the hex head bolts and tighten them to 60-70 ft. lbs. torque.
2. Install the drag links on the pitman arms and install the castellated nuts and cotter pins.
3. Position the battery carrier on the steering gear housing. Install the Proof-Meter cable clip and the battery ground cable to the battery carrier at this time. Secure the battery carrier to the steering gear housing with (2) hex head bolts and lock-washers.
4. Install the hydraulic connections from the cylinders and from the pump to the control valve.
5. Insert the tail light wire in the clip on the steering gear housing if the tractor is equipped with a tail light.
6. Position the hood lower rear panel on the tractor and install the panel to the steering gear housing with (2) hex head bolts, flatwashers and lock-washers and tighten them securely.
7. Install the head light switch in the hood lower rear panel assembly if the tractor is so equipped.
8. Position the generator regulator on the steering column bracket, install the retaining screws, and tighten them securely.
9. Attach the junction block to the mounting pad on the steering column.
10. Position the instrument panel over the top of the steering column and attach the panel to the lower rear hood panel.
11. Insert the temperature gauge and oil pressure gauge lines in the clip on the fuel tank support.
12. Insert the ammeter wire through the cage on the back of the ammeter and secure the wire to the junction block.

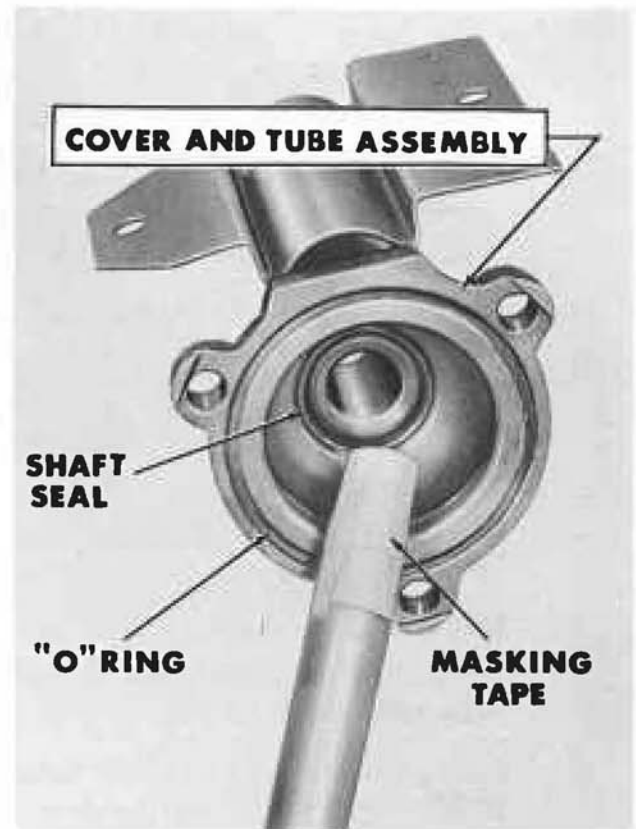


Figure 20 - Installing the Cover and Tube Assembly

13. Connect the battery ground cable to the positive terminal on the battery.
14. Connect the Proof-Meter cable at the instrument panel if the tractor is equipped with a Proof-Meter.
15. Position the throttle lever through the instrument panel, throttle lever arm, a flat washer and the throttle lever bracket. Do not secure the throttle lever arm at this time.
16. Secure the spring to the throttle lever with a flat washer and cotter pin.
17. Secure the throttle lever arm to the throttle lever.
18. Install the throttle lever arm link between the throttle lever arm and the bell crank.
19. Position the spring seat, felt packing, and the spring on the top of the steering column.
20. Install the steering wheel and the retaining washer and nut and tighten securely. Be sure the steering wheel is installed with one spoke lined up straight ahead when the wheels are in the straight ahead position.
21. Before installing the two hood side panels to the instrument panel and lower rear panel, fill and operate the power steering system as outlined in steps 7, 8, and 9 on page 18 to check for leaks at the hydraulic tubing connections.
22. Install the two hood side panels to the instrument panel and the lower rear panel.

#### 4. OVERHAUL - POWER CYLINDERS

**NOTE:** The Power Cylinders are right hand and left hand assemblies. Be sure to identify them as such to assure that they are positioned correctly during installation.

##### A. Removal

1. Place a drain pan under the cylinder to be removed.
2. Disconnect the hydraulic tubing from the rear of the cylinder.
3. Remove the nut from the forward end assembly and drive the end assembly from the drag link with a soft faced hammer.
4. Remove the nut from the rear end assembly and drive the end assembly from the radius rod with a soft faced hammer.
5. Drain the oil from the cylinder by moving the rod back and forth and allowing the oil to drain from the ports at the end of the cylinder assembly.

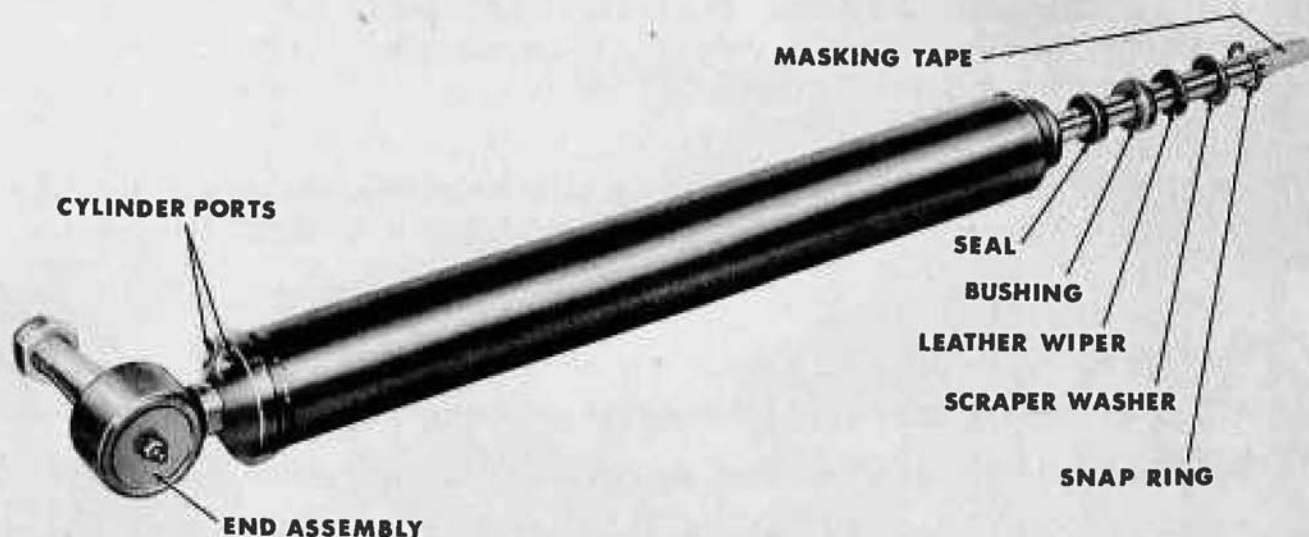


Figure 21 - Power Cylinder Assembly

### B. Disassembly

1. Remove the forward or piston rod end assembly from the piston rod.
2. Remove the snap ring from the rod end of the cylinder with Tru-Arc No. 1 Snap Ring Pliers.
3. Extend the piston rod to the end of its travel.
4. Remove the metal scraper washer, the leather wiper and the aluminum bushing from the rod.
5. The seal will normally come off its seat by actuating the piston rod assembly a few times. If it does not do this, remove the seal with an awl or other sharp tool.

### C. Cleaning, Inspection and Repair

1. Clean the cylinder and rod with a suitable solvent.
2. Inspect the cylinder body for damage or evidence of leakage at the seams and damage to the threads on the connecting ports.
3. Inspect the rod for excessive gouging or distortion. Replace the cylinder assembly if any such damage is found.
4. Inspect the forward or piston rod end assembly for gouging of the tapered stud, damage to the threads, and freedom of movement of the flexible joint. Replace if necessary. If signs of damage are found on the rear or port end assembly, replace the entire cylinder assembly.

5. Inspect the tubing seats in the ports in the rear of the cylinder for distortion or damage. If damaged, the tubing seats can be removed by turning an E-Z-Out into the seat and pulling the E-Z-Out and seat from their position with pliers.
6. If the tubing seats are replaced, position the new seat squarely in its bore and thread the existing fitting into the port until the tube seat is firmly in place.

#### D. Assembly

1. Mask the threaded end of the piston rod to protect the seal during assembly.
2. Soak the seal and wiper ring in automatic transmission fluid, Type "A."
3. Install the seal on the rod with the lips facing the rear of the cylinder. Use extreme caution sliding the seal over the end of the rod to prevent damage to the seal lips.
4. Press the seal into its seat using a deep socket. The seal has a .010 inch O.D. interference fit and care must be taken to press the seal in straight to avoid distortion.
5. Install the wiper back up bushing, the wiper, and the metal scraper ring. The raised center portion of the metal scraper ring must face outward.
6. Install the snap ring with the sharp edge outward.
7. Install the forward or piston rod end assembly on the piston rod.

#### E. Installation

The power cylinders must be installed so that the ports at the rear of the cylinder are at the bottom of the cylinder.

1. Install the rear or port end assembly in the mounting pad in the radius rod. Secure the end assembly to the radius rod with a 9/16" - 18 hex nut.
2. Install the forward or piston rod end assembly in the mounting pad in the drag link. Secure the end assembly to the drag link with a 1/2" - 20 hex nut.
3. Install the hydraulic tubing in the cylinder ports as shown in Figure 22.

## 5. TUBING

#### A. Removal

If it is necessary to remove the hydraulic tubing because of leakage or damage, proceed as follows: [www.ntractorclub.com](http://www.ntractorclub.com)

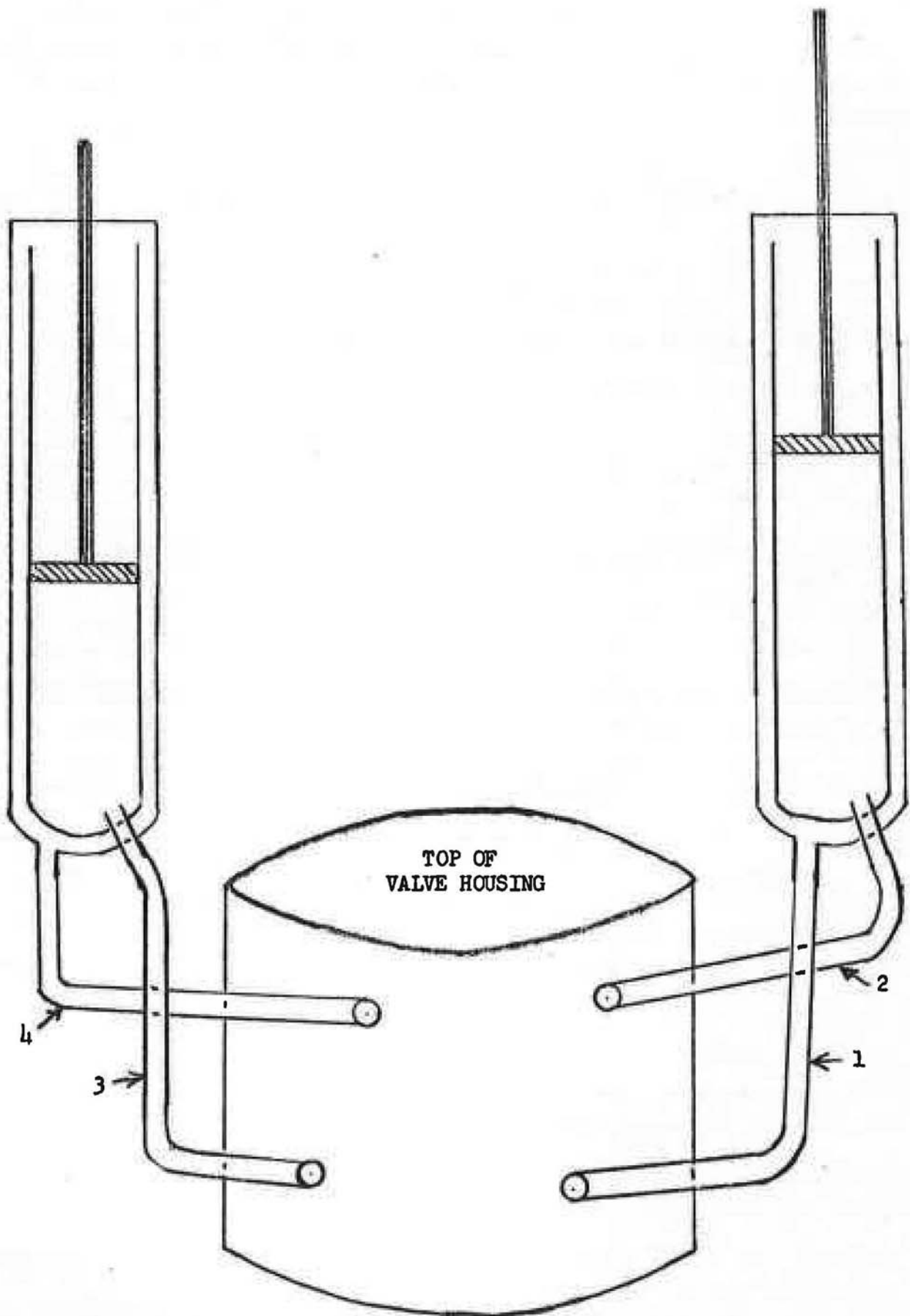


Figure 22 - Control Valve to Power Cylinder Tubing Installation

1. Remove the tubing attaching clips that secure the tubing to the tractor.
2. Loosen the fittings at each end of the tube being removed and carefully remove the tubing from the tractor.

#### B. Replacement

1. Place the tube being installed between the units of the system being connected.
2. Make sure each end of the tube aligns with the ports of the units being connected without distortion of the tube. Thread the fittings into the ports and tighten the fittings firmly but do not tighten excessively.
3. Install the clips that secure the tubing to the tractor.

### 6. MAINTENANCE

Very little maintenance is required to keep the power steering system operating properly. The oil reservoir should be filled to the full mark on the dipstick attached to the filler cap with Automatic Transmission Fluid Type "A," after installation on the tractor, and the level should be maintained thereafter.

**NOTE:** When filling the power steering system, the system should be cycled several times by turning the steering wheel to one extreme and then the other with the engine operating. This procedure will fill the control valve and power cylinders. Then refill the reservoir, if necessary, to the proper dipstick level.

The oil should be changed only when it is necessary to drain the power steering system for repairs.

- A. The oil filter element assembly should be replaced if damaged, or cleaned if a considerable amount of sediment is noted using the following procedure:
  1. Remove the oil reservoir cover and withdraw as much oil as possible from the reservoir with a suction gun.
  2. Remove the pump return line from the rear of the reservoir by loosening the hose clamps and removing the hose from the reservoir pipe.
  3. Loosen the reservoir clamp ring and withdraw the reservoir assembly from the pump body.
  4. Remove the cotter pin and filter element hex head fitting. Remove the element from the reservoir.
  5. Clean the reservoir thoroughly.
  6. Clean the element with a suitable solvent and reinstall the element, or if damage or considerable clogging is noted, replace it with a new element.



7. Position the flat washer on top of the element and secure the element in place with the hex head fitting and cotter pin.
  8. Reinstall the reservoir on the pump body and secure it in place with the clamp ring.
  9. Reconnect the pump return line at the back of the reservoir.
  10. Replenish the system with Automatic Transmission Fluid Type "A."
- B. Check the tubing connections periodically to see that they are firmly seated.
- C. Keep the pump drive belt at proper tension (approximately 1/2" deflection) by adjusting the turnbuckle as necessary.
- D. The power steering system has eight pressure type lubrication fittings. They are located at each end of each drag link and at each end of each power cylinder. Lubricate these fittings daily or every ten hours with pressure gun grease.

## 7. TROUBLE SHOOTING

### Trouble

### Possible Cause of Trouble

Pump not priming

1. Weakened or broken plunger spring. When compressed to a height of 61/64 inch, the spring should exert a force of 29.7 to 36.3 lbs.
2. Flow valve stuck in open position. Check for dirt or burrs on flow spool or in valve liner.

Reduced or no flow

1. Flow valve stuck in open position. Check for dirt or burrs on flow spool or valve liner.
2. Relief valve leaking. Check for dirt or nicks on relief valve seat. Replace flow spool and relief valve assembly and clean the flow spool spring screen.
3. Weakened or broken relief valve spring. Replace flow spool and relief valve assembly.
4. Hex head bolts on either end of pump loose. Torque to indicated specifications.

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