



POWER STEERING
FOR MODEL 648
Service Manual 9-51520

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JI Case
A Tenneco Company



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INTRODUCTION

This service manual section covers the full time hydro static power steering system used in the Model 648 Loader and 648 Loader-Backhoe.

Pump supply oil for the power steering system comes from the loader bucket control valve outlet port to the power steering control valve inlet port.

Return oil from the power steering control valve return port tees into the return line upstream of the return line filter screen.

Relief valve protection for the power steering system is provided by the attachment lift relief valve located in the travel control valve.

The power steering control valve directs oil to and from the manual pump and steering cylinder.

The manual pump is turned by the steering wheel and is a positive displacement gerotor, bi-directional pump. The manual pump provides steering control and operational flow and pressure through the power steering control valve to the steering cylinder.

If the engine is stopped, the tractor can be steered by increased manual effort. A check valve in the power steering control valve is provided to allow this feature.

Steering effort will also increase if either the attachment lift or loader bucket circuit is held against the relief valve or if the engine is operated at reduced RPM.

SPECIFICATIONS

Pump.....	6.5 GPM (24 l/m at 3000 engine RPM and 1500 PSI (10 300 kPa)
Relief Valve	1550 ± 50 PSI (10 700 ± 300 kPa) at 3600 engine RPM.
(Attachment lift relief valve) Located in travel control valve.	
Oil	API Service Classification SE or CC SAE 20W-40 Motor oil
Toe In Adjustment.....	1/8" to 3/8" (3.2 mm to 9.5 mm) toe in.

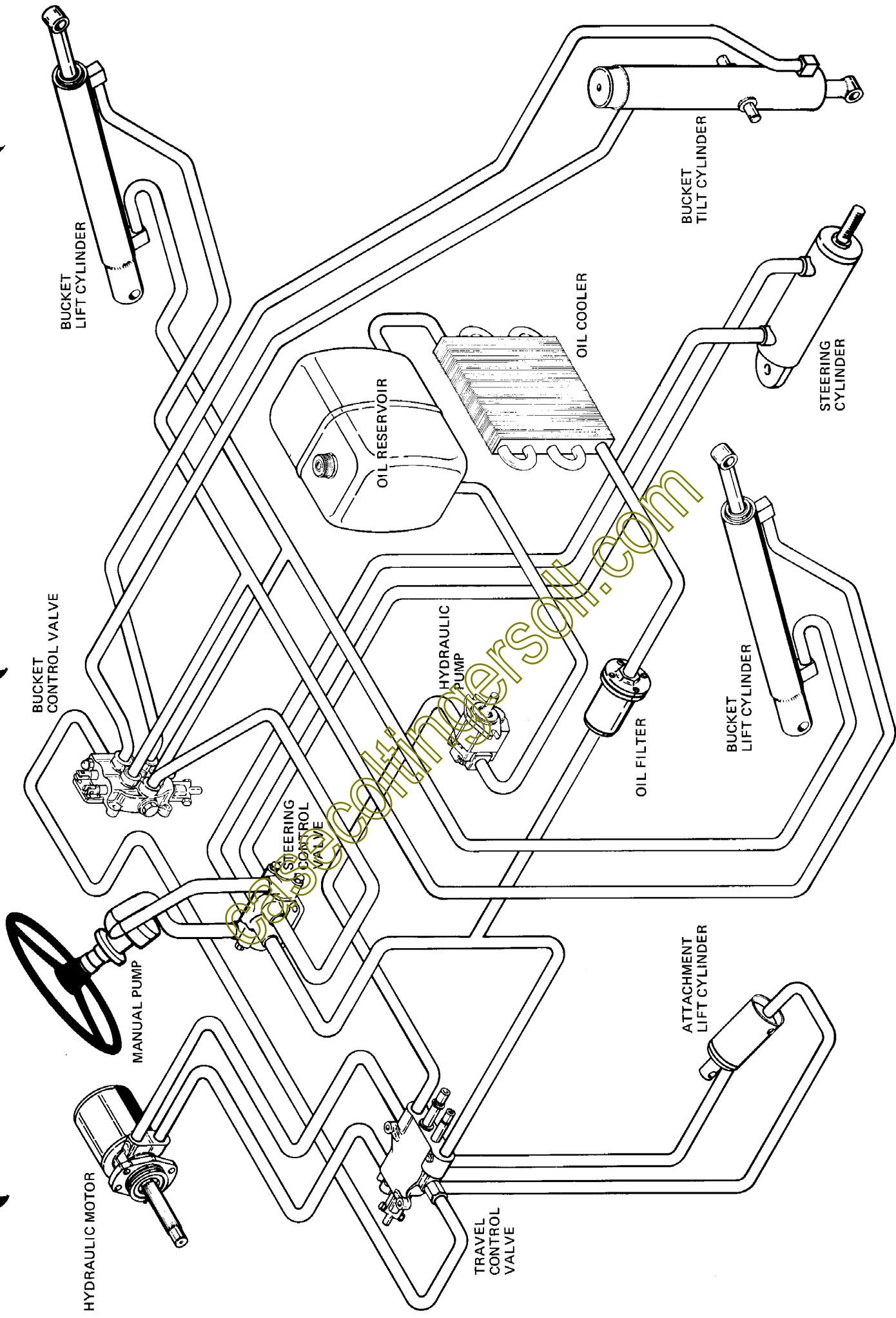


FIGURE 1 HYDRAULIC SYSTEM

HOW IT WORKS AND OIL FLOW DIAGRAMS

RIGHT TURN - ENGINE RUNNING

RESERVOIR AND PUMP

Whenever the engine is running the hydraulic pump operates continuously, drawing oil from the reservoir. The oil is directed to the steering control valve by first passing through the backhoe or PTO valve if so equipped, the travel control valve and loader bucket control valve. The attachment lift relief valve protects the power steering system from excessive pressure.

MANUAL STEERING PUMP

The manual steering pump, in a right hand turn, pressurizes oil from three stator and rotor cavities through three holes in the pump body into three holes in the commutator. The oil then passes from the three holes through the center of the commutator to the rearward cavity and out through the right hand port to the control valve.

CONTROL VALVE

The pressurized oil from the manual pump R. H. port enters the front inlet port of the valve. This pressurized oil moves the spool rearward uncovering passages which permits oil from the hydraulic pump to pass through the spool and out the rear valve port. The oil then enters the L. H. port of the manual pump. The manual pump increases this hydraulic pump pressure and directs it to and through the control valve to the front port to the power steering cylinder.

The pressurized oil is directed to and retracts the power steering cylinder, turning the wheels in a R. H. turn. Return oil being displaced from the power steering cylinder returns through the rear steering cylinder port and passages in the control valve and returns to the filter, oil cooler and reservoir.

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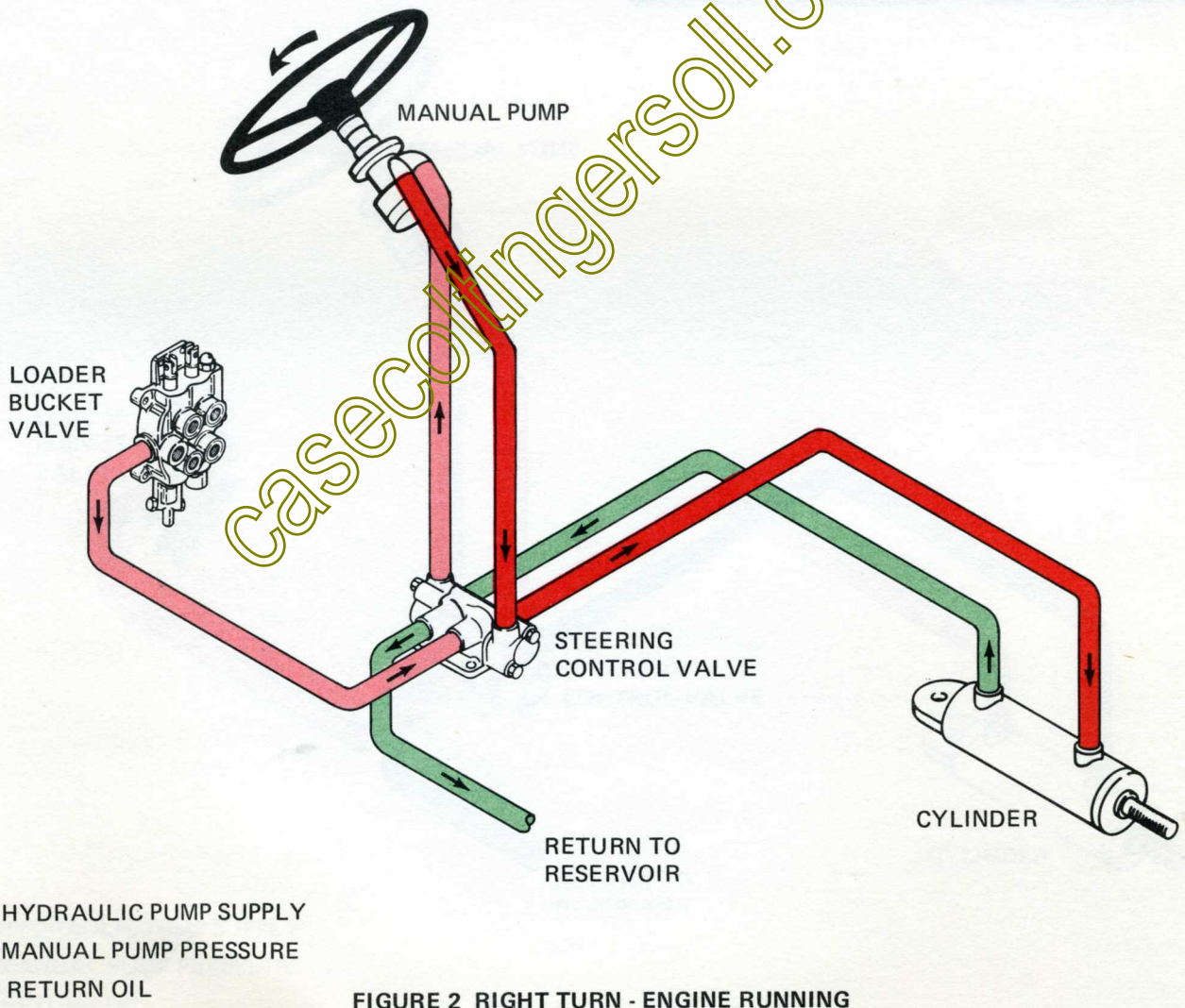
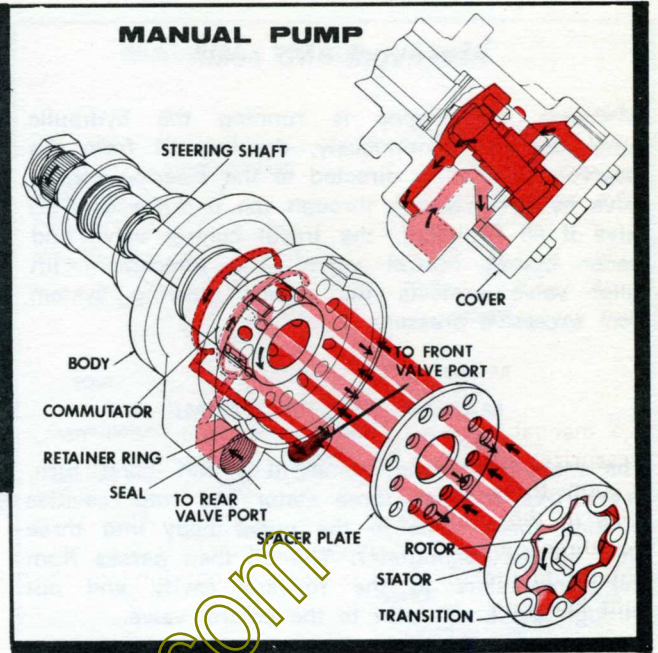
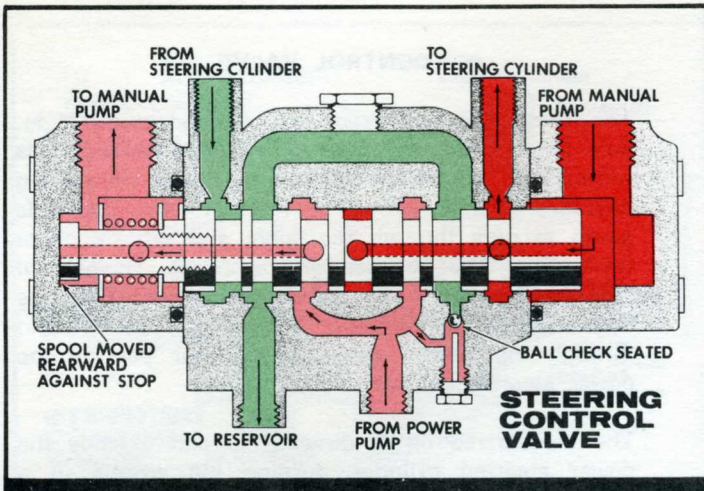


FIGURE 2 RIGHT TURN - ENGINE RUNNING

LEFT TURN - ENGINE RUNNING

RESERVOIR AND PUMP

Whenever the engine is running the hydraulic pump operates continuously, drawing oil from the reservoir. The oil is directed to the steering control valve by first passing through the backhoe or PTO valve if so equipped, the travel control valve and loader bucket control valve. The attachment lift relief valve protects the power steering system from excessive pressure.

MANUAL STEERING PUMP

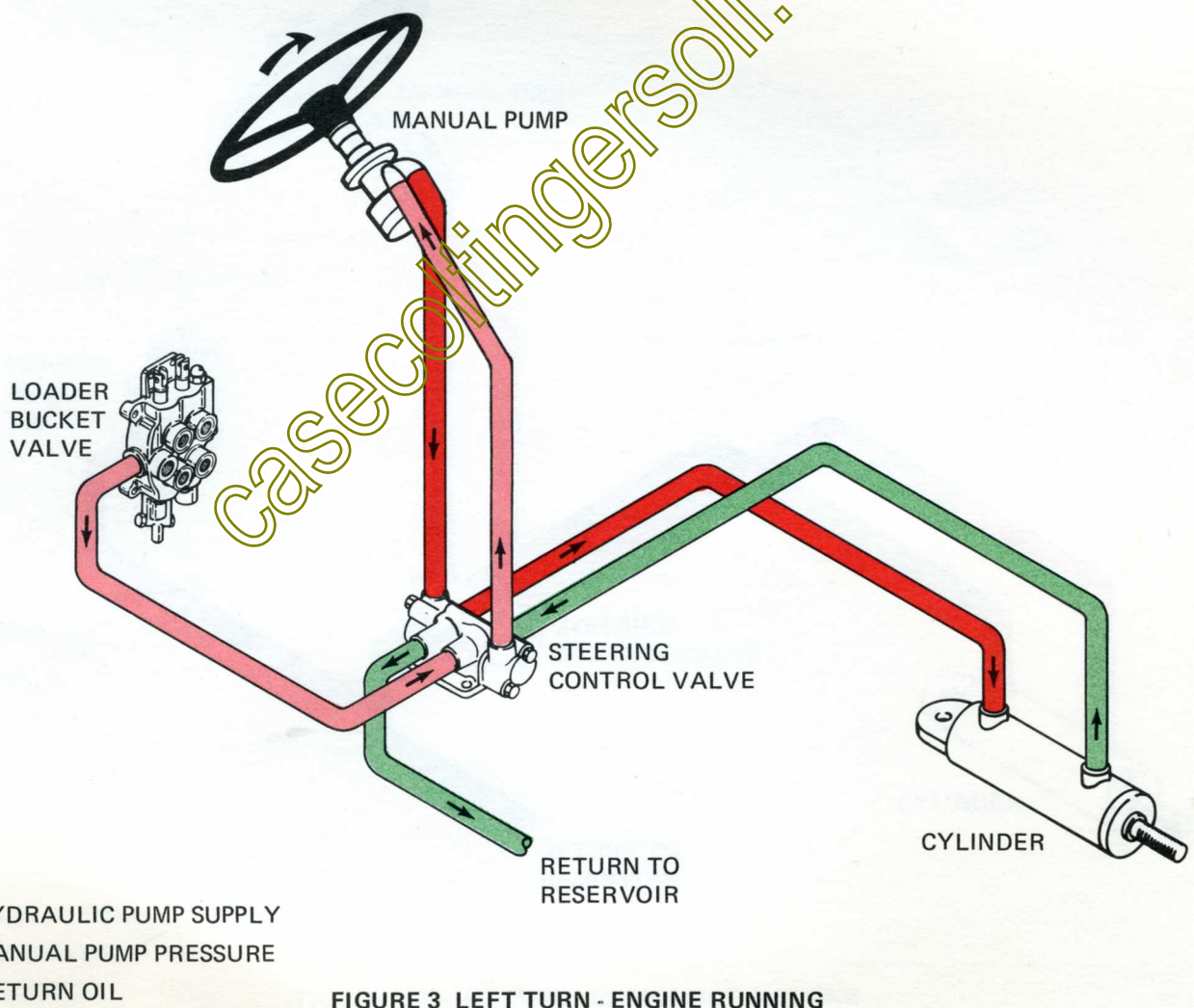
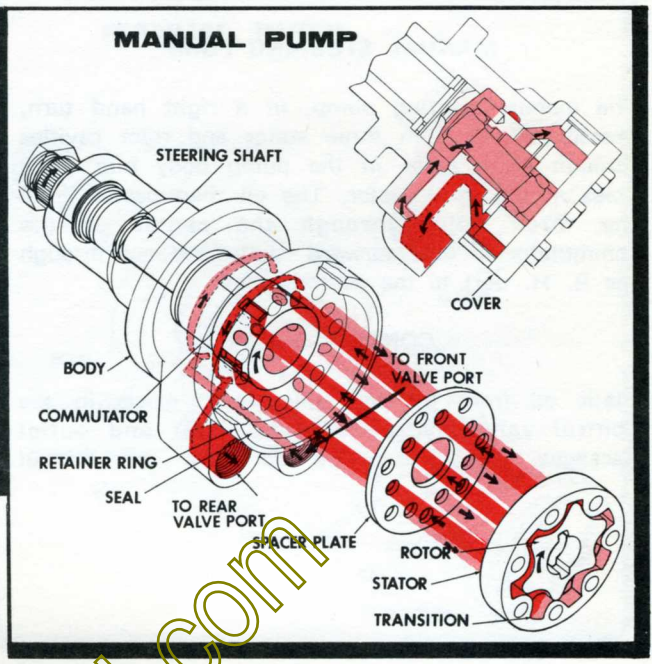
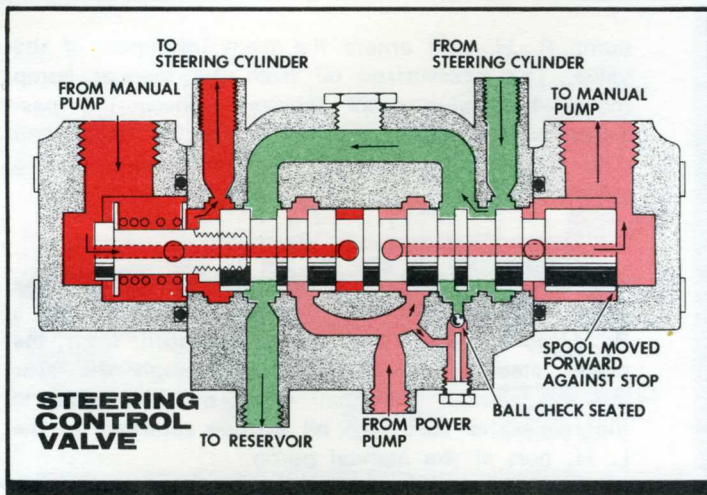
The manual steering pump in a left hand turn, pressurizes oil from three stator and rotor cavities through three holes in the pump body into three slots on the commutator. The oil then passes from the three slots to the forward cavity and out through the L. H. port to the control valve.

CONTROL VALVE

The pressurized oil from the manual pump L.H. port enters the rear inlet port of the valve. This pressurized oil moves the spool forward uncovering passages which permits oil from the hydraulic pump to pass through the spool and out the front valve port. The oil then enters the R. H. port of the manual pump. The manual pump increases this hydraulic pump pressure and directs it to and through the control valve to the rear port to the power steering cylinder.

The pressurized oil is directed to and extends the power steering cylinder, turning the wheels in a L. H. turn. Return oil being displaced from the power steering cylinder returns through the front steering cylinder port and passages in the control valve and returns to the filter, oil cooler, and reservoir.

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- HYDRAULIC PUMP SUPPLY
- MANUAL PUMP PRESSURE
- RETURN OIL

FIGURE 3 LEFT TURN - ENGINE RUNNING

RIGHT TURN - ENGINE NOT RUNNING

MANUAL STEERING PUMP

The manual steering pump, in a right hand turn, pressurized oil from three stator and rotor cavities through three holes in the pump body into three holes in the commutator. The oil then passes from the three holes through the center of the commutator to the rearward cavity and out through the R. H. port to the control valve.

CONTROL VALVE

Static oil from the hydraulic pump exists in the control valve hydraulic pump inlet and outlet passages. The pressurized oil from the manual

pump R. H. port enters the front inlet port of the valve. This pressurized oil from the manual pump moves the valve spool rearward uncovering passages which permit pressurized oil to enter and pass through the front port to the power steering cylinder.

This pressurized oil is directed to and retracts the power steering cylinder, turning the wheels in a R. H. turn. Return oil being displaced from the power steering cylinder returns through the rear steering cylinder port, ball check and the spool to the rear valve port. The oil is then returned to the L. H. port of the manual pump.

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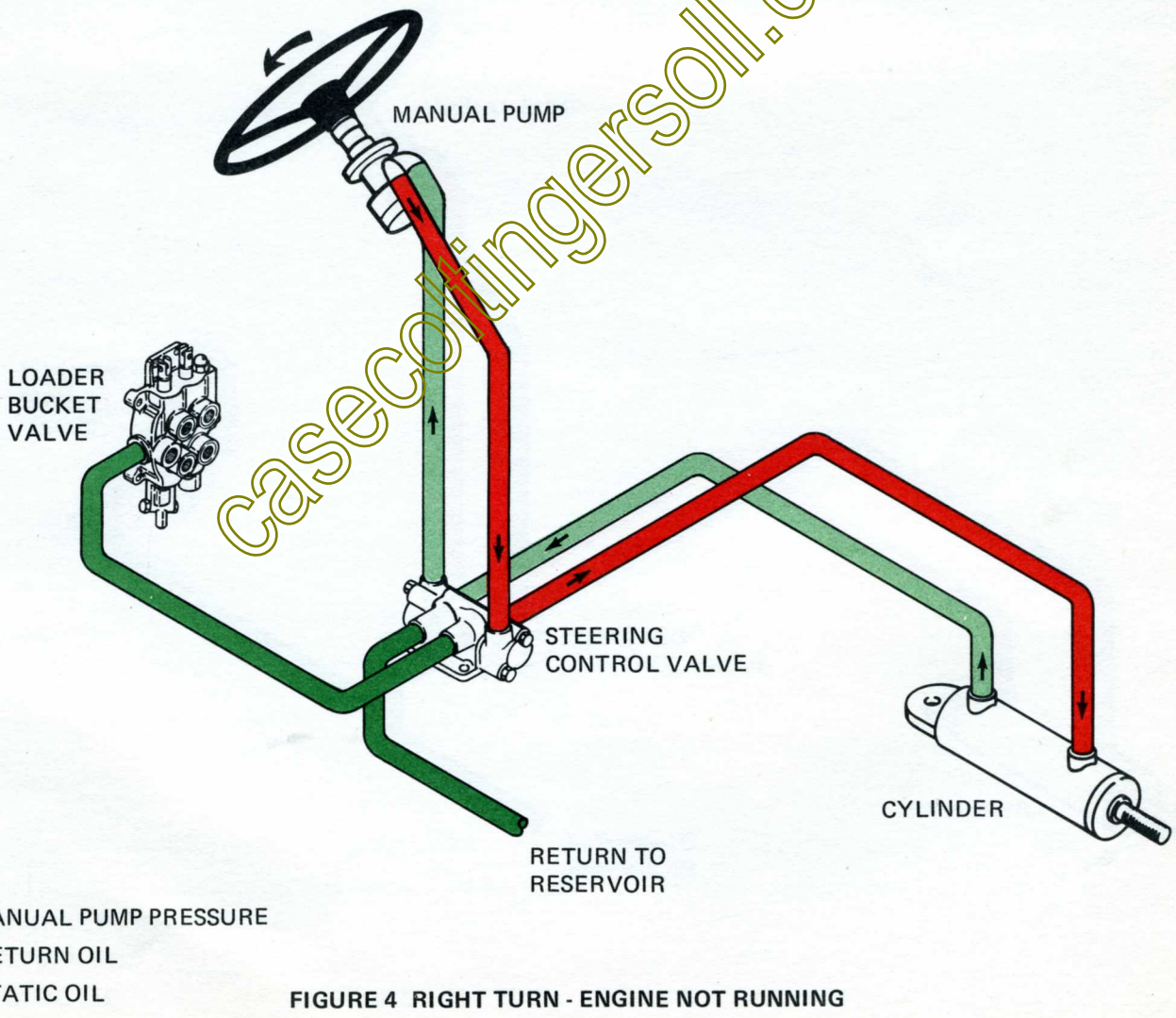
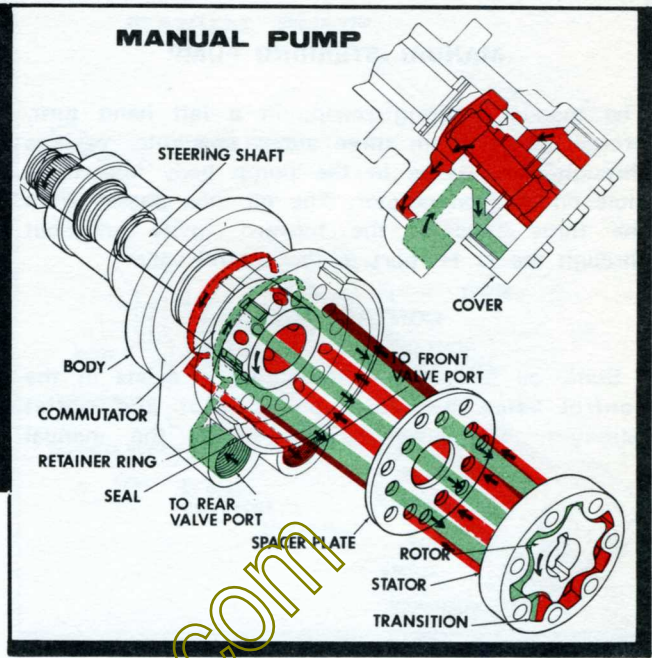
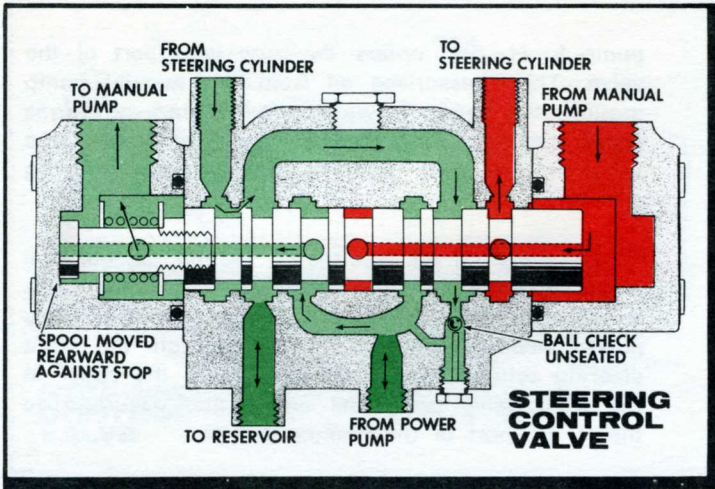


FIGURE 4 RIGHT TURN - ENGINE NOT RUNNING

LEFT TURN - ENGINE NOT RUNNING

MANUAL STEERING PUMP

The manual steering pump, in a left hand turn, pressurizes oil from three stator and rotor cavities through three holes in the pump body into three slots on the commutator. The oil then passes from the three slots to the forward cavity and out through the L. H. port to the control valve.

CONTROL VALVE

Static oil from the hydraulic pump exists in the control valve hydraulic pump inlet and outlet passages. The pressurized oil from the manual

pump L. H. port enters the rear inlet port of the valve. This pressurized oil from the manual pump moves the spool forward, uncovering passages which permit pressurized oil to enter and pass through the rear port to the power steering cylinder.

This pressurized oil is directed to and extends the power steering cylinder, turning the wheels in a L.H. turn. Return oil being displaced from the power steering cylinder returns through the front steering cylinder port, ball check and the spool to the front valve port. The oil is then returned to the R. H. port of the manual pump.

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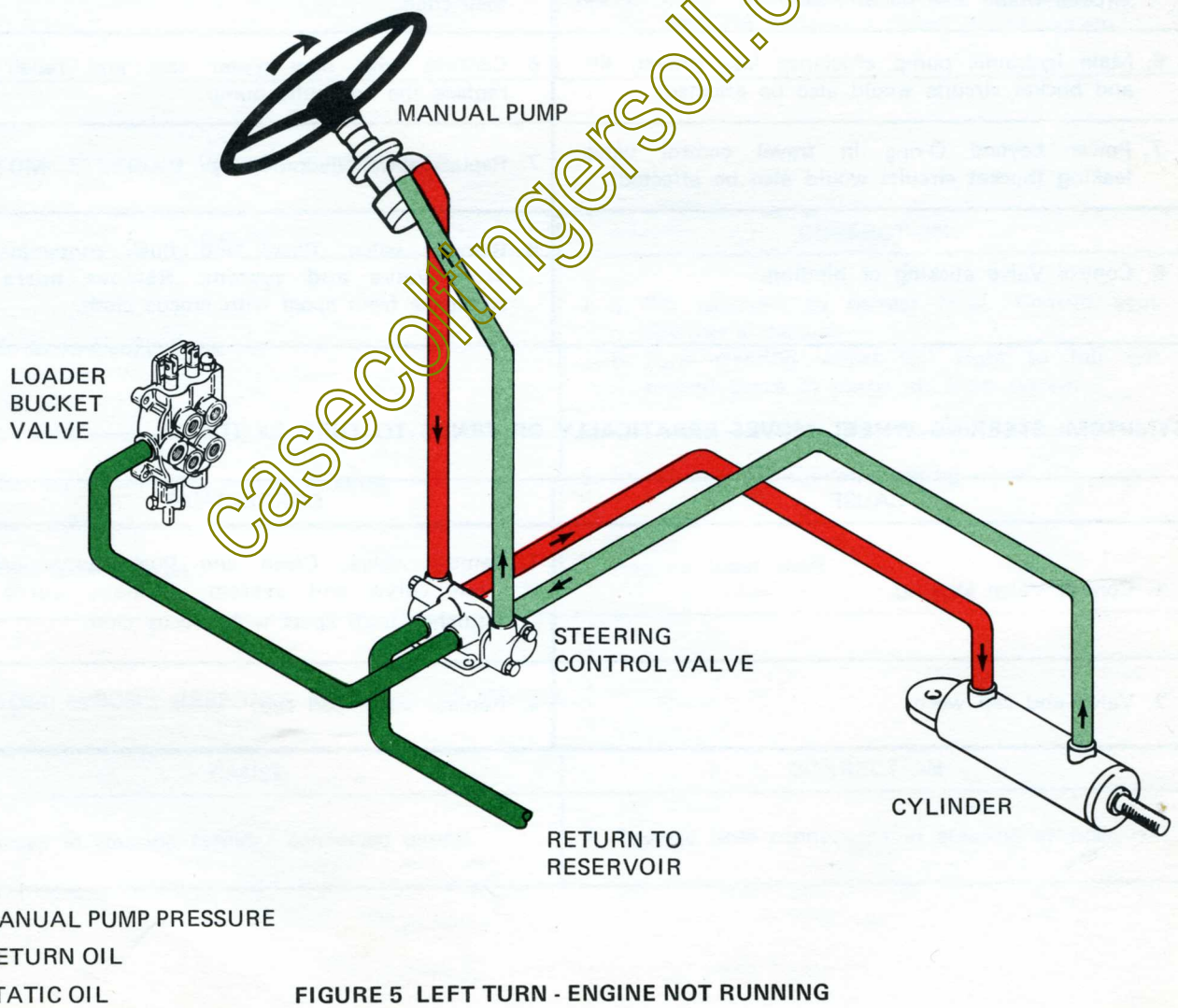
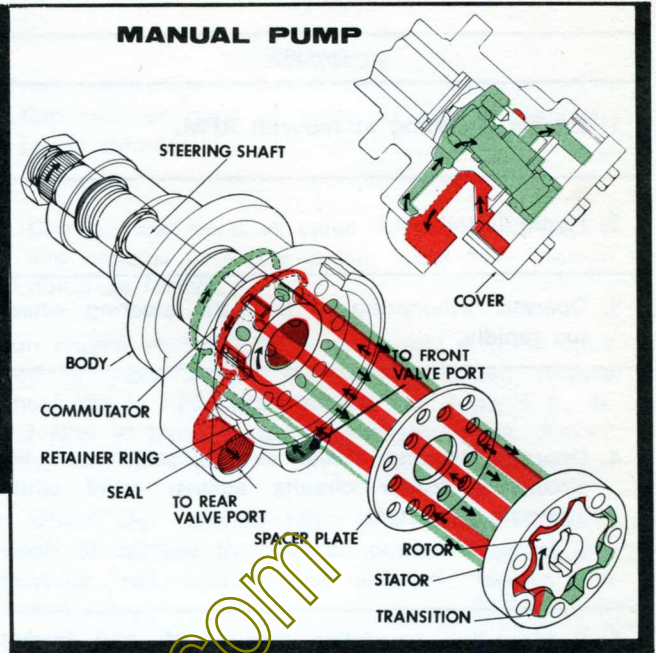
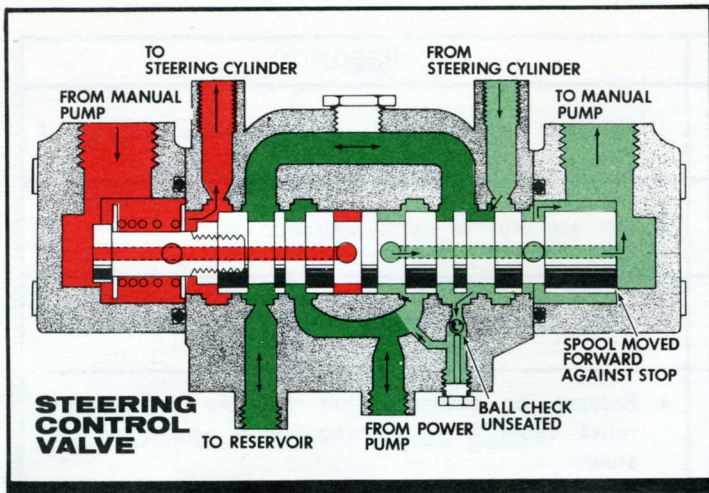


FIGURE 5 LEFT TURN - ENGINE NOT RUNNING

TROUBLESHOOTING AND TESTING THE POWER STEERING SYSTEM

SYMPTOM: EXCESSIVE STEERING EFFORT REQUIRED

CAUSE	CORRECTION
1. Engine operating at reduced RPM.	1. Increase engine speed.
2. Hydraulic oil cold.	2. Operate unit to warm hydraulic oil.
3. Operator attempting to turn the steering wheel too rapidly.	3. Turn steering wheel at a normal rate of speed.
4. Operator holding travel circuit, attachment lift circuit or loader circuits against relief while attempting to steer.	4. Release or feather other controls to prevent relief valve from opening while attempting to steer. NOTE: Relief valve will open reducing power to other circuits if steering wheel is held against its stop.
5. Suction line restriction (travel, lift and bucket circuits would also be affected.)	5. Confirm with flow meter test and remove restriction.
6. Main hydraulic pump efficiency loss (travel, lift and bucket circuits would also be affected).	6. Confirm with flow meter test and repair or replace the hydraulic pump.
7. Power beyond O-ring in travel control valve leaking (bucket circuits would also be affected).	7. Replace power beyond O-ring.
8. Control Valve sticking or binding.	8. Remove valve. Clean and flush contamination from valve and system. Remove burrs or scratches from spool with crocus cloth.

SYMPTOM: STEERING WHEEL MOVES ERRATICALLY OR TENDS TO TURN BY ITSELF.

CAUSE	CORRECTION
1. Control Valve sticking.	1. Remove valve. Clean and flush contamination from valve and system. Remove burrs or scratches from spool with crocus cloth.
2. Valve end cap worn.	2. Replace valve end cap.

SYMPTOM: EXCESSIVE STEERING WHEEL SLIP.

CAUSE	CORRECTION
1. Leaking cylinder piston.	1. Cap cylinder ports at valve. If slip is reduced, repair cylinder.
2. Leaking control valve or manual pump.	<p>2. Cap cylinder ports at valve as in "1" above. If slip remains excessive isolate valve from manual pump as follows.</p> <p>Run engine at 3,600 RPM and apply 6 ft. lb. (8.2 Nm) of input torque to steering wheel. Record wheel slip in RPM. Stop engine and apply 6 ft. lb. (8.2 Nm) of input torque to steering wheel. Record wheel slip in RPM.</p> <p>If wheel slip remains high with engine stopped, repair or replace the manual pump. If wheel slip becomes less with engine stopped, replace the control valve.</p> <p>NOTE: Some steering wheel slip is normal and does not indicate a defect in the system.</p>

SYMPTOM: STEERING WHEEL TURNS FREE.

CAUSE	CORRECTION
1. Air in hydraulic lines.	<p>1. a. Fill reservoir to correct level. Consult your operator's manual.</p> <p>b. Turn steering wheel full right to full left several times to purge air from system.</p>
2. Steering wheel loose or key missing.	2. Install key and tighten steering wheel nut.
3. Input shaft broken.	3. Replace input shaft.

SYMPTOM: WRONG RESPONSE TO STEERING WHEEL

CAUSE	CORRECTION
1. Hoses to steering cylinder connected wrong.	1. Reverse hose connections at steering cylinder.

COMPONENT REMOVAL AND INSTALLATION

MANUAL PUMP

REMOVAL

1. Remove the rear access panel.
2. Remove the tubes between the manual pump and the control valve. Cap or plug the ports of the valve, pump, and tubes to prevent dirt entry.
3. Carefully remove the steering wheel center cap by prying at the two locking tabs.
4. Remove the steering wheel.
5. Remove the collar from the steering shaft by pulling upwards.
6. Remove the cotter pin which secures the attachment lift control lever to its lower support.
7. Remove the link to the lift spool from the lift control lever.
8. Pull the attachment lift lever up to clear the working area.
9. Remove the four bolts that secure the manual pump to the instrument panel.

INSTALLATION

1. Position the manual pump with the work ports facing forward.
2. Loosely install the four mounting bolts.
3. Install and tighten the tubes between the manual pump and control valve.
4. Tighten the four mounting bolts.
5. Connect the attachment lift lever.
6. Install the steering shaft collar, steering wheel and cap.
7. Install the rear access panel.

CONTROL VALVE

REMOVAL

1. Remove the rear access panel.
2. Remove the battery and battery tray. Tag the wires to insure proper reconnection.
3. Remove the cotter pin which secures the attachment lift control lever to its lower support.

4. Remove the link to the lift spool from the lift control lever.
5. Remove all hoses and tubes connected to the control valve. Cap or plug the ports to prevent dirt entry.
6. Remove the three bolts holding the control valve to the frame.
7. Remove the valve through the access panel opening.

INSTALLATION

1. Install the control valve through the access panel opening with the cylinder ports to the left and the inlet and outlet ports to the right.
2. Loosely install the three mounting bolts.
3. Loosely install all hoses and tubes to the control valve.
4. Tighten all hoses and tubes and the three mounting bolts.
5. Connect the attachment lift lever.
6. Install the battery tray and battery.
7. Install the rear access panel.

STEERING CYLINDER

REMOVAL

1. Turn the front wheels to the full left hand turn position.
2. Remove the front ball joint from the left spindle.
3. Remove and plug (to prevent dirt entry) the hydraulic lines from cylinder ports.
4. Remove the rear shoulder bolt from the cylinder.
5. Remove the cylinder.

INSTALLATION

1. Install the cylinder with the work ports facing upward.
2. Install the rear shoulder bolt and front ball joint.
3. Install the hose from the rear of the control valve to the piston end of the cylinder.
4. Install the hose from the front of the control valve to the rod end of the cylinder.

DISASSEMBLY, INSPECTION AND ASSEMBLY OF COMPONENTS

STEERING CYLINDER

DISASSEMBLY

1. Secure the cylinder in a vise at the piston end mounting bracket. To prevent damage to the cylinder, do not place the body of the cylinder (9) in the vise.
2. Use a spanner with 1/4 inch (6.35 mm) dowels on 2 inch (50.8 mm) centers to loosen the gland (3).
3. Remove the gland (3).
4. Pull the rod and piston (6) from the body (9).
5. Remove the seals (8, 7, 5, 4, 2) and wiper (1).

INSPECTION

Clean all parts before inspection. Inspect the rod, piston, and cylinder body for nicks, scratches, or burrs. Remove nicks, scratches, or burrs with a crocus cloth.

Replace the necessary components if damage is severe.

ASSEMBLY

1. Install o-ring (7) onto the piston.
2. Warm piston seal (8) to insure that it is pliable. Install piston seal (8) onto the piston on top of o-ring (7).
3. Lubricate the piston and rod (6) with a small amount of 20W-40 motor oil.
4. Insert piston and rod (6) into cylinder body (9). Use care not to damage the piston seal (8) on the cylinder body (9) threads.
5. Install the rod seal (2) inside the gland (3). The wide skirt of the seal (2) must face the piston end of the cylinder.
6. Install the back-up ring (4) and o-ring (5) onto the gland (3).
7. Install the wiper (1) to the gland (3) with the cone shaped end facing outward.
8. Install the gland and tighten securely using the proper spanner.

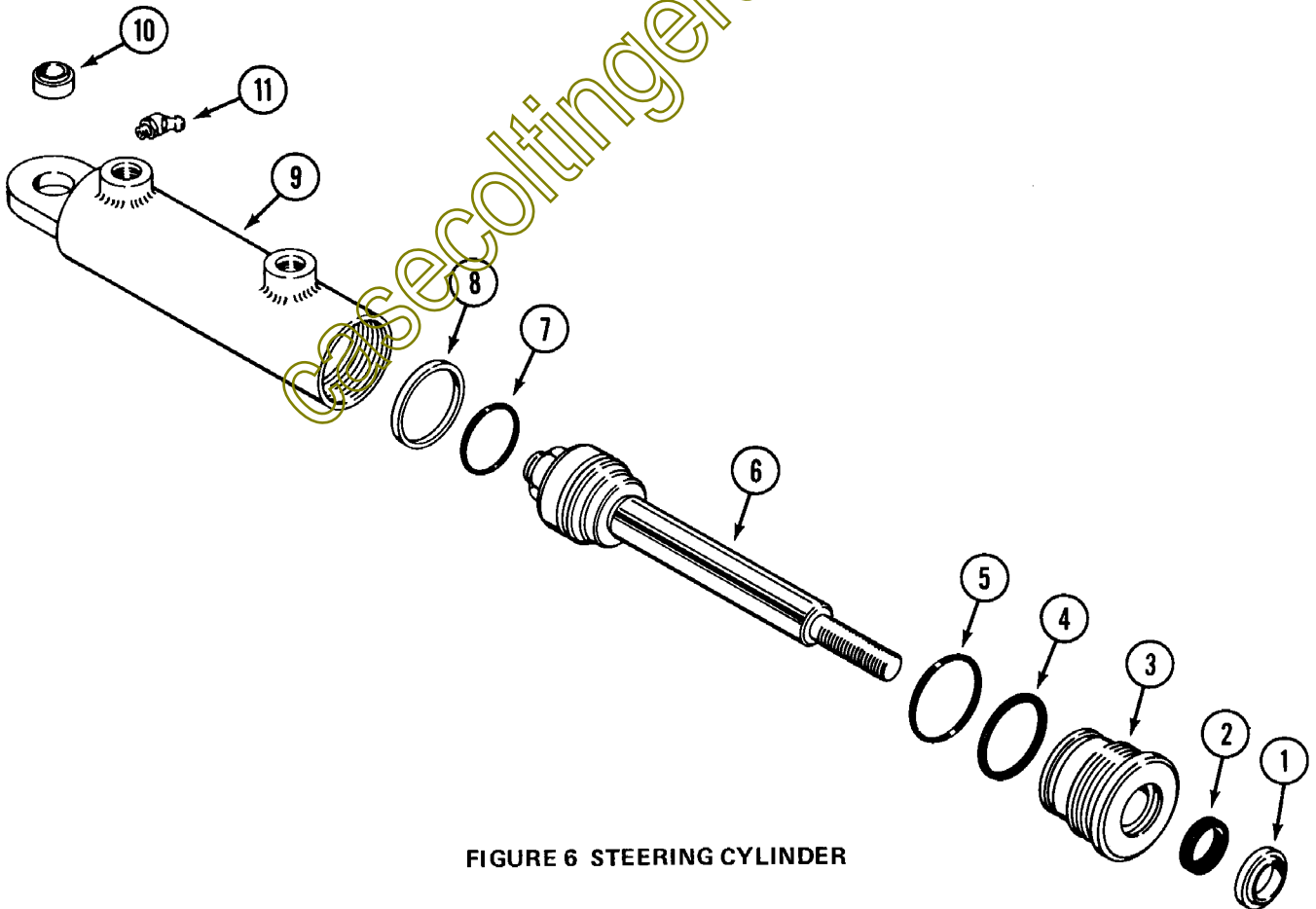


FIGURE 6 STEERING CYLINDER

MANUAL STEERING PUMP

DISASSEMBLY

1. Clamp the manual steering pump in a vise with steering wheel shaft pointing down. This will prevent the internal parts of the pump from falling out.
2. Unbolt the end cover (17) and remove. Mark the stator (14) and rotor (13) with an indelible marking pencil for proper installation.
3. Remove the spacer (16), seal (15), stator (14), rotor (13) and spacer plate (9).
4. Remove lower drive link pin (10), commutator (8), drive link (7) with upper link pin (6) and commutator drive pin (5).
5. Remove steering shaft (4), thrust bearing (2) and thrust washer (3).
6. Remove the pump from the vise and remove the rubber water seal (24), felt bushing (23), and snap ring (22).
7. Remove and discard the retainer washer (21), spacer (if so equipped), backing ring (20) and seal (19) ("O" ring or cup type).
8. Remove the bearing (1) by pressing from the steering wheel end of housing with the lower machined face of the housing setting on a block of wood.

INSPECTION

Clean all parts before inspection being careful not to damage any machined surfaces.

Check the thrust bearing (2) for excess wear or looseness.

Inspect all machined surfaces for abnormal wear, scratches and scoring. A polished pattern on the spacer plate (9) and end plate (17) due to rotor action is normal.

Check the rotor (13) to stator (14) clearance using a narrow feeler gauge (refer to inset E) the clearance should not exceed .007 inch (.13 mm).

Check the rotor (13) to stator (14) thickness (inset D) with a micrometer or dial indicator. If rotor thickness is more than .002 inch (.05 mm) less than thickness of the stator (14) replace stator and rotor.

Inspect rotor vanes and springs as indicated in Figure 7. Refer to inset B and C.

Check the clearance between the large end of the steering shaft (4) and the body (26), it should not exceed .006 inch (.15 mm). Replace the part that shows the most wear.

ASSEMBLY

1. Install new bearing (1), by pressing against the hardened end of the bearing shell on which the number appears, into the body from the rotor end to a depth of 3-27/32 inches (97.5 mm) (refer to inset A).
 2. Install new thrust bearing (2) and thrust washer (3) onto shaft (4). Coat the shaft area above the thrust bearing with No. 2 Moly Disulfide grease to displace any air from being locked in the cavity in the housing when pump is reassembled.
 3. Install the shaft (4), commutator drive pin (5), drive link (7) with upper link pin (6).
 4. Lightly oil the commutator (8) and install it with a slight rotary motion, engaging the drive pin (5).
 5. Install the spacer plate (9) and lower drive link pin (10).
 6. Install the rotor (13), stator (14) aligning original marks, new seal (15) and spacer (16).
 7. Install the end cover (17) and tighten the bolts (18) to 18 - 22 foot pounds (25 - 29 Nm) of torque.
 8. Install new teflon backed oil seal (19), new backup ring (20) and new retainer (21). Install these parts only far enough into the pump body to allow the snap ring (22) to be installed. These parts can only be bought in the seal kit.
 9. Install snap ring (22), with rounded edge toward retainer (21), felt bushing (23) and water seal (24).
- NOTE:** In some hand pumps the spacer between the retainer and backup ring was used in production pumps. Do not reinstall this spacer when installing seal kit which has teflon backed oil seal.
10. Lubricate the pump by filling one port with clean oil and turn the steering shaft until oil appears at the other port.

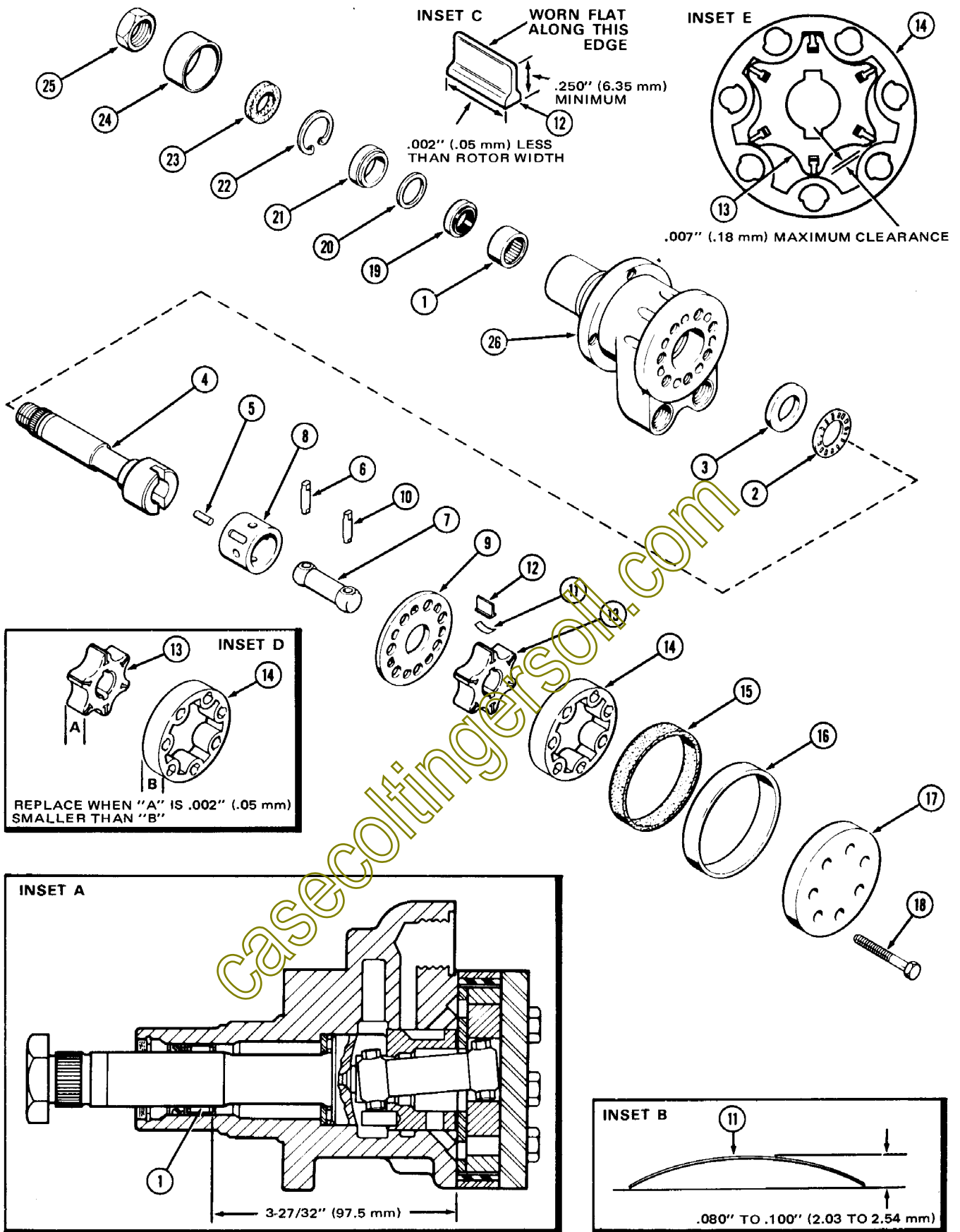


FIGURE 7 MANUAL STEERING PUMP

STEERING CONTROL VALVE

DISASSEMBLY

1. Mark the end caps (10) and body (8) for proper installation.
2. Remove the end caps (10) and "O" rings (9).
3. Slide the valve spool (7) out of the centering spring (5) end of the valve body (8).
4. To remove the centering spring assembly (5), insert a small rod in the cross drilled hole in the spool (7) and a small rod in the centering screw shank (6). Unscrew the centering screw from the valve spool. Be careful not to damage the valve spool. Remove the washers (4) and centering spring (5).
5. Remove the ball check plug (3), "O" ring (2) and 1/4" ball (1) from the body.

INSPECTION

Clean all parts before inspection. Inspect the valve spool (7) and body (8) bore for nicks, scratches or burrs. If valve spool or body is damaged, complete valve must be replaced.

Inspect ball check (1) and seat for cracks or nicks.

Inspect the centering spring (5) for cracked coils. The spring should be replaced if it does not meet the following specifications.

Free Length860" (21.84 mm)
Active Coils	6
Wire Diameter080" (2.03 mm)
2 Pounds Pressure	Compressed Length .824" (20.93 mm)

Replace all "O" rings, lubricate all parts with oil.

ASSEMBLY

1. Install ball check (1), new "O" ring (2) and plug (3).
2. Install centering washers (4) and spring (5) on the centering screw (6).
3. Install the centering screw (6) into valve spool (7) and tighten to 15 foot pounds (20 Nm).
4. Install valve spool (7) into the centering spring end of the valve body (8). Make sure the spool moves freely in the body.
5. Install new end cap "O" rings (9) and end caps (10), aligning original marks. Torque bolts to 14 to 17 foot pounds (19 - 23 Nm).

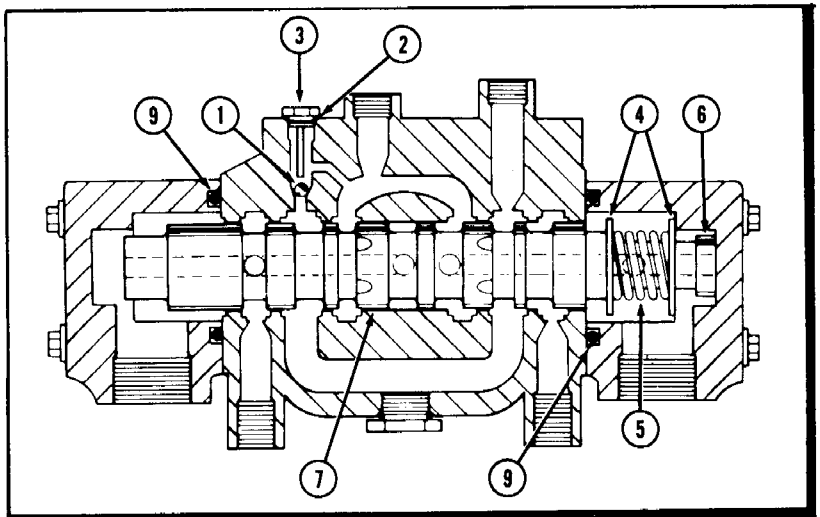
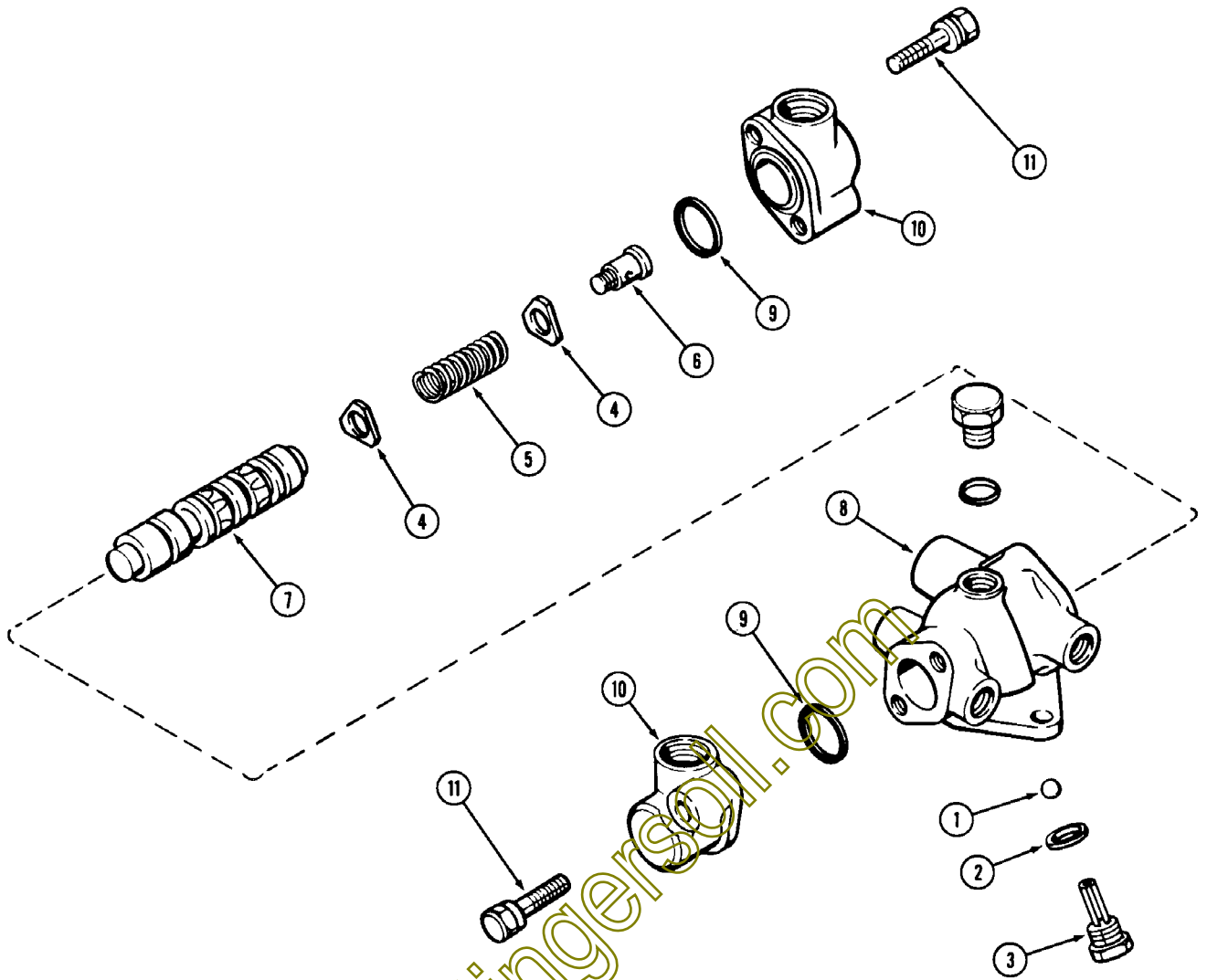


FIGURE 8 STEERING CONTROL VALVE

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