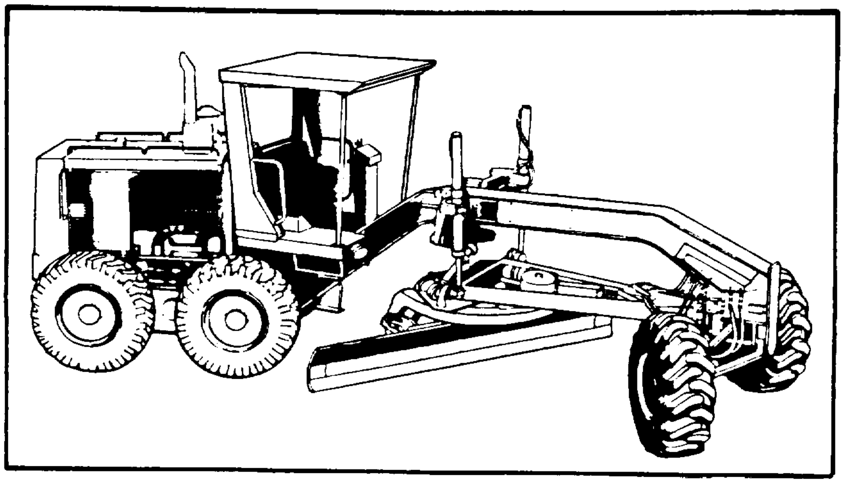
TECHNICAL MANUAL
UNIT, DIRECT AND GENERAL SUPPORT
MAINTENANCE MANUAL
FOR
GRADER, HEAVY, ROAD, MOTORIZED, DIESEL ENGINE DRIVEN
TYPE I (NONSECTIONALIZED) NSN 3805-01-252-0128
TYPE II (SECTIONALIZED) NSN 3805-01-251-8252



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HEADQUARTERS, DEPARTMENT OF THE ARMY
APRIL 1989

TECHNICAL MANUAL

HEADQUARTERS
DEPARTMENT OF THE ARMY
Washington, DC, 14April 1989

UNIT, DIRECT AND GENERAL SUPPORT MAINTENANCE MANUAL FOR GRADER, HEAVY, ROAD, MOTORIZED, TYPE I NONSECTIONALIZED NSN 3805-01-252-0128 TYPE II SECTIONALIZED NSN 3805-01-251-8252

REPORTING OF ERRORS

You can help Improve this manual. If you find any mistakes or if you know of a way to improve the procedures, please let us know. Mail your letter, DA Form 2028 (Recommended Changes to Publications and Blank Forms) or DA Form 2028-2 located in the back of this manual direct to: Commander, US Army Tank-Automotive Command, ATTN: AMSTA-MB, Warren, MI 48397-5000. A reply will be furnished direct to you.

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This technical manual is an authentication of the manufacturers commercial literature and does not conform with the format and content specified in AR 310-3, Military Publications. This technical manual does, however, contain available information that is essential to the operation and maintenance of the equipment.

PART THREE
VEHICLE SYSTEMS

TORQUE SPECIFICATIONS: You will find instances in this publication where the manufacturer has used "Meter-Kilograms" or "Centimeter-Kilograms" in place of "Newton-Meters" for the metric torque. In these instances, use the following conversion factors to obtain the metric torque in "Newton-Meters."

lb. ft. x 1.355819 = N-m
lb. in. x 0.1129848 = N-m

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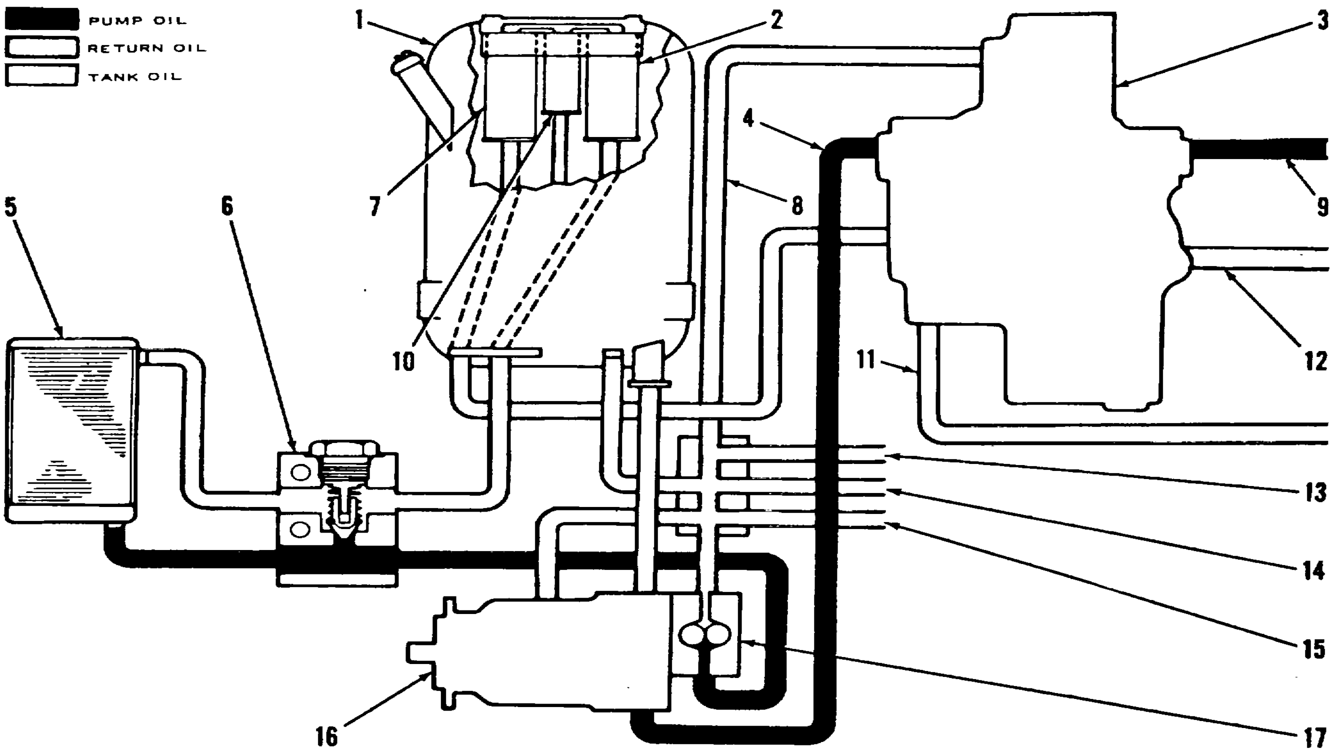
SPECIFICATIONS

NOTE: For Specifications with illustrations, make reference to the SPECIFICATIONS FOR MOTOR GRADERS HYDRAULIC AND STEERING.



TANK, PUMP AND OIL COOLER SYSTEM (SCHEMATIC)

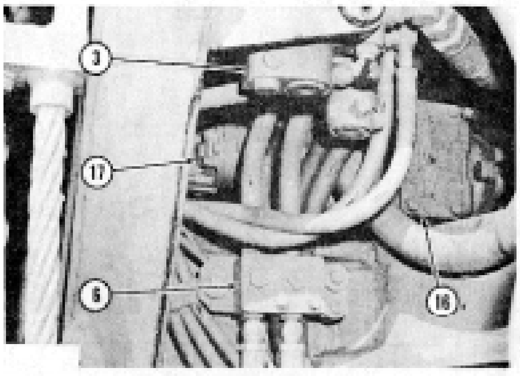
1. Tank for hydraulic oil. 2. Filter. 3. Unloading valve ({part of the combination valve). 4. Line from the variable displacement pump. 5. Cooler for hydraulic oil. 6. Bypass valve for oil cooler. 7. Filter. 8. Return line from unloading valve,. 9. Passage to the other section of the combination valve. 10. Strainer. 11. Line from the metering pump and valve for steering. 12. Passage from pressure reduction valve and relief valve. 13. Line from the swivel. 14. Line from the drive motor for the circle. 15. Line from the control valves. 16. Variable displacement pump. 17. Pump for oil to the oil cooler.

The hydraulic system is a closed center system. In a closed center system, the oil from the variable displacement pump (16), has pressure at each valve in the hydraulic system when the vehicle engine is running.

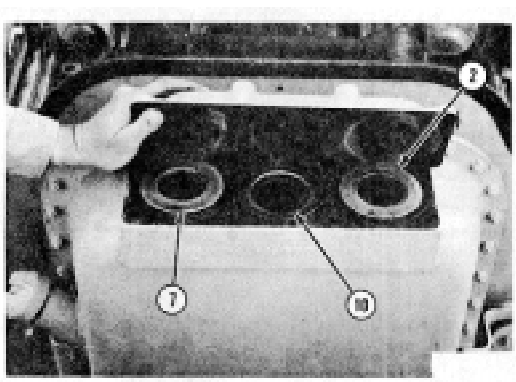
The drive shaft for pump (16) goes through the pump to the drive shaft for pump (17).

When the vehicle engine is running, both pumps are operating. Pump (16) gets oil through a line from tank (I). Lines (8, 13, 14 and 15) are for oil leakage from the valves in the hydraulic system. The oil leakage is from high pressure oil and is a source of heat. The oil from lines (8), (13), (14) and (15) and a line from the tank goes through a manifold and to pump (17). Pump (17) moves this oil through oil cooler (5) and to filter (2) in tank (1). The oil from filter (2) goes through a manifold and through strainer (10) and then into tank (1).

HYDRAULIC SYSTEM
AND STEERING



HYDRAULIC PUMP
(Seen from left side of machine)
3. Unloading valve (part of the combination valve). 6. By-pass valve for oil cooler. 16. Variable displacement pump. 17. Pump for oil to the oil cooler. The oil from the hydraulic cylinders and hydraulic motor goes through filter (7), strainer (10) and into the tank.



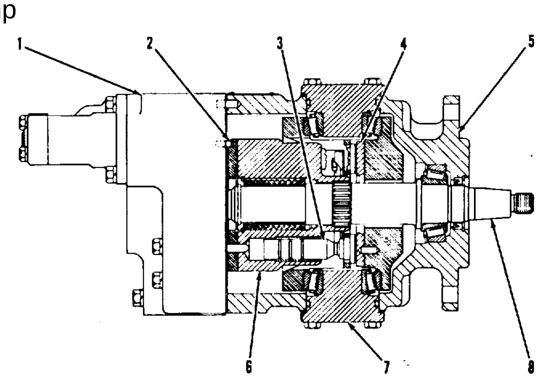
MANIFOLD FOR TANK
2. Filter (element). 7. Filter (element). 10. Strainer.
Each filter (2) and (7) has a bypass valve. If the filter element is full of dirt, and oil can not go through the element, the pressure of the oil gets an increase which opens the bypass valve. The oil through the bypass valve goes through strainer (10) and into tank (1). Each filter has an indicator that shows when the filter element is dirty.

Bypass valve (6) is for cooler (5). The bypass valve opens when the pressure of the oil from pump (17) is more than the pressure setting of the bypass valve. Dirt in oil passages in cooler (5) will cause an increase in the pressure of the oil from pump (17). The oil in the hydraulic system can get too much heat if the oil from pump (17) goes through the open bypass valve (6) and not through cooler (5).

Pump (16) gets oil through a large line from tank (I). The oil from pump (16) goes through line (4) to unloading valve (3). The unloading valve is part of the combination valve. The pump oil in the combination valve goes to all of the control valves in the hydraulic system.

VARIABLE DISPLACEMENT PUMP
The variable displacement pump is an axial piston pump. The change in the output (displacement) is automatic. The length of the stroke for the pistons is the control for the output (displacement) of the pump. With a decrease in the length of the stroke for the pistons, the output of the pump is less. The movement of a swashplate in the pump is the control for the length of the stroke for the pistons. When the engine is stopped, a spring on a valve in the pump keeps tle swashplate at the maximum angle (maximum length of the stroke for the pistons). When the engine is running, oil at the outlet pressure of the pump is in the valve against the spring. When there is an increase in the pressure of the oil from the pump outlet, the force of the oil pressure in the valve against the spring is more and the spring gets compression (shorter length). As the spring length gets shorter, the swashplate moves toward minimum angle and the output (displacement) of the pump is less.

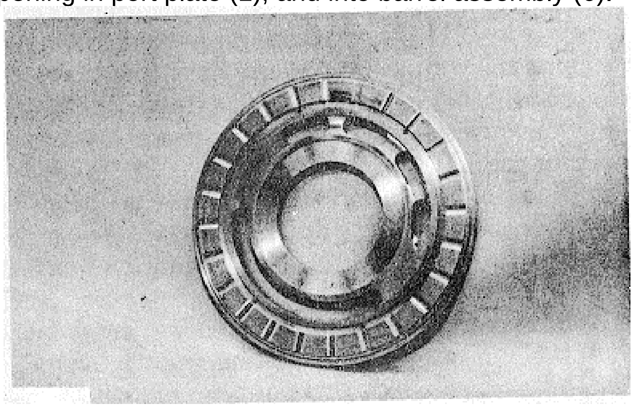
The pump has two pressure settings. The load on the hydraulic components causes the pressure setting of the pump to change. An oil line, from the oil circuits to the components, connects to a valve in the pump. The pump operates at the low setting until more oil pressure is needed for the component to move the load. When the pressure of the oil to the component and in the line to the valve in the pump gets an increase. the valve in the pump



VARIABLE DISPLACEMENT PUMP
1. Head assembly. 2. Port plate. 3. Piston (nine). 4. Thrust plate. 5. Pump body. 6. Barrel assembly. 7. Swash-plate. 8. Drive shaft.

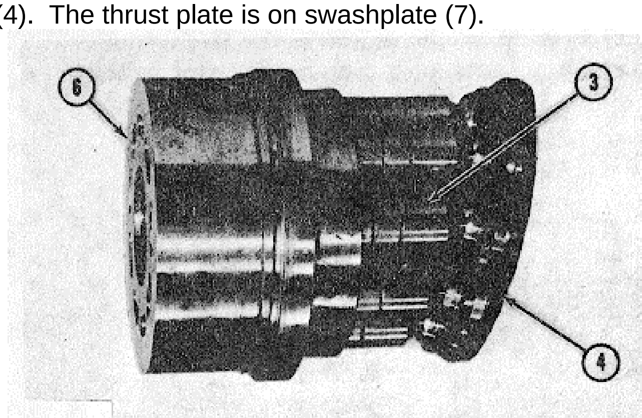
moves and the spring, which controls the angle of the swashplate, gets more force. When the sprint has more force, the length of the stroke for the pistons gets an increase and the pump operates at the high setting. The pump goes to the low setting when the pressure of the oil to the component gets a decrease.

The pump is driven by the engine crankshaft and turns at the same speed as the engine. Barrel assembly (6) and the nine pistons (3) turn when drive shaft (8) turns. When pistons (3) are at the bottom of their strokes, the oil from the tank goes through a long inlet opening in port plate (1), and into barrel assembly (6).



PORT PLATE

As the shaft, barrel assembly and pistons turn thrust plate (4) moves the pistons to the top of their strokes. The pistons push the oil through the outlet holes in the port plate and into the hydraulic system. The ball sockets on the ends of pistons (3) slide on thrust plate (4). The thrust plate is on swashplate (7).

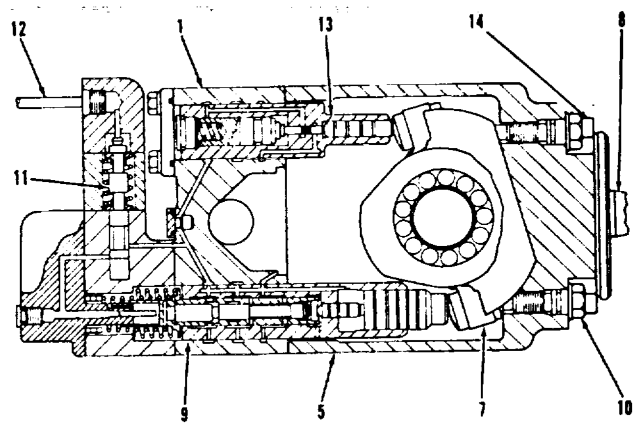


TYPICAL BARREL AND PISTONS

3. Piston (nine). 4. Thrust plate. 6. Barrel assembly.

The angle of swashplate (7) changes the displace ment of pistons (3) (changes the stroke of the pistons). The longest stroke of the pistons is whet the angle of the swashplate is approximately 16°

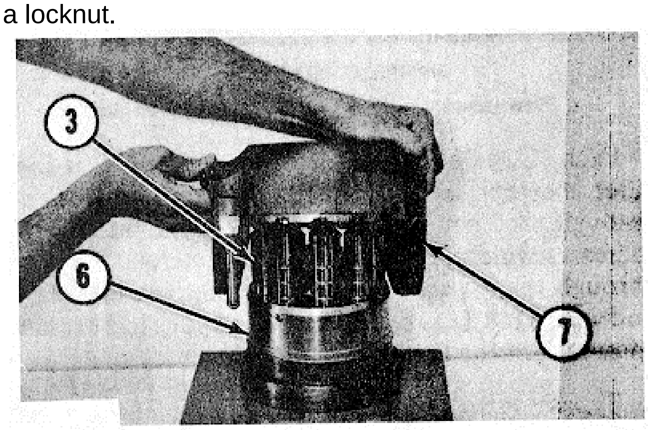
The shortest stroke of the pistons is when the angle of the swashplate is near 0°



VALVES IN VARIABLE DISPLACEMENT PUMP

1. Head assembly. 5. Pump body. 7. Swashplate. B. Drive shaft. 9. Servo valve. 10. Bolt. 11. Shuttle valve. 12.0il line from control valve for the implements. 13. Pressure reduction valve. 14. Bolt.

The increase in the angle of swashplate (7) is stopped by the end of bolt (10). Shims, under the head of bolt (10), can be removed for a decrease or added for an increase in the angle of the swashplate. Shims, under the head of bolt (14), are used to keep the angle of the swashplate from going to 0°. If the swashplate stopped at 00, there would be no stroke for pistons (3). If the pistons did not have some stroke, there would be no oil for lubrication or to cool the pump. Turn the head of bolt (14) to get less angle to the swashplate. The bolt is kept in position with a locknut.



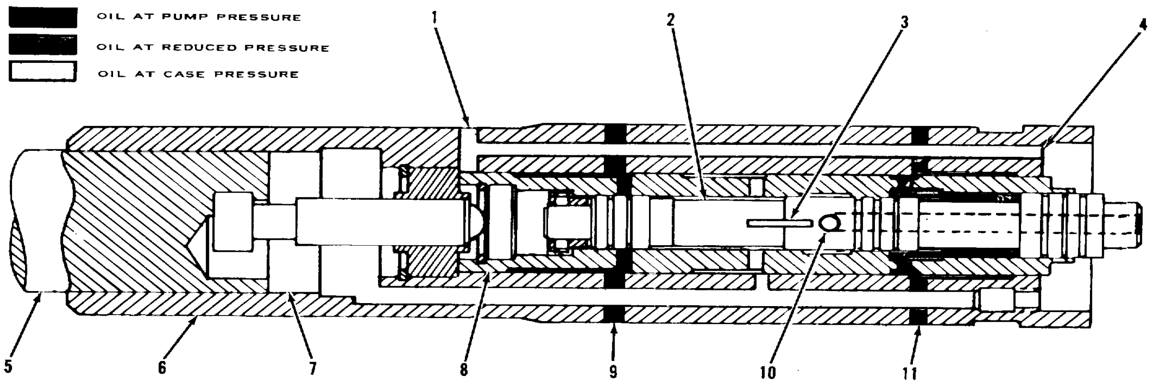
TYPICAL SWASHPLATE

3. Piston (nine). 6. Barrel assembly. 7. Swashplate.

The actions of servo valve (9) and pressure reduction valve (13) control the stroke of pistons (3) by moving swashplate (7) when either more or less pump oil is needed by the components in the hydraulic system.

The low pressure setting of the pump is approximately 2150 psi (151.1 kg/cm2). The pump operates with this pressure at all of the control valves in the hydraulic system when the engine is running and the control valves are in HOLD position. When a control valve is used, the pressure of the oil in the circuit to the component is also in line (12) to shuttle valve (11). When there is an increase in the load on the component, the pressure of the oil in this circuit gets an increase. When the pressure of the oil in the circuit gets to 1500 psi (103.5kg/cm2), the pressure of the oil in line (12) moves shuttle valve (I I). When the shuttle valve is moved, the pressure of the oil from the pump into the hydraulic circuit can go as high as approximately 3500 psi (246.1 kg/cm2).

Servo Valve, Pressure Reduction Valve and Shuttle Valve



SERVO VALVE CROSS SECTION

(Pistons in pump at longest stroke)
1. Passage for oil from the case. 2. Valve spool. 3. Groove {(three) in valve spool. 4. Passage to case. 5. Piston assembly. 6. Cartridge for servo valve. 7. Chamber. 8. Sleeve. 9. Passage for oil at pump output pressure. 10. Hole and passage to the case. 11. Passage for oil from pressure reduction valve.

The actions of the servo valve and the pressure reduction valve change the angle of swashplate (14). The change in the angle of the swashplate changes the stroke of the pistons. When the stroke of the pistons change, the gpm (litre/min) output of oil from the pump changes.

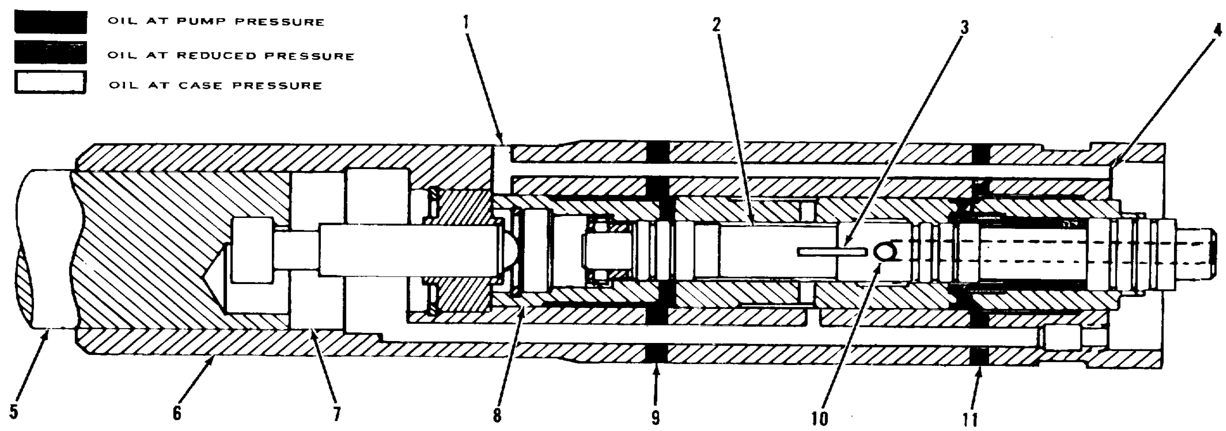
When the engine is not running, the swashplate is at the maximum angle. The swashplate can be at the maximum angle when the engine is running and two components in the hydraulic system are being operated together. The pistons, in the barrel assembly of the pump, have their longest stroke when the swashplate is at its maximum angle.

Oil at the output pressure of the pump goes into cartridge (6), through passage (9), around valve spool (2) and goes through passages in sleeve (8) and cartridge (6), into chamber (7). The oil in chamber (7) keeps piston assembly (5) at its extension and the swashplate (14) at its maximum angle.

Oil, at the outlet pressure of the pump, also goes into the pressure reduction valve, through passage (18), and through the orifice in piston (17). The orifice makes a reduction in the pressure of the oil that goes through passage (II 1) in the cartridge for servo valve (6). The force of the oil through passage (11), and on the larger surface of valve spool (2), is the same as the force spring (13) has on the valve spool.

When there is an increase in the pressure of the output oil from the pump, there is also an increase in the pressure of the oil through passage (9) and passage (I I).

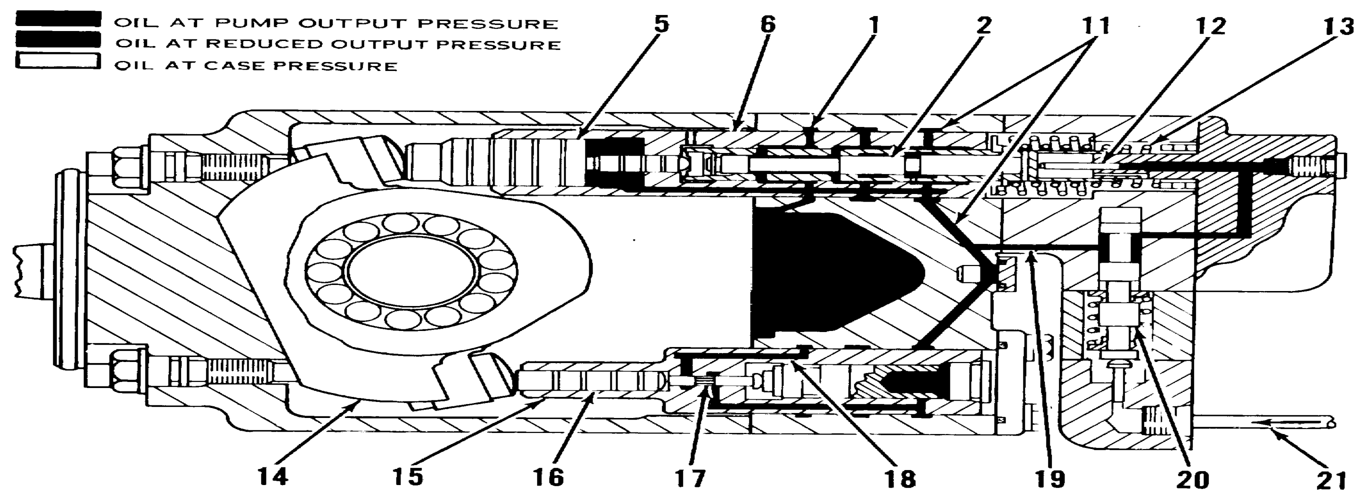
The increase of the pressure of the oil, through passage (11) and on valve spool (2), is now more than the force of spring (13) and valve spool (2) moves. The oil in passage (9) is now stopped by the valve spool. The position of valve spool (2) can now let the oil in chamber (7) go through passages in cartridge (6), sleeve (8), and through grooves (3), to the hole and passage (10) to the case.



SERVO VALVE

(Before a reduction in the stroke of the pistons)

1. Passage for oil from the case. 2. Valve spool. 3. Groove (three) in valve spool. 4. Passage to case. 5. Piston assembly. 6. Cartridge for servo valve. 7. Chamber. 8. Sleeve. 9. Passage for oil at pump output pressure. 10. Hole and passage to the case. 11. Passage for oil from pressure reduction valve.



VALVES IN THE PUMP

1. Passage for oil from the case. 2. Valve spool. 5. Piston assembly. 6. Cartridge for servo valve. 11. Passage for oil from pressure reduction valve. 12. Piston. 13. Spring. 14. Swashplate. 15. Pressure reduction valve. 16. Piston. 17. Piston with orifice. 18. Passage for oil at pump outlet pressure. 19. Oil passage. 20. Shuttle valve. 21. Oil01 line from control valve.

HYDRAULIC SYSTEM
AND STEERING

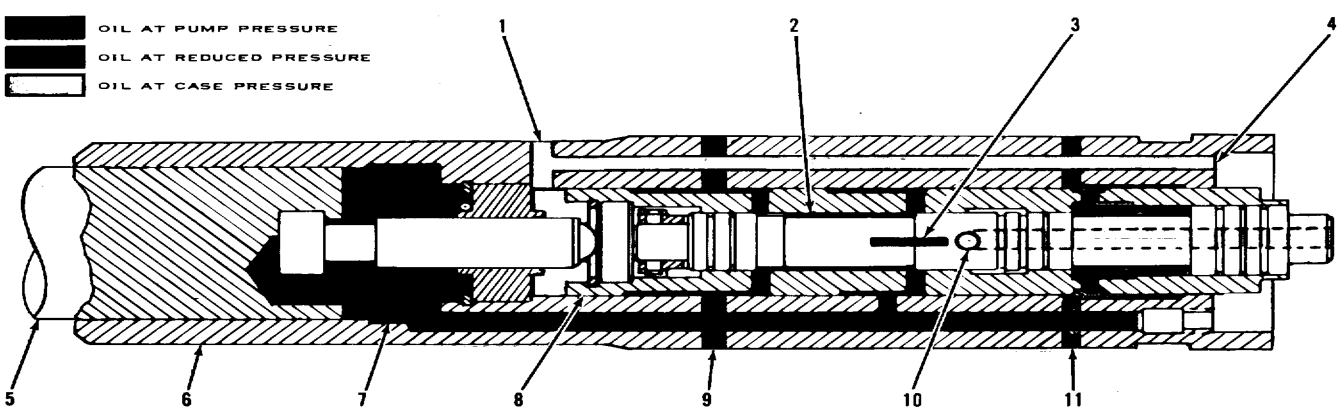
The oil, at pump output pressure, is also through passage (18) into pressure reduction valve (15). When the oil in chamber (7) can go to the case, there is no force on piston assembly (5) and the pressure of the oil through passage (18) moves piston (16). The piston moves swashplate (14).

Swashplate (14) moves piston assembly (5). Piston assembly (5) pushes the oil from chamber (7) through the hole and passage (10) in valve spool (2). The swashplate stops moving piston assembly (5) when the piston assembly moves sleeve (8) to a position where the pump output pressure oil in passage (9) can go around valve spool (2), through the passages in sleeve (8) and cartridge (6), into chamber (7). When the oil at pump output pressure is in chamber (7) on piston assembly (5), and is in pressure reduction valve (15) on piston (16), the swashplate cannot move. The angle of swashplate (14) is now less than when the pistons, in the barrel of the pump, were at the longest stroke.

When there is a decrease in the output pressure from the pump, because the load on the component in the hydraulic system which is being used is less, the pressure of the oil in passage (9) and in passage (II) is less. The force of the pressure oil from passage (11), on valve spool (2), is now less than the force of spring (13). Spring (13) now moves valve spool (2), piston assembly (5), and swashplate (14). There is now an- increase in the angle of the swashplate and the pistons in the barrel of the pump get longer strokes.

When the load on the component in the hydraulic system being used gets to 1500 psi (103.5 kg/cm2), the pressure in line (21) is also at 1500 psi (103.5 kg/cm2) and the pressure of the oil moves shuttle valve (20). When the shuttle valve is moved, the oil from pressure reduction valve (15) goes through passage (19), around the end of shuttle valve (20) and into the chamber for piston (I 2). The force of the oil in piston (12) adds to the force spring (13) has on valve spool (2). With the increase of force on valve spool (2), the output pressure of the oil from the pump can go to 3500 psi (246.1 kg/cm2). The actions of the servo valve and the pressure reducing valve are the same as when the output pressure of the oil from the pump was below 2150 psi (151.1 kg/cm2). When the pressure of the oil in line (21) is less than 1500 psi (103.5 kg/cm2), or there is no oil pressure in line (21) when the components in the hydraulic system are not being used, the output pressure of the oil from the pump is at approximately 2150 psi (131.1 kg/cm2).

Add to the washers on spring (13) if the output pressure of the oil from the pump is below 2150 psi (151.1 kg/cm2). Add to the shims on the spring in shuttle valve (20) if the shuttle valve moves when the pressure of the oil in the hydraulic system to a component is below 1500 psi (103.5 kg/cm2).



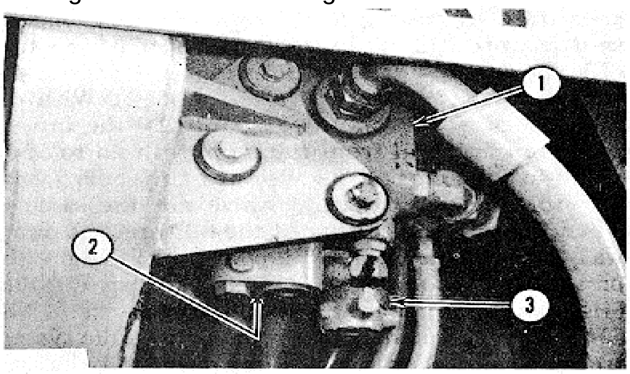
SERVO VALVE

(Pistons now have less than full stroke)

1. Passage for oil from the case. 2. Valve spool. 3. Groove (three) in valve spool. 4. Passage to case. 5. Piston assembly. 6. Cartridge for servo valve. 7. Chamber. 8. Sleeve. 9. Passage for oil at pump output pressure. 10. Hole and passage to the case. 11. Passage for oil from pressure reduction valve.

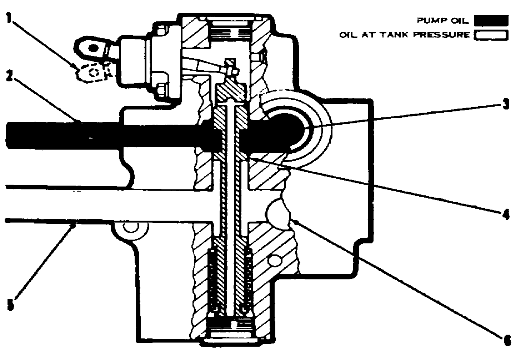
COMBINATION VALVE

The oil from the variable displacement pump goes through the combination valve when the engine is running. The pump oil from the combination valve goes to the two control valves for the implements and to the metering valve for the steering.



VALVES IN THE COMBINATION VALVE

1. Unloading valve. 2. Pressure reduction valve. 3. Relief valve. A relief valve for the oil circuits to the control valves for the implements (3), a valve that makes a reduction in the pressure of the oil from the-pump to the steering system (2), and an unloading valve (1), are parts of the combination valve.



UNLOADING VALVE
(Part of combination valve)

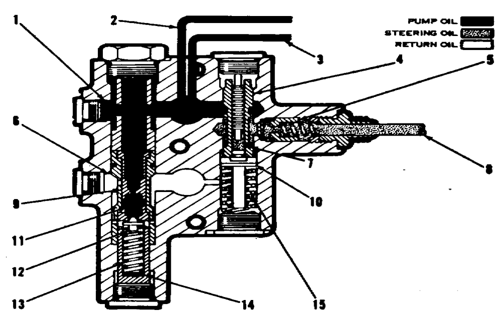
1. Control lever UNLOAD position. 2. Line from pump. 3. Opening to other part of combination valve. 4. Valve spool. 5. Line to tank. 6. Opening from other part of combination valve.

The oil from the pump goes through line (2), around valve spool (4) and through opening (3) to the other part of the combination valve and to the hydraulic system.

The pistons, in the variable displacement pump, are at their longest stroke as the engine is started. Because of the closed hydraulic system and the pump at high output gpm (litre/min), there is an added load on the starter being used to start the engine. When the outside temperature is low, the movement of the oil in the hydraulic system is slow and the pump would put more load on the starter when it is starting the engine. The unloading valve can remove most of the hydraulic load when the engine is being started. When the control lever is held in UNLOAD position (1), valve spool (4) is moved to let the pump oil through line (2) go along the groove on valve spool (4) and go through line (5) to the tank.

Relief Valve and Pressure Reduction Valve

The relief valve and the valve for the reduction of oil pressure for the steering system are in the same valve housing. The relief valve is in the circuit from the pump. The pressure reduction valve is in the same circuit as the relief valve. The pump oil, through the valve to the controls for the implements, can be as high as the setting of the relief valve. The setting of the relief valve is approximately 3900 psi (274.2 kg/cm2). The oil, through pressure reduction valve to the steering system, has a setting of a approximately 1825 psi (128.3 kg/cm2)

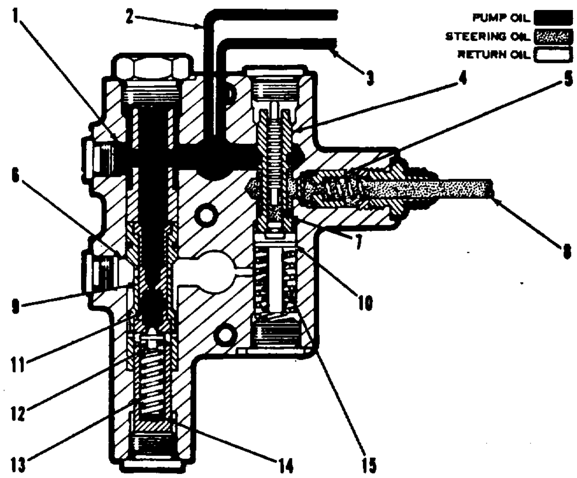


8J7238 RELIEF VALVE AND VALVE FOR PRESSURE REDUCTION

1. Passage for oil from pump. 2. Line to control for implements. 3. Line to control for implements. 4. Piston. S. Check valve. 6. Passage to tank. 7. Passage in piston. 8. Line to steering system. 9. Dump valve. 10. Washer and shims. 11. Spring for dump valve. 12. Pilot valve. 13. Spring. 14. Shims. 15. Springs (two, inner and outer).

HYDRAULIC SYSTEM
AND STEERING

NOTE: The setting used in the pressure control valve for the steering circuit is 1825 + 25 psi (128.3 + 1.8 kg/cm2).



9J4818 VALVE GROUPS

1. Passage for oil from pump. 2. Line to control for implements. 3. Line to control for implements. 4. Piston. 5. Check valve. 6. Passage to tank. 7. Passage in piston. 8. Line to steering system. 9. Dump valve. 10. Washers and shims. 11. Spring for dump valve. 12. Pilot valve. 13. Spring. 14. Shims. 15. Spring.

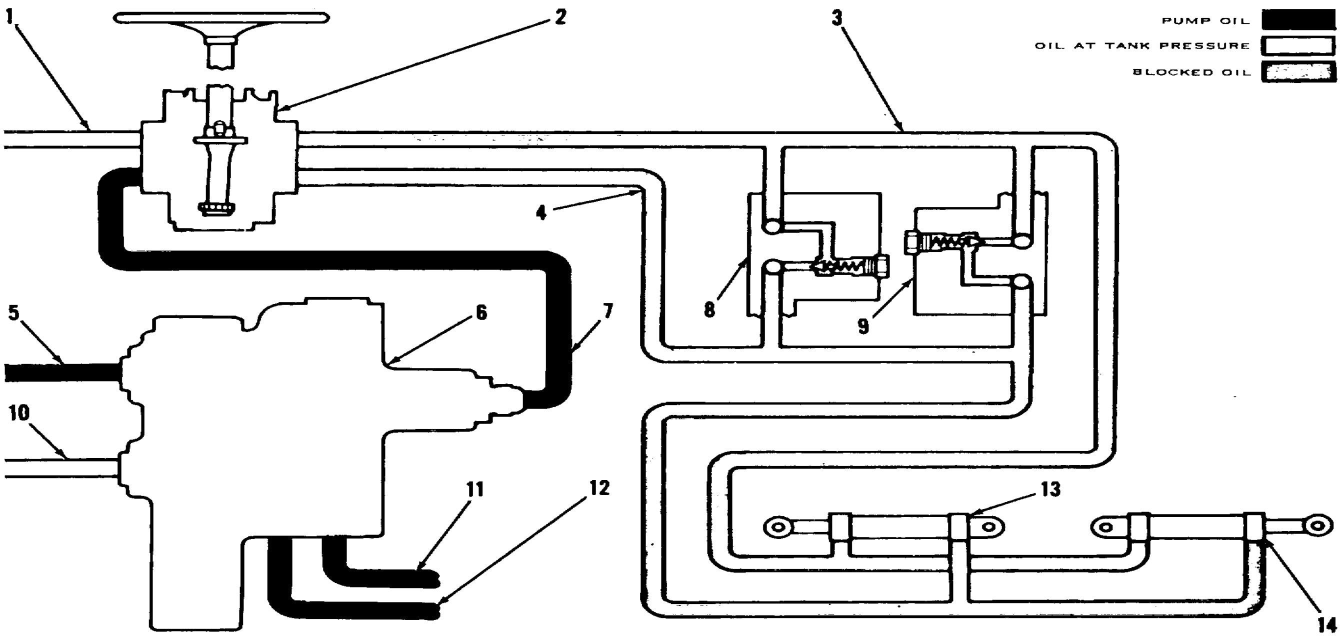
The pump oil in passage (1) goes through the orifice in dump valve (9) and into the chamber for spring (11). The pressure of the oil, and spring (1l), keeps dump valve (9) closed. The oil in the spring chamber is against pilot valve (12) which is held closed by spring (13). If the pressure of the oil gets to approximately 3900 psi (274.2 kg/cm2), the oil in the chamber for spring (11) opens pilot valve (12). This oil goes into passage (6). With only the force of spring (11) on dump valve (9), the pump oil in passage (1) opens dump valve (9) and goes into passage (6) to the tank. The relief valve prevents the pressure of the oil, between the pump and the implements, from going higher than the setting of the relief valve.

The pump oil in passage ( ) goes around piston (4), through check valve (5) and through line (8) to the metering valve for the steering system. Piston (4) is held in an open position by spring (15). The oil to check valve (5) also goes through passage (7), into a chamber in piston (4). When the pressure of the oil in line (8) and in piston (4) is approximately 1825 psi (128.3 kg'cm2), the force of the oil is more than the force of springs (15), and the piston moves to a position that stops the oil from passage (1) to line (8). When the pressure of the oil in line (8) and the piston is less than 1825 psi (128.3 kg'cm2), spring (15) moves the piston to let more oil go to line (8). When the pressure of the pump oil in passage (l) is more than 1825 psi (128.3 kg,'cm2), the action of springs (15) and the pressure of the oil in piston (4) keeps the pressure of the oil to the steering system at 1825 psi (128.3 kg,'cm2).

The pressure setting of the relief valve can be changed. Add to shims (14) for an increase. Remove shims for a decrease. Add to shims (10) for an increase in the regulation of the oil pressure to the steering system. Remove shims for a decrease in pressure.

STEERING SYSTEM

When the engine is running, the oil from the pump goes through relief and pressure reduction valve (6), through line (7), to metering valve (2) for the steering. The pressure of the oil in line (7) is approximately 1825 psi (128.3 kg,'cm2). The movement of the steering wheel operates the metering valve. When the steering wheel is being turned in the direction of a right turn (clockwise), the oil from line (7) goes through metering valve (2) and through line (3). The oil in line (3) goes to the rod end of cylinder (13), and to the head end of cylinder (14) and the rods in the cylinders move. The cylinder rods move the front wheels to positions that will let the machine make a right turn. The oil from the head end of cylinder (13) and from the rod end of cylinder (14) goes through line (4), through metering valve (2) and through line (I) to the tank.

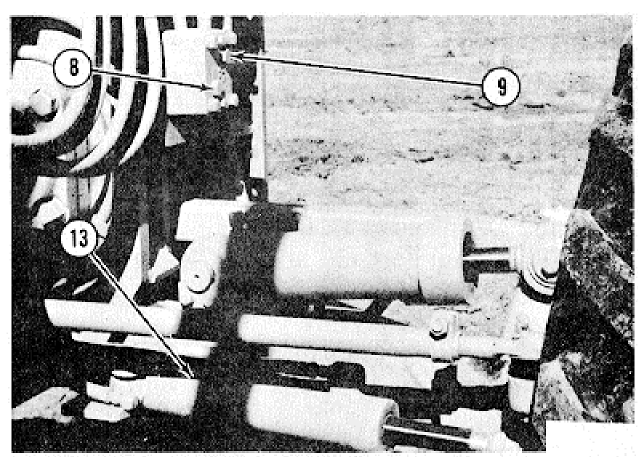


HYDRAULIC SYSTEM FOR STEERING

1. Line to tank. 2. Metering valve for steering. 3. Line to rod end of right cylinder and to head end of left cylinder. 4. Line to head end of right cylinder and rod end of left cylinder. 5. Passage for pump oil. 6. Combination valve (relief and pressure reduction valves). 7. Line for oil to the metering valve. 8 and 9. Relief valves (both in the same housing) for the steering cylinders. 10. Passage for oil to tank. 11. Line to control valve for implements. 12. Line to control valve for implements. 13. Steering cylinder on right side. 14. Steering cylinder on left side.

When the steering wheel is not being turned the oil in lines (3) and (4), and in cylinders (13) and (14), can not move and the front wheels stay in position. If the side of one of the front wheels hits a restriction (material that will not move), the positions of the front wheels twill move. The force on the side of the wheel causes an increase in the pressure of the oil in the cylinders and in one of the lines to the cylinders. When the pressure of the oil in the line gets to 1700 psi (119.5 kg'cm2), relief valve (8) or (9) opens. The high pressure oil in the line goes through the open relief valve and into the other line to the cylinders. This lets the positions of the front wheels change.

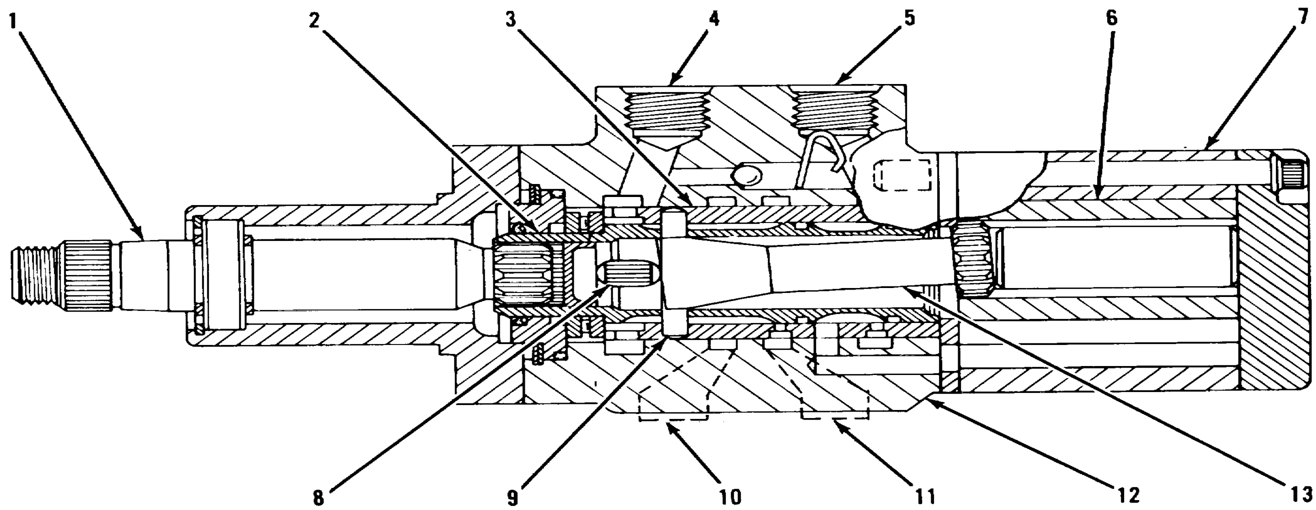
The pressure setting of relief valves (8) and (9) can be changed. For an increase in the pressure setting, add shims in the plug over the spring in the valve. Remove shims for a decrease in the pressure setting.



FRONT OF MOTOR GRADER

8 and 9. Plugs for relief valve. 13. Steering cylinder on right side.

Metering Valve for Steering



METERING VALVE FOR STEERING

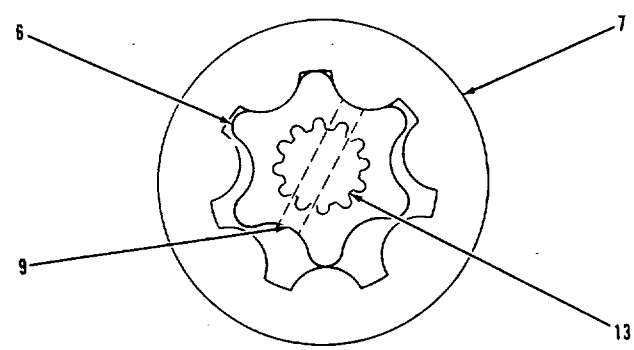
1. Shaft. 2. Spool. 3. Sleeve. 4. Outlet (to tank). 5. Inlet (for pump oil). 6. Pump gear. 7. Pump gear (internal). 8. Flat springs. 9. Pin. 10. Opening to steering cylinders (left). 11. 0pening to steering cylinders (right). 12. Body. 13. Drove.

When the engine is running, the pump keeps the pressure of the oil in inlet (5) at approximately 1825 psi (128.3 kg cm2). The pump oil does not go through the metering Nvalve until the steering wheel is turned.

The steering wheel is installed on shaft (1). When the steering wheel is turned clockwise to make a right turn, shaft (1) turns spool (2). After the spool turns a few degrees, flat springs (8), in the spool, turn sleeve (3). The spool and the sleeve turn, but they turn a few degrees from being together. The pin (9), in spool (2), turns drive (13) which turns pump gear (6) in pump gear (7). Pump gear (7) does not turn.

When spool (2) moves before sleeve (3) is moved, the holes in the sleeve get in line with grooves in the spool. The pump oil in inlet (5) goes through the holes in the sleeve into the grooves in the spool. The oil in the grooves goes through other holes in the sleeve and through a passage in body (12). The oil from the passage in the bode goes into pump gears (6) and (7).

As pump gear (6) is turned by drive (1 3), the oil is moved to another passage in body (1 2), through more holes in the sleeve and other grooves in the spool, and through opening (11) to the steering cylinders. The oil from the cylinders goes through opening (10), passages in body (1 2), holes in sleeve (3), grooves in spool (2) and through passages to outlet (4). The oil from outlet (4) goes to the tank.



PUMP GEARS IN METERING VALVE

6. Pump gear. 7. Pump gear (internal). 9. Pin. 13. Drive.

When turning the steering wheel is stopped, most of the parts connected to shaft (I) also stop. Flat springs (8) now move the sleeve a few degrees in the same direction that it was being turned. Now the holes in the sleeve do not line up with the grooves in the spool and the flow of oil stops in inlet (5) of the metering valve. When the steering wheel is not being turned, the oil cannot get in or get out of the steering cylinders which keeps the wheels positioned for a right turn.