

# Troubleshooting, Testing & Adjusting

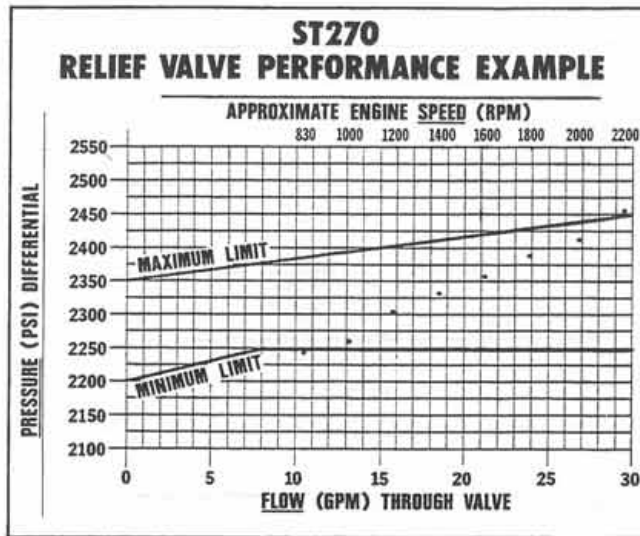


Figure 48:

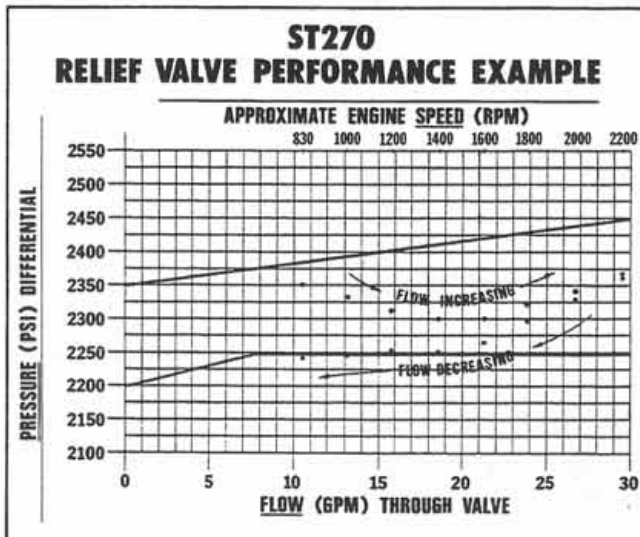


Figure 49:

If the pressure curve demonstrates low pressure at any point AND high pressure at high flow as shown here on the graph, the relief valve cartridge should be changed. Either the spring is being fully compressed before the poppet is fully opened, the cartridge seals are leaking badly, or the poppet is sticking. Regarding the spring, the fully compressed condition is called COIL BIND, and is caused by excessive shimming to overcome settling of the spring length. (See Fig. 48)

Note the reading difference between engine speed increasing and speed decreasing. If the difference in pressure is more than 100 PSI for the same flow rate (or engine speed), then the relief poppet is not able to move freely enough and requires cleaning or replacement. (See Fig. 49)

The priority valve and steering valve can be tested with the flow analyzer still connected. Pressure readings should be obtained with the load valve fully opened. The flow analyzer will now be used to measure temperature and control pressure only. The test data obtained here is valuable in identifying how certain problems influence the hydraulic system. To begin with, measure the control pressure with the engine at low idle, then at rated speed. Record the readings and compare them against the minimum and maximum pressures that are specified for the tractor model being tested. (See Fig. 50)

# Troubleshooting, Testing & Adjusting

TRACTOR MODEL	ST 210 RC 210	ST 220 ST 251 <u>ST 310</u> <b>EXAMPLE BEING TESTED</b>	PT 225 PT 250 ST 250 PT 270 ST 270	ST 320 PT 350 ST 350	ST 325	ST 450 (#130)
Engine Make And Model	CAT 3208	Cummins N-855 NT-855 NTA-855	Cat 3306	Cummins VT-903	Cat 3406	Cummins KTA-1150
Engine Idle Speed(RPM)	830	830	830	830	830	Use 830 for test purposes
Engine Rated Speed	2800	2100	2200	2600	2100	2100
Maximum Pump Output GPM at idle-No Load	7.1	11.3	12.2	10.5	12.4	15.9
Minimum Pump Output GPM at idle-No Load	6.4	10.2	11.0	9.5	11.2	14.3
Minimum Pump Output GPM at idle-2250 PSI Pressure	4.3	8.5	9.1	6.3	9.3	11.9
Maximum Pump Output GPM at rated speed No Load	23.9	28.7	32.4	33.8	32.9	38.9
Minimum Pump Output GPM at rated speed No Load	21.5	25.8	29.1	30.4	29.6	35.0
Minimum Pump Output GPM at rated speed 2250 PSI Pressure	19.1	22.9	25.9	27.0	26.3	31.1
Minimum Main And Secondary Relief Valve Setting PSI. Locate Lowest Pressure Curve Area	2250	2250	2250	2250	2250	2250
Maximum Main And Secondary Relief Valve Setting PSI At Highest Area Of Pressure Curve	2450	2450	2450	2450	2450	2450
Steering Circuit Load Sense Relief Valve Pressure Setting PSI	2000	2000	2000	2000	2000	2000
Detent Release Pressure Setting PSI	2150	2150	2150	2150	2150	2150
Minimum Control Pressure PSI at idle speed	150	150	150	150	150	80
Maximum Control Pressure PSI at rated speed With Flow Regulator at Highest Flow	340	270	ST-300 PT-350	ST-350 PT-460	340	430
Reservoir Pressure Relief Setting PSI	5	Atmospheric	5-PT only ST-Atmospheric	5-PT only ST-Atmospheric	Atmospheric	5
Oil Temperature During all Testing °F and °C	160 71	160 71	160 71	160 71	160 71	160 71
Steering Performance Time in Seconds Req. to turn lock to lock. Check at test idle speed & traveling on hard surface.	5.2 to 6.3	4.5 to 5.4	ST-4.4 to 5.2 PT 4.9 to 5.9	ST-4.8 to 5.7 PT-5.4 to 6.5	4.5 to 5.4	6.5 to 8.0 see note
Flow Regulator Valve Adjustment Range GPM	8 to 20	8 to 20	8 to 20	8 to 20	8 to 20	12 to 25
Neutral Pressure at steering valve exhaust - PSI at test idle speed.	2 to 3	2 to 3	2 to 3	2 to 3	2 to 3	8 to 10
Neutral Pressure at steering valve exhaust -PSI at rated speed	5 to 7	5 to 7	ST 5 to 7 PT 7 to 9	ST 5 to 7 PT 8 to 10	5 to 7	15 to 20

NOTE: On ST 450 Models, steering performance at low engine speed is influenced by the flow regulator setting for the power brake booster. Ensure the regulator is adjusted according to the brake systems service manual before judging the remainder of the system.

Figure 50:

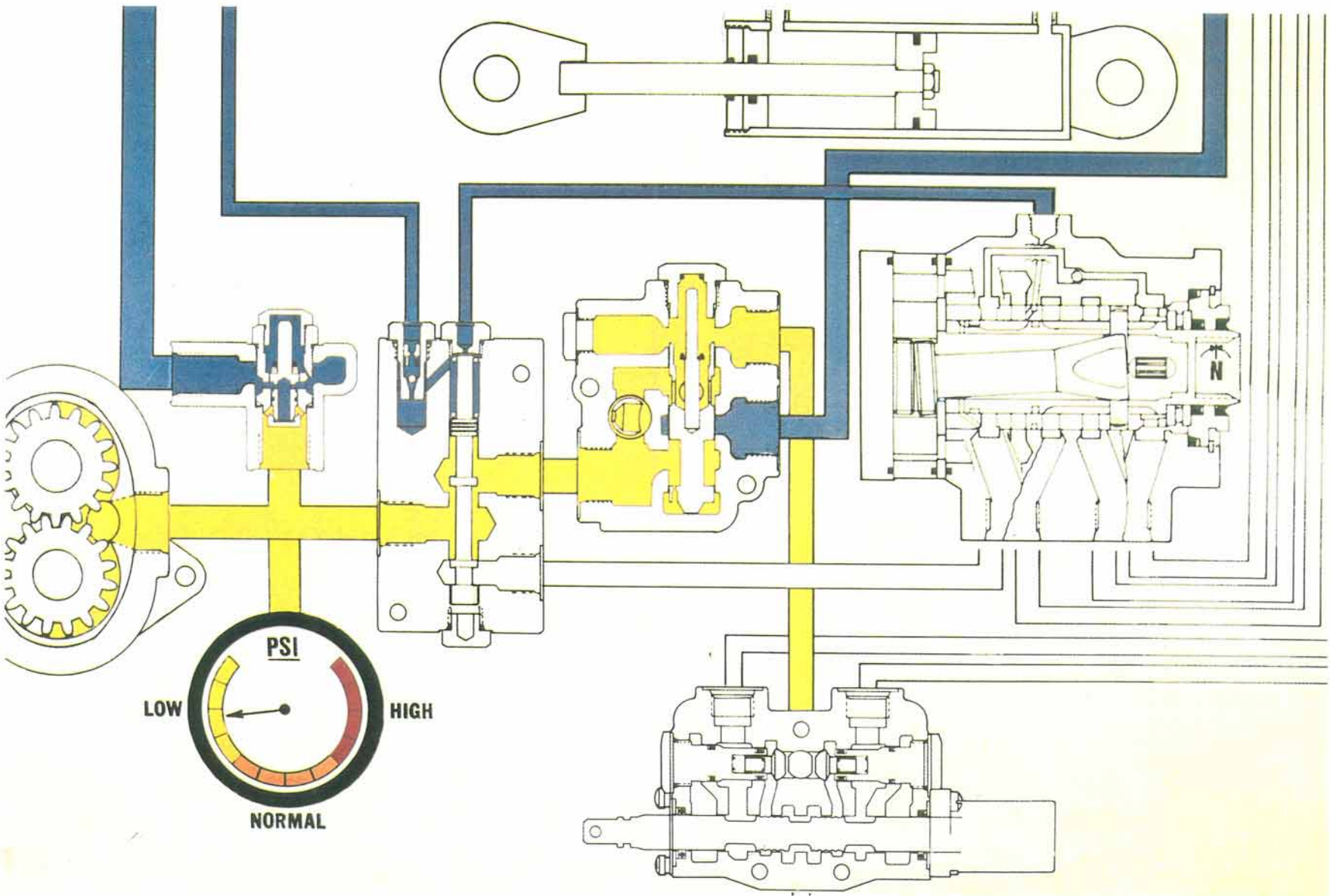


Figure 51:



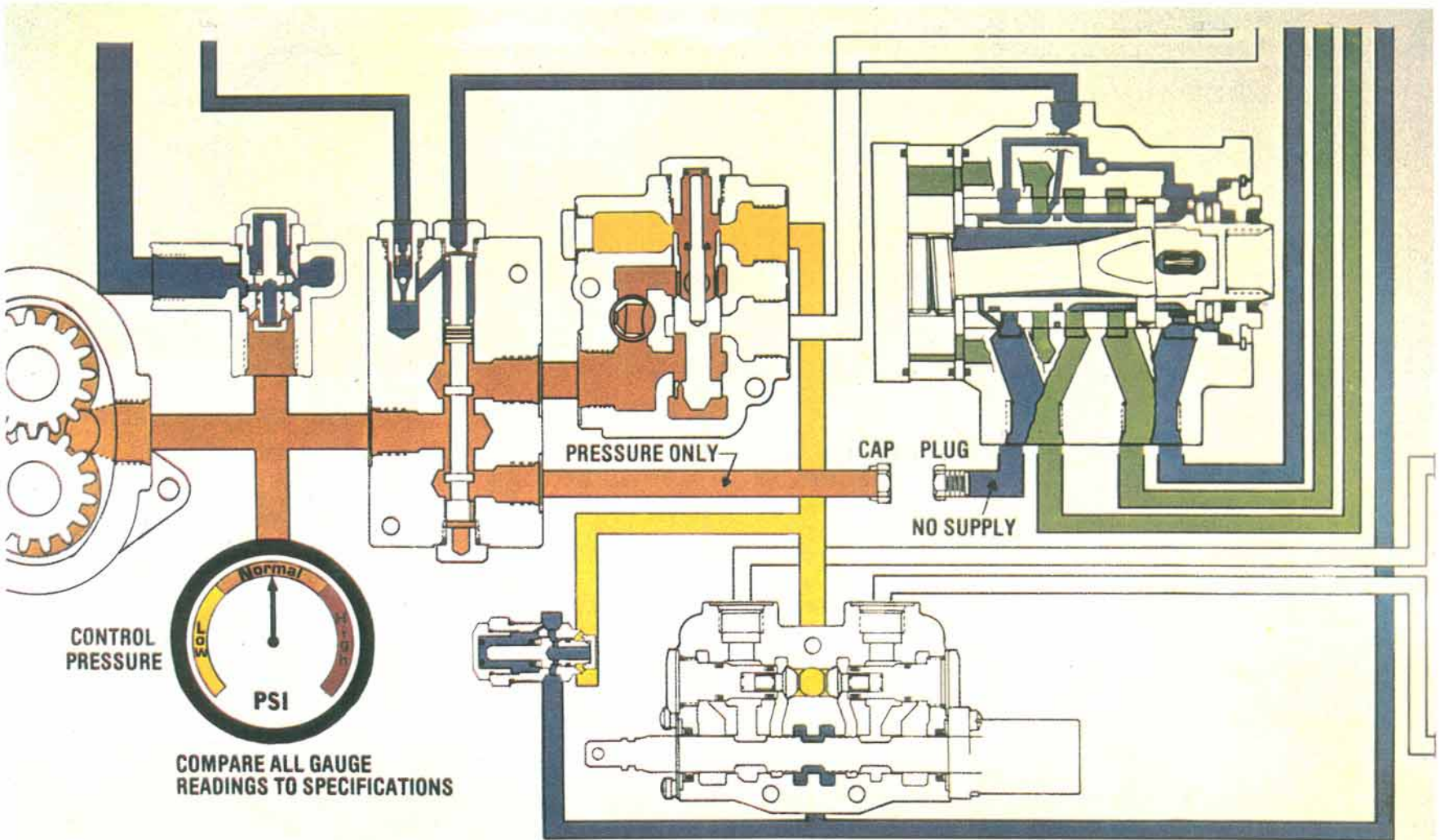


Figure 52:

# Troubleshooting, Testing & Adjusting

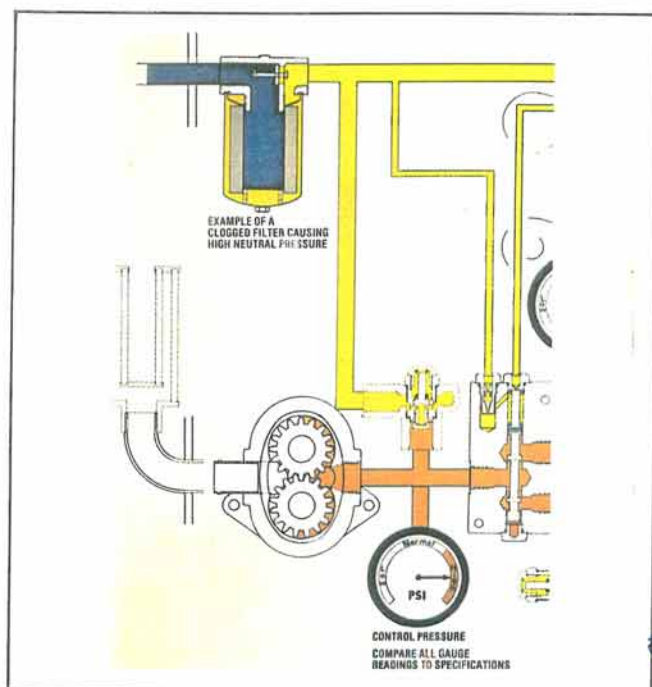


Figure 53:

150  
270  
Control psi

If the minimum reading is lower than specified, there may be spring breakage or weakening on the priority spool, or the spool may be damaged or sticking in a position against spring pressure, thus allowing oil to enter the implement circuit too freely. This is usually associated with poor steering response or no steering. However, if these parts are not the cause, you must investigate further. (See Fig. 51)

Hand pump

Remove the line at the supply port of the steering valve. Close the openings with a cap and plug of the proper type. Run the engine again to obtain your readings as before. If the minimum control pressure is now met, the steering valve is faulty due to excessive leakage through the unit. But, if it is still not high enough, the problem is in the flow regulator, which will be covered later. (See Fig. 52)

↻

In reference to our first test with the steering valve still fully connected, if the maximum control pressure reading was higher than specified, then check for a clogged oil filter or an inoperative bypass valve in the filter head. Again, be sure the oil is near the test temperature. (See Fig. 53)

If the supply line to the steering valve was disconnected, reconnect at this time and proceed testing if the problem is not yet found. Excessive control pressures usually cause overheating of oil because more pressure is required to shift the spool against spring pressure, at which time a pressure drop is formed by the spool's metering edge at the implement port of the valve. As in relief valves, the greater the pressure drop, the more heat the oil will absorb. But, keep in mind that the system may be aggravated with other performance deficiencies, not just overheating alone. Usually a hissing sound can be heard in the faulty area. (See Fig. 54)



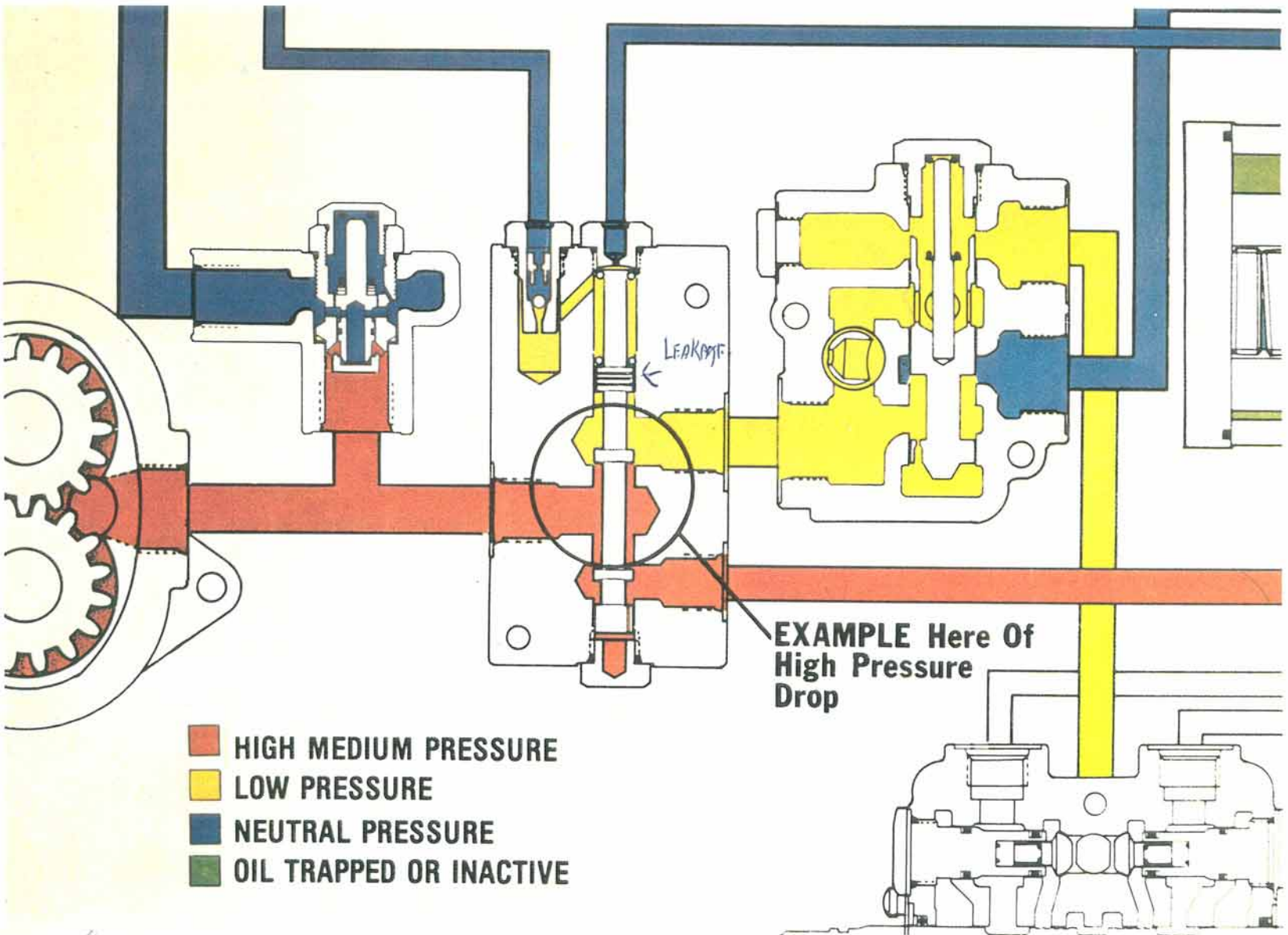


Figure 54:

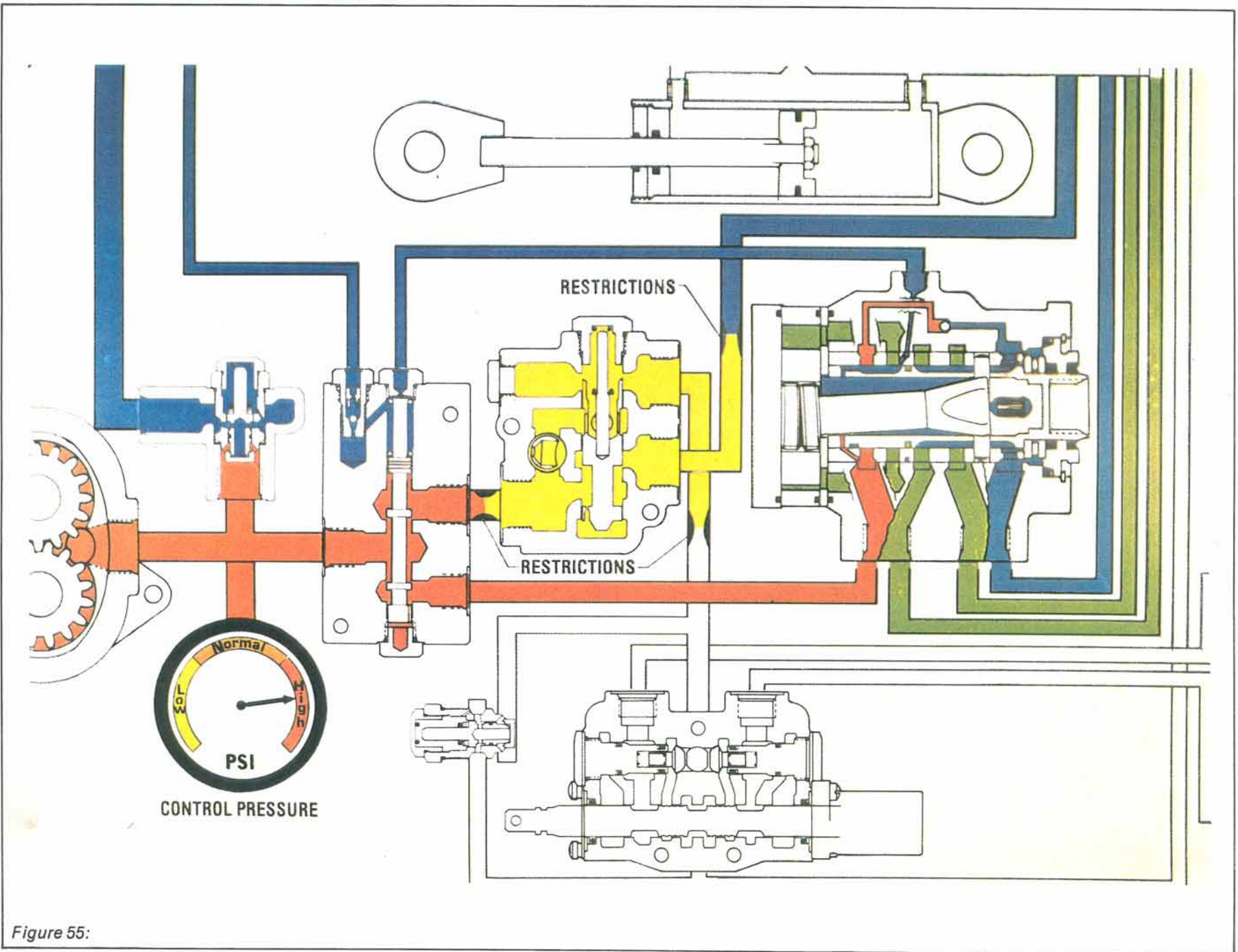


Figure 55:

# Troubleshooting, Testing & Adjusting

An excessive control pressure reading may also be caused by high neutral pressures in the implement circuit just beyond the priority valve. If all steering performance qualities are good, then it is very likely that the implement circuit has a restriction due to a kinked, flattened or obstructed line. If hose is used, an inner hose liner failure can be suspected. Other possibilities include a malfunctioning flow regulator or implement control valve, but these will be covered later. (See Fig. 55)

Check the movement of the steering wheel. It should have a few degrees of free rotation from neutral in either direction. When it is rotated toward either full spool deflection, it should return to neutral by the steering valve centering springs alone. If it does not, check for improper mounting of the steering column and valve before condemning the units. (See Fig. 56)

As discussed previously, if the inner spool of the steering valve is deflected from neutral, a load sense signal is produced. When the wheel is not turned but sticks out of neutral, the control pressure becomes low working pressure, not great enough to steer the tractor. If a situation of this type is found, repair or replace the unit at fault and retest the control pressure before continuing to the remaining tests. (See Fig. 57)

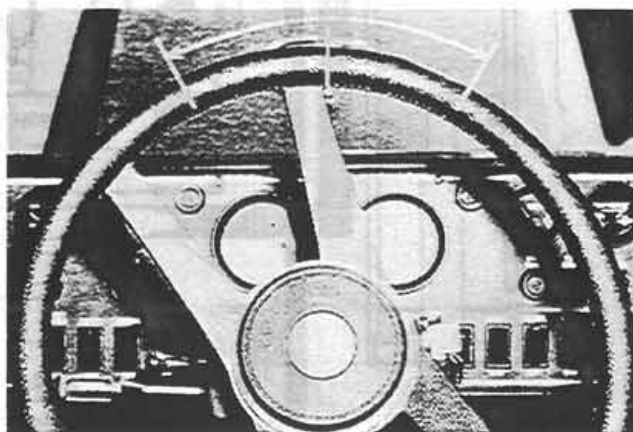


Figure 56:



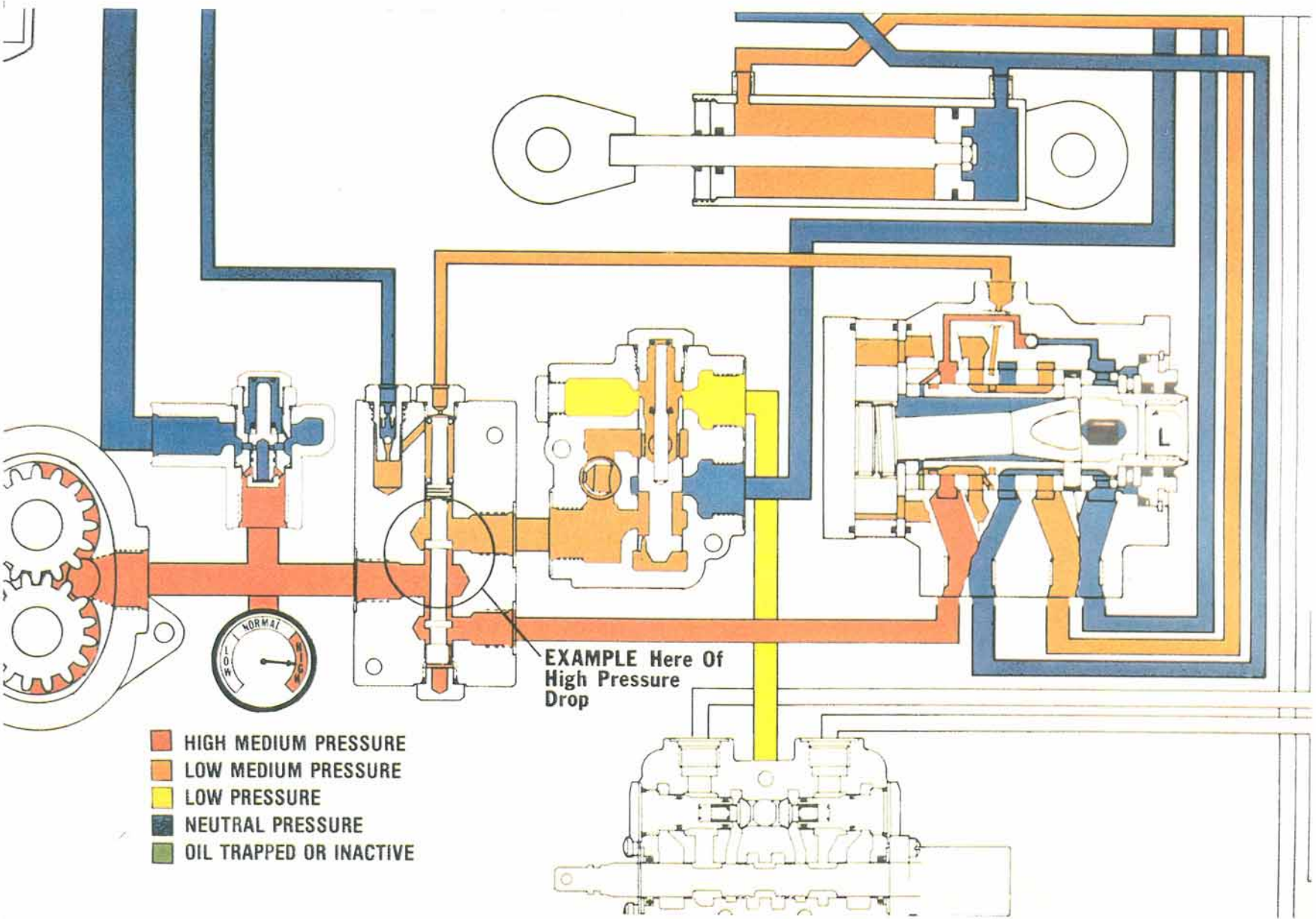


Figure 57:

## Troubleshooting, Testing & Adjusting

Before spending time preparing for further testing, it may be time saving to examine the priority valve's internal parts. Check for evidence of previous "tampering." Shimming or substitution of the spring is not permissible since the wrong spring rate could influence high control pressure. (See Fig. 58)

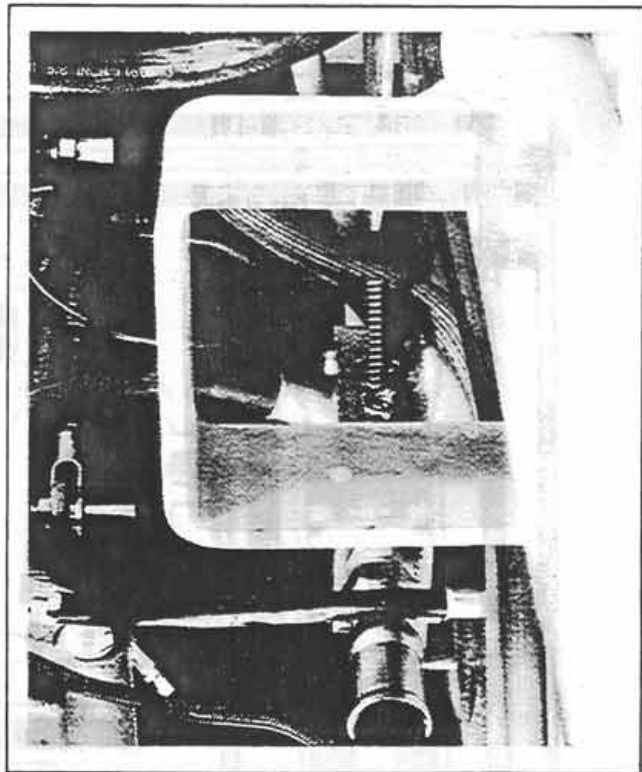


Figure 58:

Look for any signs that would cause interference of spool movement, either mechanically or hydraulically. First remove the spool from the valve and while doing so check its freedom of mechanical movement (Fig. 59).

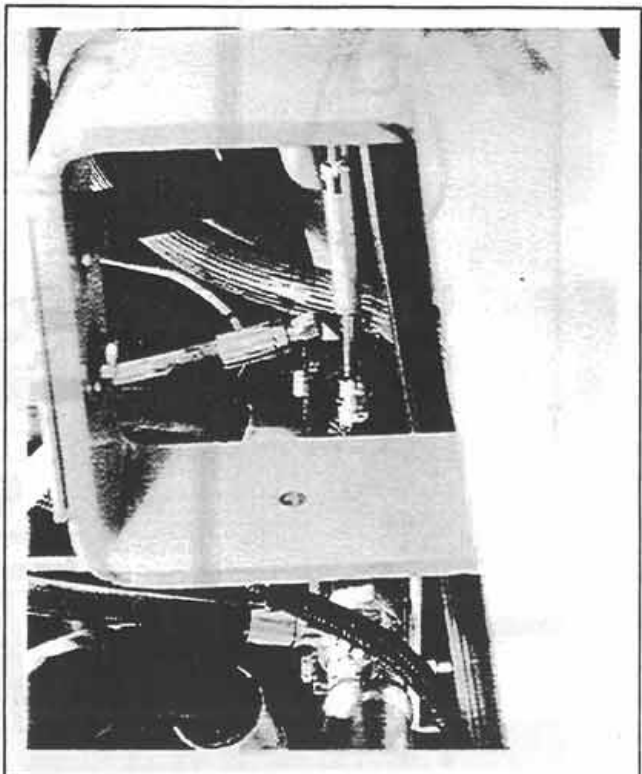


Figure 59:

# Troubleshooting, Testing & Adjusting

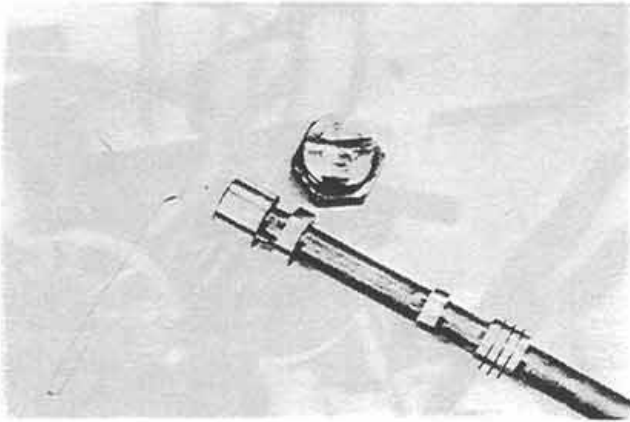


Figure 60:

Check the nonsprung end of the spool. Its control orifice must be open. This would have a hydraulic effect as would the next item. The load sense inlet orifice in the spring cap must also be open. If debris is trapped on the spool side of the orifice, it can produce a "check valve" effect to prevent the spool travel against spring pressure. If any of these faults exist, correct them and perform the control pressure test again. If test results are not acceptable or performance problems are still noted, go to the next step (see Fig. 60).

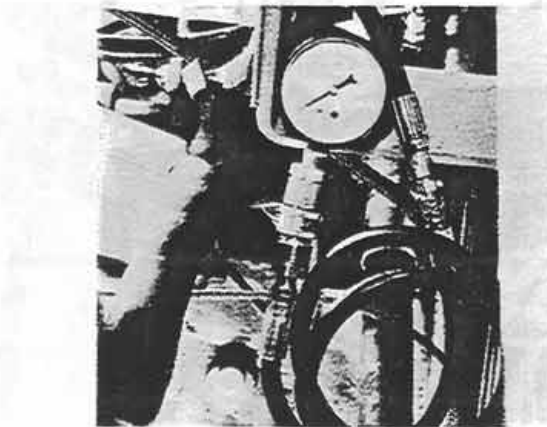


Figure 61:

Continue your testing by disconnecting the load sense line at the priority valve and connect a 0 (zero) to 600 PSI gauge to the hose end. This gauge will be able to measure the load sense signal in the steering valve. (See Fig. 61)



Figure 62:

On the steering valve, disconnect the line from the exhaust port fitting and adapt a swivel tee fitting between the fitting and line. (See Fig. 62)



# Troubleshooting, Testing & Adjusting

**NOTE:** If there is limited access to the steering valve exhaust port, the swivel tee fitting may be installed between the return manifold and steering valve exhaust hose. (See Fig. 63)

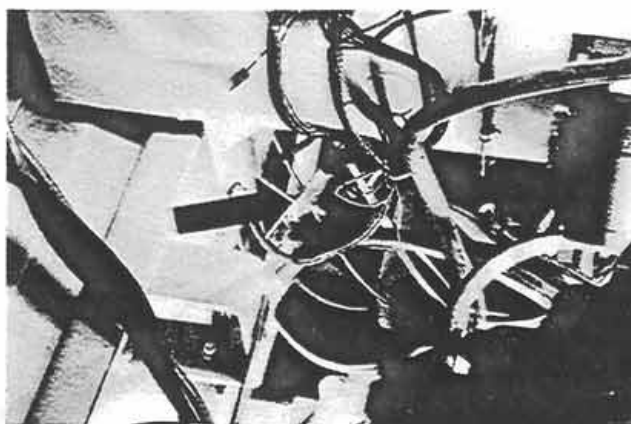


Figure 63:

Adapt a small swivel tee to the load-sense fitting of the priority valve and connect an additional load-sense line between both tee fittings. (See Fig. 64)

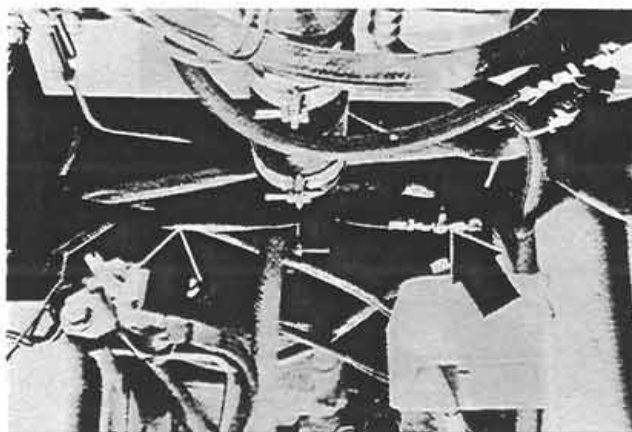


Figure 64:

Install a 0 to 600 PSI gauge to the remaining tee port at the priority valve. The neutral pressure at the steering valve exhaust port will be measured with this gauge. These preparations are needed to determine which area of the system is causing high control pressure by the process of gauge comparison. (See Fig. 65)

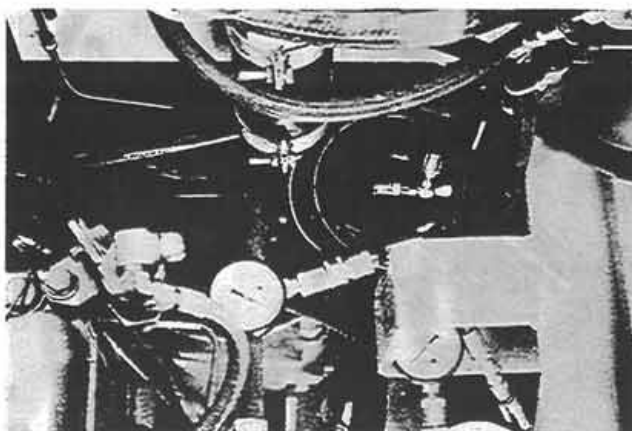


Figure 65:

Remember that during neutral steering demands, the load sense circuit should see neutral pressure. We have ensured this by directly connecting the priority valve load-sense with the steering valve exhaust, which is the same neutral pressure the load-sense would normally see during neutral steering. The normal neutral pressures at the steering valve exhaust port are specified for each model. (See Fig. 66)

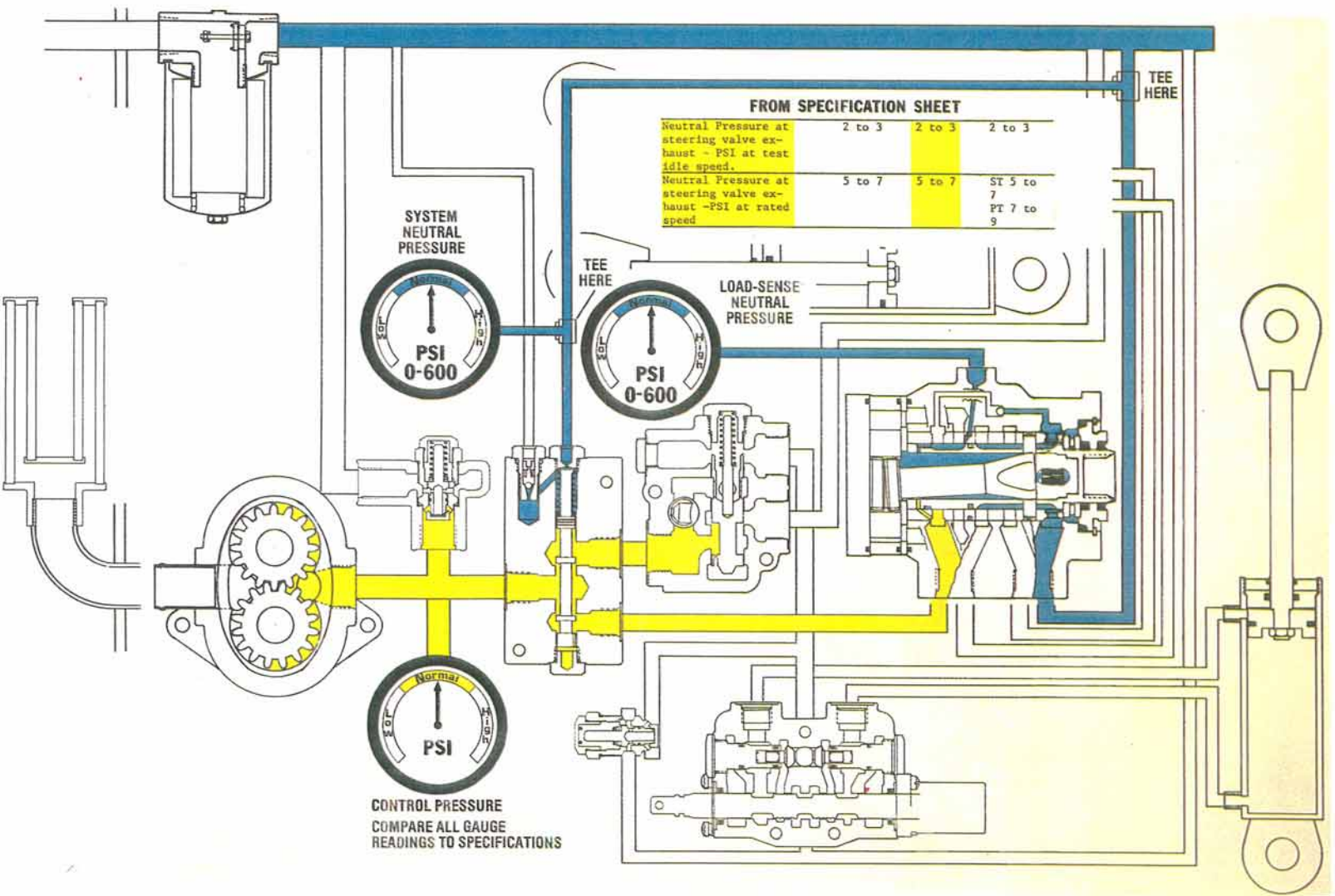


Figure 66:

# Troubleshooting, Testing & Adjusting

Start the engine and perform the control pressure test again and, in addition, record all gauge readings. Be careful not to turn the steering wheel during this time. When you have recorded all the readings at rated engine speed, idle the engine back and switch it off. (See Fig. 67)

The first thing to consider is neutral pressure. If it was not in the specified range, you must correct any restriction in the return circuitry between component exhaust ports and reservoir, then perform the test again. (See Fig. 68)

When the neutral pressure is correct but the control pressure is still high, the priority valve must be replaced due to excessive wear. This wear condition allows more oil past the spring end of the spool than the inlet orifice can handle, thus creating a pressure buildup in addition to spring pressure. (See Fig. 69)

If the neutral pressure was now acceptable, and the control pressure is too high, the load sense pressure reading should be considered next to see if the steering valve is faulty. The neutral and load sense pressures should be nearly identical in the neutral steering mode, but if the load sense pressure exceeds neutral pressure by more than 20 PSI, the interior of the valve is either dirty, worn or damaged and will need cleaning or replacement. If the steering valve passes this test, proceed to the next one, which will deal more directly with steering performance. (See Fig. 70)

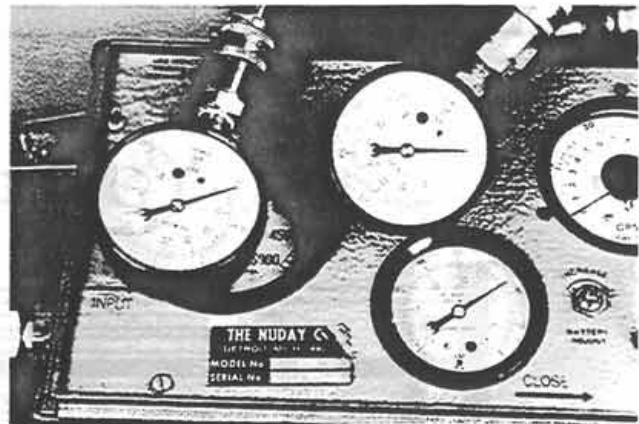


Figure 67:



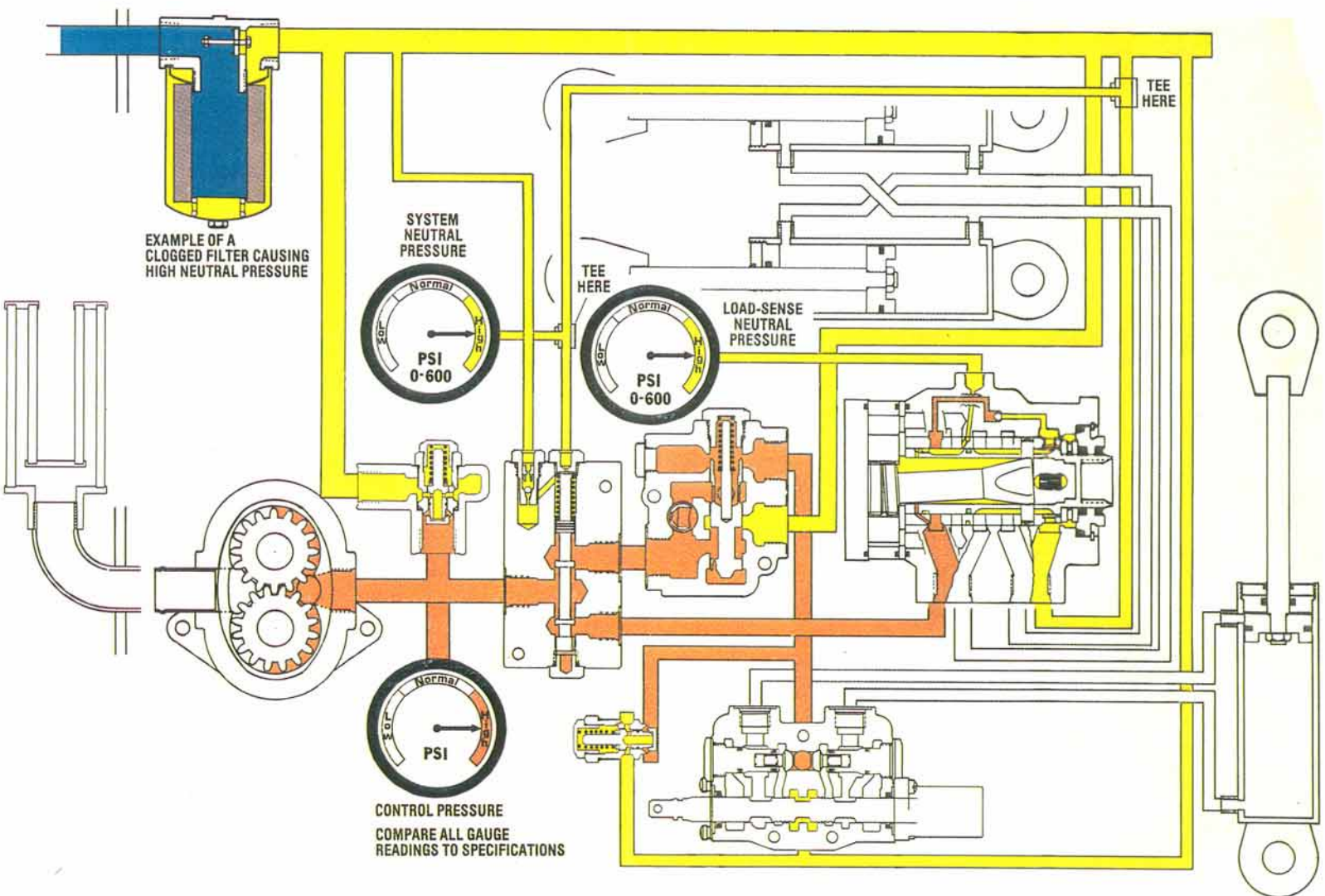


Figure 68:

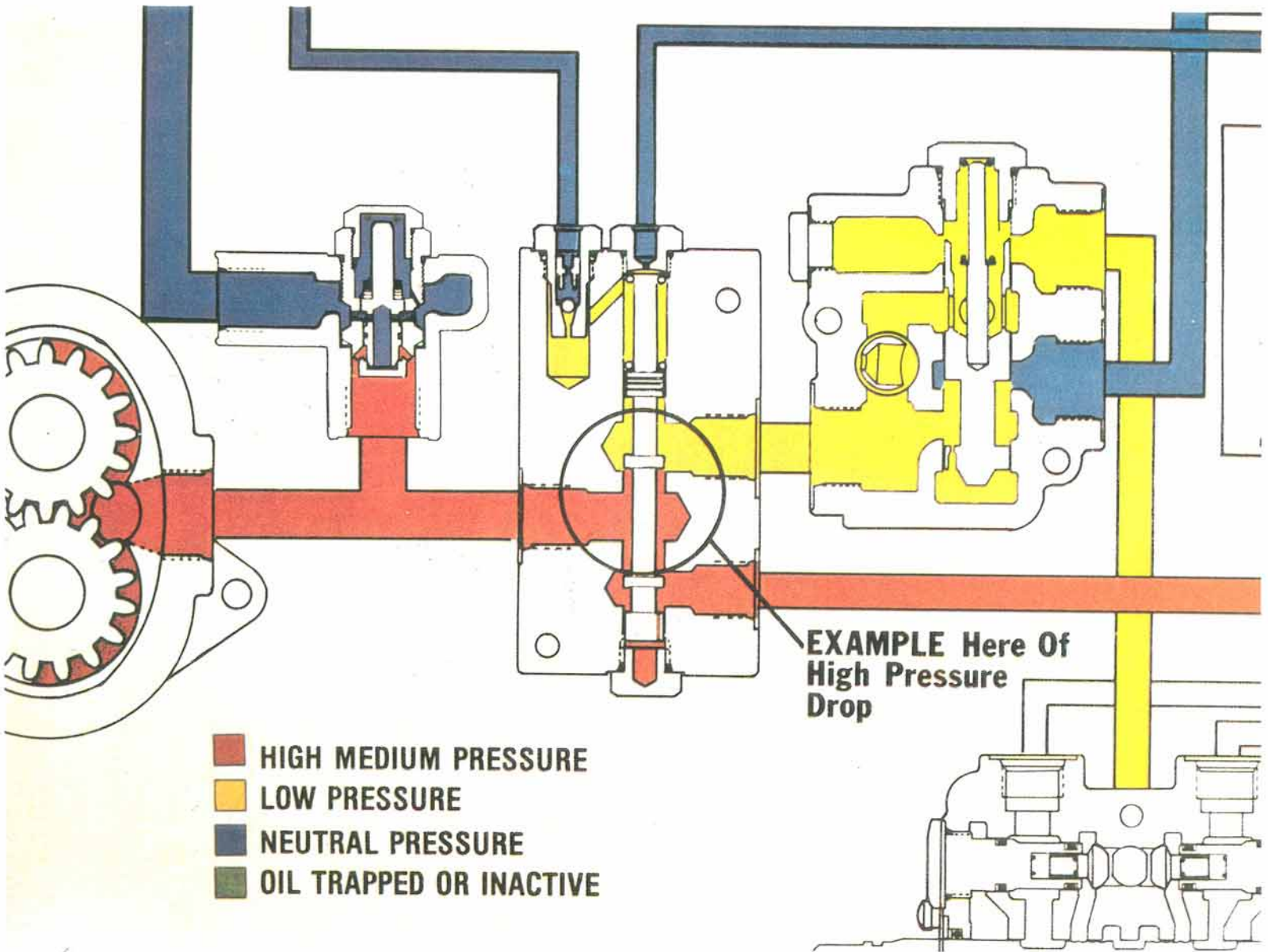


Figure 69:

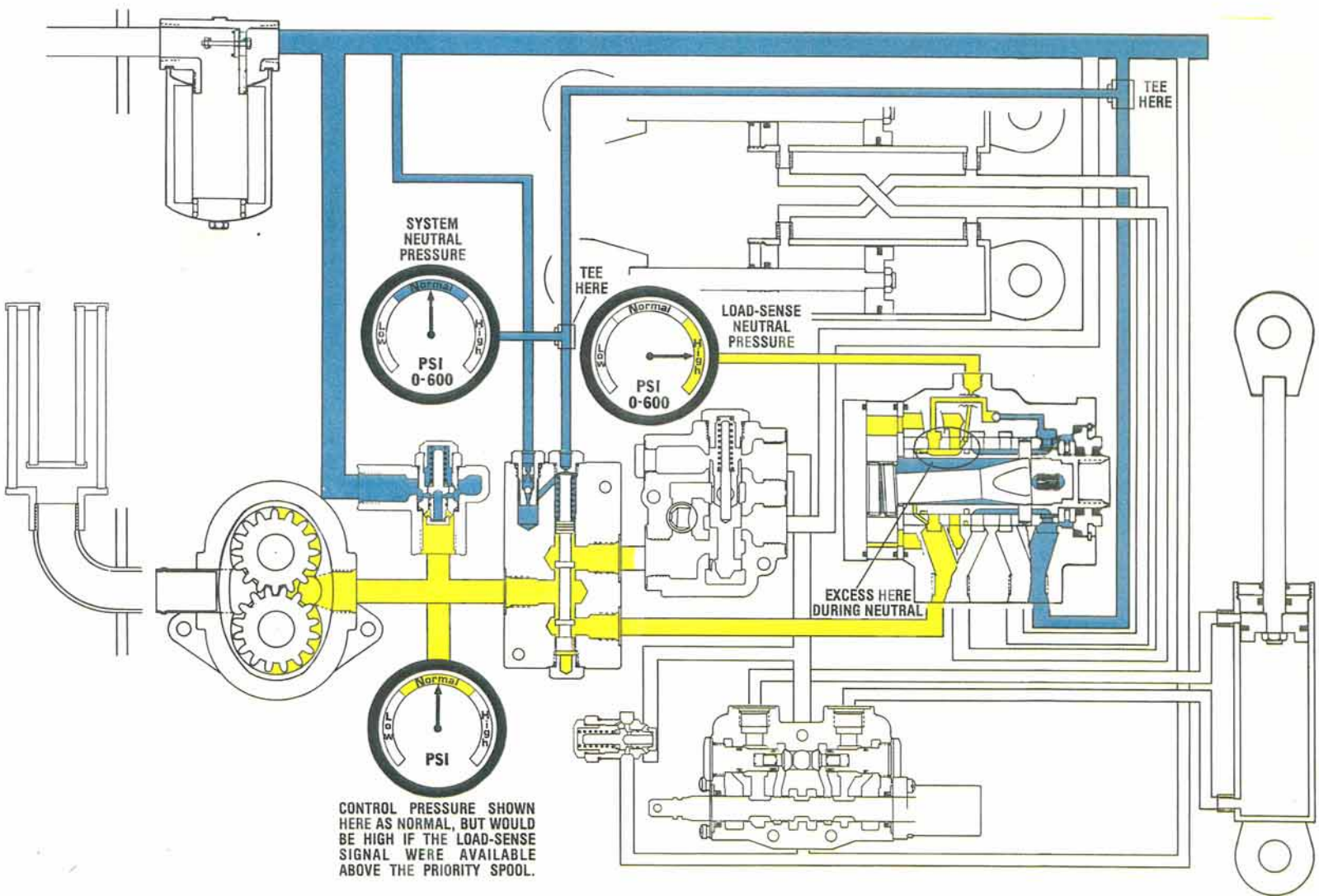


Figure 70:



# Troubleshooting, Testing & Adjusting

Remove the test gauges, tees and lines and reinstall the tractor's original lines as they should be, but leave the flow analyzer installed. Disconnect the line from the load-sense relief valve cap and plug the openings. (See Fig. 71)

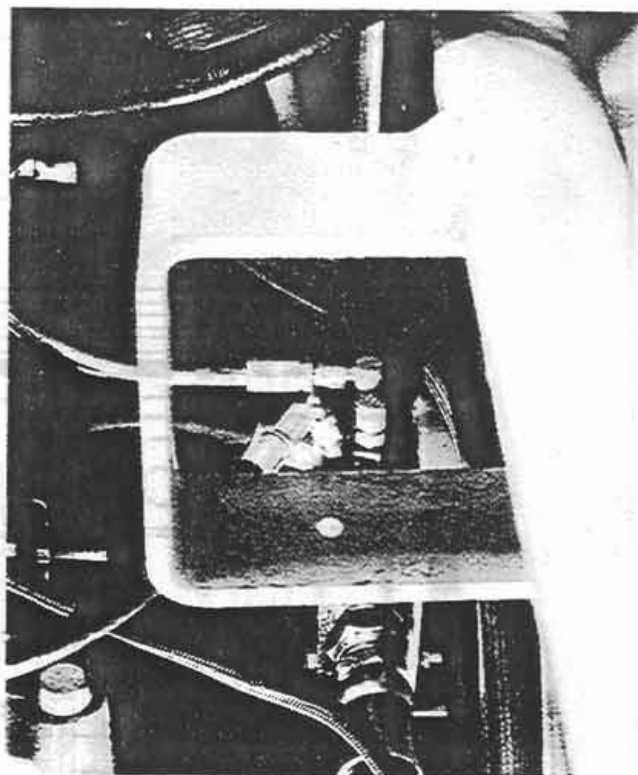


Figure 71:

Remove the relief valve and install an adapter with a gauge port between the load-sense and priority valve. Connect a zero to 3000 PSI gauge to adapter gauge port using a line so the gauge can be read from inside the cab. (See Fig. 72)

Remember the articulation locks or cylinder stops? Leave them installed! Run the engine at idle speed and note the pressure readings on the test gauge and flow analyzer when the steering wheel is forced fully to the right, then fully to the left. Both gauge readings should be nearly identical (which is in fact the equivalent of main relief pressure as the load sense relief is blocked). If the load sense pressure does not reach main relief pressure in each direction, the steering valve must be cleaned or replaced because of internal clogging or leakage. Stop the engine when the test is completed. (See Fig. 73)

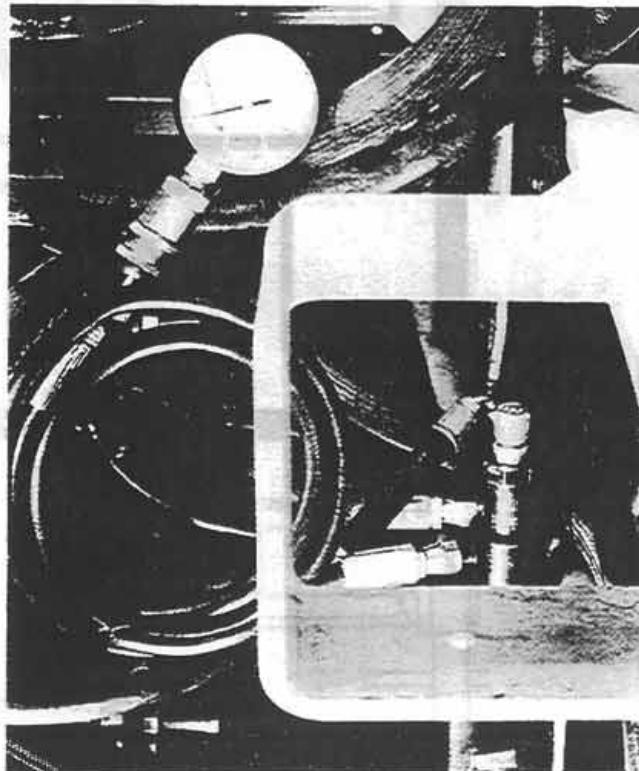


Figure 72:

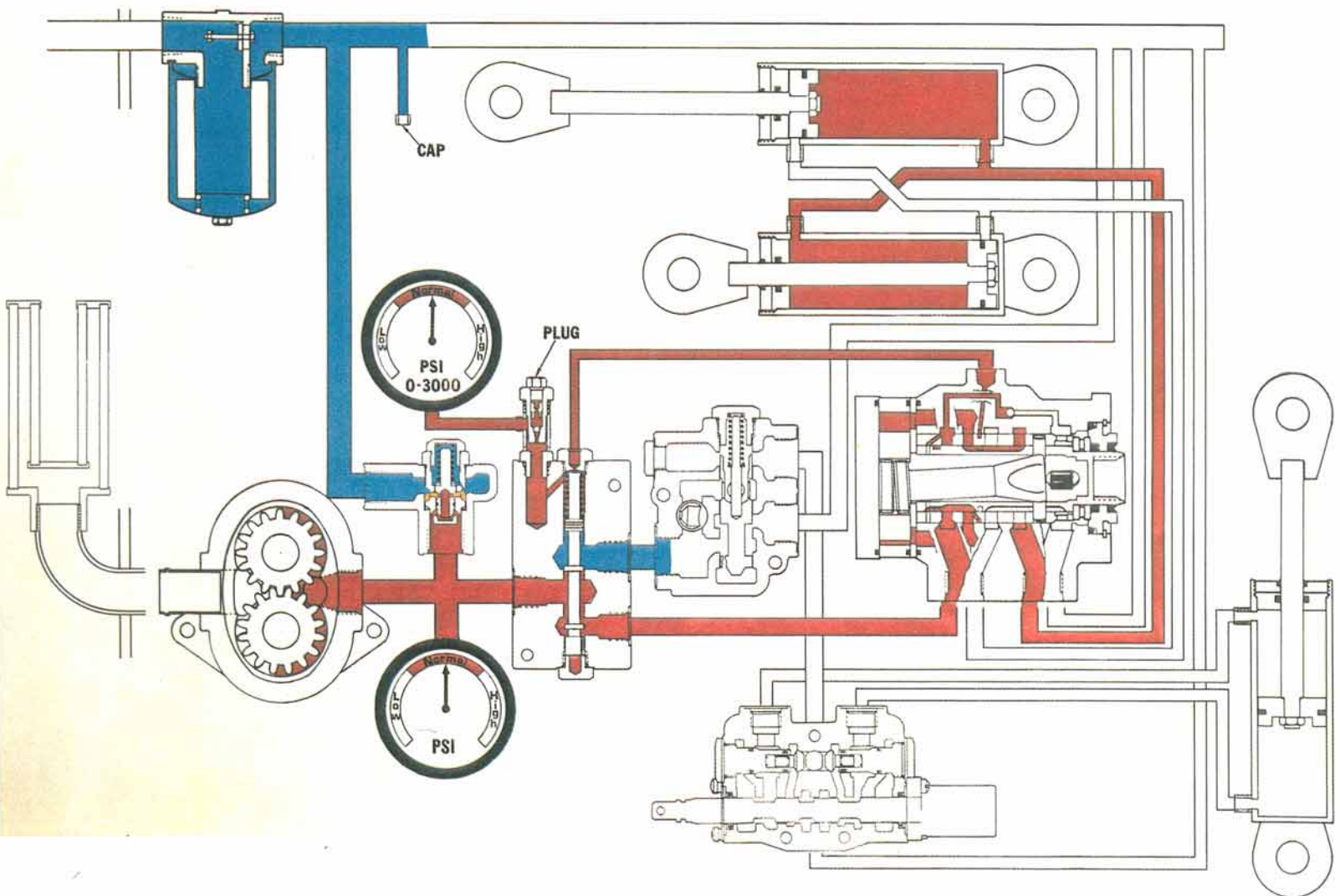


Figure 73:

## Troubleshooting, Testing & Adjusting

To test the load sense relief valve, remove the cap from its fitting and connect an extra line that will drain into a container visible from inside the cab. With the load-sense gauge installed from the previous test, you are now prepared for the last two instrument tests on the steering system. (See Fig. 74)

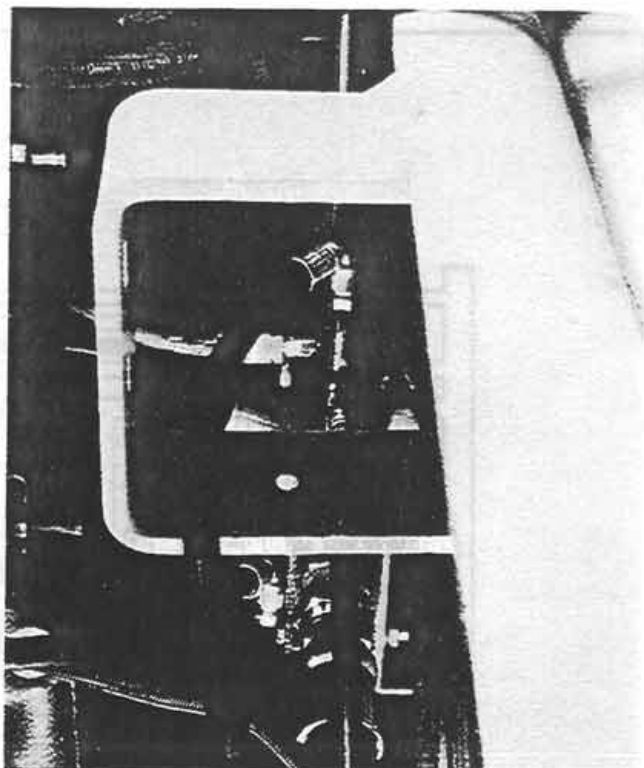


Figure 74:

The engine may be run at idle speed. As the steering wheel is turned fully to either direction, the load-sense gauge should register the specified pressure and a stream of oil should leave the drain line. (See Fig. 75)



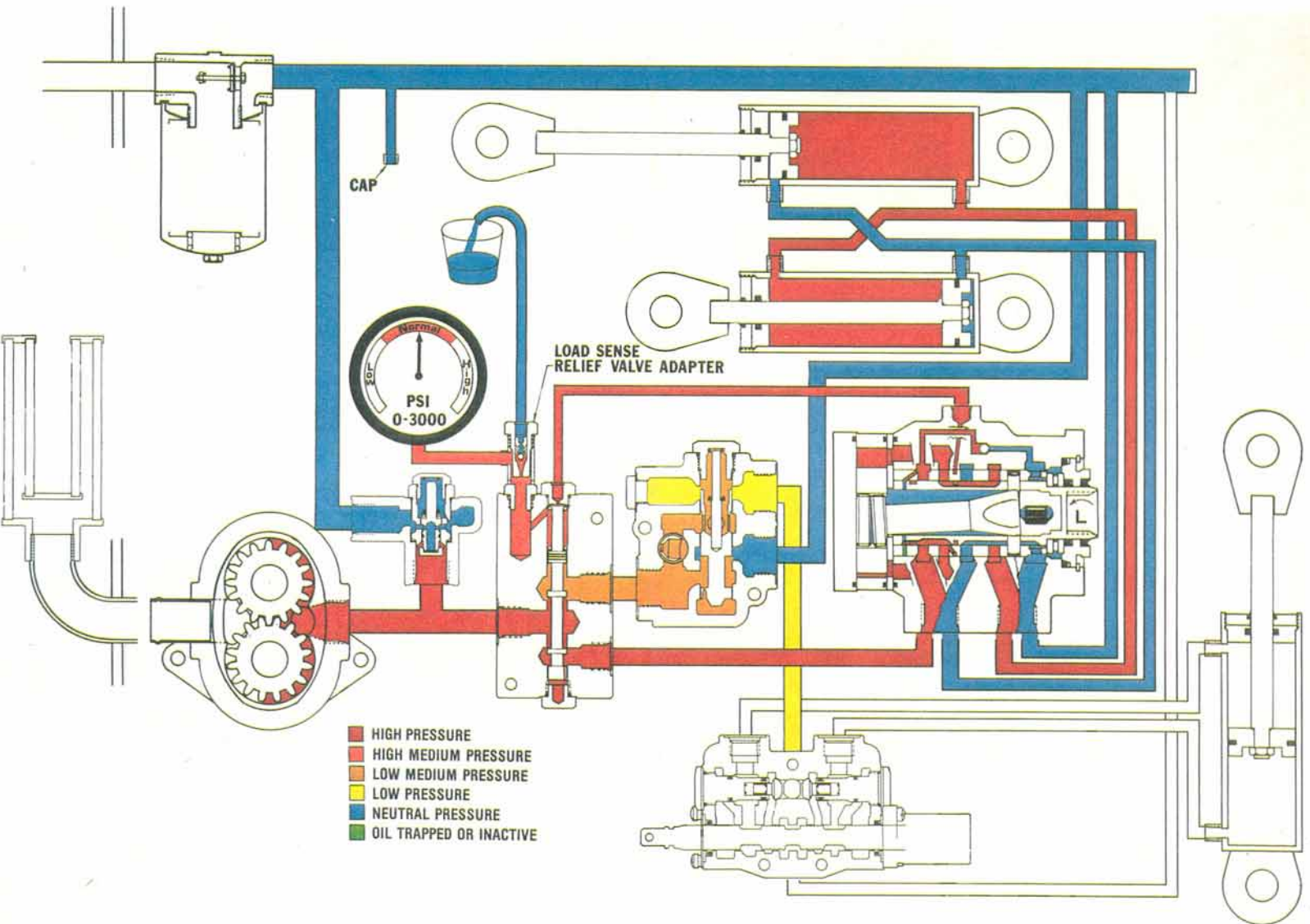


Figure 75:

# Troubleshooting, Testing & Adjusting

If the load sense gauge does not register the correct pressure, stop the engine and either adjust or replace the valve. Adjusting can be done with an Allen wrench after the exhaust fitting is removed from the load-sense valve body. Clockwise rotation causes a pressure increase. Be sure to engage the wrench fully into the Allen set screw. Reinstall the exhaust fitting and drain line, then retest after each adjustment. If you have difficulty in reaching the proper adjustment, either replacement or total disassembly and inspection of load-sense relief is necessary. (See Fig. 76)

The final test for the load-sense relief is the leakage test. Restart the engine and run at idle. Carefully turn the steering wheel until the load-sense reading is 200 PSI below the specified pressure setting and maintain that pressure. If there is any flow or leak off at the drain line, replace the valve. When or if a new valve is installed, it is wise to pressure test it also if you've already prepared for it. (See Fig. 77)

Guide yourself by these basic rules: the main system relief pressure must be correct, the load-sense relief must not exceed main relief pressure and the system must be free of contamination. If any of these rules are broken, there may be no steering priority during implement circuit usage or no implement functions during steering demands.

After completing all of the previous instrument testing, you have established that the steering system has the ability to meet all the pressure requirements to overcome the loads exposed to the steering cylinders. Yet another element remains in relation to flow, and that is steering performance time. But before you continue, remove all test equipment, articulation locks, wheel blocking, etc. Reconnect all lines that were removed for testing. Steering performance times should be checked with a stop watch or wrist watch.



**CAUTION:** Do this test in an area that is spacious enough to avoid damage or personal injury. Do not allow other people in the area.

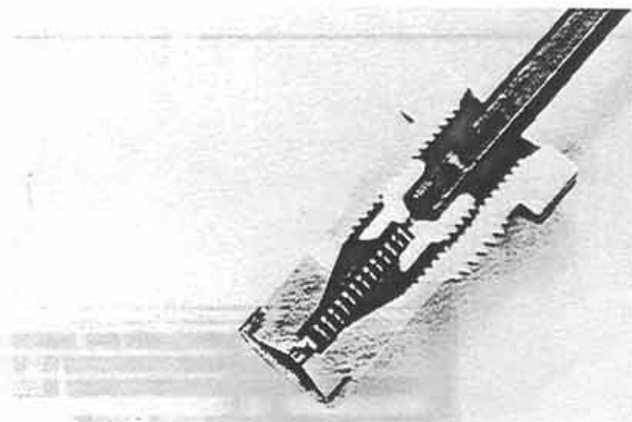


Figure 76:

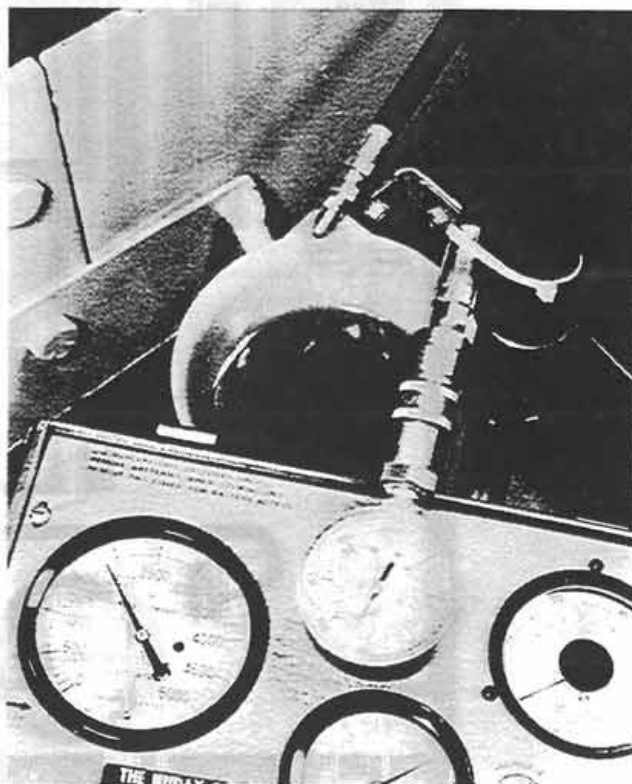


Figure 77:

# Troubleshooting, Testing & Adjusting



Figure 78:

During the time when the tractor is traveling on a hard surface with the engine at idle speed, measure the time spent to steer from one extreme position to the next. (See Fig. 78)

The acceptable time can vary as specified for each model tractor, but does not give consideration to the application of equipment such as dual wheels, mounted implements, etc. If you measure excessive time to complete a turn, check for deficiency in the pump or steering cylinders. However, if excessive time was consistently measured in one direction only, the steering valve is faulty in the flow aspect. (See Fig. 79)

# Troubleshooting, Testing & Adjusting

TRACTOR MODEL	ST 210 RC 210	ST 220 ST 251 ST 310	PT 225 PT 250 ST 250 PT 270 ST 270	ST 320 PT 350 ST 350	ST 325	ST 450 (#130)
Engine Make And Model	CAT 3208	Cummins N-855 NT-855 NTA-855	Cat 3306	Cummins VT-903	Cat 3406	Cummins KTA-1150
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Engine Rated Speed	2800	2100	2200	2600	2100	2100
Maximum Pump Output GPM at idle-No Load	7.1	11.3	12.2	10.5	12.4	15.9
Minimum Pump Output GPM at idle-No Load	6.4	10.2	11.0	9.5	11.2	14.3
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Minimum Pump Output GPM at rated speed No Load	21.5	25.8	29.1	30.4	29.6	35.0
Minimum Pump Output GPM at rated speed 2250 PSI Pressure	19.1	22.9	25.9	27.0	26.3	31.1
Minimum Main And Secondary Relief Valve Setting PSI. Locate Lowest Pressure Curve Area	2250	2250	2250	2250	2250	2250
Maximum Main And Secondary Relief Valve Setting PSI At Highest Area Of Pressure Curve	2450	2450	2450	2450	2450	2450
Steering Circuit Load Sense Relief Valve Pressure Setting PSI	2000	2000	2000	2000	2000	2000
Detent Release Pressure Setting PSI	2150	2150	2150	2150	2150	2150
Minimum Control Pressure PSI at idle speed	150	150	150	150	150	80
Maximum Control Pressure PSI at rated speed With Flow Regulator at Highest Flow	340	270	ST-300 PT-350	ST-350 PT-460	340	430
Reservoir Pressure Relief Setting PSI	5	Atmospheric	5-PT only ST-Atmospheric	5-PT only ST-Atmospheric	Atmospheric	5
Oil Temperature During all Testing °F and °C	160 71	160 71	160 71	160 71	160 71	160 71
Steering Performance Time in Seconds Req. to turn lock to lock. Check at test idle speed & traveling on hard surface.	5.2 to 6.3	4.5 to 5.4	ST-4.4 to 5.2 PT 4.9 to 5.9	ST-4.8 to 5.7 PT-5.4 to 6.5	4.5 to 5.4	6.5 to 8.0 see note
Flow Regulator Valve Adjustment Range GPM	8 to 20	8 to 20	8 to 20	8 to 20	8 to 20	12 to 25
Neutral Pressure at steering valve exhaust - PSI at test idle speed.	2 to 3	2 to 3	2 to 3	2 to 3	2 to 3	8 to 10
Neutral Pressure at steering valve exhaust -PSI at rated speed	5 to 7	5 to 7	ST 5 to 7 PT 7 to 9	ST 5 to 7 PT 8 to 10	5 to 7	15 to 20

NOTE: On ST 450 Models, steering performance at low engine speed is influenced by the flow regulator setting for the power brake booster. Ensure the regulator is adjusted according to the brake systems service manual before judging the remainder of the system.

Figure 79: