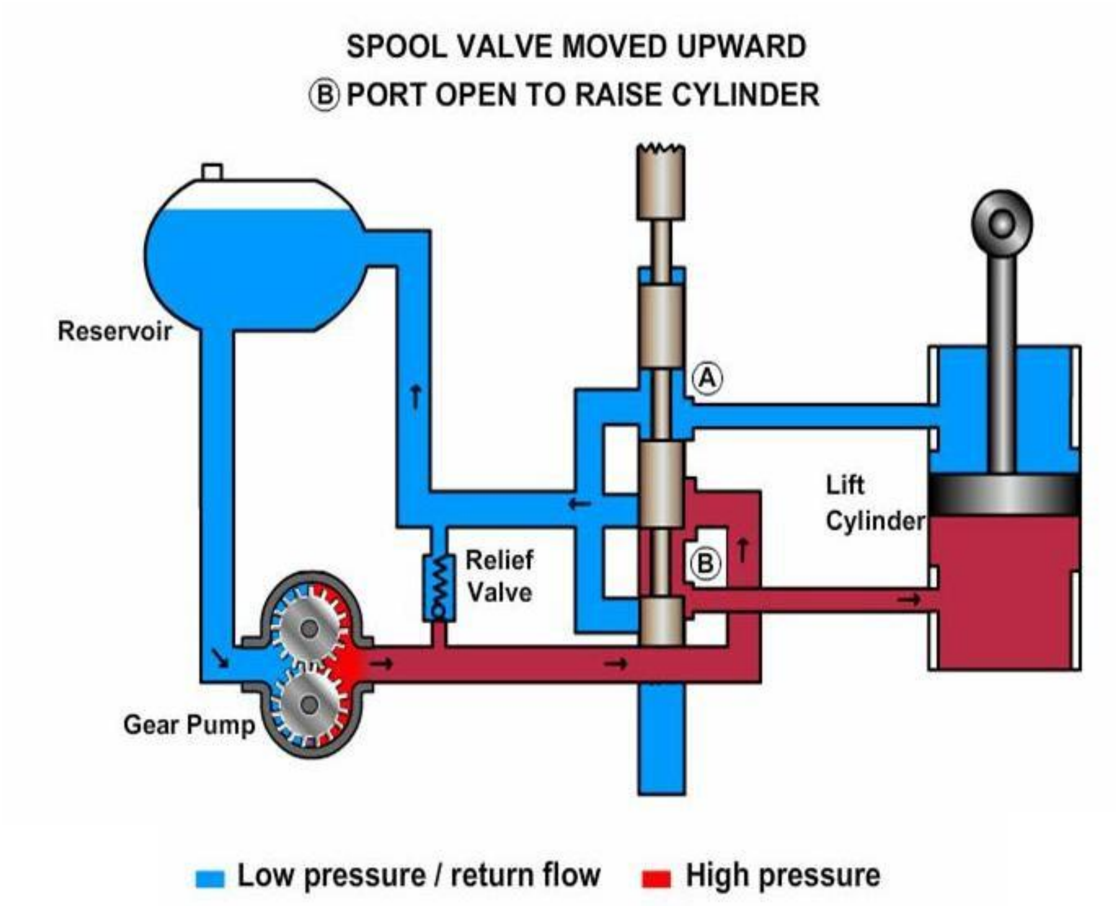
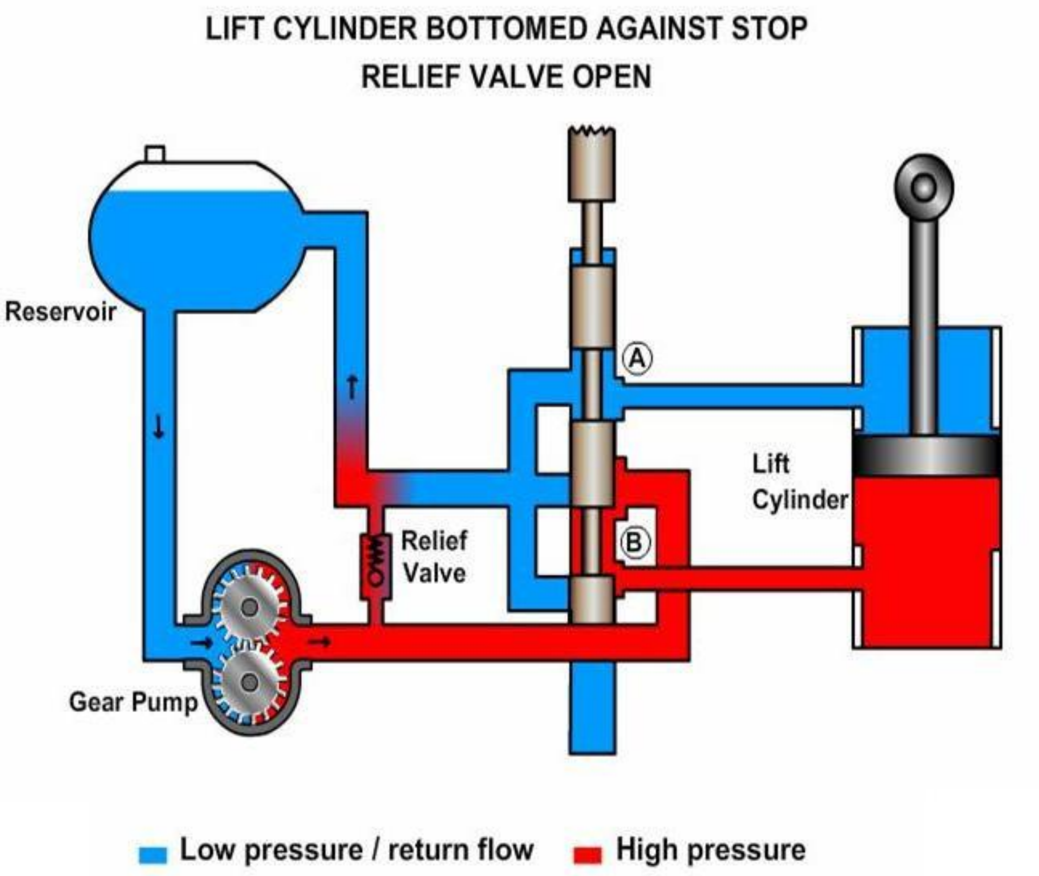
Basic Hydraulic System

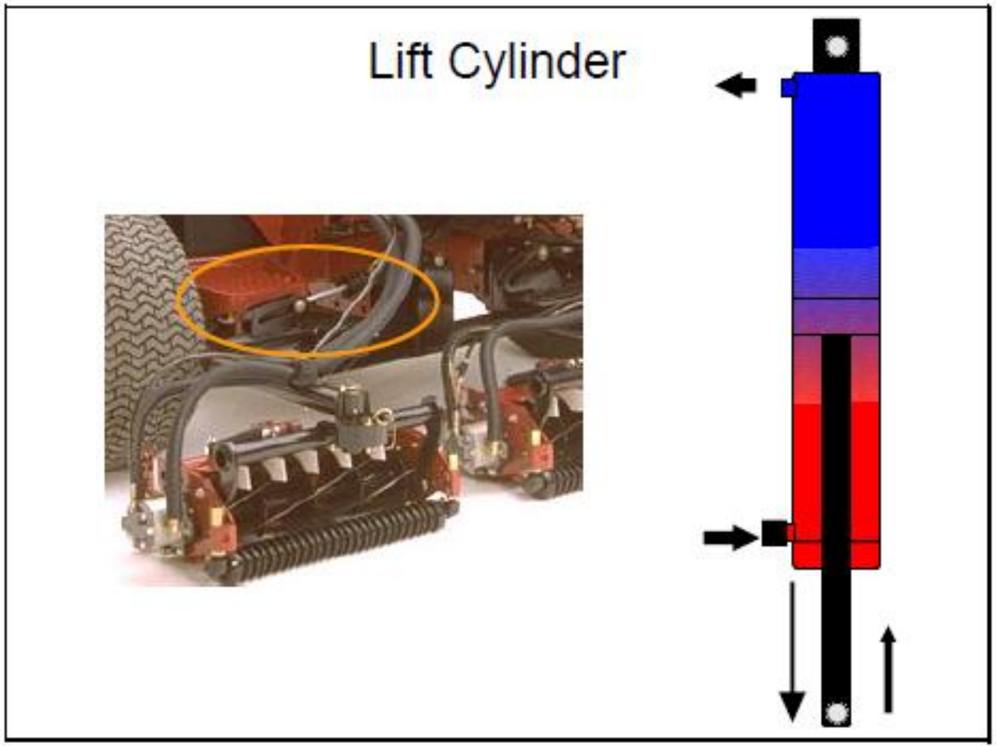


Here we have a spool valve in simple hydraulic system. You can see that the valve is in the neutral position and all the flow from the pump is directed back to the reservoir.

If the spool is moved upward, the oil flow from the pump is directed through the spool to one end of the lift cylinder. The oil in the opposite end of the cylinder is pushed out as the ram extends, and will pass through the valve and return to the reservoir.

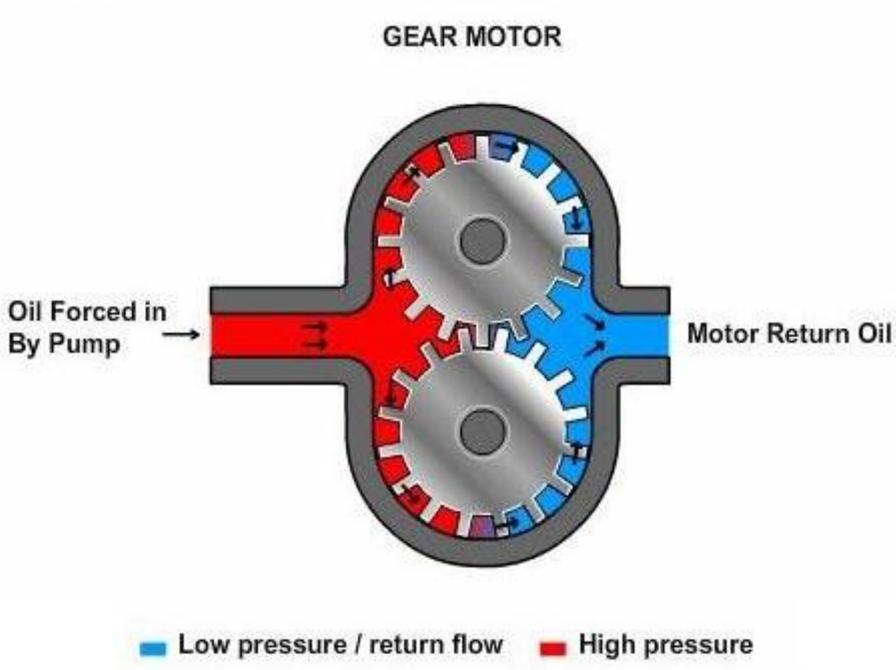


Since the fluid from a positive displacement pump must flow continuously whenever the pump is running, it must have some where to go if not being used by the actuators. If the load on the cylinder becomes too great or if the ram bottoms out, the flow from the pump will be directed past the relief valve returning to the reservoir.



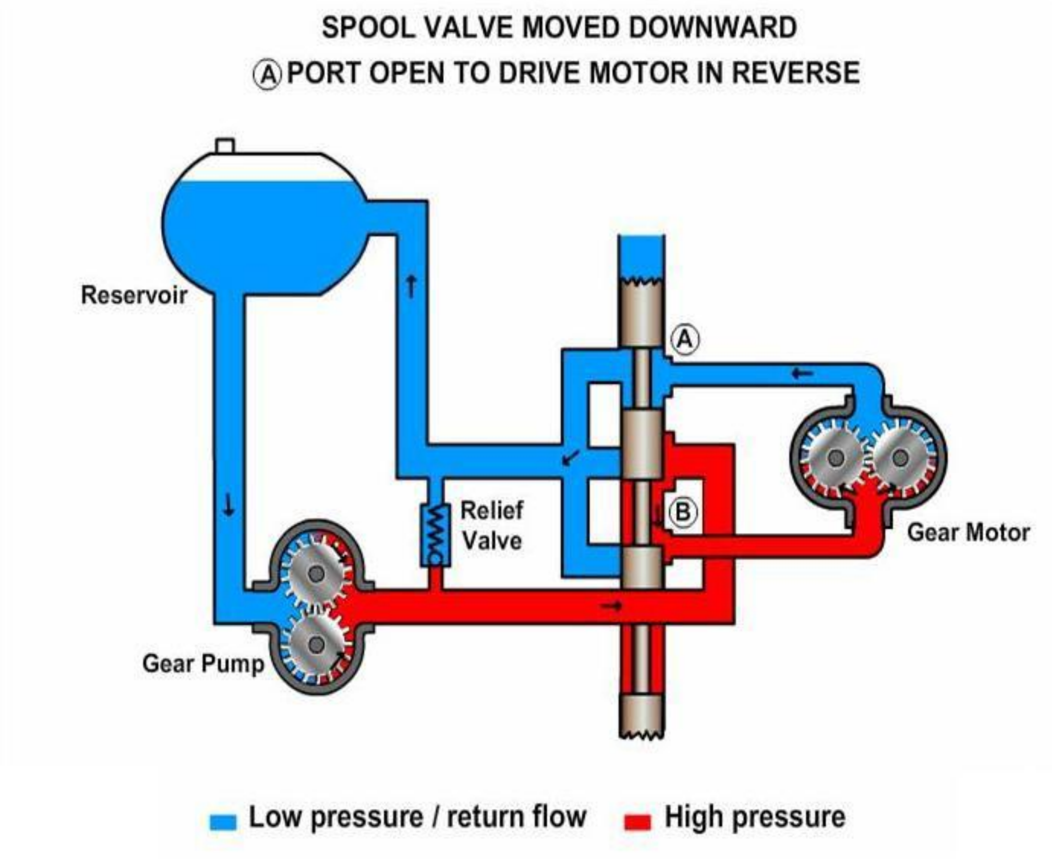
The flow diagram in the previous two illustrations shows the piston (barrel) end of the cylinder being pressurized to lift the load.

Motor



Substituting the lift cylinder with a gear motor, we can now utilize our basic circuit to create rotational movement to drive attachments. The adjacent photo shows a hydraulic motor used to drive the reel on a cutting unit.

Many hydraulic motors will have two larger hoses for the pressure and return lines and a small case drain hose. The smaller case drain hose carries fluid from internal motor leakage back to the reservoir. A small amount of internal leakage is designed in to these motors to lubricate and cool motor components.



This illustration shows the basic circuit and components necessary to drive the cutting unit reels.

With the spool in the upward position, the oil flow is directed through the spool valve to the lower port driving the motor in the forward direction.

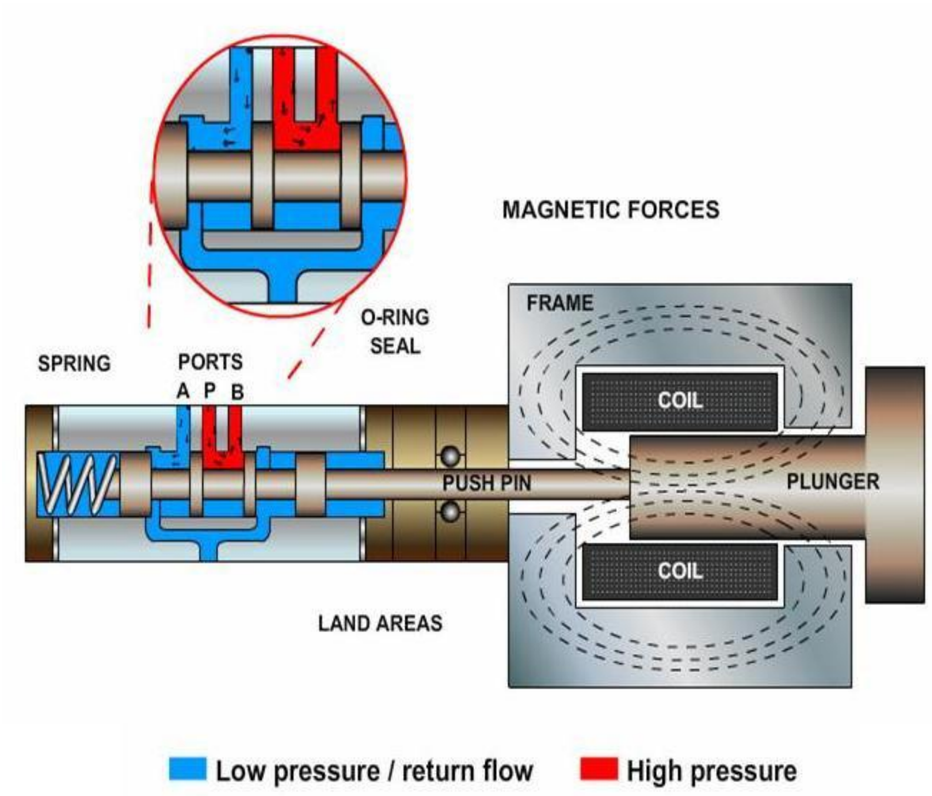
Actuating the spool to the down position, the flow of oil from the pump is directed to the opposite port of the motor. The motor then rotates in the reverse direction, such as when back-lapping the cutting unit.

Electric / Hydraulic Control Valves

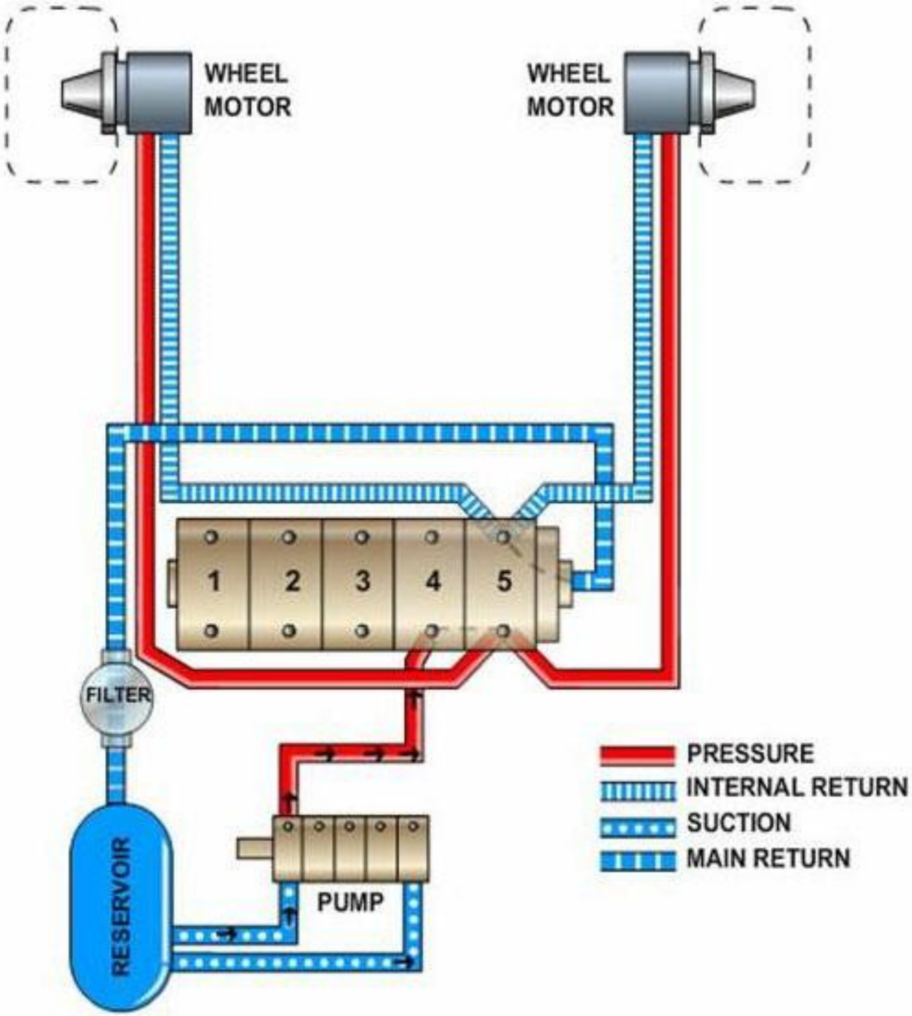
The valve system may consist of several spool valves threaded into a machined valve body. This valve body contains the internal porting to direct the fluid flow. The outer ports on the valve block are threaded to allow hoses and lines to be connected to it.

Solenoid Valve

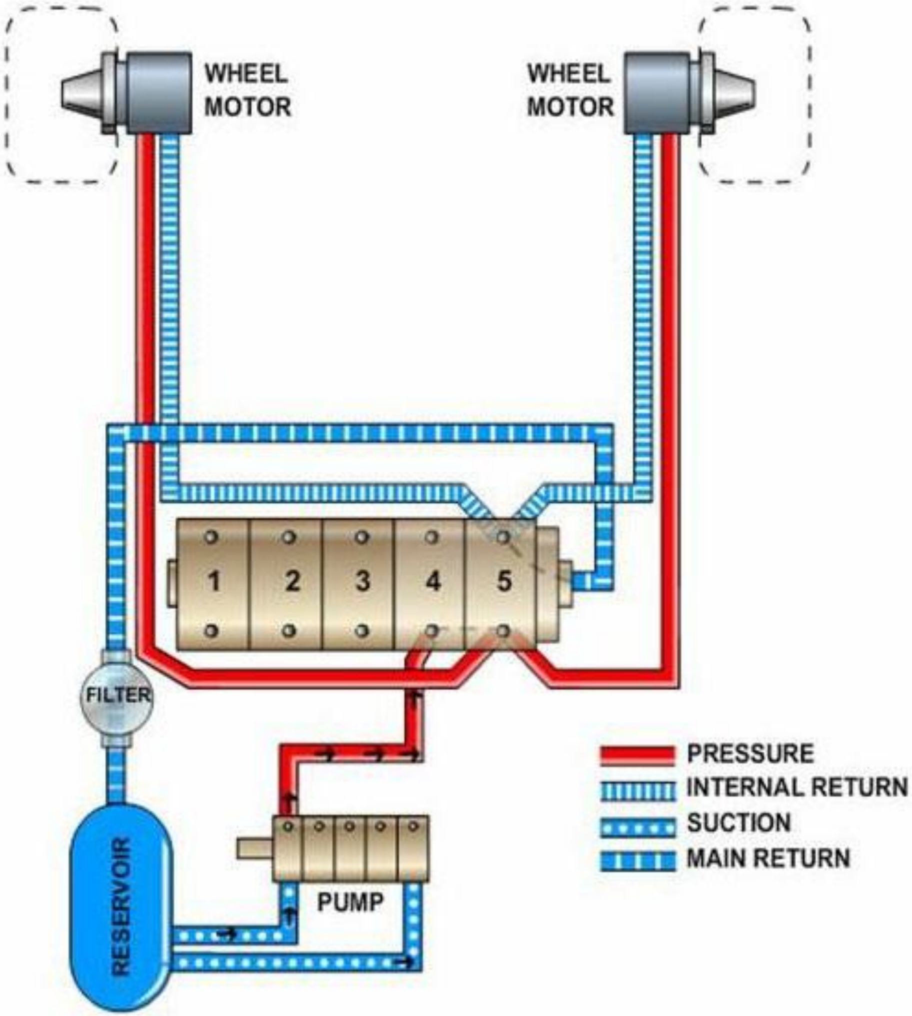
The solenoid valves consist of the valve cartridge and the solenoid coil. To disassemble the valve remove the coil assembly and then carefully unscrew the valve body. The O-rings and seals should be replaced whenever a valve body is removed or replaced.



The electric solenoid valve operates by supplying electrical current to a coil magnet, the magnetic field moves a valve spool and this directs the oil. The thing to remember is that the only difference between a hydraulic\electric valve, and a manually actuated hydraulic valve is the way that the spool is moved.



This illustration shows the traction drive circuit for a Greensmaster riding mower. This circuit and components are used to drive the unit in the No.1 traction position. When the engine is started, the pump draws oil from the reservoir through the suction lines. Oil from the No.4 section of the pump passes through the fitting in the No.4 spool valve into the valve. The traction lever, when located in the No.1 position, moves the spool so oil is directed to flow into the No.5 metering valve section. When the traction pedal is pushed forward oil flows out the lines at the rear of the metering valve section to each motor to drive the motors. Low pressure oil returns through the valve and the main return line, through the filter to the reservoir.

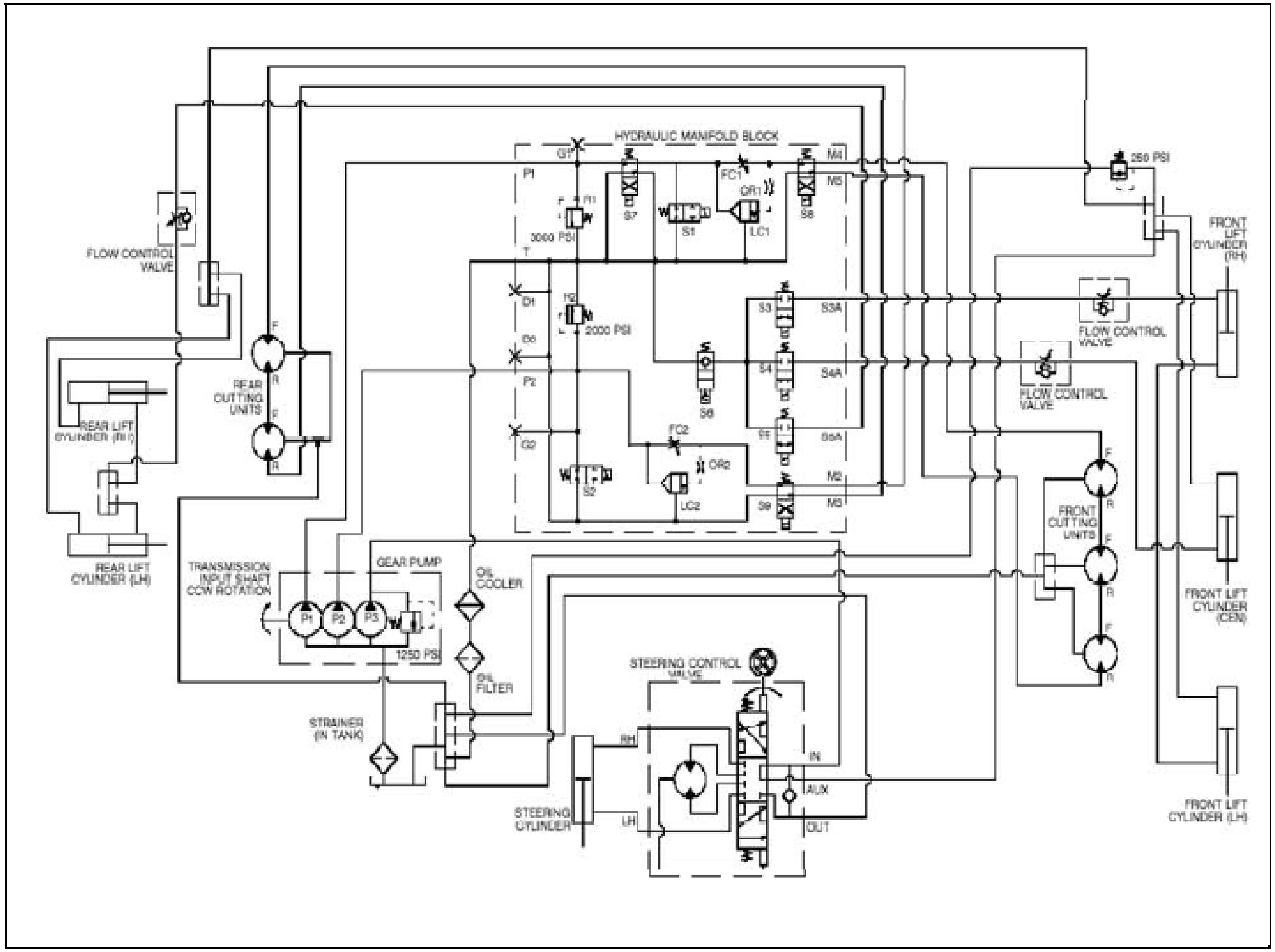


The more sophisticated a hydraulic system becomes, the greater the importance of separating the system into individual circuits when diagnosing a hydraulic problem.

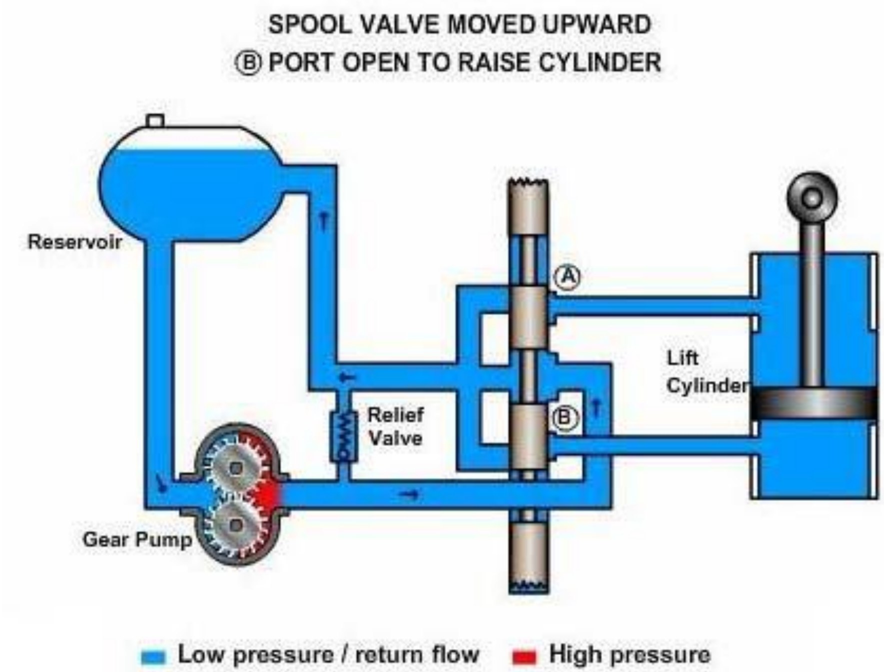
NOTE!!

Accurate diagrams of hydraulic circuits are essential to the technician who must repair it. If you don't understand how the system operates, it is very difficult to diagnose possible hydraulic problems.

Hydraulic Schematics

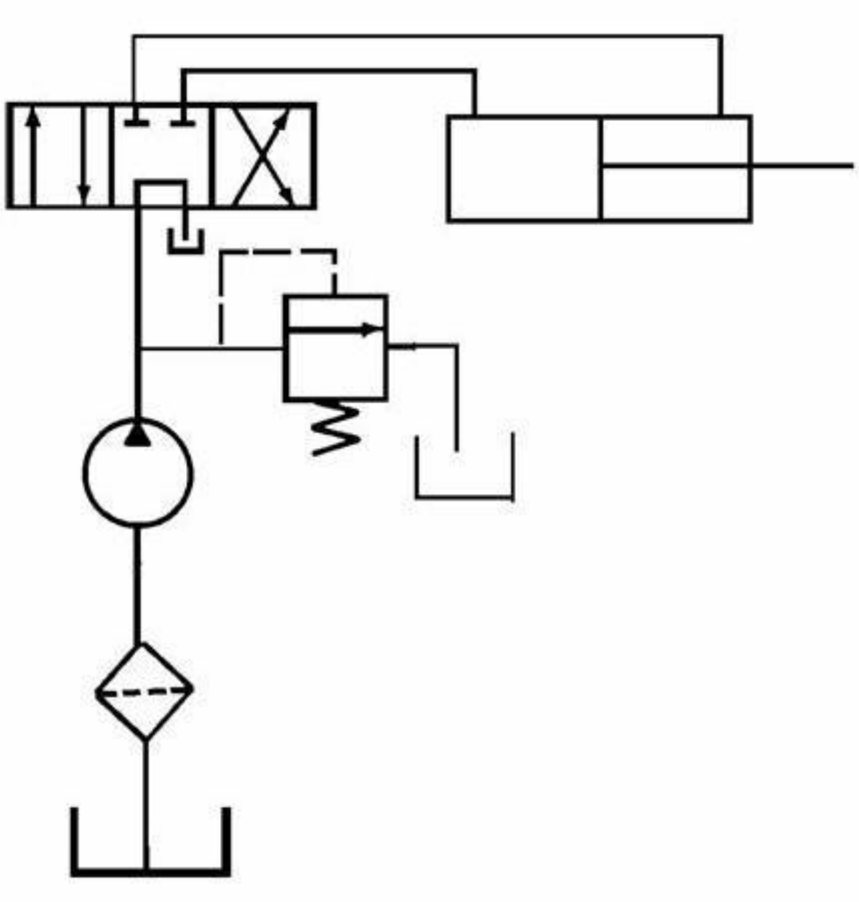


This looks very complicated. To make it easier to understand, we are going to learn how to look at individual circuits (e.g., steering, lift, mow) instead of the entire system.



Accurate diagrams of hydraulic circuits are essential to the technician who must diagnose and repair possible problems. The diagram shows how the components will interact. It shows the technician how it works, what each component should be doing and where the oil should be going, so that he can diagnose and repair the system.

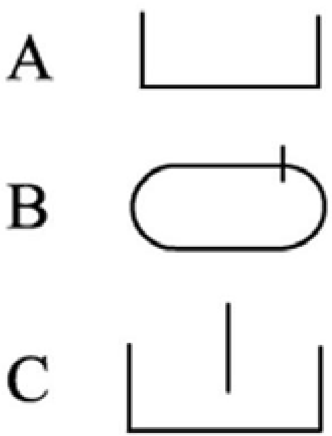
There are two types of circuit diagrams. **Cutaway Circuit Diagrams show the internal** construction of the components as well as the oil flow paths. By using colors, shades or various patterns in the lines and passages, they are able to show many different conditions of pressure and flow.



Schematic Circuit Diagrams are usually preferred for troubleshooting because of their ability to show current and potential system functions. A schematic diagram is made up of consistent geometric symbols for the components and their controls and connections.

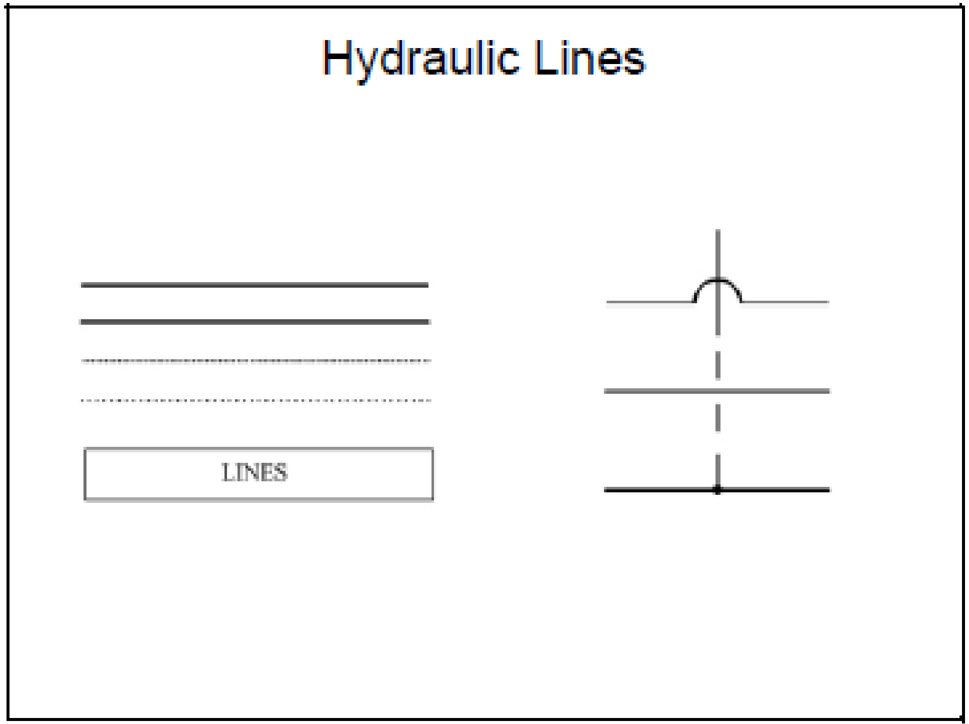
A combination of these symbols are shown in this manual. There are difference between the systems but there is enough similarity so that if you understand the symbols in this manual you will be able to interpret other symbols as well.

Hydraulic Reservoirs



Reservoirs are pictured as either an open square meaning it is a vented reservoir, or a closed reservoir meaning that it is a pressurized reservoir. Every system reservoir has at least two lines connected to it, and some have many more. Often the components that are connected to it are spread all over the schematic. Rather than having a lot of confusing lines all over the schematic, it is customary to draw individual reservoir symbols close to the component. Similar to the ground symbol in some wiring schematics. The reservoir is usually the only component to be pictured more than once

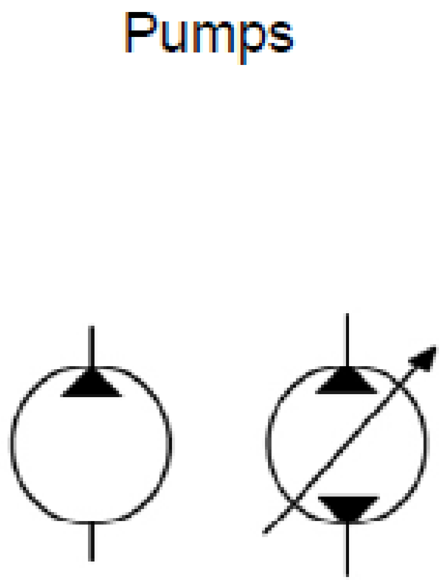
Lines



A hydraulic line, tube, hose or any conductor that carries the liquid between components is shown as a line. Some lines have arrows to show direction of oil flow, and lines may be shown as dashed lines to show certain types of oil flow.

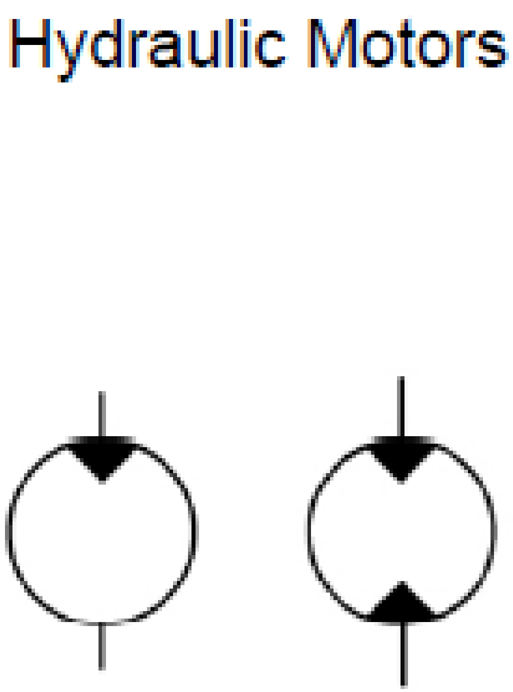
There are lines that cross other lines but are not connected, there are several ways to show lines that are not connected. Lines that are connected are shown with a dot or sometime just as two lines crossing. If the schematic shows a specific symbol to show lines that are not connected then anything else is connected.

Hydraulic Pumps



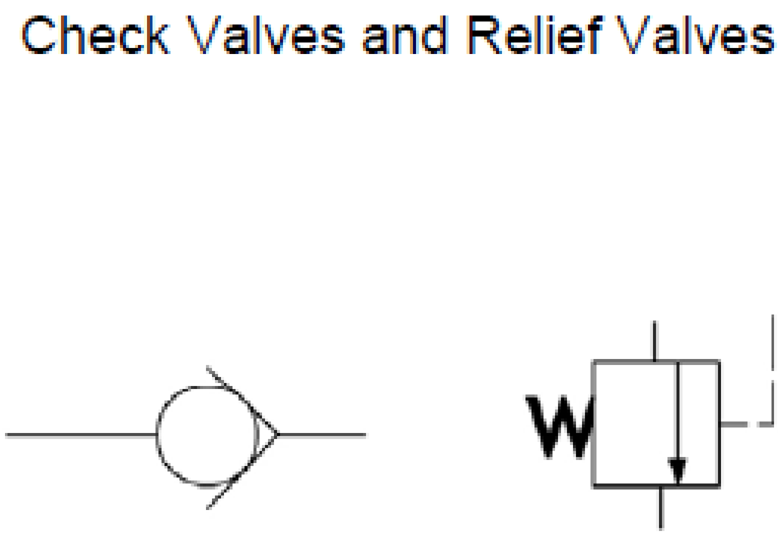
There are many basic pump designs. A simple fixed displacement pump is shown as a circle with a triangle that is pointing outward. The triangle points in the direction that the oil will flow. If the pump is reversible or is designed to pump in either direction, it will have two triangles in it and they will point opposite of each other indicating that oil may flow in both directions. An arrow through the pump shows that it is a variable displacement pump.

Hydraulic Motors



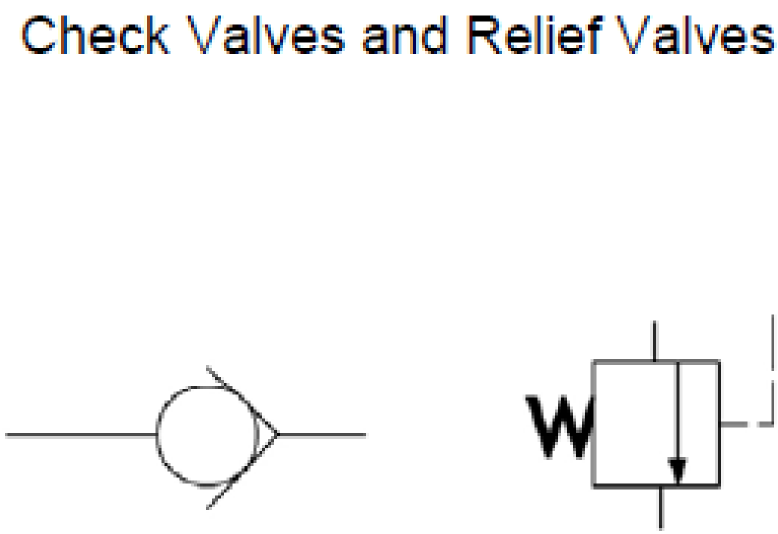
Hydraulic motor symbols are circles with triangles, but opposite of a hydraulic pump, the triangle points inward to show the oil flows in to the motor. One triangle is used for a non-reversible motor and two triangles are used for a reversible motor. An arrow through a motor shows that it is a variable speed motor.

Check Valves



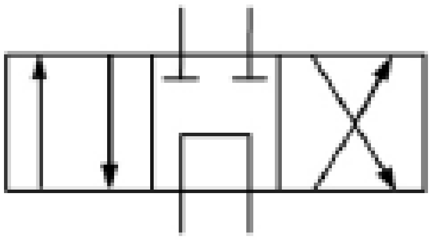
A check valve is shown as a ball in a V seat. When oil pressure is applied to the left side of the ball, the ball is forced into the V and no oil can flow. When oil pressure is applied to the right side of the ball, the ball moves away from the seat and oil can flow past it. A by-pass check is a one way valve with a spring on the ball end of the symbol. This shows that pressurized oil must overcome the spring pressure before the ball will unseat.

Relief Valves



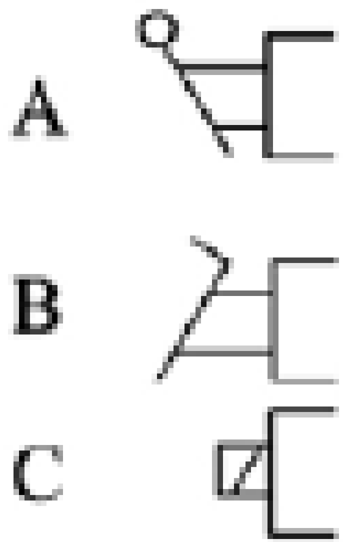
A relief valve is shown as a normally closed valve with one port connected to the pressure line and the other line connected to the reservoir. The flow direction arrow points away from the pressure line and toward the reservoir. When pressure in the system overcomes the valve spring, pressure is directed through the valve to the reservoir.

Control Valves



A control valve has envelopes (squares) that represent the valve spool positions. There is a separate envelope for each valve position and within these envelopes there are arrows showing the flow paths then the valve is shifted to that position. All the port connections are drawn to the envelope that shows the neutral position of the valve. We can mentally visualize the function of the valve in any position. A valve that has parallel lines drawn outside of the valve envelopes shows that this valve is capable of infinite positioning. This valve usually operated between the positions shown. An example of this type of valve would be a flow priority valve or a pressure regulating valve.

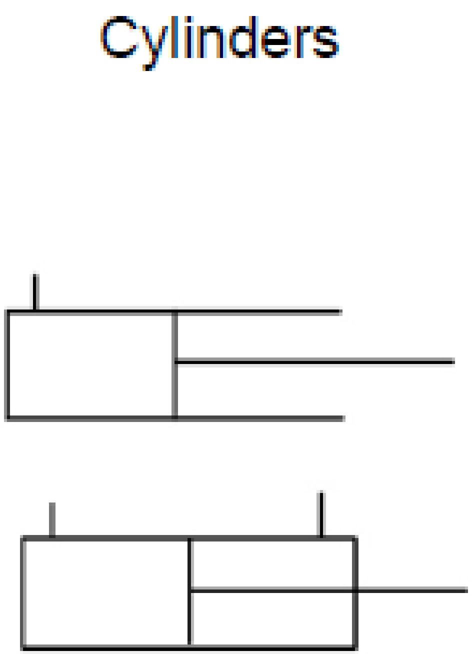
Valve actuators



The valve spools can be controlled a variety of ways.

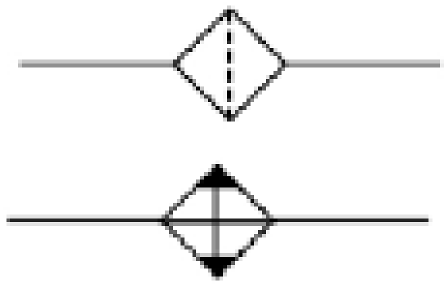
The top picture (A) shows the symbol for a lever control. The middle picture (B) shows the symbol for a pedal control (foot operated). The lower control (C) is an electric solenoid.

Hydraulic Cylinders



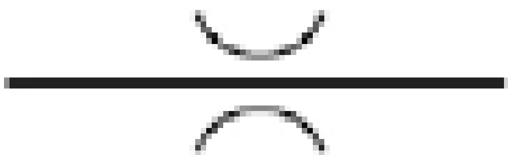
A cylinder symbol is a simple rectangle representing the barrel. The rod and piston are represented by a tee that is inserted into the rectangle. The symbol can be drawn in any position.

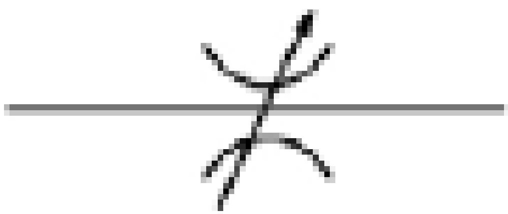
Filters and Coolers



Filters, strainers and heat exchangers (coolers) are shown as squares that are turned 45 degrees and have port connections at the corners. A dotted line 90 degrees to the oil flow indicates a filter or a strainer. A solid line 90 degrees to the oil flow with 2 triangles pointing out indicates a cooler. The symbol for a heater is like that of a cooler, except the triangles point inward.

Flow Controls





The basic flow control is a representation of a restrictor. If the restrictor is adjustable a slanted arrow will be drawn across the symbol.

Valve Enclosures

When you see an enclosure outline, that indicates that there are several symbols that make up a component assembly such as a valve body or valve stack. The enclosure outline appears like a box and is broken with dashes on all sides.