Newsletters That Teach.

Direct Acting Relief Valves

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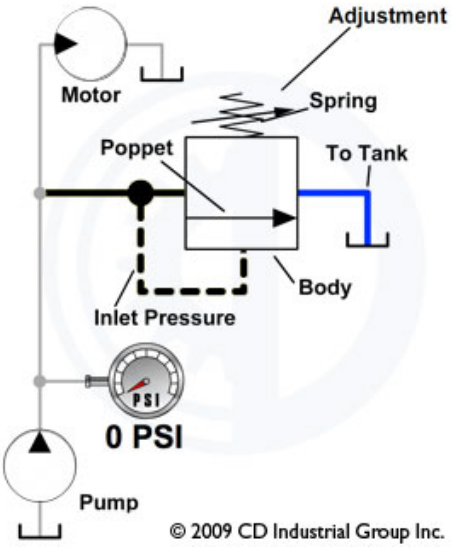
Posted in Hydraulic

Happy New Year, and welcome to our next newsletter installment! The topic in the next few editions of Newsletters That Teach is pressure valves. We'll show you how to identify them correctly on your schematics and understand the valve's basic functioning.

We'll start this week with a super simple, direct acting style of pressure relief valve. These valves perform the valuable function of limiting maximum system pressure. The matching interactive teaching simulation on our training login page will allow you to get a complete grasp of this topic.

Direct Acting Relief Valves

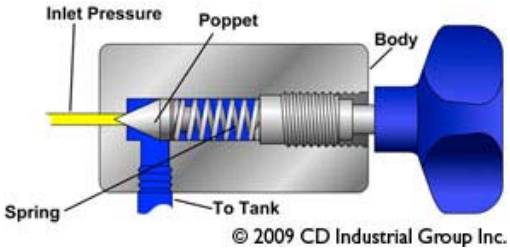
While inexpensive, the direct acting style is not very efficient. ***Direct acting*** means that there is only one poppet and one spring. The poppet has to be large enough to allow the entire flow of the pump to pass through at some point. The spring then needs to be large and strong enough to hold the poppet closed when the system pressure is less than the maximum.



The Symbol: How to Read it

Examine the symbol for a relief valve carefully and compare the symbol elements to the actual valve parts.

In your mind, animate the arrow inside the valve body. As maximum system pressure is reached imagine that pressure in the dashed pilot line pushing the arrow up against the spring. When the arrow connects the inlet and outlet, the relief valve is fully open. The spring will push the arrow back down (closing off flow) when the system pressure is weaker than the spring setting.



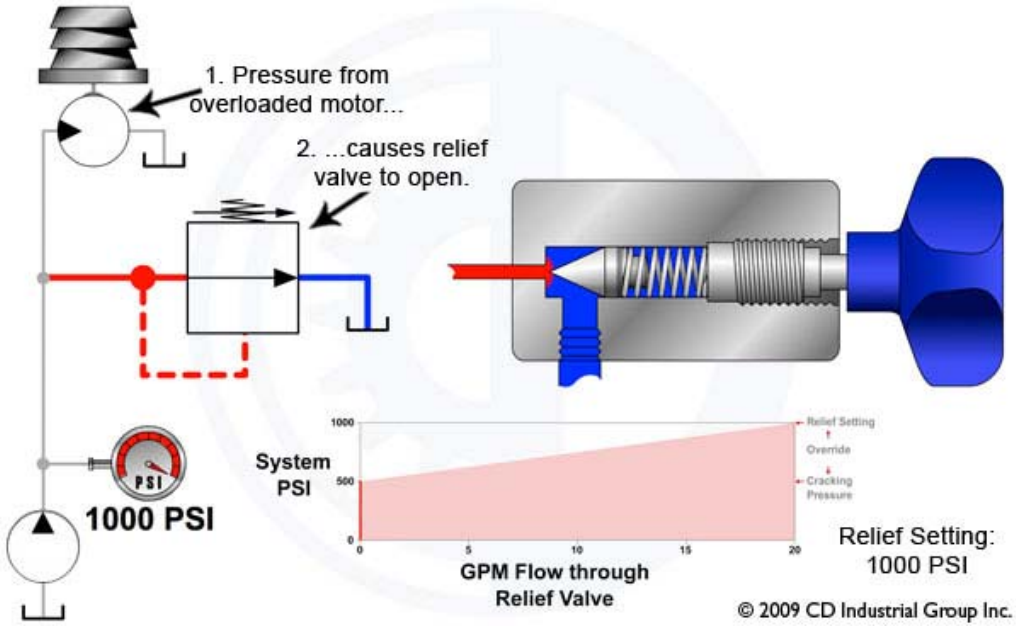
Question: Where does pressure come from in a hydraulic system?

Answer: From resistance to flow. Resistance to flow happens when there is a restriction in the flow path or when the cylinder or motor (actuator) is heavily loaded with hard work to do. This second reason is really just another type of restriction to flow.

The Relief Valve Opens: At What Pressure?

If the spring on the relief valve is set to limit the absolute maximum pressure to 1000 PSI, is that when the relief valve begins to open? No. Not in the case of the direct acting style of relief valve. If 1000 PSI is the maximum allowable system pressure, then the relief poppet has to start cracking open at a lower pressure.

Why is this so? This occurs because as system pressure builds (from whatever restriction caused it) the poppet has to travel a certain distance for the relief valve to eventually take the entire flow of the system. As the poppet travels, the spring is being compressed and is therefor becoming stronger in its counter force. The spring's strength is at 1000 PSI when the poppet has been pushed back to allow full flow.

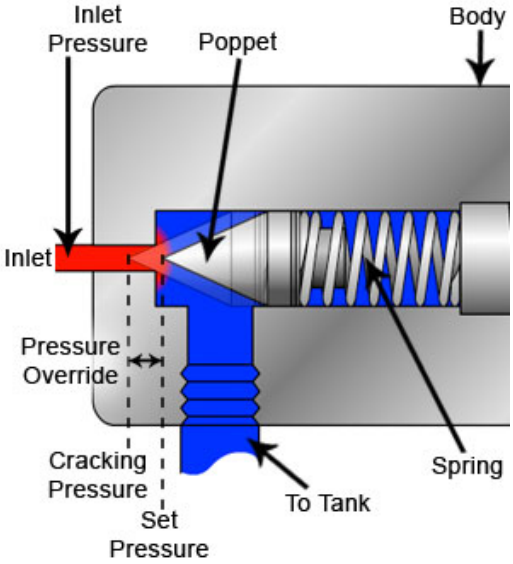


Relief Valve Specifications

The relief valve is said to have a *full flow pressure*, or a *set pressure* of 1000 PSI.

This very same relief valve then will have a cracking pressure that is several hundred PSI lower than the set pressure. In some cases a direct acting relief valve set to 1000 PSI will crack open at 500 PSI. This difference between the cracking pressure and set pressure (also 500 PSI) is referred to as the *pressure override*.

Most catalog data sheets for a pressure valve will include a graph (see above) showing the difference in flow rates through the valve from cracking pressure up to set pressure.



Relief Valve Divides Flow

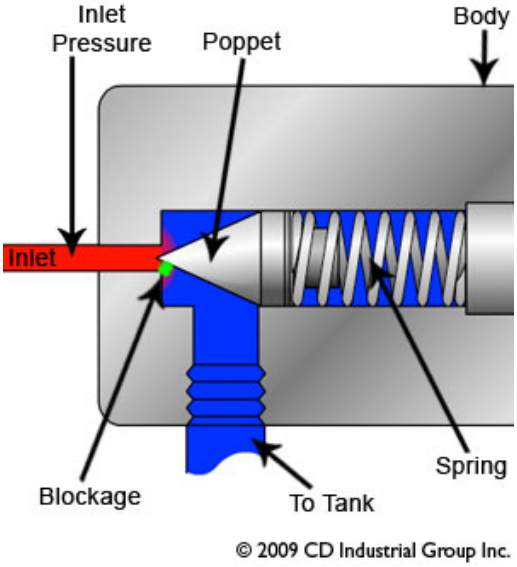
What do you think is happening to the hydraulic system performance when the relief valve is between the cracking and set pressures? If you guessed that the actuator is slowing down during that time, you're absolutely right.

Cracking Pressure: The pressure level at which the relief valve first begins to open.

Full Flow Pressure (Set Pressure): The pressure level at which the relief valve is wide open.

Pressure Override: The difference between the cracking pressure and set pressure.

So here's what we have. The actuator is loaded with heavy work to do, to the point that the maximum allowable and safe system pressure is being approached. At cracking pressure that actuator begins to slow down as some of the pump's flow is now passing through the relief valve. The actuator continues to slow down further as it is loaded and eventually comes to a stop at the relief valve's set pressure.



Troubleshooting Tip

Can you see how a problem with undesirable actuator slow down could be caused be a relief valve that won't close up? If there was a small particle trapped between the poppet and the seat, the relief would still limit maximum system pressure. But when system pressure was down at cracking pressure or lower, some system flow would be diverted back to tank resulting in a slower actuator.

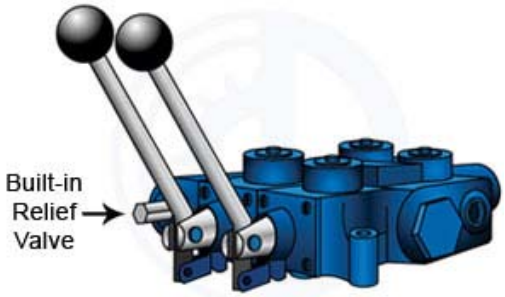
Heat: Energy Wasted

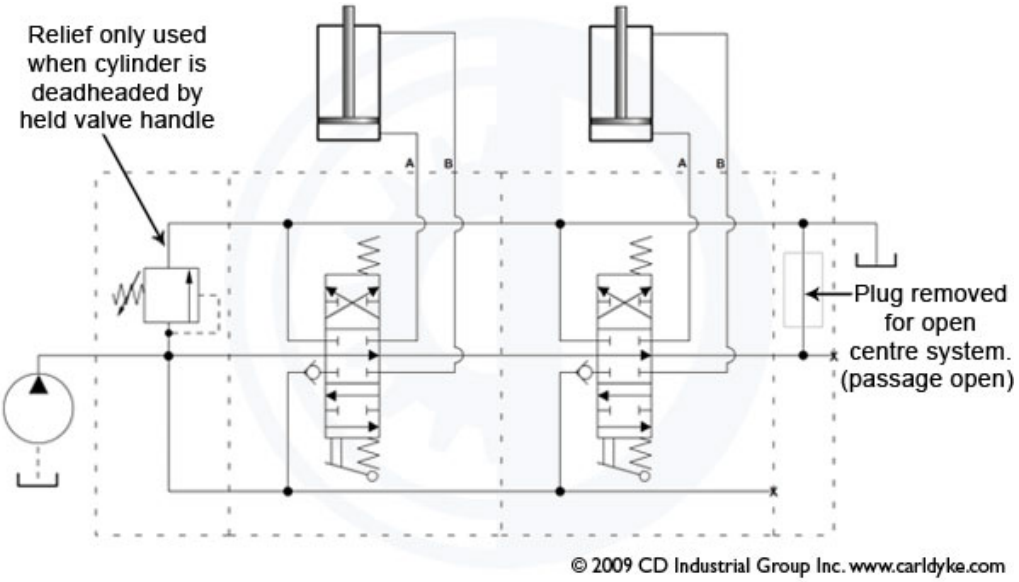
If it was desired to have normal actuator speeds right up to 1000 PSI, then the relief valve setting would have to be increased. Is there anything wrong with that? Not if all of the components in the system can handle the pressure.

This is not efficient however. If 1000 PSI is the maximum pressure needed to do the hardest work, why should the pressure rise all the way to say 1500 PSI when the system is relieving to tank? This 1500 PSI spring induced load is doing nothing useful. All that is happening is that the energy being used to turn the pump is being converted to heat at the relief valve.

Sufficient for Some Systems

Still, in a hydraulic system that features an open centre with the pump's flow dumped back to tank through directional valves when not needed, a direct acting relief valve may be sufficient. This relief valve might only open to limit pressure when a cylinder is dead headed at the end of its stroke with a valve handle held in an actuated position.





Balanced Style Relief Valve

If the relief valve sees frequent use in a hydraulic system, then a balanced style is much more efficient. It has a much smaller difference (pressure override) between cracking pressure and set pressure. We'll look at that type of relief valve next time.