Balanced/Pilot Relief Valves

Feb 13, 2009
Posted in Hydraulic

Thanks to all of you who have recently expressed your appreciation for educational value in these tutorials. Forward and circulate these emails among your colleagues as a low cost training option during these uncertain times.

Direct Acting Relief Valve Bad! (or at least not as efficient)

Last time we covered the direct acting relief valve. We covered the schematic symbol and how to read it and we looked at the valve's fundamental operating principles. If you can recall, the direct acting relief has some serious performance limitations. In order to avoid loosing flow to your actuator as the relief valve cracks open when the maximum system pressure is approached, the direct acting relief valve has to be set several hundred PSI higher than the optimal pressure limit. **Lots of energy is wasted with this type of relief valve.**

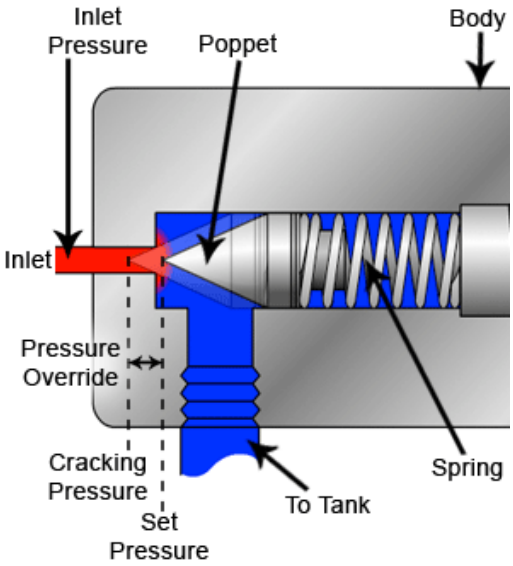
Balanced Type of Relief Valve Good! (much more efficient)

This edition of NEWSLETTERS THAT TEACH covers the balanced type of relief valve. The big difference with this valve is the much smaller pressure override value. Do you remember what pressure override is?

Review From Pressure Valves, Part 1

A relief valve is said to have a full flow pressure, or a **set pressure of a certain PSI** (1000 PSI, for example).

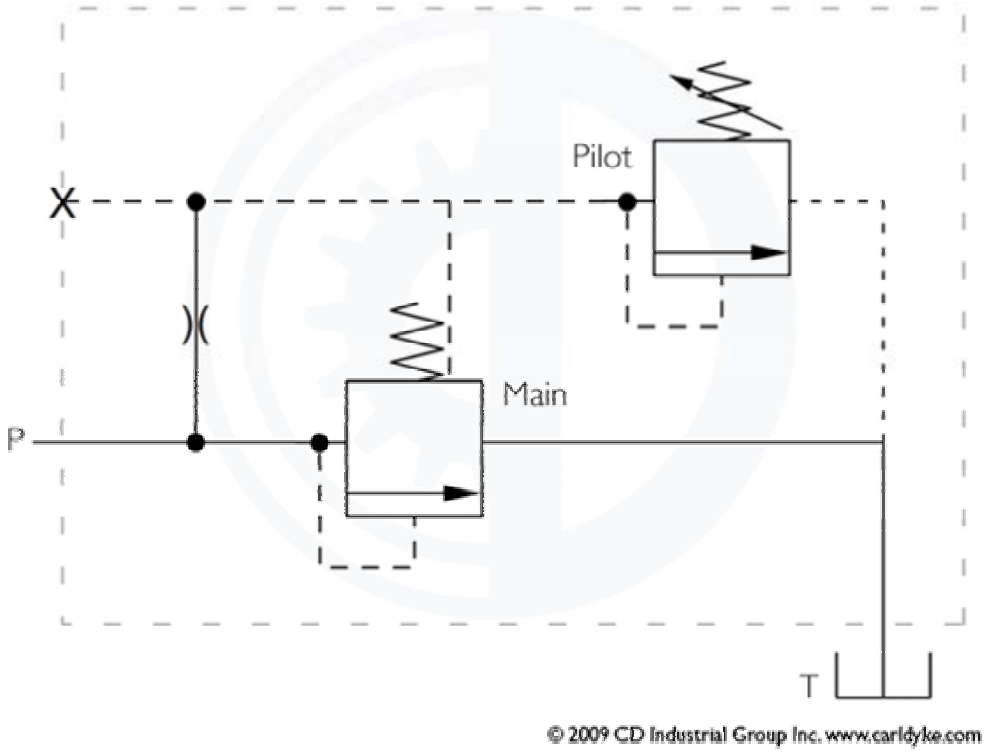
This very same relief valve then will have a cracking pressure that is several hundred PSI lower than the set pressure. In some cases a direct acting relief valve set to 1000 PSI will crack open at 500 PSI. This difference between the cracking pressure and set pressure (also 500 PSI) is referred to as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



In a balanced relief valve with its small pressure override, the valve moves from its cracked open state to its full flow state within a 50 PSI range. Some valves have only a 20 PSI pressure override.

What does this mean for hydraulic system performance? It means that if you need to be able to work with pressure up to 1000 PSI in your system, then you only have to set the full flow relief pressure at 1020 PSI. With the less efficient direct acting style of relief valve the full flow pressure would have to set at 1300 to perhaps 1500 PSI. **A relief valve is a load on the system when it is open just as a lift cylinder is a load.** The relief valve however does no useful work. It converts the system input energy to heat.

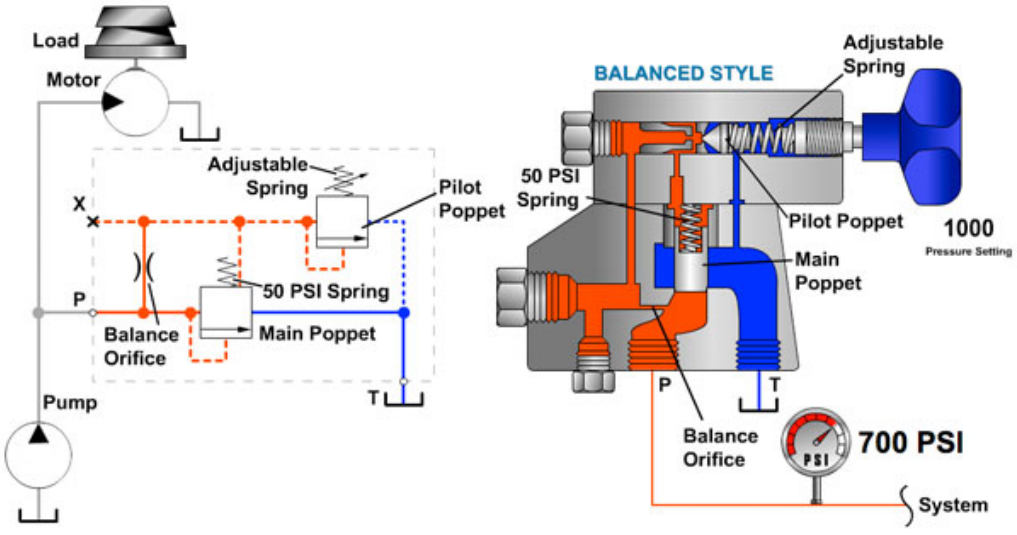
There are a few different schematic symbols for a balanced type of relief valve. One popular symbol is shown below. Note: On many schematics the balanced type of relief valve just appears as a direct acting type. Check the bill of materials and the valve model to be sure.



© 2009 CD Industrial Group Inc. www.carldyke.com

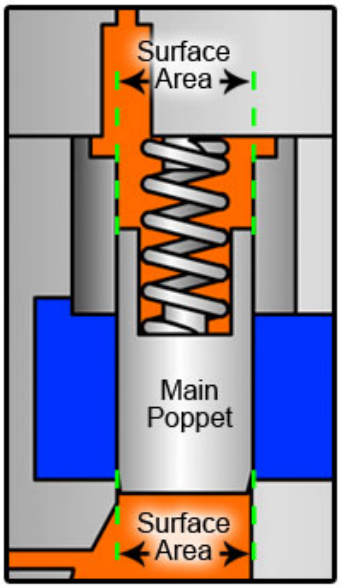
Understanding the Valve Operations

Many other pressure valves other than the relief valve (e.g. pressure reducing valve) operate on the balanced principle as well. Understanding one balanced valve helps you understand others. The principal of balance comes from the fact that when closed, there is essentially the same hydraulic pressure and surface area on both sides of the main valve poppet. In some valve designs the same hydraulic pressure and surface area is on both sides of two controlling surfaces that are attached to the main poppet.



© 2009 CD Industrial Group Inc. www.carldyke.com

Keeping it Closed!

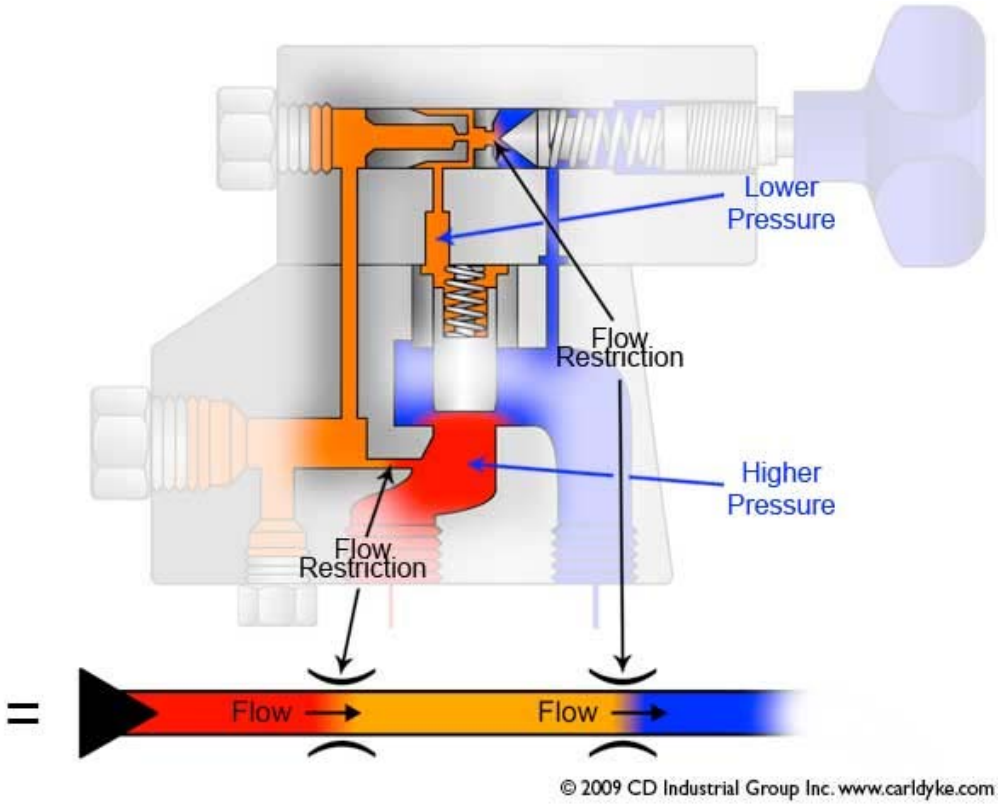


© 2009 CD Industrial Group Inc.

To keep the valve from popping open and dumping the system flow back to tank, there is a main poppet spring. This spring however only has a strength equivalent to 20 to 50 PSI in most models. So how does the valve stay closed when the system pressure is at normal high values? Simple. Notice that the system pressure is distributed to both sides of the main poppet. Both sides have the same surface area therefore the forces on both sides are equal too. One side has the additional force of a spring (20 to 50 PSI) that keeps the poppet closed under normal system pressures.

How Does it Open?

The pilot section at the top of the valve has a very stiff, small diameter spring and a small poppet. When system pressure reaches maximum, the pilot section becomes the easier passage as the small poppet cracks open. As the pilot poppet unseats, the pressure above the main poppet becomes lower than the pressure below the main poppet. Why does the pressure above the main poppet decrease when the pilot poppet opens? This happens because of the control orifice. Remember that any time fluid flows through a restriction, that restriction causes a pressure drop. When there are several restrictions in a row (pilot poppet is another restriction when partly open), there are pressure drops at each point.

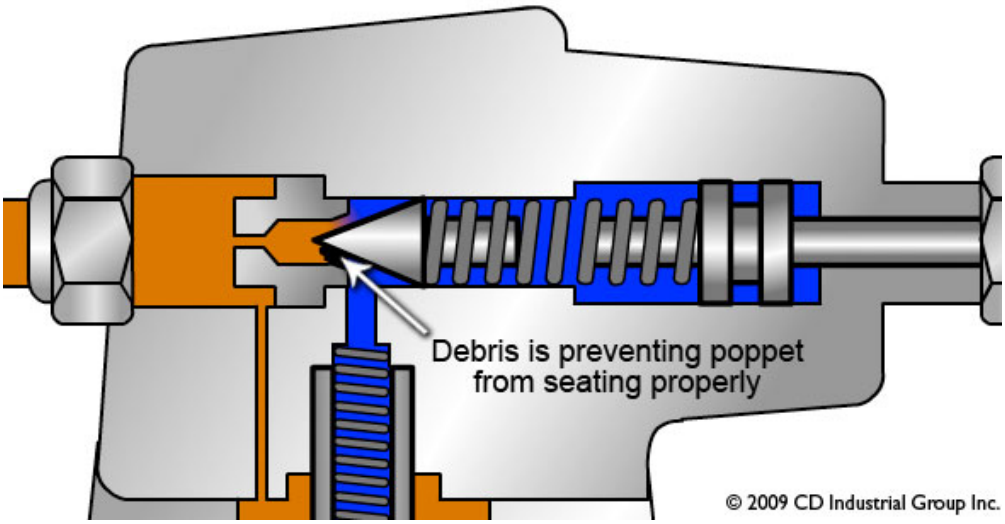


The main poppet cracks open when the pressure below is greater than the pressure above, and when that difference is greater than the spring that normally holds it closed. Remember that the spring on the main poppet only has a strength of approx. 20 - 50 PSI. The greater the pressure differential (caused by how far the pilot poppet opens) the more the main poppet opens up.

The efficiency of this type of valve comes in the form of being able to set the relief valve only slightly higher than the maximum required system pressure. The reason this valve can accomplish the relief function with such a small pressure override is due to the facts we've discussed and that only a very small percentage of the system's total flow is used in the piloting of the valve. Because of this fact a small pilot poppet can be used with a small diameter, adjustable spring.

Troubleshooting!

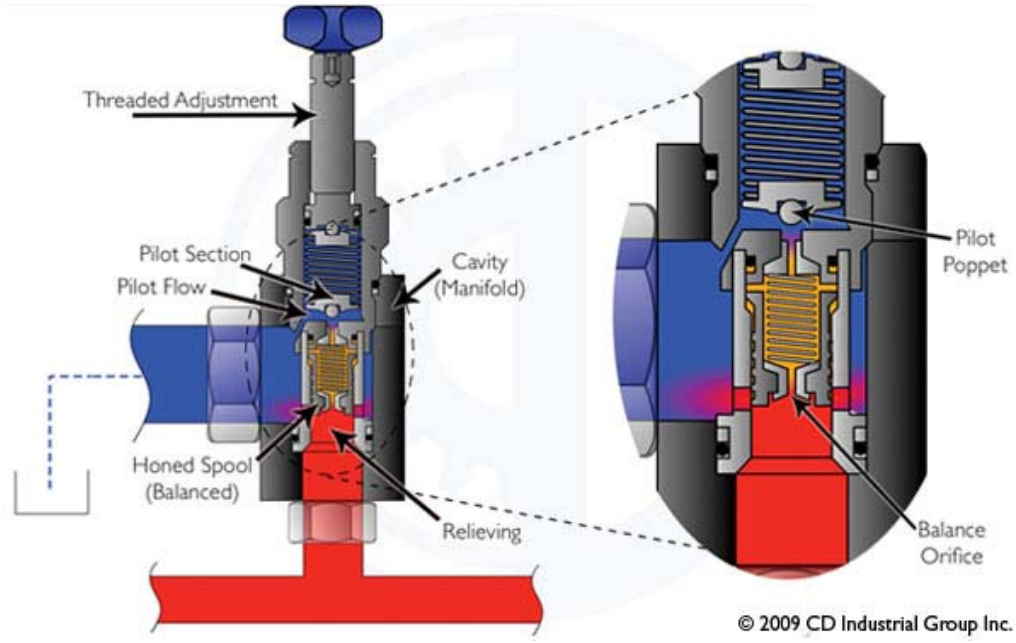
Question: What will change about hydraulic system performance if you have a contaminant particle trapped in the pilot poppet's seat?



Answer: If there is some flow through the pilot poppet when the system pressure is well below the high level, then you may notice very little change in performance. Your speed measurements might have to be very accurate to detect the change in flow. If however the particle is fairly large, your system may no longer be able to reach normal system high working pressures. In trying to adjust the valve to a higher setting, you'll probably find that the highest pressure you can achieve in the system is not changing.

Cartridge Valves

If your system has a screw-in style cartridge relief valve you may well have all of the benefits of the balanced type. Many of these valves have the same balance and pilot section features. Have a look at the technical illustration for your relief valve to see if it has one spring or two springs. Remember that the balances type of relief valve always has two springs.



Until next time.....