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The Direct Operated Solenoid Valve

The direct operated solenoid valve is probably the most commonly used mechanism in many pneumatic systems. Valves with this basic design and different materials in the flow path are commonly used for water, oil and gases (WOG). If you ever wondered what a WOG valve was (common in bronze body ball valves), now you know.

The most common style of direct operated solenoid valves use an iron armature with an elastomer seal on one or both ends. One end seals against pressure, and if the unit has an exhaust path, the other end seals the exhaust when operated. You don't have to be simple-minded to appreciate the beauty of this simple mechanism. As a stand-alone valve, shown in the diagram below, these are easy to recognize. Where you may not have recognized this direct operated solenoid valve is as the solenoid pilot operator for any number of spool and poppet valves, process valves, etc.

The dynamic of this mechanism is a classic solenoid with added features to produce a directional control valve for liquids and gases. The armature blocks the orifice and alternatively provides a generous annular ring flow path with a short stroke. With little dynamic friction and "stopper" seals, this mechanism is prepared for many million trouble-free cycles, often without lubrication and adequate filtration.

• A spring holds the armature against the valve seat (orifice) in the body to block pressure. The spring force must be greater than the force of the pressure times the area.

• To use the same mechanism at a higher pressure, either the spring must have more force, the area of the orifice must be smaller, or a combination of the two.

• When energized, the solenoid creates electromagnetic force to pull the armature deeper into the cavity of the surrounding coil, which compresses the spring.

• The exhaust path is blocked by the opposite seal on the armature. At this point, pressure will assist the exhaust closure.

• With the armature deeper inside the coil cavity, the lines of permeability are increased and the electrical current is reduced from inrush to holding current.

• The term "direct" implies that the solenoid valve was actuated directly as a result of the electrical current without assistance.

• A common manual override might be located in the body or base of the solenoid mechanism to raise the armature (valve) mechanically with a lever or cam when pushed or turned.

• The exhaust path is often threaded, possibly 10-32 UNF or M5. For some applications, introducing pressure into the exhaust path provides a remote override effect or alternative pressure input. The threaded exhaust allows exhausting fluid to be plumbed away for clean rooms or nasty gases.

• When actuated and in a holding current condition, the majority of these valves are rated for continuous duty. They may be turned on and left on.

• If the armature (sticks) does not move into the holding position and the coil continues to draw "in-rush" current, the excess heat will soon destroy the coil.

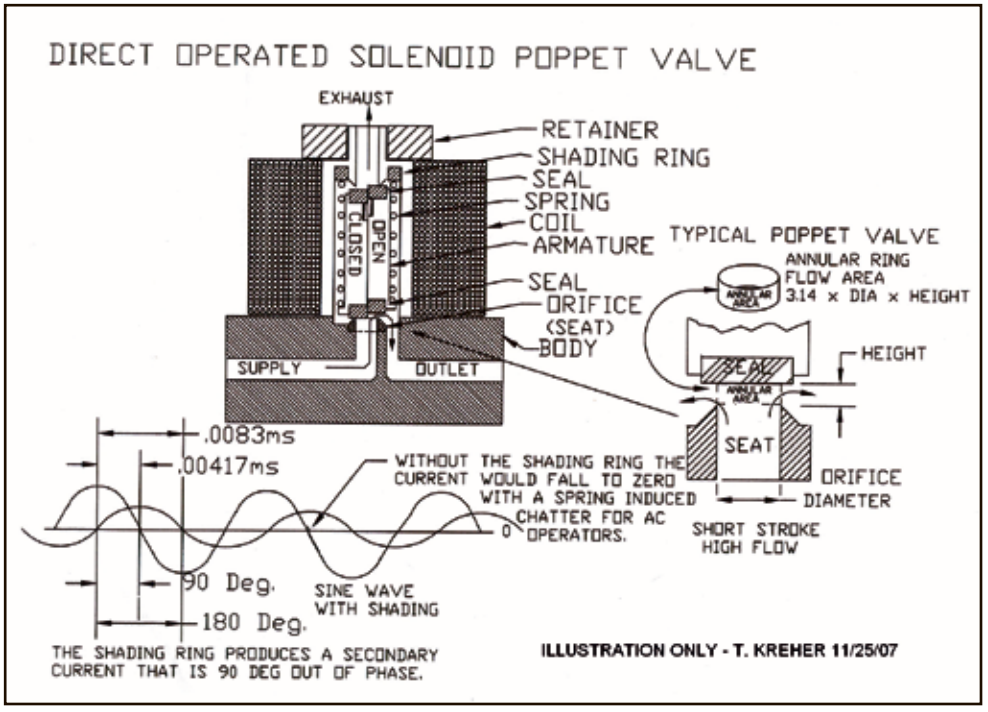
• The nature of an alternating current sign wave presents an interesting wrinkle as it passes through zero voltage. Without a remedy, the spring will force the armature out of the coil cavity until the voltage and current increase again.

• A shading ring is installed that produces a small counter current that is 90 degrees out of phase with the main sign wave. As the main current approaches zero, the counter current from the shading ring will add enough current to hold the spring compressed. Many manufacturers place a shading ring (coil) in all of their valves. If an AC coil is used to replace a DC coil, the valve will still work if the coil matches the electrical signal applied.

• In a world that is increasingly lean and green, we use valves that are almost the same except for a standard and low-watt solenoid operation.

• You know the drill. To go from a 7-watt coil to a 2-watt coil, we must deal with a change in magnetic force. Swapping the coil spring and orifice will correct the balance of forces required. Remember, there is more to it than just a coil swap.

Tiny- to modest-sized direct operated solenoid valves provide pressure to small cylinders and pilot pressure to much larger valves and devices. This drop-dead simple little beauty is one of my favorites.



About the author:

Tom Kreher began his career in pneumatics by working for Norgren for 30 years. He started Applied Pneumatic Controls with his wife Gloria in 1995. He can be reached at tom@applied-pneumatic.com.