TechTIPS

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The APPLICATION of Pneumatic VALVES

Inside

HIGH Flow In A Miniature PACKAGE with CLIPPARD'S New DV Valve

Mary Gannon, Design World Senior Editor

Clippard's entry into the miniature electronic valve market began in 1973, when Leonard Clippard, founder, introduced the EV line of valves that utilized only one moving part, the "spider." Today, the EV valve is still serving a very horizontal market with thousands of installed applications in a multitude of industries. Since the initial introduction, several new series have been added to the line, including; Corrosion-Resistant, Oxygen Clean, Analytical, ECN, EVN, ETN, Proportional Control, Intrinsically Safe, EM and ES series, all which utilize the "spider" design. Enter the new DV Valve.

New design challenges

According to Dave McBreen, the DV valve project design engineer at Clippard, the all-new design began with the coil. "It's not that we designed the valve around the coil," said Dave, "but we knew our design parameters called for the coil to be less than 2.0 W, so we began there. The 2.0 W would allow us to see what kind of magnetic pull we could generate." McBreen goes on to say that many coils were made in the attempt to optimize one. This led to an optimized solenoid needed for the valve. The process for determining the correct coil was enhanced by a coil calculator. The calculator, which was designed by Clippard's engineering department, greatly reduced the design time and provided the exact specifications of the coil.

Once he had the design criteria, McBreen felt that his biggest challenge was to consider the manufacturing processes needed to get the product out the door—how to get a cost effective, optimized design through manufacturing and yet be fairly simple to assemble was the challenge. Included in this thought process was the concern with size limitations; the valve needed to be small. Yet, he had other criteria to consider, including power, flow, pressure, and materials.

The requirement from the very beginning called for all metal parts to be stainless steel with the nozzle and bobbin utilizing certain plastics that would allow for FDA approval. The all-stainless housing provides many environmental advantages and is manufactured in three parts. McBreen is very enthused about the three-part design and just what a "robust package" it delivers. "It can be taken apart and put back together in seconds," said McBreen. One of the main reasons for this is that the valve only has one moving part—the "spider."

The all-new spider, designed from stainless steel, is capable of flows to 100 lpm at 100 psig. Although this is a new spider design, compared to the existing EV line, it is still a poppet valve. With a preload of approximately 0.017 in., stroke up to 0.018 in., and response time of 10-15 msec, the DV Series can be utilized in many applications. And, with the over-molded seal, the DV Series will continue the high standard set by the industry-leading EV line for leak-free operation, which is particularly meaningful for analytical applications.

McBreen also noted that, "in addition to being very economical to produce,

Featured Video:

Introducing Clippard's New DV Valve

HIGH Flow In A Miniature PACKAGE with CLIPPARD'S New DV Valve

(continued)

the straight-forward, robust design leads to a hassle-free assembly. The new valve has another feature not readily found in other miniature valves: bi-directional flow. It is designed to serve as a dual flow valve within a certain pressure range. Applications requiring this feature should be discussed with Clippard's technical staff prior to installation."

Manufacturing begins

After two years of building prototypes and testing (using FEA stress analysis on the spider and magnetic analysis software for the valve) it is now ready for market, according to McBreen. Initially the product will be offered with an orifice of 0.052 or 0.070 in., with manifold or cartridge style mounts, and voltages in 12 and 24 VDC. Air and other compatible gases are the recommended media with the standard seal but other seals are available for use with other medias. Simply changing the coil, nozzle orifice or mounting options helps to enable special customer applications.

The DV line will be assembled in Clippard's Fairfield, Ohio plant along with the EV line and other Minimatic electronic valves where, according to Steve Schutte, Plant Manager, "all work cells and personnel are prepared for a very positive response to this new product. The ability to produce thousands of valves per week is due in no small part to the straightforward design, which means a straightforward assembly. In addition, an automatic tester is in place which ensures 100% of the valves will go through the testing process." He also noted the testing equipment was designed and built by Clippard.

Featured Video:

Engineering Clippard's New DV Valve

Application potential

Now that the design and manufacturing processes have been finalized, where will the valve be used? According to Rob Clippard, Vice President Sales & Marketing at Clippard, "one of the key applications will be in the medical field. Although there are numerous applications within the medical industry, none will be more applicable for this valve than blood pressure cuffs. Additionally, applications requiring some sort of pressure monitoring, pulse monitoring of the heart or perhaps oxygen therapy have a great amount of potential. With its high flow capability, respirator applications will definitely be one of the most common uses. Other applications in the medical field would include ventilator and kidney dialysis machines."

While medical will be a primary market, according to Rob, there are many other applications and markets, including gas chromatography, liquid chromatography-mass spectrometry, and other applications requiring analysis. He noted the valves would be used throughout the packaging industry, especially where small banks of manifold mounted valves would be needed.

Future development

So, what's ahead for the DV valve? According to John Campbell, President, "this is one of the new generational valves and we believe it will contribute to the success of the company for a long time. From this basic design we expect to be successful from the start; we'll be growing into many other products as we continue to invest in engineering and continue to believe in new product development as the key to our future." DW

CLIPPARD **EFB** Series Electronic **FILL & BLEED** Circuits

Courtesy of Clippard

A FILL AND BLEED CIRCUIT is a combination of pneumatic valve components used to inflate a volume or apparatus in one controllable function, and to release or vent pressure in a second controllable function. Fill and Bleed Circuits are commonly used in many applications where a particular pressure, firmness, or position can be controlled with the addition or venting of pressure.

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Featured Video:

Design World's Product Showcase – Clippard's New DV Valve

Design World's Editorial Director Paul Heney highlights Clippard Instrument Laboratory's new DV valve, an electronic valve for pneumatic applications that offers high flow rates of 100 lpm at 100 psig while offering extremely low leakage rates. The energy-efficient design only consumes 1.9 W, making it ideal for packaging, medical, analytical and more applications.

For more information on the DV Valve, visit http://www.clippard.com/link/dw1405715

WHY Choose Quick-Connect FITTINGS?

Courtesy of Clippard

Have you ever used a piece of equipment with a Quick-Disconnect fitting? Sometimes they are also called Quick-Disconnect connectors or couplings. If you have used them at some point you know how convenient, effective and noteworthy they are for many applications. If you have never used this piece of equipment, it is definitely worth learning more about them because they are easy to implement and versatile. Most fittings come in three shapes; straight, tee or 90° elbow, but they are not limited to these shapes. The purpose of this type of fitting is to be able to disconnect two parts without disrupting the pressure of the contents in the tube or pipe and reconnect them just as easily.

Besides easy on and easy off what makes quick disconnect couplings so beneficial and helpful to so many industries? First of all, safety. No machines are needed to disconnect the tube or hose from the fitting and everything can be done and controlled by hand. Having full control over the connecting and disconnecting insures no slip of a button and less man power is needed. Another safety feature is the fitting holds all pressure and does not let gas or liquid escape the hose or tube when it is disconnected. Therefore, when removing no bleeding, purging air or recharging is necessary. The disconnection can be done easily and promptly.

So where can these fittings be found and how much do they cost? The answer for both of these questions varies vastly. To find one of these products you can look near or far, as far as kilometers underwater used in drilling operations or high in orbit around earth, for docking spacecraft. Also, you are able to find them as close as walking into a garage and finding a Quick-Disconnect fittings on the air hose attached to the air compressor. Cost can also vary considerably, all depending on the size, application and material. As you can imagine, underwater drilling will employ a larger fitting than a small air hose used in a mechanics garage. Additionally, materials may change because of corrosive materials present or extreme temperatures.

Quick-Disconnect fittings are used as high as space and as deep down as drilling wells. These fittings are used across a plethora of industries including water transport, chemical industries and pluming in addition to the examples already presented. Limiting the examples to only a few industries does not begin to show the helpfulness and versatility of these components that can make the task at hand so much easier.

View Clippard Quick-Connect Fittings

PNEUMATIC Valves

Paul Heney, Design World Editorial Director

Compressed air pneumatic systems require methods of safe and precise control of the actuators unique to their accoutrement. Although the medium is fluid, just as hydraulic or process water systems, the execution of control is different in many ways than with a liquid. What is shared in the conduction of any fluid power medium is the need for valves to control force, velocity and direction of movement.

Air preparation

Pressure relief valves will control pressure at their inlet port by exhausting pressure to atmosphere. Relief valves are typically used only in receivers or air storage devices, such as accumulators, as a means to prevent excessive pressurization. As such, relief valves are often called safety valves and are not typically appropriate for use anywhere but the air preparation stage.

Pressure regulators in pneumatic systems limit pressure downstream of the unit by blocking pressure upstream at the inlet. Regulators are used in the air preparation stage, as well as in control of cylinders and motors. The letter R in the acronym FRL stands for regulator, which is installed downstream of the receiver tank, but before the circuit they are regulating pressure for.

Sometimes multiple stages of pressure reduction are required, especially with a large centralized compressor and receiver feeding various workstations. A regulator can control pressure within the main grid of distribution plumbing, but sometimes air is piped directly to an FRL at each workstation or machine. Pressure at this main header could be 120 psi or more, but a branch circuit could be regulated at 90 psi, for example. Most regulators are capable of relieving downstream pressure, which prevents that downstream pressure from elevating as a result of load-induced pressure or thermal expansion.

Pressure regulators can be had as stand-alone units, but sometimes a filter is attached to kill two birds with one stone. Regulators are most often available as a component of a modular set, with a filter, regulator, lubricator or dryer etc., and can be assembled in any combination. The regulator will have an inlet port, outlet port and a port for the pressure gauge, which they are most often included with.

Pressure regulators can also be used to control pressure for individual actuators, such as an inline regulator or work-port mounted regulator. These are typically quite small and included with reverse flow check valves, as would be required for double acting function of a cylinder, for example. Further still, differential pressure regulators are offered by some manufacturers, to maintain a set pressure differential between the two ports, rather than just maintaining downstream pressure. It should be noted that all pressure regulators are adjustable, most often with screws or knobs.

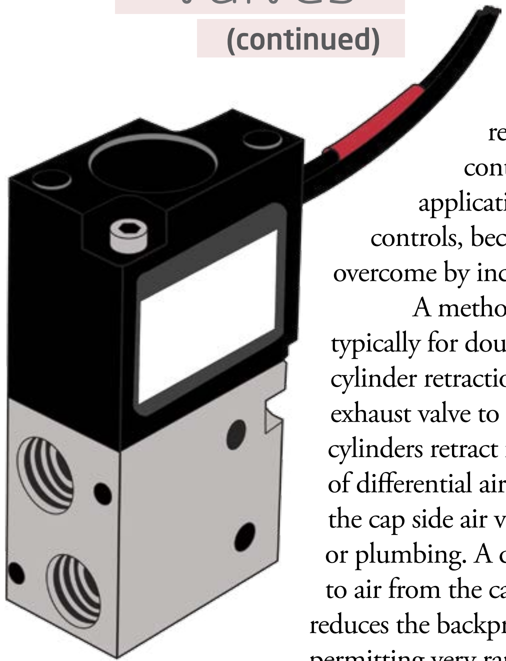
Flow controls

Also common in pneumatic systems are valves to control flow. There are fewer available types of flow valves compared to pressure or directional valves, but most circuits apply them to make for easy adjustment to cylinder or motor velocity. Controlling velocity in pneumatic systems is more complex than in a hydraulic system, because pressure differential between the work ports of a cylinder plays a larger part.

Flow control valves for pneumatic systems are quite simple, usually available in two configurations used in two different ways. One configuration is merely a variable restriction, with a screw or knob adjustment to open and close a variable orifice, which is also often referred to as a needle or choke valve. The other type introduces a check valve, which allows free flow in one direction, and restriction in the opposing direction. For whatever reason, this valve has hijacked the name flow control all for itself.

Flow control valves are applied in two different ways; meter in or meter out. Meter in is the method of controlling the rate of airflow as it enters a motor or cylinder. When metering in, a cylinder will move rapidly with high force and efficiency, but the motion of the piston is prone to spongy and unpredictable movement. When metering out, the cylinder velocity is more stable and repeatable, but efficiency and dynamic force are lost to the energy

PNEUMATIC Valves (continued)



required to push past the flow control. Regardless, most pneumatic applications operate using meter out flow controls, because the disadvantages are easy to overcome by increasing upstream pressure.

A method of increasing cylinder velocity, typically for double acting or spring-return cylinder retraction functions, is to add a quick exhaust valve to the cap side work port. Because cylinders retract faster than they extend as a result of differential air volumes, it is harder to evacuate the cap side air volume without oversized valves or plumbing. A quick exhaust valve vents directly to air from the cap side work port, and massively reduces the backpressure created upon retraction, permitting very rapid piston velocity.

Directional control valves

Pneumatic directional valves are available in many sizes, styles and configurations. At the basic end of the spectrum is the simple check valve, which allows free flow in one direction and prevents flow in the reverse direction. These can be installed anywhere from right after the receiver to within a flow control valve itself.

As directional valves grow in complexity, they are specified under a general naming practice related to the number of positional envelopes of the valve and the number of work ports in the valve, and specifically in the order described. For example, if it has five ports, port 1 will be for pressure inlet, ports 2 and 4 for work ports, and 3 and 5 for the exhaust ports. A valve with three positions will have a neutral condition, extend condition and retract condition. Putting it all together, this describes a five-way, three-position valve, also referred to as a 5/3 valve. The common configurations seen in pneumatics are 5/3, 5/2, 4/2, 3/2 and sometimes 2/2 valves.

Also part of the description of a directional valve is its method of both operation and positioning. The valve operator is the mechanism providing the force to shift the valve between its positions. The operator can be a manual lever, electric solenoid, an air pilot, or cam mechanism, to name a few. Some valves are a combination of these, such as a solenoid pilot valve, which is a tiny valve providing pilot energy to move the main-stage valve. Positioning of any valve is achieved by either a spring, such as with a 5/2 spring-offset valve, or with detents in 5/2 detented valves.

A 5/2 spring-offset valve will return to its starting position when energy is removed from its operator, like de-energizing the coil, or removing pilot pressure. A 5/2 detented valve will stay in the position it was last activated to until the operator switches it again.

Pneumatic valves are manufactured in various incarnations. Poppet valves are simple, using a spring to push a face of the poppet down on its seat. Construction can be metal-to-metal, rubber-to-metal or even with diaphragms. Poppet valves can often flow in one direction, just as a check valve, but need to be energized to flow in reverse. They are limited to two- or three-way port configurations, although they can mimic four- or five-way valves when used in parallel. They offer typically high flow conductance for their size, and are generally very resistant to contamination.

Spool valves use a notched metal cylinder that slides within a precisely machined body, drilled with three to five ports, or even seven ports if the valve is pilot operated. Low-end valves consist of only a spool and body, and are prone to internal leakage. Better valves use seals in the body or spool to prevent leakage between ports. High-end spool valves are constructed with precision, often requiring fine lapping procedures during manufacturing, and with their tight tolerances, often require few seals, improving reliability and longevity. Other forms of high-end valves use a sliding block of metal or ceramic, which is not only efficient, but also extremely resistant to contamination, making them great for dirty environments.

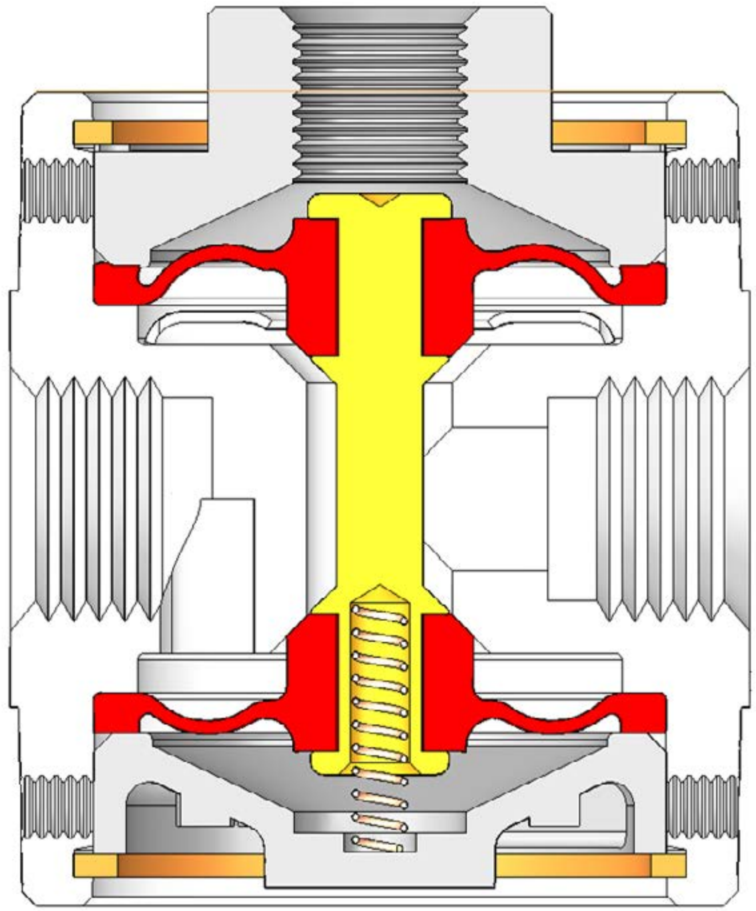
Mounting considerations

Pneumatic directional valves come in both standard and non-standard mounting configurations. The non-standard valve is constructed at the whim of the manufacturer, with port layout, operator style and mounting options unique to their product. They can be inline, subplate mounted or sectional stacks mounted in a row. Because each manufacturer does mounting differently, it is best to research the product appropriate for your application.

Luckily, most manufacturers have lines of standardized valves suiting one or more specification, such as ISO 5599-1, with its staggered oval ports; this means one manufacturer's valve will fit the subplate or manifold of another manufacturer's. Port and electrical connections are standardized with most valves as well. NPT ports are common, but many new valves come with push lock fittings on the subplate itself. Electrical connectors for standardized valves are frequently DIN, mini-DIN or with field bus connection, making the operation of a dozen valves as easy as one connector. DW

COMMON Uses Of PNEUMATIC Valves

Paul Heney, Design World Editorial Director



Pneumatic valves include manual valves, mechanical valves, air-piloted, solenoid-piloted and vacuum-piloted. These terms relate to how the valve will be actuated. This is a critical component in understanding how to properly use the valve in an application, but it is essential to understand how a valve is designed. There are four basic valve designs: poppet, diaphragm poppet, spoppet and spool.

Poppet valves use a rubber molded poppet wrapped around the stem and move along the bore of the valve, creating a seal when the poppet is in its seat. One specific advantage to using a valve with this type of internal design is the compatibility with a variety of media other than compressed air. The unique feature that allows this compatibility is less lubrication sensitivity due to few sliding parts or (dynamic seals). Other features within this poppet design include valves that are more tolerant of minor air sediment or debris. They have excellent exhaust capacity and are capable of high flow rates. The poppet design provides a faster response rate due to short stroke and can be mounted in several ways. Poppet valves more readily lend themselves to 2- or 3-way configurations, although 4-way configurations can be achieved by using dual 3-way poppet sets in one valve body. Poppet valves are typically unbalanced designs that use the air pressure as the primary force to return the valve to a given position. This concept ensures that the valve will return to the desired position even if the return spring fails. Balanced poppet valves are used to reduce actuation force and achieve lower current consumption in solenoid valves. Balanced valves typically provide smaller overall physical size and produce greater flow capacity.

Diaphragm-poppet valves expand the poppet valves' design by the use of a diaphragm. Its outer webbing guides the poppet to its seat without using sliding seals. Diaphragm-poppet designs are usually unbalanced, providing the same assurance of return to a given position as the poppet valve. The diaphragm increases durability especially with different or non-lubricated media. The diaphragm also allows for the potential use of liquids through the body of the valve depending on application and rubber compatibility. A variety of durometer and diaphragm compounds make it simple to modify a valve based on the environmental or application requirements for operation. Also,

COMMON Uses Of PNEUMATIC Valves

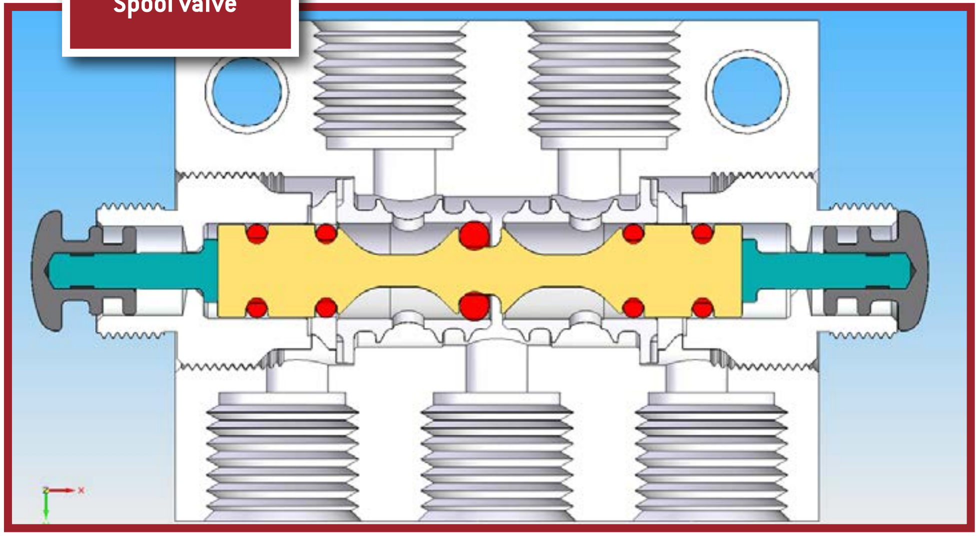
(continued)

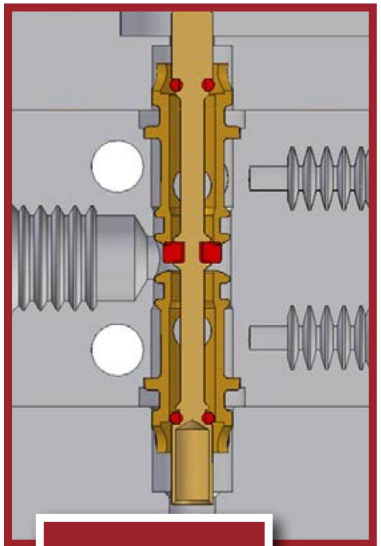
expect extremely low leak rates due to strong sealing control. Diaphragm-poppet valves make 2- or 3-way configurations available, as well as the possibility of 4-way valves, by using dual 3-way diaphragm poppet sets in one valve body.

Spoppet valves combine two designs to provide a blend of primary poppet sealing in conjunction with a minimal number of sliding seals, thus emulating characteristics of a poppet and spool valve design. Spoppet designs retain some unbalance characteristics but with some balance of pressure to reduce actuation forces. This design provides the benefits of the poppet valve with a reduced sensitivity to lubrication. Only one sliding seal engaged at a time reduces the drag within the valve body. These designs can sometimes bridge the gaps or limitations of poppet and spool valves making them more useable in numerous critical applications. By blending the designs, spoppets provide more cost efficient 3- and 4-way valves, and can be used in many different environments and applications.

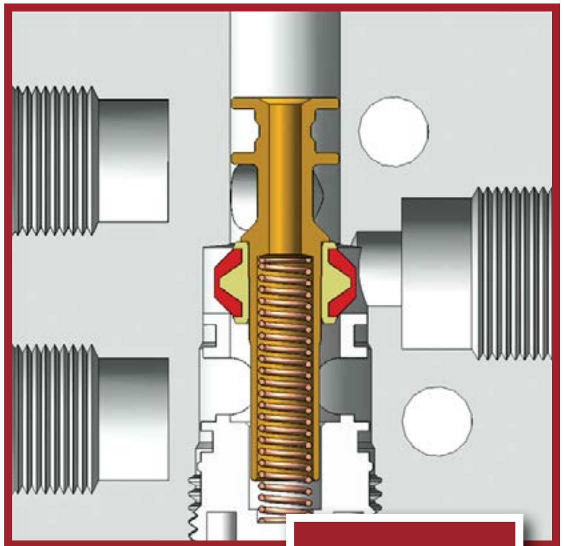
Spool valves are available in three types: Lapped-/shear-design with no seals, dynamic seals, or 0-ring. Spool valves are designed to be more cost-effective when manufacturing for 4-way valves and are conversely less adaptable for 2- or 3-way configurations. Spool valves can be either balanced or unbalanced, depending on desired position control required. Therefore, understanding this valves' function is critical to the application requirements. Lapped- or shear-design spool valves can operate without lubrication but are less tolerant of variations in lubrication or by-products of compressing the air at the air compressor. Hence, further conditioning of the compressed air is required prior to use. Dynamic seal spool valves generally require lubrication. Lapped spool valves have higher leak rates that may make them unacceptable for control of medias other than air, or limited media sources (air/gas tanks/bottles). DW

Spool valve





Spoppet valve



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