Valve Operation

Normally closed valves remain in the closed position when the coil is not energized or return to the closed position upon removal of voltage from the coil.

Normally open valves remain in the open position when the coil is de-energized or return to the open position upon removal of voltage from the coil.

1 Direct Lift Normally Closed

Opening

When voltage is applied across the coil leads a current is produced in the coil windings which generates a magnetic field. The magnetic field attracts the plunger and causes it to move toward the center of the coil or magnetic stop. Initially the plunger slides freely on the stem until it impacts the nut or shoulder at the end of the stem. The plungers momentum is then transferred to the stem and the stem is lifted off the seat screw or bottom nut orifice thus initiating flow through the valve.

Closing

When voltage is removed from the coil leads, the magnetic field collapses. Gravity pulls both the plunger and stem down until the stem point seals off the orifice stopping flow through the valve.

2 Direct Lift Normally Open

Closing

When voltage is applied across the coil leads a current is produced in the coil windings which generates a magnetic field. The magnetic field attracts the plunger and causes it to move toward the center of the coil or magnetic stop, compressing the plunger return spring as it travels. The plunger assembly continues to move until the stem shuts off the valve orifice stopping flow through the valve.

Opening

When voltage is removed from the coil leads, the magnetic field collapses. The force exerted by the compressed plunger return spring then pushes the plunger up from its position at the center of the coil or adjacent to the magnetic stop. Initially the plunger slides freely on the stem until it impacts the nut or shoulder at the end of the stem. The plunger's momentum is then transferred to the stem and the stem is lifted off the seat screw or bottom nut orifice thus initiating flow through the valve.

The following types of valves have magnetic stops that the plunger is held against when the valve is actuated: 500 N.O., 12000, 13000, 14000, 15400 N.O., 30400 N.O. & N.C., 30800 N.O. & N.C., 35000 N.O. & N.C., 40000 N.O. & N.C., 50000 N.O. & N.C.. Shading rings located on the magnetic pole faces are utilized in AC versions of these valves to minimize the chatter of the plunger against the magnetic stop. The changing magnetic field in the coil induces an electric current in the shading ring which in turn generated a secondary magnetic field which is out of phase with the coils magnetic field. This magnetic field generated by the shading ring is strong enough to hold the plunger against the magnetic stop during the time that the coil's magnetic field is a it's minimum, thus preventing the chattering or AC hum. The stainless steel valves use silver (999 fine) ring(s) and the bronze valves use copper (electrical grade) ring(s).

3 Pilot Operated Normally Closed

Opening

When voltage is applied across the coil leads a current is produced in the coil windings which generates a magnetic field. The magnetic field attracts the plunger and causes it to move toward the center of the coil or magnetic stop. Initially the plunger slides freely on the stem until it impacts the nut or shoulder at the end of the stem. The plungers momentum is then transferred to the stem and the stem is lifted off the seat screw pilot orifice. Fluid from the cavity above the piston flows through the pilot orifice in the seat screw and through the drilled hole in the center of the piston to the downstream side of the valve. Pressure above the piston decreases since the pilot orifice is larger in diameter that the bleed orifice. Inlet pressure acting around the annular area outside of the main valve seat at the bottom of the piston then pushes the piston up, thus initiating flow through the valve.

Note that flow through the valve creating a pressure drop across the valve is required to hold the piston open. If flow is diminished the piston will move toward the closed position. To maintain the valve fully open a pressure drop of 3 to 5 psid across the valve is required.

Closing

When voltage is removed from the coil leads, the magnetic field collapses. Gravity pulls both the plunger and

stem down until the stem point seals off the pilot orifice. Fluid flow from the valve's inlet side through the bleed orifice in the piston charges the cavity above the piston to a pressure equal to the valves inlet pressure. Since downstream pressure is acting against the center portion of the bottom of the piston, the pressure forces acting on the piston are unbalanced and act to push the piston to the closed position (gravity and, with some valves, a piston spring assists in the closing).

It is characteristic for pilot operated valves to briefly open if subjected to a shock or sudden surge of inlet pressure. This is caused by the elevated inlet pressure pushing the piston open before the pressure above the piston can build via flow through the small bleed orifice. Once the pressure above the piston equalizes with the inlet pressure the valve closes.

4. Pilot Operated Normally Open

Closing

When voltage is applied across the coil leads a current is produced in the coil windings which generates a magnetic field. The magnetic field attracts the plunger and causes it to move toward the center of the coil or magnetic stop, compressing the plunger return spring as it travels. The plunger assembly continues to move until the stem shuts off the pilot orifice in the seat screw. Fluid flow from the valve's inlet side through the bleed orifice in the piston charges the cavity above the piston to a pressure equal to the valves inlet pressure. Since downstream pressure is acting against the center portion of the bottom of the piston, the pressure forces acting on the piston are unbalanced and act to push the piston to the closed position (gravity assists in the closing).

Opening

When voltage is removed from the coil leads, the magnetic field collapses. The force exerted by the compressed plunger return spring then pushes the plunger up from its position at the center of the coil or adjacent to the magnetic stop. Initially the plunger slides freely on the stem until it impacts the nut or shoulder at the end of the stem. The plungers momentum is then transferred to the stem and the stem is lifted off the pilot orifice in the seat screw, thus initiating flow through the pilot orifice in the seat screw. Fluid from the cavity above the piston flows through the pilot orifice in the seat screw and through the hole in the center of the piston to the downstream side of the valve. Pressure above the piston decreases since the pilot orifice is larger in diameter that the bleed orifice. Inlet pressure acting around the annular area outside of the main valve seat at the bottom of the piston then pushes the piston up, thus initiating flow through the valve.

Note that flow through the valve creating a pressure drop across the valve is required to hold the piston open. If flow is diminished the piston will move toward the closed position. To maintain the valve fully open a pressure drop of 3 to 5 psid across the valve is required.

5 Semi-direct Lift Normally Closed

Opening

When voltage is applied across the coil leads a current is produced in the coil windings which generates a magnetic field. The magnetic field attracts the plunger and causes it to move toward the center of the coil or magnetic stop. Initially the plunger slides freely on the stem until it impacts the nut or shoulder at the end of the stem. The plungers momentum is then transferred to the stem and the stem is lifted off the seat screw orifice (This much of the action is identical to the pilot operated valves). The stem – plunger assembly continues its motion until the shoulder on the stem contacts the piston rod link. The piston rod link is attached to the piston, so as the stem – plunger assembly completes its motion, the piston is pulled from the main valve seat effecting the full opening of the valve. In actuality, the fluid force affect the motion of the piston at pressures above approximately 5 psig and the magnetic force on the plunger (through the mechanical connection of the stem to the plunger via the piston rod link) is sufficient to lift the piston at lower pressures.

Closing

When voltage is removed from the coil leads, the magnetic field collapses. Gravity pulls both the plunger and stem down until the stem point seals off the orifice in the piston rod link. Fluid flow from the valve's inlet side through the bleed orifice in the piston charges the cavity above the piston to a pressure equal to the valve's inlet pressure. Since downstream pressure is acting against the center portion of the bottom of the piston, the pressure forces acting on the piston are unbalanced and act to push the piston to the closed position (gravity and, in some valves, a piston spring assists in the closing).

Note: In this type of valve the piston opens and closes fully independent of line pressure or system flow.

It is characteristic for semi-direct lift valves to briefly open if subjected to a shock or sudden surge of inlet pressure. This is caused by the elevated inlet pressure pushing the piston open before the pressure above the piston can build via flow through the small bleed orifice. Once the pressure above the piston equalizes with the inlet pressure the valve closes.

6 Semi-direct Lift Normally Open

Opening

When voltage is removed from the coil leads, the magnetic field collapses. The force exerted by the compressed plunger return spring then pushes the plunger up from its position at the center of the coil or adjacent to the magnetic stop. Initially the plunger slides freely on the stem until it impacts the nut or shoulder at the end of the stem. The plungers momentum is then transferred to the stem and the stem is lifted off the seat screw orifice (This much of the action is identical to the pilot operated valves). The stem – plunger assembly continues its motion until the shoulder on the stem contacts the piston rod link. The piston rod link is attached to the piston, so as the stem – plunger assembly completes its motion, the piston is pulled from the main valve seat effecting the full opening of the valve. In actuality, the fluid force effect the motion of the piston at pressures above approximately 5 psig and the magnetic force on the plunger (through the mechanical connection of the stem to the plunger via the piston rod link) is sufficient to lift the piston at lower pressures.

Closing

When voltage is applied across the coil leads a current is produced in the coil windings which generates a magnetic field. The magnetic field attracts the plunger and causes it to move toward the center of the coil or magnetic stop, compressing the plunger return spring as it travels. The plunger assembly continues to move until the stem shuts off the pilot orifice in the seat screw. Fluid flow from the valve's inlet side through the bleed orifice in the piston charges the cavity above the piston to a pressure equal to the valve's inlet pressure. Since downstream pressure is acting against the center portion of the bottom of the piston, the pressure forces acting on the piston are unbalanced and act to push the piston to the closed position (gravity assists in the closing).

Note: In this type of valve the piston opens and closes fully independent of line pressure or system flow.

7 13000 3-way Direct Lift

Normally Closed Valves

The inlet is the FNPT port on the bottom of the valve body. The normally closed port is on the side of the valve body. When the coil is energized flow is from the port on the bottom of the valve body to the port on the side of the valve body and the port at the top of the valve is closed off. When the coil is not energized there is no flow and the port on top of the valve is open to the port on the side of the valve body.

Normally Open Valves

The inlet is the ¼˝ MNPT port at the top of the valve (in the center of the nameplate). The normally open port is in the side of the valve body. When the coil is not energized, there is flow from the port on top of the valve to the port on the side of the valve body. When the coil is energized, the inlet port on top of the valve is closed off and the port on the side of the valve body is open to the port on the bottom of the valve.

Directional Flow Valves

The inlet is the FNPT port on the side of the valve body. When the coil is not energized, the inlet port is open to the port on top of the valve and the port at the bottom of the valve body is shut off. When the coil is energized the port at the top of the valve is shut off and the inlet port is open to the port at the bottom of the valve body.

The opening and closing operation is the same for each of the above three types of valves.

Opening

When voltage is applied across the coil leads a current is produced in the coil windings which generates a magnetic field. The magnetic field attracts the plunger and causes it to move toward the magnetic stop. Initially the plunger slides freely on the stem until it impacts the nut or shoulder at the end of the stem. The plungers momentum is then transferred to the stem and the stem is lifted off the seat screw orifice. Plunger assembly motion continues until the top stem seals off the orifice at the top of the cylinder cap thus shutting it off.

Closing

When voltage is removed from the coil leads, the magnetic field collapses. Gravity and the plunger return spring pulls both the plunger and stem assembly down until the top stem opens the orifice at the top of the cylinder cap and the bottom stem seals off the orifice in the seat screw.

8 35000 Series Externally Piloted

These valves can be either normally open or normally closed depending on how the pilot is plumbed. There are also internal differences between normally open and normally closed valves.

The normally closed valve has the pilot inlet attached to the ¼˝ MNPT port at the top of the valve (in the center of the nameplate). The pilot exhaust port is the ¼˝ FNPT port in the side of the bonnet (the cylinder between the

valve body and coil housing).

The normally open valve has the pilot inlet plumbed to the ¼˝ FNPT port in the side of the bonnet (the cylinder between the valve body and coil housing). The pilot exhaust is the ¼˝ MNPT port at the top of the valve (in the center of the nameplate).

Opening
When voltage is applied across the coil leads a current is produced in the coil windings which generates a magnetic field. The magnetic field attracts the plunger and causes it to move toward the magnetic stop. Initially the plunger slides freely on the stem until it impacts the nut or shoulder at the end of the stem. The plungers momentum is then transferred to the stem and the stem is lifted off the seat screw orifice. Plunger assembly motion continues until the top stem seals off the orifice at the top of the cylinder cap thus shutting off pilot flow. Pressure above the piston is bled off through drilled passageway in the bonnet and the seat screw to the pilot exhaust port. Inlet pressure acting around the annular area outside of the main valve seat at the bottom of the piston then pushes the piston up, thus initiating flow through the valve.

Closing
When voltage is removed from the coil leads, the magnetic field collapses. Gravity and the plunger return spring pulls both the plunger and stem assembly down until the top stem opens the orifice at the top of the cylinder cap and the bottom stem seals off the orifice in the stationary seat screw. Fluid flow from the pilot supply then flows directly into the cavity above the piston and charges this volume to a pressure equal to the valves inlet pressure
(assuming that the inlet pressure is being used as the pilot supply). Since the pilot pressure acts over the entire area of the piston and the downstream pressure is acting only against the center portion of the bottom of the piston, the pressure forces acting on the piston are unbalanced and act to push the piston to the closed position (gravity assists in the closing).

Note that the time to charge the volume above the piston and thus affect valve closure is considerably less than with flow through a bleed orifice in the piston as in other pilot operated valves.

With upstream line pressure used as source for pilot pressure the fastest closing times will be achieved when the maximum pressure drop is present across the valve. See page 75 for pilot plumbing and pressure requirements.

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