SOLENOID AND PRESSURE OPERATED VALVE TECHNOLOGY

Function, terminology and construction types

SOLENOID VALVES

A solenoid valve is a combination of two functional units:

1. A solenoid operator essentially consisting of a coil, core, core tube, shading coil and spring(s).
2. A valve body containing orifices in which a disc, diaphragm or piston etc. is positioned according to the type of technology used.

The valve is opened or closed by movement of the magnetic core which is drawn into a solenoid when the coil is energised.

SOLENOID VALVE TERMINOLOGY (Fig. 1)

Bleed orifice or bleedhole
Small orifice that allows the inlet flow to pressurise the top side of the diaphragm or piston providing the seating force for tight closure.

Bonnet
Screwed plug or bolted cover on the valve body on which the core tube with inner parts is fitted.

Coil
Electrical part of the valve consisting of a spool wound with insulated copper wire creating a magnetic flux when energised. The coil is held in place on the tube with a retaining clip.

Core
Soft-magnetic plugnut moved by magnetic forces (flux generated by the coil).

Core spring
Spring which keeps the core in fixed position when the coil is de-energised.

Core tube
Stainless steel tube closed at one end, installed to improve the magnetic flux of the solenoid coil upon energisation.

Disc, valve disc
Sealing material on the core or disc-holder which shuts off the seat orifice.

Disc holder
Valve part, actuated by the core, in which the sealing disc is inserted.

Disc spring
Spring in the disc holder which provides a positive closing action to the disc.

Pilot orifice
Orifice located in the centre of a diaphragm or a piston of pilot operated valves, opened or closed by the core.

Plugnut
Stationary core pressed in the closed end of the core tube, installed to improve the magnetic flux of the solenoid coil upon energisation.

Seals
Elements ensuring the tightness of the valve at the valve seat and against outside atmosphere.

Seating or valve seat
Specially formed border of the main valve.

Shading coil
Ring inserted in the core side surface of the plugnut to limit vibration of the core in AC constructions. Shading coils are normally made of copper, but silver is also used. No shading coil is required in DC-constructions.

Solbase assembly
Assembly of core tube, plugnut and bonnet.

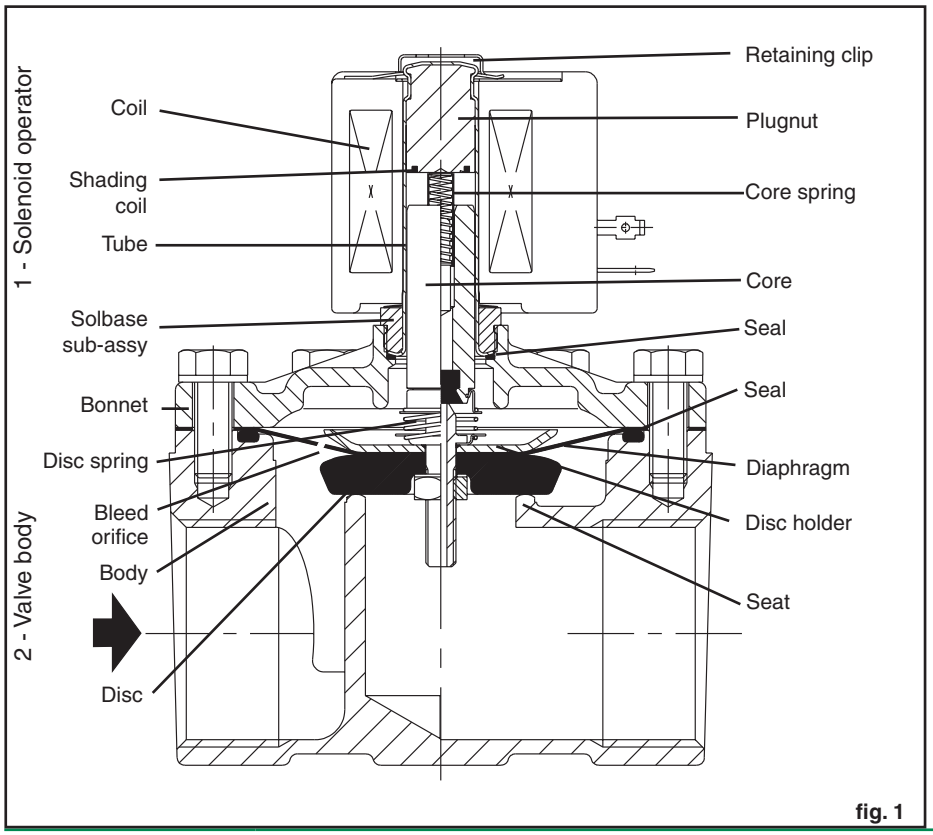

fig. 1

TYPES OF SOLENOID VALVES

Direct operated 2/2 solenoid valves
The core is mechanically connected to the disc and opens or closes the orifice, depending on whether the solenoid coil is energised or de-energised.

Core-disc valve construction (**Fig. 2**).
Operation is not dependent upon line pressure or rate of flow (zero or maximum rated pressure). These valves are generally available in 2/2 NC/NO and 3/2 NC/NO/U versions.
NC – Normally closed:

NO = Normally open

U = Universal

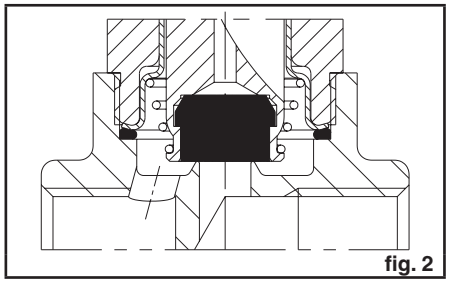
fig. 2

Pilot operated 2/2-3/2 solenoid valves
These valves use the inlet pressure (or full line pressure) for operation. They have two orifices (pilot and bleed).

When the solenoid is energised, the pilot orifice is opened to release pressure from the top of the diaphragm (or piston) to the outlet side of the valve. The resulting difference in pressure causes the main orifice to open.

When the solenoid is de-energised, the pilot orifice is closed and the full line pressure is applied to the top of the diaphragm (or piston) through the bleed orifice, providing seating force for tight closure. These valves are generally available in 2/2 NC/NO and 3/2 NC/NO versions.

Two construction types are available:

- **Floating** diaphragm (**Fig. 3a**) or **floating** piston (**Fig. 3b**):
  This type of construction requires a minimum pressure drop for the valve to open and remain in the open position.

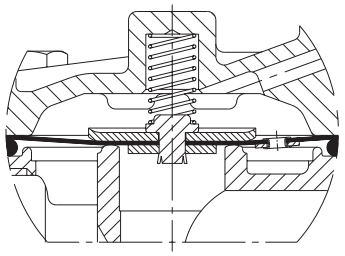

fig. 3a

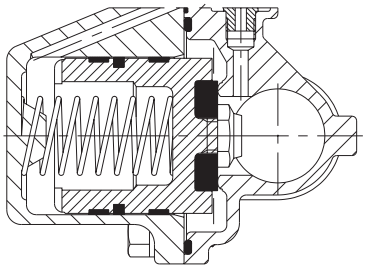

fig. 3b

- **Hung-type** diaphragm (**Fig. 4**) :
  This type of valve construction operates from zero to the maximum pressure rating. When energised, the core, which is mechanically connected to the diaphragm, opens (or closes) the valve.

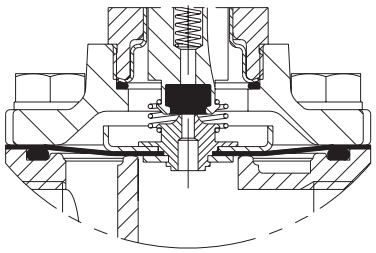

fig. 4

Direct or pilot operated 4/2, 5/2 and 5/3 solenoid valves

These solenoid valves are generally used to operate actuators (cylinders, pressure operated valves). They have 4 or 5 pipe connections, 2 positions (open/closed) or 3 positions (5/3, W1 center closed, 5/3, W3 center open to exhaust).

Available types of construction:

- Monostable function, single solenoid: The solenoid valve returns to its rest position on loss of electrical power (spring return). Slide disc valve construction, 4/2 (**Fig. 5a**). Poppet valve construction, 4/2 (**Fig. 5b**). Spool valve construction, 5/2 (**Fig. 5c**).
- Bistable function, dual solenoid: The actuated or rest position is held, even on loss of electrical power (memory function). Slide disc valve construction, 4/2 (**Fig. 5a**). Spool valve construction, 5/2 (**Fig. 5c**).

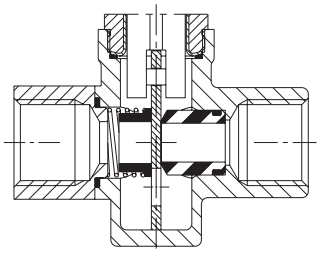

fig. 5a

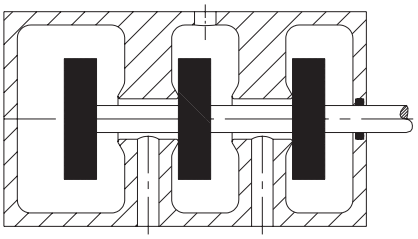

fig. 5b

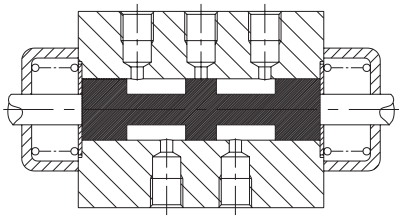

fig. 5c

- 5/3 function:
  In the rest position, the spool is centered in the middle position when the solenoid is de-energised. W1, centre closed to pressure, no pressure is applied to the orifices; W3, centre open to exhaust, outlets 2 and 4 are opened to exhaust (orifices 3 and 5).

Solenoid valves for steam service (See Section: Hot Water & Steam)

- Core-disc valve construction, stainless steel seat, long service life, for rapid-cycling steam applications up to 165°C / 170°C (**Fig. 6a**).
- Piston valve construction made of stainless steel or brass, long service life, for rapid-cycling steam applications up to 184°C (**Fig. 6b**).
- Hung-type diaphragm valve construction for low pressure and high flow (**Fig. 6c**).

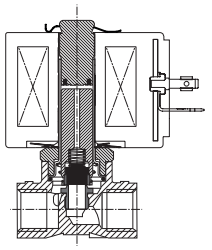

fig. 6a

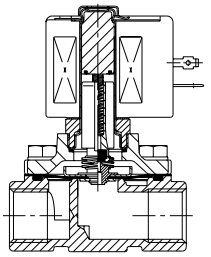

fig. 6b

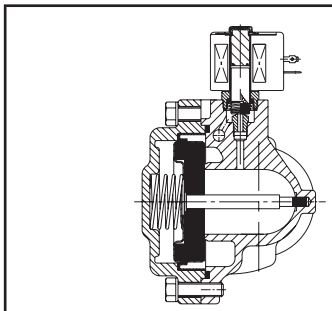

fig. 6c

PRESSURE OPERATED VALVES

Valves designed for the control of high pressure fluids at low pilot pressures.
A "differential" action is achieved by way of the surface of the piston or diaphragm (pilot pressure) which is larger than the surface of the disc (fluid pressure).

A pressure-operated valve has two basic functional units:

1. An operator with a piston or diaphragm.
2. A valve body containing an orifice in which a disc is positioned.

The open or closed position of the valve is directly dependent upon the position of the stem. The stem is moved by the piston or diaphragm, depending on whether the operator is pressurised or exhausted.

A 3/2 solenoid pilot valve NC is connected to the piston or diaphragm and operates the opening and closing of the pressure operated valve disc.

PRESSURE OPERATED VALVE TERMINOLOGY (Fig. 2a/2b)

Bonnet, cover
Cover which is screwed on to protect the operator (valve series 290/390/298/398). It generally contains the optical position indicator and keeps the internal parts in place.

Diaphragm
Moving element of a type AD valve which provides for the vertical movement of the operator stem via the pressure supplied by the pilot valve.

Disc, valve disc
Sealing material on the core or disc-holder which shuts off the seat orifice.

Disc seal
Sealing element of the seat/disc of the valve.

Piston
Moving element of a type 290/390/298/398 valve which provides for the vertical movement of the operator stem via the pressure supplied by the pilot valve.

Stem
Moving element to open and close the valve disc.

Stuffing box
Enclosure containing reinforced PTFE chevrons to form a seal around the operator stem.

Valve seal
Ensures internal/external leak-tightness.

Wiper seal
Designed to exclude foreign debris from contaminating the stuffing box.

Yoke
Part of the operator which serves as a support for the piston or diaphragm (valve type AD).

TYPES OF PRESSURE OPERATED VALVES

2/2-3/2 pressure operated valves
Piston valve construction (operator, series 290/390/298/398, **Fig. 7a**) or diaphragm valve construction (type AD, **Fig. 7b**). These valves are available in 2/2 NC/NO and 3/2 NC/NO/U versions.

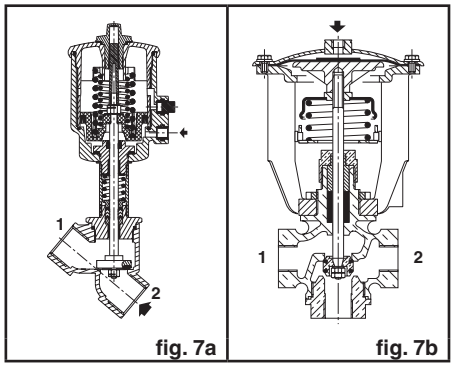

fig. 7a fig. 7b

2/2-3/2 pressure operated valves for steam service (Section H, 901)
Valve constructions for rapid-cycling steam applications up to 184°C (**Fig. 7a/7b/8a**), 250°C (**Fig. 8b**).

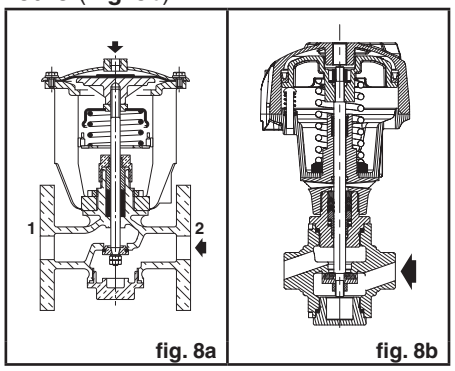

fig. 8a fig. 8b

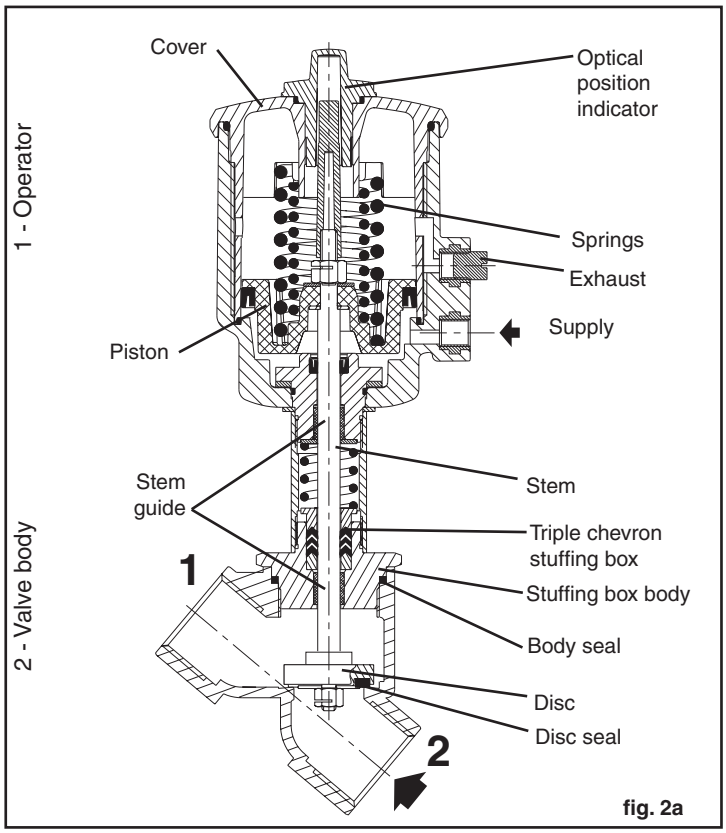

fig. 2a

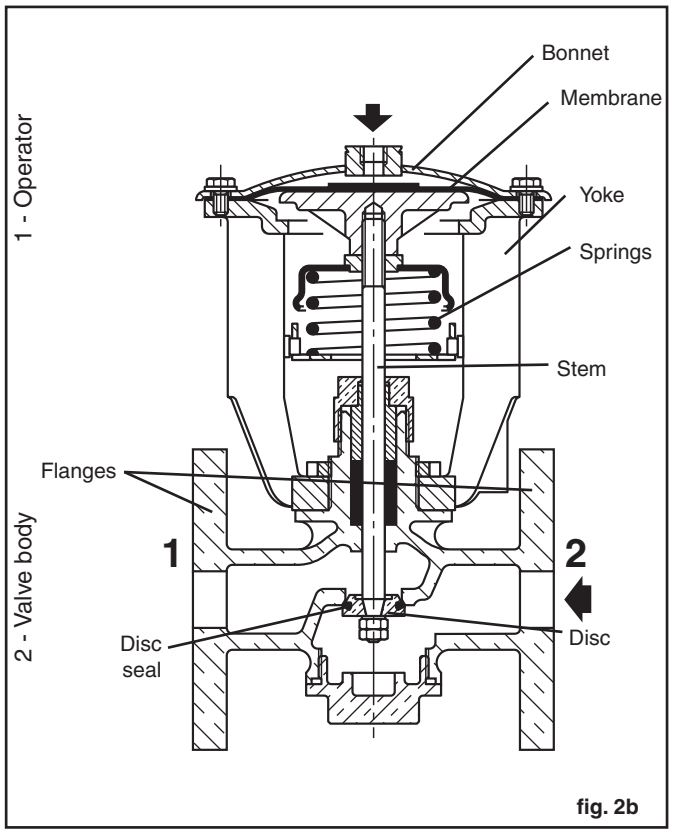

fig. 2b