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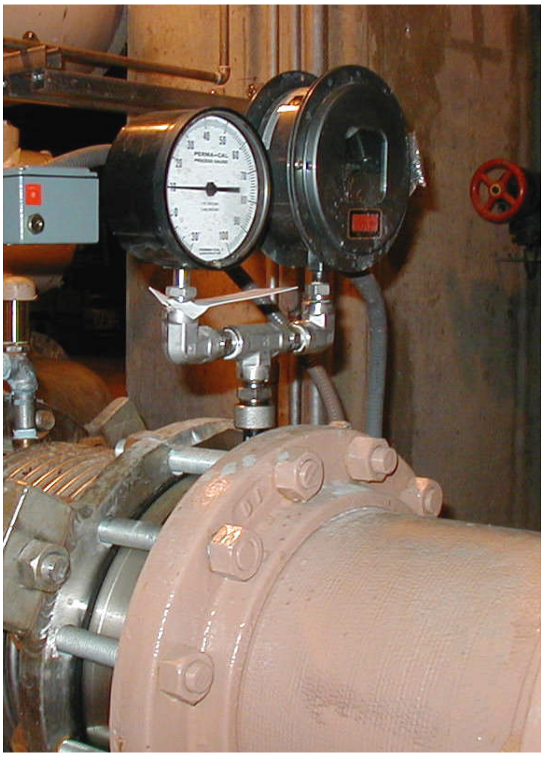
Mechanical vs. Solid State Pressure Switches



Onyx Isolator Rings have traditionally been supplied with mechanical gauges and mechanical switches to monitor process pressure and pump performance. These do a fine job, but many users are changing over to solid state switches. This paper will discuss some of the pros and cons of each.

Principle of operation:

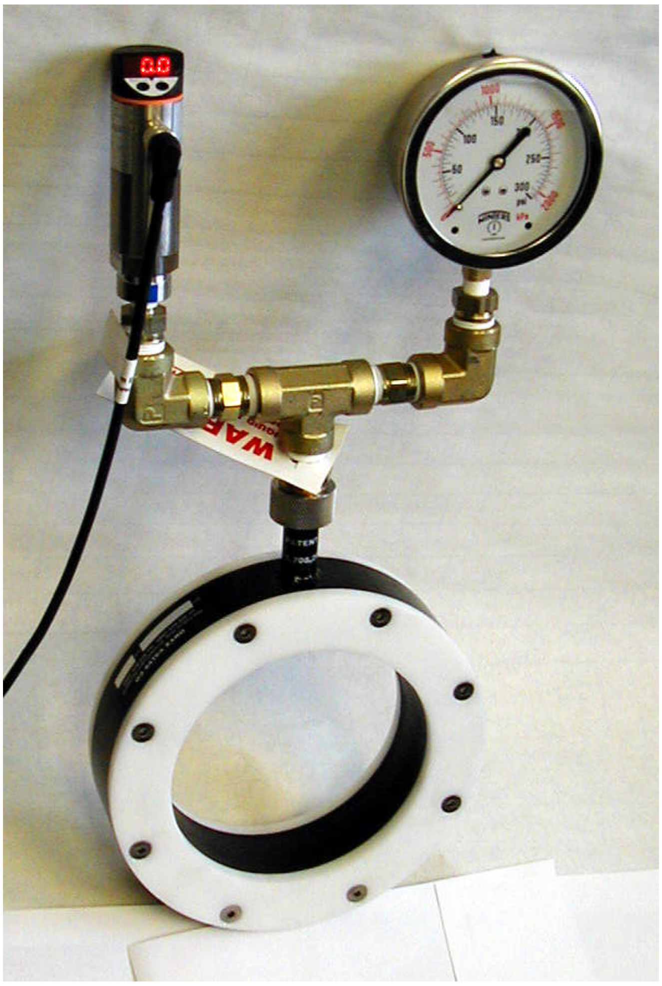
Mechanical pressure switches operate with either a piston and spring, or a bourdon tube and mercury vial. In the piston and spring arrangement, when pressure builds up to the point where it crosses the set point, the piston pushes on a snap acting switch to transfer mechanical contacts.

In a mechanical bourdon tube switch, a bourdon tube tilts a rocking beam fitted with a glass vial of mercury. When pressure builds up to the set point, the beam rocks over and mercury in the glass tube rolls from one end to the other, where it submerges electrical contacts completing the circuit.

In contrast, a solid state switch uses a metal diaphragm about the size of a dime with a micro-miniature strain gauge etched onto its dry surface. Increasing pressure changes the impedance of the strain gauge. A digital comparator monitors the output from the strain gauge and compares it to the user specified set point. When the set point is reached, the electronic circuit turns on a solid state relay, completing the circuit.

Accuracy: A typical mechanical Bourdon tube pressure switch has a published repeatability of ±1%. In comparison, a solid-state switch like the A-B 836 has a published repeatability of ±0.2%, a five-fold improvement in performance.

Dead-band adjustment: A mechanical Bourdon tube switch with a range of 2 to 60 psi has a minimum dead-band of 3 psi. The solid-state A-B switch with the same range has a minimum Dead-Band of 0.30 psi, a ten-fold improvement in performance.



The difference is even more striking in the low range. A Bourdon tube mechanical switch in a compound range has a minimum dead-band of 1 psi compared to the solid-state A-B switch in the same range which has a minimum dead-band of 0.1 psi. If you are trying to monitor suction pressure on a pump, this is the difference between best resolution with a mechanical switch of 2.3 feet of water column and the solid state switch with a resolution at 3 inches of water column.

There's a big difference in field adjustment setting as well. Mechanical switches typically require screw drivers or wrenches, and setting the switch - even with a so-called "dial" - is a trial and error method. In contrast, the solid state switch is a matter of pushing a few buttons and programming in the exact set point you want.

Attitude: Snap acting mechanical switches can be mounted in any position, but mechanical switches with mercury elements MUST be mounted vertical and upright or they will not function.

All solid state switches can be mounted in any position without affecting their operation.

Over Pressure: Mechanical switches with a bourdon tube can not be subject to pressure over the maximum range. In contrast a solid state switch can tolerate a substantial over pressure without adverse effects. The solid-state A-B switch in a 60 psi range has a 160 psi maximum working pressure; a 150 psi range solid state switch can go to 400 psi without ill effects.

Price: The cost of a mechanical switch by itself is generally lower than a solid state switch; however, the solid state switch has a digital read out for pressure, so the gauge is superfluous. A solid state switch is (almost) always less expensive than a mechanical switch + gauge assembly.

Power requirements: There are three advantages to the mechanical switch:

1. You don't need to know the operating voltage in advance. A mechanical switch can work on either AC or DC power at almost any voltage. In contrast solid state switches come in two distinct flavors: Low voltage (12-30 volt DC) and high voltage (90 to 250 volts AC) so you have to know what power level you are dealing with ***before*** placing an ordering the switch.

2. Mechanical switches can handle higher electrical loads. The Bourdon tube element example can handle 4 Amps at 120 volts AC, compared to the solid state switch which can handle 2.5 Amps at the same voltage. Solid state DC switches are generally rated at ¼ Amp at 24 VDC.

3. Mechanical Switches use 2-wires. Solid-state switches come in several varieties; most require a third wire for a common, although some of the higher end switches operate with only 2 wires like their mechanical counterparts.

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Onyx Valve Company manufacturers a complete line of pinch valves, valve actuators, controls, and pressure isolators.

Previously, Gardellin was Engineering Manager for Robbins & Myers Co. He was an engineer with Met-Pro Fybroc Co where he developed fiberglass horizontal and vertical pumps from 5 to 200 HP. He holds a BS degree in engineering from Drexel University. He is a registered professional engineer in Maryland and New Jersey. He holds several patents related to pressure measurement and control, and is the author of numerous technical articles related to valves and controls including the Encyclopedia of Chemical Processing and Design.