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INTELLIGENT PRESSURE REGULATOR

The invention relates to fluid pressure regulators and more particularly, to an improved fluid pressure regulator having intelligent electronics and software to enhance performance.

BACKGROUND OF THE INVENTION

5 In general, the four basic elements of a process control loop include a process variable to be controlled, a process sensor or measure of the process variable's condition, a controller, and a control element. The sensor provides an indication of the process variable's condition to the controller, which also contains an indication of the desired process variable condition, or the "set point." The controller compares the process variable's condition to the set point and calculates a
10 corrective signal, which it sends to the control element to exert an influence on the process to bring it to the set point condition. The control element is the last part of the loop, and the most common type of final control element is a valve, though it may also comprise a variable speed drive or a pump, for example.

A pressure regulator is a simple, self-contained control system that combines the process
15 sensor, the controller and the valve into a single unit. Pressure regulators are widely used for pressure control in fluid distribution applications and the process industries, for example, to maintain a desired, reduced outlet pressure while providing the required fluid flow to satisfy a variable downstream demand. Pressure regulators fall generally into two main categories: direct-operated regulators and pilot-operated regulators.

20 A typical prior art direct-operated regulator 11 is illustrated in Figure 1. Typical applications for direct-operated regulators include industrial, commercial, and gas service; instrument air or gas supply; fuel gas to burners; water pressure control; steam service; and tank blanketing. The direct-operated regulator 11 includes a regulator body 12 which has an inlet 13 and an outlet 14. A fluid flow passage area 15 having a restriction area 16 connects the inlet 13
25 and outlet 14. The restriction area 16 has a throttling element 17, such as a plug, membrane, vane, sleeve or similar restricting device which, when moved, limits the flow of the fluid (gas or liquid). An actuator including a sensing element having two sides responds to variations in the

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fluid pressure being controlled. Examples of sensing elements include membranes, diaphragms or pistons. The embodiment illustrated in Figure 1 uses a diaphragm 18 for the sensing element. Control pressure is applied to the first side, or control side 19 of the sensing element via a control line or a passage 20 internal to the regulator body 12. If a control line is used for this purpose, it may be integral to the regulator body 12 or located in the adjacent piping. The second side, or reference side 21 of the sensing element is typically referenced to atmosphere. An additional force such as a spring 22 may be applied to the actuator, which biases the throttling element into a predetermined position representing a set point.

The direct-operated regulator 11 illustrated in Figure 1 is considered a "pressure reducing" regulator because the sensing element (diaphragm 18) is connected by an internal passage 20 to pressure downstream of the regulator (on the fluid outlet-side) 14. An increase in downstream pressure is applied to control side 19 through the internal passage 20, applying pressure to the diaphragm 18, and forcing it up against the force of the spring 22. This, in turn, moves the throttling element up into the flow restriction area 16, reducing the fluid pressure to the regulator outlet 20.

Pressure reducing regulators regulate flow by sensing the pressure downstream of the regulator. A typical application of a pressure reducing regulators is on steam boilers, where pressure reducing regulators provide the initial pressure regulation. If the diaphragm 18 were connected to upstream pressure and the throttling element 17 were moved to the other side of the restrictor 16, the direct-operated regulator 11 would be considered a "back pressure" regulator. Back pressure regulators are applied, for example, in association with compressors to ensure that a vacuum condition does not reach the compressor.

A pilot-operated regulator is similar in construction to a direct-operated regulator. A typical prior art pressure reducing pilot operated regulator 23 is illustrated schematically in Figure 2A, and a prior art back pressure pilot operated regulator is illustrated in Figure 2B. The pilot operated regulator includes all the structural elements of the direct operated regulator with the addition of the pilot 24 (also called a relay, amplifier, or multiplier). The pilot is an auxiliary device which amplifies the loading pressure on the regulator actuator to regulate pressure. The