Robertshaw
INDUSTRIAL PRODUCTS DIVISION

Self-Actuated Temperature Regulator Operation

Robertshaw temperature regulators for heating, cooling, bypass, diverting and ventilation service for space, liquid, equipment and industrial process temperature control are of two general types: Vapor Pressure Type, described on this page; and Hot Chamber Type, described inside. Both types are self-powered with no requirement for compressed air, electricity, water or other auxiliary external power for their operation. They are simple in design, easy to install and sturdily constructed with high quality to provide years of maintenance- and trouble-free service.

VAPOR PRESSURE TYPE

DESCRIPTION

A vapor pressure type regulator is actuated by power developed from evaporation of a liquid contained in the sensing bulb. A spring mounted in the frame assembly provides opposing force and the means of adjusting the regulator setpoint.

The construction of a typical vapor pressure type regulator is illustrated by Figure 1. The principal parts are: (1) valve assembly; (2) frame assembly; (3) bellows chamber; (5) connecting capillary; (6) sensing bulb; (7) upper stem: (8) adjusting spring; (9) setpoint adjustment wheel; (10) valve stem; (11) valve plug; (12) port; and (13) vapor trap.

The thermal element consists of the cup and bellows assembly which forms the bellows chamber (3); capillary (5); sensing bulb (6); and the contained thermostatic charge liquid which develops the power for stem movement in response to temperature changes.

The setpoint adjustment range is normally selected so that the desired control or setpoint falls within the upper third of the setpoint adjustment range.

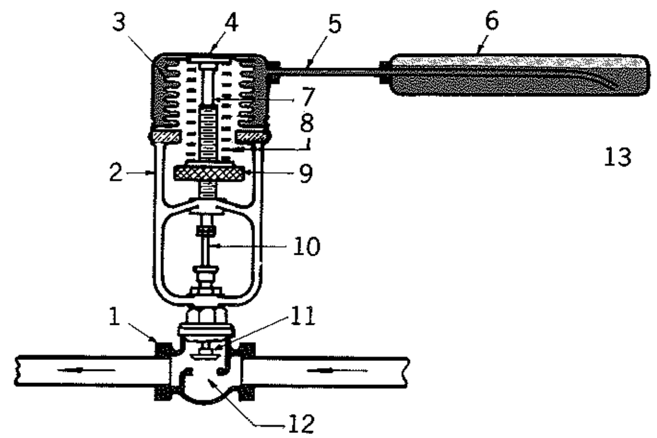

Figure 1

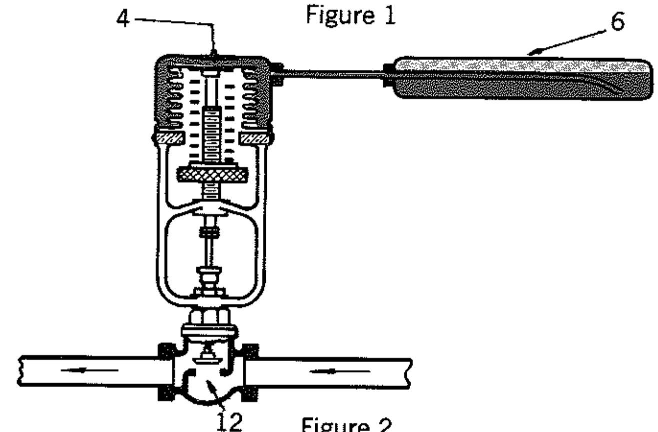

Figure 2

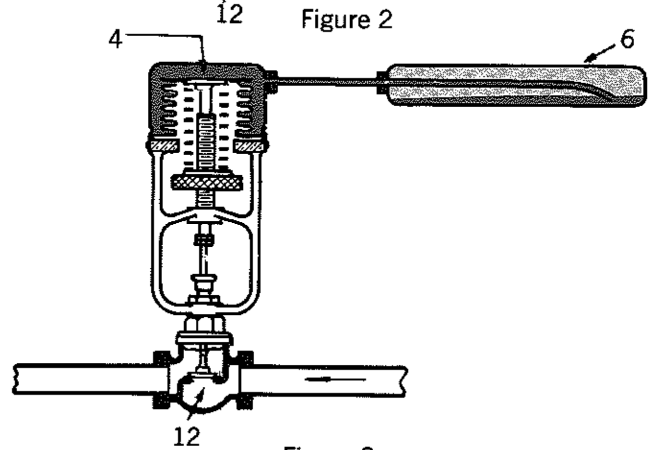

Figure 3

APPLICATION

One frequent and basic application for self-actuated temperature regulators is on steam heated water generators. With the regulator valve (1) properly installed in the steam line and sensing bulb (6) installed through the tank wall to measure the water temperature, the regulator operation is as follows:

The thermostatic charge liquid in the sensing bulb begins to vaporize as the temperature of the medium to be controlled (water in this example) approaches the desired control or setpoint at the sensing bulb. The pressure developed against the liquid surface by the increased vaporization forces some liquid out of the bulb through the capillary (5) to the bellows chamber (3), which in turn moves the upper stem (7) and valve stem (10) downward to move the direct-acting valve toward the closed position and, thereby, regulates the amount of steam allowed to flow into the generator heating element. As the temperature at the sensing bulb begins to decrease when there is a water drawdown, the vapor pressure in the sensing bulb reduces and the spring (8) in the frame assembly pushes the stems and bellows chamber upwards. This action forces the thermostatic charge liquid back into the sensing bulb and, also, opens the direct-acting valve to allow more steam to flow into the generator heating element to bring the temperature of the makeup water up to the setpoint. In actual operation, the properly sized valve modulates or throttles around the mid-stroke position as the desired control or setpoint temperature is maintained.

Figures 1, 2 and 3 illustrate the above comments.

Figure 1 shows the valve positioned (12) for full steam flow with a cold sensing bulb which would be typical at startup.

Figure 2 shows the valve at the mid-stroke position with an increased vapor area in the sensing bulb (6) and an increased liquid volume (4) in the bellows chamber with downward stem movement. This illustration is typical during the normal water drawdown situation with the setpoint maintained.

Figure 3 illustrates the closed valve position (12) with the temperature at the sensing bulb slightly above the control or setpoint with a notable increase in vapor volume in the the sensing bulb (6) and liquid in the bellows chamber and total downward valve stem movement. This illustration is typical of periods of downtime when there are no water demands and no water temperature lost.

The control or setpoint within the adjustable setpoint range is set by rotating the knurled adjustment wheel (9) in the frame assembly. Compressing the spring through wheel rotation increases the spring thrust and, therefore, the amount of vapor pressure action required to overcome the spring. The result is a higher control or setpoint.

Sensing bulbs are available in numerous types and sizes and of various materials to meet most requirements. Example: When controlling temperature of air or gases, the regulator may be equipped with an externally finned type bulb. Separable wells are available as are options on capillary materials and lengths.

When used for cooling service such as cold water or ethylene-glycol mixture, a reverse-acting valve is used. When so equipped, the valve opens when temperature at the bulb increases — the thermostatic system of the regulator functions same as described above. Three-way valves are also available for cooling service where diverting, bypass or mixing are required. Regulator valves are available in numerous sizes and types.

HOT CHAMBER TYPE

DESCRIPTION

The Hot Chamber Type Temperature Regulator is designed for heating service only with steam as the heating medium. Those units with soft seats are rated for a 15 psi maximum steam supply pressure, while the metal-to-metal seated units are rated for 75 psi maximum inlet pressure. They are widely used for space heating unit heaters, radiators, and ventilation pre-heater and anti-freeze duct controls in buildings and aboard ships as well as for small storage tanks, steam tables, fruit curing bins, ovens, etc. They are self-actuated, compact, packless, sensitive, sturdy and economical.

The construction and operation of the Hot Chamber Type Regulator (Figure 4) differs significantly from the Vapor-Pressure Type. Externally, the design consists of valve assembly, capillary and sensing bulb with either direct (5) or remote mounted setpoint adjustment. A Sylphon® monel seamless bellows (1) located in the valve, serves as the "hot chamber" which carries the valve plug (7) and eliminates the need for valve stem packing. The term "hot chamber" stems from the fact that the bellows is constantly surrounded by steam when the unit is in service.

OPERATION

The actuating assembly consists of the sensing bulb (4) with integral, scaled setpoint adjustment (5), capillary (3), valve cap (9), and the "hot chamber" (1).

Figure 4 illustrates the cold bulb or start-up position. The sensing bulb is completely filled and the capillary is partially filled with a thermostatic charge liquid. The internal spring (6) positions the "hot chamber" so that the valve port (8) is full open. At start-up, full steam flow is accomplished.

Figure 5 illustrates the control setpoint position. A temperature rise at the sensing bulb causes the thermostatic charging liquid to expand through the capillary to the "hot chamber" entrance (2). As a drop of liquid enters the "hot chamber," the drop immediately vaporizes due to the heat of the steam which surrounds the bellows. As more drops of liquid are vaporized in the "hot chamber" in response to the continued temperature increase at the bulb, the developing vapor pressure overcomes the opposing spring force (6) to extend the "hot chamber" bellows (1) and move the plug (7) toward the port (8) which restricts the steam flow. A properly sized unit would approach and modulate around the valve mid-stroke position when the control point for the space, liquid or process is satisfied.

Figure 6 illustrates a no-demand or overheat position. The bulb temperature has caused sufficient liquid to move into the "hot chamber" so that the vapor pressure developed has fully extended the bellows and the plug has closed the port to prevent any additional flow. The vaporization volume within the bellows has increased noticeably.

As the temperature drops at the sensing bulb (4), the thermostatic charging liquid in the bulb contracts and consequently draws liquid from the capillary and vapor from the "hot chamber" which reverts to liquid in the capillary. The reduced vapor pressure in the "hot chamber" allows the spring force to move the "hot chamber" upwards. The steam flow is increased as the port opening increases.

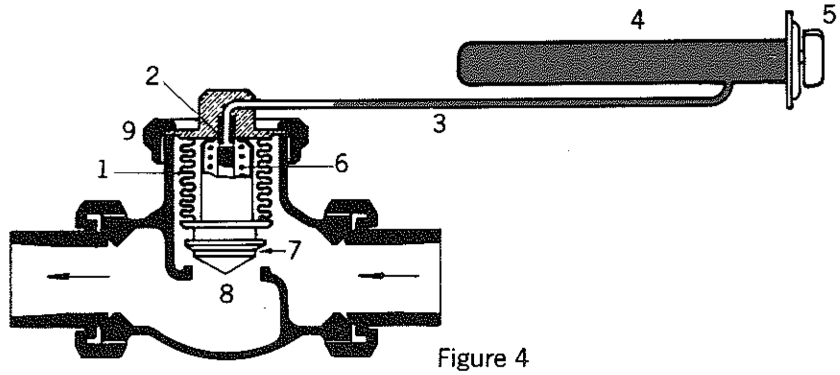

Figure 4

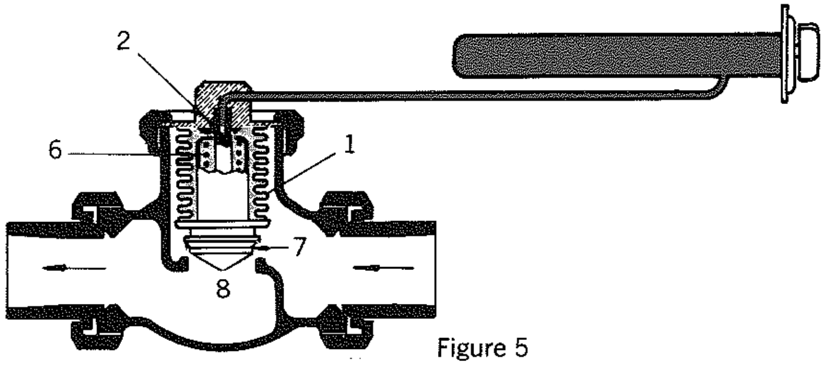

Figure 5

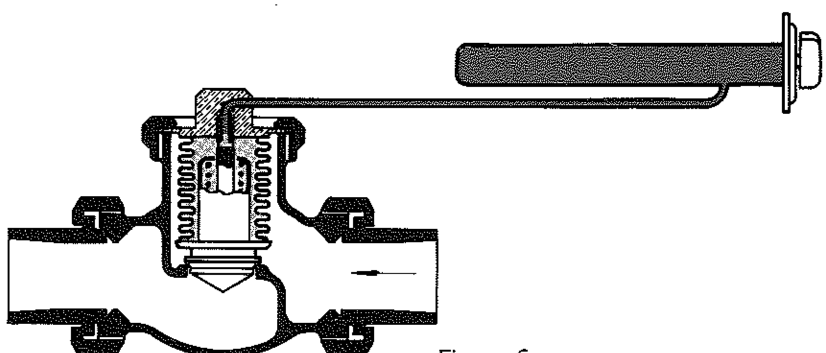
Figure 6