TYPES OF AUTOMATIC CONTROL

Operating Medium or Source of Power Supply

Automatic control systems may be classified in three broad groups based upon their primary operating media or sources of power, as follows:

1. *Electric Control Systems.* In such control systems the primary medium utilized to provide for the operation is electricity, and the basic function of these controls consists of switching or otherwise adjusting electric circuits to govern electric motors, relays or solenoids. The individual units of this type of system are interconnected by line voltage or low voltage wiring, and this wiring serves to complete the circuits carrying the commands of the controllers to the controlled valves or damper motors.

2. *Pneumatic Control Systems.* In these systems the source of power for operation is compressed air, furnished by one or more centrally located

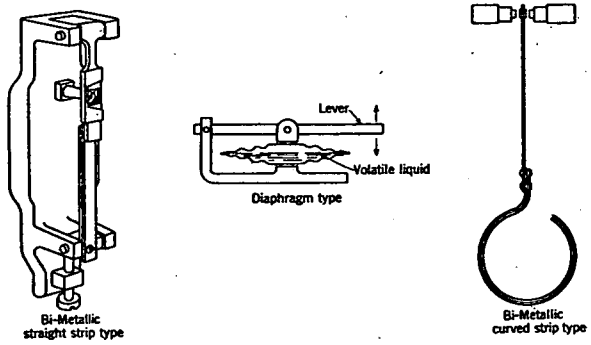

FIG. 1. TYPICAL THERMOSTATIC ELEMENTS

compressors, and distributed in special piping to the controlling and controlled devices. The pressure is varied by the controlling instruments and this variation operates the controlled devices, which may be valves, damper motors, relays or electric switches.

3. *Self-Contained Control Systems.* In self-contained control systems, the primary source of operation is the vapor pressure of a volatile liquid in the closed thermal system of the controller, which is increased or decreased in direct proportion to variation of the temperature in the controlled medium. These pressure changes are transmitted directly to the control valve or damper motor. Applications consist of valves or dampers to regulate the flow of heating or cooling media to coils, radiators, or liquid tanks, as determined by the controller element.

Typical thermostatic elements are shown in Fig. 1.

Motion of Controlled Equipment

Automatic control equipment can also be classified into two general types with respect to the characteristics of the motion imparted by the controls to the controlled equipment, such as two position or positive-acting control and modulating or graduated-action control.

In any control system it is necessary to choose the type of equipment whose characteristics permit the type of control operation desired and in many cases both types of control are used in the same system to best meet various requirements.

1. *Two Position or Positive-acting Control.* This type of control operates positively between two positions such as *on and off* or *open and closed* with no intermediate positions or degrees of motion between the two extremes of operation. A simple thermostat which starts and stops an oil burner or a unit heater motor is an example of this type. As applied to a valve or a damper, the action of the controlling device would serve to fully open or fully close the valve or damper.

In some applications of this type of control, artificial heat is applied to the sensitive element of the room thermostat at the same time that heat is being added to the space under the control of the thermostat in order to produce more frequent operation. This usually results in more accurate control of the heat source.

2. *Modulating or Intermediate Control.* This type of control causes motion in the controlled device in proportion to motion caused in the controller by fractional degree variations in the medium to which the controller is responsive. After a fractional change has been measured at the controller and has effected a new position of the valve or damper in proportion to the amount of such change, the system stands by awaiting further change at the controller before any additional motion occurs. The extent of the motion is limited only by the limits of the controller and by the intensity of the change of conditions as measured. With this type of control, the damper or control valve may be operated in intermediate positions between its extreme limits in order to properly modulate or proportion the flow of air, steam or water, reacting with changes of conditions at the controller. Various modifications of this type of control are available, designed to meet special requirements and conditions, all based on operation of the controlled equipment in intermediate positions.

These controlling devices may be made to operate relatively faster or slower for any change in condition of the fluid being controlled. For example, a thermostat modulating a damper may move it from one extreme to the other in one degree temperature change, or many degrees change may be required to produce this same action. This characteristic is sometimes called the *sensitivity* of an instrument. The sensitivity may be fixed, or adjustable.

This type of control motion cannot be used on valves of one-pipe steam systems as the partial opening of the valves will not permit the condensate to escape against the flow of incoming steam. Where this type of control is used to control the flow of steam to a heater coil of a fan system which is in the direct path of untempered outdoor air at temperatures below freezing, care should be taken that the control point and operating characteristics of the regulator are such that the valve is open far enough, at air temperatures below freezing, to prevent the freezing of condensate in any part of the coil.

Control for Individual Rooms and Small Buildings

Control systems vary considerably with the type, size and occupancy of the building, and with the heating or cooling system, humidity supplying