tween maximum and minimum load. The rate of reset is manually adjustable and must be set to meet the load requirements of the individual system.

Controllers may also be designated by types as: a *non-indicating controller*, when it does not indicate the controlled condition and performs the control function only; an *indicating controller*, when fitted with a pointer, thermometer, or gage which indicates the controlled condition; a *recording controller*, when it is combined with a clock mechanism and chart which records the controlled condition.

ACTUATING DEVICES

The starting point of any control system is the thermostat, hygrostat, pressure regulator, or other mechanism which is sensitive to a change and responds in the desired manner.

Thermostats are usually of the room, duct, or immersion types. Various types of thermostats found in common use are defined in the following paragraphs.

1. A *thermostat* is an instrument which is responsive to changes in temperature, and initiates a force that repositions valves, dampers, etc., to maintain selected temperatures.

2. A *room thermostat* is usually mounted on the wall of the space to be controlled with the measuring element arranged so that it is affected by the room temperature.

3. A *duct thermostat* is provided with fittings suitable for installation in duct work. The *insertion* type is equipped with a rigid bulb and is arranged so that the temperature responsive element or bulb extends through the wall of the duct. The *remote bulb* type is arranged so that the bulb and instrument head are connected by means of a flexible tube of the desired length. The bulb is inserted in the duct, and the head is located where it is accessible for adjustment and inspection.

4. An *immersion thermostat* is provided with fittings suitable for installation in a pipe line or tank where a fluid tight connection is required. Both insertion and remote bulb types are available. A union connection and separable socket, when used, permit removal of the bulb without draining the line or tank. The sockets may be of copper, stainless steel, or other materials.

5. A *day-night* or *two-temperature thermostat* controls a heating or cooling source to maintain either of two selected temperatures. They may be indexed (set at desired control temperature) individually or in groups from a remote point by means of a manual or time switch.

6. A *summer-winter* or *heating-cooling thermostat* is similar to the day-night type, except that both the temperature setting and action are changed by the indexing means. Such a thermostat could open a volume damper on a rise in temperature in summer, and close the same damper on a rise in temperature in winter.

7. A *submaster thermostat* has its temperature setting raised or lowered a predetermined amount for a given change in some other variable. For example, the water temperature on a heating system may be raised as the outdoor temperature drops. A *master instrument* is used to reset a submaster thermostat and may be a switch, pressure controller, thermostat, or similar device. In the foregoing example the master thermostat would be located where it would respond to outdoor temperature, and the submaster thermostat would be located in the pipe line of the heating system.

A *hygrostat* is a controller which is sensitive to changes in relative humidity, and is available in room and duct types. Where the controlled condition is below 20 percent or above 80 percent, or the temperature is above 100 F, selection of a suitable type and kind of hygroscopic element is essential.

A *pressure regulator* is a device which is sensitive to changes in pressure. It may be of the type which controls a *single* pressure or of the *differential* type which maintains a predetermined difference between two pressures. For pressures in duct work, *static pressure regulators* are available in the *differential* type. They are sensitive to changes of 1/100 in. of water.

ACTUATED CONTROLS

Thermostats, hygrostats, pressure regulators and other actuating devices obtain control of heating and cooling mediums, fuels, liquids, etc., by actuating various control devices such as control valves, dampers, damper motors, relays, or controllers defined in the following paragraphs.

A *control valve* is designed to control the flow of fluids, and may be considered as a variable orifice which is repositioned by a motor operator, as directed by a thermostat or other controlling device.

1. A *normally open* or *direct acting valve* will assume an open position when all operating power is removed.

2. A *normally closed* or *reverse acting valve* will assume a closed position when all operating power is removed.

3. *Single seated valves* are designed for *tight* shut-off using appropriate disc materials for various pressure ranges.

4. *Pilot piston valves* serve a similar function on high pressure installations.

5. *Double seated* or *balanced valves* are designed for applications where tight shut-off is not required. They are not affected by varying inlet pressures or pressure differentials, and thus are widely used where these conditions exist.

6. A *three-way valve* is fitted with a double faced disc, operating between two ports, and functioning to close one port as the other is opened. Depending upon how it is installed, it may be used as:

   a. A *three-way mixing valve* to mix as required two fluids entering the two inlet ports and leaving through the common outlet port.

   b. A *three-way diverting valve* to divert the flow from the inlet port to either of the outlet ports.

Valve discs, poppets, and seats are available in various shapes to meet any desired flow characteristics with various materials as required by service conditions.

A *damper* is designed to control the flow of air or gases, and is similar to a valve in this respect. *Single blade dampers* are generally restricted in size because of the difficulty of securing proper operation with high velocity air. *Multi-blade* or *louver dampers* can be furnished so that adjacent blades move in the same direction or in opposite directions. The *opposed blade type* gives better directional and flow characteristics than the parallel blade type.

For long life and trouble free operation, dampers should be constructed with heavy metal frames, blades of iron adequately braced, and ample bearing surfaces of non-corrosive materials. When fairly tight closing is desired, felt may be glued and riveted on the edges and ends of the blades. Other materials for blades and frames are also used for special services.

A *damper motor* is repositioned by a controlling instrument, and is connected to the damper blades as required to give the desired movement. It can be mounted on the damper frames or mounted outside the duct and connected to an extended shaft on one or more damper blades. Suitable brackets are available for floor, wall, or duct mounting of the motor.

A *relay* is a device which uses an auxiliary source of energy to amplify or convert the force of a controller into available energy at a valve or damper motor. Various types of relays are designated as follows:

1. An *electro-pneumatic relay*, when electrically energized, starts or stops the flow of air as required.

2. A *pneumatic-electric relay*, when affected by different air pressures, starts or stops the flow of electrical energy as required.

3. A *switching relay* or *pilot valve* may be used to switch the operation of a con-