

etc., by actuating various control devices such as control valves, dampers, damper motors, relays, 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 mixing valve* is fitted with a double faced disc, operating between two ports, and functioning to close one port as the other is opened. It is used to mix two fluids as required.
7. A *three-way diverting valve* is fitted with two discs which act to close one outlet port as another outlet port opens, and thus diverts 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 lower 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 controlled device from one controller to another; or to reverse the action of a controlled device in response to an impulse from a controller.
4. An *averaging relay* is affected by the forces from two or more controllers, and the resulting flow of energy is in accordance with the average of these forces.
5. A *positioning relay* has a direct connection to a valve or damper motor lever, and is affected by both valve or damper position and controller demand. It is repositioned

by a thermostat or other controlling device, and is arranged to give a definite motor position for a given force from the thermostat without regard for motor hysteresis, friction, or pressure variations of the controlled fluid.

A *sequence controller* is used to operate two or more devices in a pre-arranged sequence. It is generally used in connection with refrigeration compressors, and may be arranged to prevent simultaneous starting in the event of temporary electrical shutdown or control medium failure.

*Manual switches* are available in the two-position or proportional types. *Two-position switches* change the flow of energy from one line to one or more other lines; or from one pair of lines to another pair of lines. *Proportioning switches* vary the flow of energy as determined by the manual setting of the switch.

## RESIDENTIAL CONTROL SYSTEMS

The control equipment function in a residence may vary from the regulation of a coal-fired heating plant to the completely automatic control of an all year air conditioning system. Regardless of the type of heating or air conditioning system used, the control system should be selected to insure safety and comfort of the occupants as well as economy of operation.

### Appliance Controls

Typical controls for the appliances used to supply heat in residences are as follows:

1. *Hand Fired Coal Burners.* The control of a hand fired coal burner for a boiler or furnace normally consists of a room thermostat operating a two position electric control motor which in turn opens the draft damper and closes the check damper on a demand for heat. The motor then closes the draft damper and opens the check damper when the thermostat is satisfied. A limit control on the boiler or furnace should be connected to the motor so that it may check the fire whenever a predetermined temperature or pressure has been exceeded. A manually operated basement switch is usually included on the motor so that the draft may be opened and the check closed when the boiler or furnace is being filled with coal.
2. *Coal Fired Stokers.* Domestic stokers are usually controlled by a room thermostat, a limit control, and a stoker relay. When the thermostat calls for heat, the relay causes the stoker motor to increase the flow of fuel and air to the burner to its maximum rate. When the thermostat is satisfied, the relay provides for a minimum flow of fuel and air to the burner to maintain the fire at its minimum rate. The limit control prevents the continuance of the maximum fuel rate if the temperature or pressure in the boiler or furnace exceeds a predetermined point and also stops all fuel feed if the fire goes out. Automatic ignition usually is not available and the firing of a stoker is normally on or off.
3. *Automatic Oil Burners.* Automatic oil burner controls normally consist of a room thermostat, a limit control, a combustion safety control, and a control relay. On a call for heat by the thermostat, the relay starts the oil burner motor which supplies oil and air to the burner. An ignition device consisting of an electric spark or a gas flame ignites the oil automatically. If for any reason the oil and gas mixture does not ignite, a time delay mechanism in the relay is operated by the combustion safety control after a predetermined length of time to cause the oil and air supply to be shut off. If the oil and air mixture ignites properly the burner continues to run until the thermostat is satisfied or until the limit control affected by the temperature or pressure in the boiler or furnace, stops the burner.
4. *Automatic Gas Burners.* The controls for an automatic gas burner usually include a room thermostat, a limit control, a safety pilot, gas pressure regulator and a gas valve (solenoid, motorized or diaphragm type). Upon a demand for heat at the thermostat, the gas valve is opened, admitting gas to the burner. The safety pilot ignites the gas which continues to burn until the thermostat is satisfied or until the limit control shuts off the gas valve. The limit control may also reduce (throttle) the gas flame as required to maintain a desired temperature or pressure of the heating medium. If the pilot flame is extinguished for any reason either before or after the main gas valve is turned on, the