APPLICATION OF CONTROL DEVICES TO A TYPICAL SYSTEM

Fig. 1 shows the location of controlling devices for a year 'round air conditioning system such as shown in Chapter 43, Fig. 3. A control diagram for pneumatic control equipment is shown in Fig. 2 for convenience in explaining the function and sequence of operation of the control in Fig. 1, but obviously, the individual controls may also be of self-contained or electrically operated type provided they obtain the same control of valves and dampers.

The auxiliary controlling devices indicated may all be mounted together on an instrument board which may also contain a framed copy of the control diagram and the description of the automatic control cycle. Air gages, identified by suitable inscription plates, may be installed in the branch connections to and from the auxiliary devices on the instrument board to indicate the functioning of the various devices.

A description of the automatic control cycle follows:

When the fan motor is stopped, solenoid air valve E-1, actuated from the fan motor circuit, is de-energized and exhausts its branch to close minimum outdoor damper D-1, reposition three-way air valve V-a to close heating coil valve V-1, and remove main air from remote bulb indicator dew-point thermostat T-1, thereby closing maximum outdoor damper D-2 and opening return air damper D-3.

When the fan motor is started, E-1 fills its branch, thereby opening minimum outdoor damper D-1, repositions V-a to permit T-3 and T-4 to control V-1 and supplies main air to T-1 to permit same to operate D-2 and D-3.

During the summer cooling season, manual indexing switch S-1 is positioned to fill its branch, whereby it supplies main air to dew-point thermostat T-2, positions three-way air valves V-e and V-f to permit T-3 to control face damper D-4 and by-pass damper D-5, positions three-way air valve V-b to close heating coil valve V-1, positions three-way air valveV-c to remove the control of maximum outdoor damper D-2 and return air damper D-3 from dew-point thermostat T-1 and place these dampers under the control of dew-point thermostat T-2.

When S-1 is positioned as noted, remote bulb dew-point thermostat T-2 functions on a rising temperature to first gradually open maximum outdoor damper D-2 while simultaneously closing return air damper D-3 and on a further slight temperature rise, gradually positions chilled water valve V-2 to pass chilled water to the dehumidifier. The reverse operating sequence occurs on a falling dew-point temperature. Should the outdoor wet-bulb temperature rise above the desired indoor wet-bulb temperature, positive acting outdoor wet-bulb thermostat T-5, positions three-way air valve V-d to remove dampers D-2 and D-3 from the control of T-2, thereby closing outdoor damper D-2 and opening return air damper D-3.

On a rising return air temperature T-3 functions to open face damper D-4, while simultaneously closing by-pass damper D-5 as required to maintain the desired return air temperature. The reverse operation occurs on a falling return air temperature.

During all seasons except the summer cooling season, manual switch S-1 is positioned to exhaust its branch, thereby making dew-point thermostat T-2 inoperative and positions chilled water valve V-2 for continuous recirculation, positions three-way valve V-b to permit heating coil valve V-1 to be operated as required, positions three-way valve V-c to permit T-1 to control D-2 and D-3, positions three-way valve V-e to permit T-3 to operate through low limit discharge thermostat T-4 to control heater valve V-1 and positions three-way valve V-f to open normally closed face damper D-4 and close normally open by-pass damper D-5.

When switch S-1 is positioned as noted, remote bulb dew-point thermostat T-1 functions on a rising temperature to gradually open maximum outdoor damper D-2, while simultaneously closing return air damper D-3 as required to maintain the desired dew-point temperature. The reverse operation occurs on a falling dew-point temperature. When the outdoor wet-bulb temperature rises above the desired dew-point temperature, the dew-point temperature will rise accordingly until such time as the system is indexed for summer cooling and chilled water is made available to drop the dew-point temperature.

Return air thermostat T-3 functions on a rising temperature to pass air through low limit discharge thermostat T-4 to gradually close heating coil valve V-1. Should the discharge temperature fall below the operating point of T-4, this thermostat will release air from its branch to gradually open V-1 as required to maintain the desired low limit discharge temperature regardless of the operation of T-3.

CHAPTER 35

Motors and Motor Controls

Motor Rating; Functions of Motor Control Equipment; Direct Current Motors, Types, Control Equipment and Specifications; Alternating Current Motors, Types, Control Equipment and Specifications; Gear Motors; Glossary of Motor Terms, Enclosures, Speed Classification and Mounting

THE electric motor, available in many different types suitable for various services, is now the most widely used form of prime mover. The equipment for starting, controlling and protecting these motors varies with the type and with the functions it is desired to attain. Motors are divided into two general classifications, *alternating-current* or *direct-current*, depending on the power source to be used.

In selecting a motor for a particular application consideration must first be given to the type of power supply available. All machinery has certain load characteristics which may vary with speed. Some types may have a constant torque over wide ranges of speed, while others may have changing torques with changing speed. Consideration should be given to selecting the motor and the motor control which best suit the requirements of the drive.

MOTOR RATING

The rating of an electric motor depends upon the total temperature which the motor attains under operating conditions. This total temperature depends on both the ambient temperature and the temperature rise of the motor. As motor temperature rise is in turn determined by the ability of the motor to dissipate heat, circulation to the motor should not be restricted. Improper selection of motors with regard to temperature ratings may result in high motor operating temperatures with accompanying reduction in motor life.

In general, the electrical insulation is the portion of the motor most susceptible to injury from high operating temperatures. Of the several types of insulation which are available, the most common type, specified as Class A by the *National Electrical Manufacturers Association*, consists of cotton, felt, paper or similar organic materials and permits a 55 C rise in temperature over a 40 C ambient temperature. Class B insulation consists of mica, asbestos, fiber glass, or similar inorganic materials and permits a 75 C rise in temperature over the 40 C ambient temperature. Other types of insulation such as silicone resin are available and permit extremely high operating temperatures.

The mechanical construction of the different types of motor enclosures and the rise in temperature with Class A insulation for each type are enumerated in the glossary at the end of this chapter. Since the difference in temperature between the hottest spot and the nominal temperature, as measured by a thermometer, is greater for a completely unprotected machine than it is for an enclosed machine, the permissible temperature rise is smaller for an open motor.

FUNCTIONS OF CONTROL EQUIPMENT FOR MOTORS

In general, control equipment for all types of motors should provide: (1) means of disconnecting the motor from the power supply; (2) means