indicates continuous circulation of the heat in a medium with control provided to vary the temperature of the medium.

INDICATING AND RECORDING EQUIPMENT

In addition to the automatic control of temperature and humidity conditions, visual indication and permanent chart records of the variables involved are desirable. They provide an accurate check on the performance of the system both from the standpoint of conditions maintained and cost of operation. Instruments are available to provide accurate records of these variables, such as pressure, temperature, humidity, flow and CO_2, which go to make up a complete heating or air conditioning system. In some cases the control equipment is provided with indicating or recording mechanisms by means of which the performance of the controls may be observed or recorded and in other cases separate instruments are used for the purpose.

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 for totally enclosed motors. 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 for totally enclosed motors. Other types of insulation such as silicone resin are available and permit much higher 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 between the hottest spot and the maximum observable temperature, as measured by a thermometer, is greater for an open machine than for an enclosed machine, the permissible temperature rise is 50 C for an open motor.