

connecting of loads on the power line and they are likely to vary with different power companies.

11 • In controlling direct current motors what two methods are used, what speed ranges are obtained, and what is the relative efficiency of each method?

In controlling direct current motors, resistance is placed in either the armature circuit or the field circuit. For armature control, the speed is reduced with the increase of resistance. With the field control, the speed is increased with the addition of resistance in the field circuit.

For most listed direct current motors, it is possible to obtain operation up to a speed ratio of two to one with field control equipment. This type of control is used in connection with shunt wound motors for best results.

For speed adjustment by resistance in series with the armature circuit, a reduction of 50 per cent in speed can generally be obtained. This control can be used with either shunt or compound wound motors.

The field control method of changing speeds on direct current motors is the most efficient. Due to the large current in the armature circuit, this method results in a high loss when the speed is reduced any appreciable amount. It is well to remember that with field control only constant horsepower output is obtained, therefore, care should be taken that the motor at normal speed is large enough to care for any increase in load as a result of speeding up the unit.

12 • What reduction in speed is possible and how is it obtained when alternating current slip ring motors are used?

Speed variation in slip ring motors is obtained by inserting resistance in the secondary circuit. This generally allows for a 50 per cent speed reduction when it is fully loaded at normal speed.

From 20 to 30 per cent speed reduction can be obtained through the use of line voltage control of an adjustable varying speed motor with a fan closely motored (*i.e.*, the fan approximately fully loads the motor).

Chapter 43

TEST METHODS AND INSTRUMENTS

Pressure Measurement, Temperature Measurement, Air Movement, Humidity Measurement, Carbon Dioxide Determination, Dust Determination, Flue Gas Analysis, Measurement of Smoke Density, Heat Transmission, Eupatheoscope Problems in Practice

SEVERAL types of measuring apparatus are available for accurately determining the thermal capacity and air movement of gaseous vapors and homogeneous materials. This chapter gives a brief description of the principal instruments used in connection with the proper control and testing of heating and air conditioning installations.

PRESSURE MEASUREMENT

Atmospheric pressure is usually measured by a *mercurial barometer* which, in its simplest form, consists of a glass tube about 3 ft long, closed at the upper end, filled with mercury and inverted in a shallow bath of mercury. The pressure of the atmosphere on the exposed top of the mercury in the cistern supports a column of mercury in the tube to a height of about 30 in. Readings are taken of the height of the column between the levels of mercury in the tube and in the cistern. Atmospheric pressure is the same as the pressure exerted by this supported column of mercury, and, in pounds per square inch, is equal to its height in inches times 0.491, which is the weight in pounds of 1 cu in. of mercury. At latitude 45 deg and sea level, and at a temperature of 32 F, the atmosphere will support a column of mercury 29.921 in. in height. The pressure of 14.7 lb per square inch, derived by multiplying 29.921 by 0.491, is called *standard* or *normal barometric pressure*. Since the height of the barometer depends on the density of the mercury as well as on the pressure of the atmosphere, and since the density is dependent on the temperature, mercurial barometer readings should always be corrected for temperature. An *aneroid barometer* contains no liquid; it is portable but less accurate than the mercurial barometer. Atmospheric pressure in bending the thin corrugated top of a partially exhausted metallic box, or in distorting a thin-walled bent tube of metal, is made to move a pointer.

Pressures above or below atmospheric are usually measured by means of gages which indicate the difference between the pressure being measured and atmospheric pressure at the same time and place. A gage which indicates pressures higher than atmospheric is known as a *pressure gage*, and a gage which indicates pressures lower than atmospheric is known as a *vacuum gage*. The most common type of these gages contains a flexible hollow metal tube of oval cross section, known as a *Bourdon tube*. When subjected to unequal inside and outside pressures, this tube tends to