not greater than 100 deg from the vertical, cannot enter the machine either directly or by striking and running along the surface.

Totally Enclosed Non-Ventilated motors (55 C rise) are so constructed as to prevent exchange of air between inside and outside of the case, but are not air tight and are not equipped with external cooling means.

Totally Enclosed Fan-Cooled motors (55 C rise) are similar to totally enclosed, non-ventilated machines, except that exterior cooling is provided by means of a fan or fans integral with the machine.

Explosion Proof motors (55 C rise) have an enclosing case designed to withstand an explosion of a specified gas or vapor which may occur within it, and to prevent the ignition of the gas or vapor surrounding the motor by sparks, flashes, or explosions of the gas or vapor which may occur within the machine casing.

Dust Explosion Proof motors (55 C rise) have an enclosing case designed and constructed so as not to cause the ignition or explosion of an atmosphere of the specific dust, or to cause ignition of dust on or around the machine. (Proper overload protection and cleanliness are required for successful operation).

Water Proof motors (55 C rise) are so constructed as to exclude water applied in the form of a stream from a hose.

Dust Tight motors (55 C rise) are so constructed that the enclosing case will exclude dust.

Motor Speed Classifications

A Constant Speed Motor is one in which the speed remains practically constant with changes in load; *e.g.*, a d-c shunt wound motor or a-c squirrel-cage motor with low slip.

A Varying Speed Motor is one in which the speed varies with the load, usually decreasing when the load increases; *e.g.*, a d-c series motor or an induction motor with large slip.

An Adjustable Varying Speed Motor is one in which the speed can be adjusted gradually, but when once adjusted for a given load will vary in considerable degree with change in load; *e.g.*, a shunt wound d-c motor adjusted by armature resistance control.

An Adjustable Speed Motor is one in which the speed can be varied gradually over a considerable range, but when once adjusted remains practically unaffected by the load; *e.g.*, a d-c shunt motor with field resistance control. The standard ratings for open type, adjustable speed motors, having a speed range of 3 to 1 and greater are in accordance with the following:

(1) A standard continuous horsepower rating at 150 per cent of minimum speed with a temperature rise of 40 C.
(2) The next higher standard continuous horsepower rating at 3 times minimum speed with a temperature rise of 40 C.
(3) Between 150 per cent of minimum speed and 3 times minimum speed, the standard continuous horsepower rating with a temperature rise of 40 C will vary with the speed along a straight line connecting these two horsepower ratings. No further increase in horsepower is recognized above 3 times minimum speed.
(4) Below 150 per cent of minimum speed the lower continuous horsepower rating (see preceding item 1) will apply with a temperature rise of 50 C.
Example: 20/25 hp, 400 to 1600 rpm. This motor may be rated 20 hp, 40 C at 600 rpm and 25 hp, 40 C from 1200 to 1600 rpm. Between 600 and 1200 rpm the rated horsepower increases directly with speed from 20 to 25 hp.
(5) Motors may also be rated 1 hour with temperature rise of 50 C with the higher horsepower rating (see preceding item 2) throughout the entire speed range.
Example: 20/25 hp, 400 to 1600 rpm. This motor may be rated 25 hp, 50 C. 400/1600 rpm; 1 hour.

Mechanical Modifications

Vertical Mountings are available for such applications as pumps, agitators, and so forth. This type of application may require a special umbrella-type hood to protect against dripping liquids.

Flanged Mountings are available for use where motors are built in as part of machines. Motors may also be supplied with flush plate mountings, suitable for close coupled pump and similar applications.

CHAPTER 40

SOUND CONTROL

Unit of Noise Measurement, Apparatus for Measuring Sound, General Problem, Kinds of Noise, Noise Transmitted Through Ducts, Design Room Noise Level, Noise Generated by Fans, Natural Attenuation of Duct System, Duct Sound Absorbers, Air Supply Noises, Cross Transmission Between Rooms, Controlling Vibration from Machine Mountings

IN ventilating and air conditioning a building or a room, consideration must be given to the effect of the mechanical system on the acoustics of the space conditioned. It is important to consider also that the use of air conditioning often permits keeping the windows closed, thus giving relief from certain external noises, but at the same time increasing the necessity of providing adequate sound control.

It is assumed that in a given space the architect and acoustical engineer have produced a room or rooms which are satisfactory for speech, music, or other uses. The ventilating engineer's sole function is to ventilate and air condition these rooms properly so that they will be physically comfortable without adding any acoustical hazards.

UNIT OF NOISE MEASUREMENT

According to an international standard, the *decibel* (*db*) is the unit for expressing sound pressure levels. The *sound pressure level*, in decibels, is given by the relation:

$$db = 20 \log_{10}\left(\frac{P}{0.0002}\right) \qquad (1)$$

where P = the sound pressure in dynes per square centimeter.

The reference pressure (0.0002 dynes per square centimeter) is a sound pressure which is slightly less than the threshold of audibility, at the frequency of 1000 cycles per second, for the person of average hearing. This reference point is approximately the minimum sound pressure that would be audible in a very quiet room to an observer having acute hearing. The ear is essentially a pressure operated device; hence, the sensation of loudness, or magnitude of sound is governed by the sound pressure existing at the point of reception.

The sound level meter measures sound level pressure, the measurement being expressed as *sound level* on a decibel scale with zero corresponding to the reference pressure of 0.0002 dynes per sq cm at 1000 cycles. In the higher ranges of the decibel scale, approaching 120 db, the sensation is one of feeling, and at higher levels the sensation becomes painful.

Associated with sound pressure level is the *sound intensity level*, expressed in decibels above a standard reference intensity. Sound intensity is the average rate of sound energy transmitted through a unit area normal to the direction of propagation, commonly expressed in watts per square centimeter. The *sound intensity level*, in decibels, is given by the relation: