

general long radius elbows and gradual changes in shape tend to maintain uniform velocities accompanied by decreased turbulence, lower resistance and a minimum of noise.

Heavy canvas connections are recommended on both the inlet and outlet to all fans. The fan discharge connections shown in Fig. 7 are marked *good*, *fair*, and *poor* in the order of the amount of turbulence produced. An inspection of the heater connections shown in Fig. 7 will readily show that uniform velocity through the heater cannot be expected in the diagram noted *poor*. When obstructions cannot be avoided, the duct area should never be decreased more than 10 per cent and then a *streamlined* collar should be used. Larger obstructions require an increase in the duct size in order to maintain as nearly uniform velocity as possible. Branch take-offs should always be arranged to cut or slice into the air stream in order to reduce as far as possible the losses in velocity head.

The recommended gages for sheet metal duct construction are given in Table 4. Weights of sheet metal per square foot of surface for different gages are given in Table 5. The weights of various gages and the areas for any length of run of rectangular sheet metal ducts may also be determined from Fig. 8. The bottom scale represents the sum of the two sides of the duct and the oblique lines give the length of run in feet. Proceeding horizontally to the right from the intersection of vertical and oblique lines on the chart, the area of the duct may be determined in the first vertical scale. The scales to the right give the weights of the duct run for different gages of metal. In calculating the weights of duct, it is considered good practice to allow 20 per cent additional for weights of joints and bracings. Various weights and thicknesses of standard copper sheets will be found in Table 6.

REFERENCES

- Method of Determining Rectangular Equivalents and Weights of Ducts, by Peter Franck (A.S.H.V.E. JOURNAL SECTION, *Heating, Piping and Air Conditioning*, December, 1940).
- The Flow of Liquids, by W. H. McAdams (*Refrigerating Engineering*, February, 1925, p. 279).
- A Study of the Data on the Flow of Fluids in Pipes, by Emory Kemler (A.S.M.E. Transactions, Hydraulics Section, August 31, 1933, p. 7).
- Air Conditioning and Engineering, American Blower Corp.
- Fan Engineering, Buffalo Forge Co.
- Heat Power Engineering, by Barnard, Ellenwood, and Hirshfeld, Part III.
- Mechanical Engineers' Handbook, by Lionel S. Marks, McGraw-Hill Book Co.

Chapter 32

SOUND CONTROL

Decibel Defined, Apparatus for Measuring Noise, Problem of Sound Control, Acceptable Noise Levels, Controlling Vibration from Machine Mountings, Controlling Noise through Room Wall Surfaces, Noise Transmitted Through Ducts, Duct Lining Formula

IN ventilating and air conditioning a building or a room, the effect of the mechanical system employed must be considered 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 not assumed that the ventilating and air conditioning engineer will attempt to improve the acoustics of the space that is being conditioned, but the designer should have at least enough fundamental knowledge of the acoustical effects of the system which is being designed to be sure that no damaging effects occur to the existing acoustical properties. 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

By a recently adopted international standard, two terms are used for noise measurement. The *decibel* (db) is the physical unit for expressing intensity or pressure levels. The *phon* is the unit of loudness level. The loudness level, in phons, of any sound is by definition equal to the intensity level in decibels of a thousand cycle tone which sounds equally loud.

The decibel is defined by the relation $N = 10 \log_{10} \frac{I_1}{I_0}$, where N is the number of decibels by which the intensity flux I_1 exceeds the intensity flux I_0 . The intensity flux is the measure of the energy contained in a sound wave and is defined in terms of micro-watts per square centimeter of wave front in a freely traveling plane wave. It is usually more convenient to select an arbitrary reference intensity for I_0 and express all other intensities in terms of decibels above that level. For this purpose a reference intensity of 10^{-16} watts per square centimeter has been selected. This intensity is slightly less than the threshold of audibility