BIBLIOGRAPHY

FLUID FLOW (See Chapter 4)

Engineering Applications of Fluid Mechanics, by J. C. Hunsaker and B. G. Rightmire, 1947 (McGraw-Hill Book Company, Inc.)

Elementary Mechanics of Fluids, by Hunter Rouse 1946. (John Wiley & Sons, Inc.)

The Flow of Liquids, by W. H. McAdams, (*Refrigerating Engineering*, February, 1925, p. 279).

The Flow of Fluids in Closed Conduits, by R. J. S. Pigott, (*Mechanical Engineering*, Vol. 55, 1933, p. 497).

A Study of the Data on the Flow of Fluids in Pipes, by E. Kemler, (A.S.M.E. Transactions, Vol. 55, 1933, Hydraulics, p. 7).

Mechanical Similitude and Turbulence, by T. von Karman (translated and reprinted as Technical Memorandum N.A.C.A. No. 611, 1931).

Turbulent Flow in Pipes, with Particular Reference to the Transition Region Between the Smooth and Rough Pipe Laws, by C. F. Colebrook, (*Journal, Institute of Civil Engineers*, Vol. II, 1938-39, p. 133).

Evaluation of Boundary Roughness, by H. Rouse (Proceedings Second Hydraulics Conference, *University of Iowa*, Bulletin 27, 1943).

FLOW OF AIR IN DUCTS

Frictional Resistance to the Flow of Air in Straight Ducts, by F. C. Houghton, J. B. Schmieler, J. A. Zalovcik, and N. Ivanovic (A.S.H.V.E. TRANSACTIONS, Vol. 45, 1939, p. 35).

Analysis of Factors Affecting Duct Friction, by J. B. Schmieler, F. C. Houghten, and H. T. Olson, (A.S.H.V.E. TRANSACTIONS, Vol. 46, 1940, p. 193).

The Flow of Air In Ducts, by E. Kemler, (Heating and Ventilating, May 1936, p. 38).

Total, Static and Velocity Pressure, by A. A. Berestneff, (*Heating, Piping and Air Conditioning*, March 1932, p. 195).

PRESSURE LOSS IN ELBOWS

Flow of Fluids Through Valves, Fittings and Pipe, (Crane Co., Technical Paper No. 409).

Pressure Losses for Fluid Flow in 90° Pipe Bends, by K. H. Beij, (*National Bureau of Standards*, Research Paper 1110, Journal of Research July 1938, p. 1).

Pressure Loss in Ducts with Compound Elbows, by J. R. Weske, (N.A.C.A. Wartime Report, Originally issued as A.R.R. Feb. 1943).

DUCT DESIGN

A Rational Method of Duct Design, by L. G. Miller, (A.S.H.V.E. TRANSACTIONS, Vol. 43, 1937, p. 71).

MISCELLANEOUS

Performance Tests of Asbestos Insulating Air Ducts, by R. H. Heilman and R. A. McArthur (A.S.H.V.E. TRANSACTIONS, Vol. 44, 1938, p. 197).

CHAPTER 42

SOUND CONTROL

Unit of Noise Measurement, Apparatus for Measuring Noise, 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, Grille Selection, 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, 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 $N = 10 \log_{10} \frac{I_1}{I_o}$, where N is the number of decibels by which the intensity flux I_1 exceeds the intensity flux I_o. The intensity flux is the measure of the intensity of a sound wave and is defined in terms of watts per square centimeter passing through a unit area of wave front in a freely traveling plane wave. It is usually more convenient to select an arbitrary reference intensity for I_o 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 for the average ear at a frequency of 1,000 cycles per second. This reference level also corresponds to a pressure of 0.0002 dynes per square centimeter for sound in air at usual room temperatures.

A stated sound level in decibels, unless otherwise defined, will thus be related to a threshold of 10^{-16} watts. For example, a level of 60 db above this reference threshold is 10^{-10} watts. In a similar manner, when sound measurements are given in actual intensity or energy units, they can be converted to decibels by this relation.

Since the decibel is based on a ratio, it can only be employed when related to a reference threshold level as given. Noise levels, which vary