

- A.S.H.V.E. RESEARCH REPORT No. 1264—Entrainment and Jet-Pump Action of Air Streams, by G. L. Tuve, G. B. Priester, and D. K. Wright, Jr. (A.S.H.V.E. TRANSACTIONS, Vol. 48, 1942, p. 241).
- A.S.H.V.E. RESEARCH REPORT No. 1248—Control of Air Streams in Large Spaces, by G. L. Tuve and G. B. Priester (A.S.H.V.E. TRANSACTIONS, Vol. 50, 1944, p. 153).
- A.S.H.V.E. RESEARCH REPORT No. 1328—The Discharge of Air from a Long Slot, by Alfred Koestel and G. L. Tuve (A.S.H.V.E. TRANSACTIONS, Vol. 54, 1948, p. 87).
- A.S.H.V.E. RESEARCH REPORT No. 1365—Air Streams from Perforated Panels, by Alfred Koestel, Philip Hermann and G. L. Tuve (A.S.H.V.E. TRANSACTIONS, Vol. 55, 1949, p. 283).
- A.S.H.V.E. RESEARCH REPORT No. 1404—Comparative Study of Ventilating Jets from Various Types of Outlets, by Alfred Koestel, Philip Hermann, and G. L. Tuve (A.S.H.V.E. TRANSACTIONS, Vol. 56, 1950, p. 459).
- A.S.H.V.E. RESEARCH REPORT No. 1429—The Control of Air Streams from a Long Slot, by Alfred Koestel and C. Y. Young (A.S.H.V.E. TRANSACTIONS, Vol. 57, 1951, p. 407).
- A.S.H.V.E. RESEARCH REPORT No. 1476—Air Velocities in Ventilating Jets, by G. L. Tuve (A.S.H.V.E. TRANSACTIONS, Vol. 59, 1953, p. 261).

A.S.H.A.E. Cooperative Research at Kansas State College

- A.S.H.V.E. RESEARCH REPORT No. 1327—Downward Projection of Heated Air, by Linn Helander and C. V. Jakowatz (A.S.H.V.E. TRANSACTIONS, Vol. 54, 1948, p. 71).
- A.S.H.V.E. RESEARCH REPORT No. 1475 (In Cooperation with the Industrial Unit Heater Association)—Maximum Downward Travel of Heated Jets from Standard Long Radius ASME Nozzles, by Linn Helander, S. M. Yen, and R. E. Crank (A.S.H.V.E. TRANSACTIONS, Vol. 59, 1953, p. 241).

A.S.H.A.E. Cooperative Research—General

- A.S.H.V.E. RESEARCH REPORTS No. 857, 911 and 966—Measurement of the Flow of Air Through Registers and Grilles, by E. L. Davies (A.S.H.V.E. TRANSACTIONS, Vol. 36, 1930, p. 201; Vol. 37, 1931, p. 619 and Vol. 39, 1933, p. 373).
- A.S.H.V.E. RESEARCH REPORT No. 1076—Air Distribution from Side Wall Outlets, by D. W. Nelson and D. J. Stewart (A.S.H.V.E. TRANSACTIONS, Vol. 44, 1938, p. 77).
- A.S.H.V.E. RESEARCH REPORT No. 1092—The Flow of Air Through Exhaust Grilles, by A. M. Greene, Jr. and M. H. Dead (A.S.H.V.E. TRANSACTIONS, Vol. 44, 1938, p. 387).
- A.S.H.V.E. RESEARCH REPORT No. 1155—The Performance of Stack Heads, by D. W. Nelson, D. H. Krans, and A. F. Tutill (A.S.H.V.E. TRANSACTIONS, Vol. 46, 1940, p. 205).
- A.S.H.V.E. RESEARCH REPORT No. 1165—Development of Instruments for the Study of Air Distribution in Rooms, by A. P. Kratz, A. E. Hershey, and R. B. Engdahl (A.S.H.V.E. TRANSACTIONS, Vol. 46, 1940, p. 351).
- A.S.H.V.E. RESEARCH REPORT No. 1206—Performance of Stack Heads Equipped with Grilles, by D. W. Nelson, D. H. Lamb and G. E. Smedberg (A.S.H.V.E. TRANSACTIONS, Vol. 48, 1942, p. 279).
- A.S.H.V.E. RESEARCH REPORT No. 1226—Performance of Side Outlets on Horizontal Ducts, by D. W. Nelson and G. E. Smedberg (A.S.H.V.E. TRANSACTIONS, Vol. 49, 1943, p. 58).

Other Papers Presented at A.S.H.A.E. Meetings

- A.S.H.V.E. RESEARCH REPORT No. 1051—The Noise Characteristics of Air Supply Outlets, by D. J. Stewart and G. F. Drake (A.S.H.V.E. TRANSACTIONS, Vol. 43, 1937, p. 81).
- A.S.H.V.E. RESEARCH REPORT No. 1158—Dirt Patterns on Walls, by R. A. Nielsen (A.S.H.V.E. TRANSACTIONS, Vol. 46, 1940, p. 247).
- A.S.H.V.E. RESEARCH REPORT No. 1381—Balancing Air Delivery of a System of Manifold Air Diffusers, by G. S. Dauphinee and Peter Argentieri (A.S.H.V.E. TRANSACTIONS, Vol. 55, 1949, p. 213).
- A.S.H.V.E. RESEARCH REPORT No. 1382—Air Distribution and Draft, by John Rydberg and Per Norbäck (A.S.H.V.E. TRANSACTIONS, Vol. 55, 1949, p. 225).
- A.S.H.V.E. RESEARCH REPORT No. 1471—Room Air Distribution Research for Year 'Round Air Conditioning, Part I—Supply Outlets at One High Sidewall Location, by S. F. Gilman, H. E. Straub, A. E. Hershey, and R. B. Engdahl (A.S.H.V.E. TRANSACTIONS, Vol. 59, 1953, p. 151).
- A.S.H.V.E. RESEARCH REPORT—Room Air Distribution Research for Year 'Round Air Conditioning, Part II—Supply Outlets at Three Floor Locations, by H. E. Straub and S. F. Gilman (A.S.H.V.E. TRANSACTIONS, Vol. 60, 1954, p. 249).

Miscellaneous Articles

- Measuring Air Distribution and Grille Performance in Air Conditioning, by G. L. Tuve (A.S.H.V.E. JOURNAL SECTION, Heating, Piping & Air Conditioning, November 1937, p. 700).
- Air Discharge from Narrow Slots, by F. F. Stevenson (Heating, Piping & Air Conditioning, May 1941, p. 308, and June 1941, p. 368. Discussed by J. R. Fellows and D. W. Nelson, loc. cit., September 1941, p. 558 and 559).
- Vertical Air Distribution in Tall Buildings, by Sturm (Heating, Piping & Air Conditioning, June 1947, p. 69 and September 1947, p. 83).
- Efficient Air Distribution in Theatre. (Heating, Piping and Air Conditioning, Question of the Month, August 1947, p. 107; September 1947, p. 113; November 1947, p. 103).
- Test Every Air Conditioning System, by L. T. Avery and J. Black. (Heating and Ventilating, June 1948 p. 96).
- Balancing an Air Conditioning System, by L. R. Phillips. (Refrigerating Engineering, July 1950, p. 111).
- What is a Draft? (Heating, Piping & Air Conditioning, Open for Discussion, May 1951, p. 67, July 1951, p. 71, Sept. 1951, p. 69, January 1952, p. 113, March 1952, p. 73).
- Seven Questions on Ducts and Grilles. (Heating, Piping & Air Conditioning, Question of the Month, May 1952, p. 106 and July 1952, p. 111).
- Air Distribution Studies, by R. V. Martelli and H. O. Scarlett (Heating, Piping & Air Conditioning, November 1952, p. 77. Discussed by W. O. Huebner, loc. cit. Jan. 1953, p. 119 and by the Authors, March 1953 p. 85).

CHAPTER 32

AIR DUCT DESIGN

Pressure Changes, Friction Losses, Circular Equivalents of Rectangular Ducts, Dynamic Losses, Pressure Losses in Elbows, Pressure Losses in Divided-Flow Fittings, Losses Due to Area Changes, Pressure Changes, Duct Design Methods and Examples, Duct Construction Details, Heat Losses from Ducts

IN THE design of air duct systems, the objective is to provide a system that, within prescribed limits of noise and space available for ducts, efficiently transmits the required flow rate of air (cfm) to each space while maintaining a proper balance between investment and operating cost. When the heating, cooling or ventilation load is established, the total flow rate of air required can be determined by methods shown in Chapters 12 and 13. The problem is then to distribute the supply air properly among the spaces.

PRESSURE CHANGES

Ductwork imposes resistance to air flow which must be overcome by the expenditure of mechanical energy; this energy is ordinarily supplied by a fan. The portion of the air flow rate from the fan that is transmitted to a particular space is governed by the law that the loss in total pressure from the fan outlet must be the same along each air path. This also holds for the return-air system except that the loss in total pressure refers to the fan inlet. In air conditioning and ventilating work the pressure differences are ordinarily so small that the equations for incompressible flow can be applied. Additional simplicity is obtained by considering the air to be at the standard density of 0.075 lb per cu ft.

At any cross section in a duct the total pressure H is the sum of the static pressure P and the velocity pressure H_v . Thus,

$$H = P + H_v \quad (1)$$

Pressures are considered in units of inches of water. The velocity pressure is then given by

$$H_v = \left(\frac{V}{4005} \right)^2 \quad (2)$$

where V is defined by the equation

$$V = \frac{Q}{A} \quad (3)$$

where

V = mean velocity of flow, feet per minute.

Q = air flow rate, cubic feet per minute.

A = cross-sectional area of duct, square feet.

The total pressure H is a measure of the total mechanical energy at a cross section. In any duct system, the total pressure always decreases in