Table 13 Weights and Thicknesses of Steel Sheets[22]

Gage Number	Galvanized Steel Sheets (Galv. Sheet Gage)		Uncoated Carbon Steel Sheets (U. S. Standard Gage)		Chrome-Nickel Stainless Steel Sheets (U. S. Standard Gage)	
	Weight, Lb Per Sq Ft	Approx. Thickness, Inches	Weight, Lb Per Sq Ft	Approx. Thickness, Inches	Approx. Weight, Lb Per Sq Ft	Approx. Thickness, Inches
26	0.906	0.0217	0.75	0.0179	0.787	0.0187
24	1.156	0.0276	1.0	0.0239	1.05	0.025
22	1.406	0.0336	1.25	0.0299	1.313	0.0312
20	1.656	0.0396	1.5	0.0359	1.575	0.0375
18	2.156	0.0516	2.0	0.0478	2.1	0.05
16	2.656	0.0635	2.5	0.0598	2.625	0.0625
14	3.281	0.0785	3.125	0.0747	3.281	0.0781
12	4.531	0.1084	4.375	0.1046	4.593	0.1093
10	5.781	0.1382	5.625	0.1345	5.906	0.1406

P = perimeter of duct, feet.
l = length of duct, feet.
t_1 = temperature of air entering duct, Fahrenheit.
t_2 = temperature of air leaving duct, Fahrenheit.
t_s = temperature of air surrounding duct, Fahrenheit.

To obtain the temperature drop in warm air for a given distance of transmission, or the temperature rise if the duct carries air cooler than the room through which it passes, the following formulas can be used:

$$t_1 = \frac{t_s(y+1) - 2t_2}{(y-1)} \quad (18)$$

$$t_2 = \frac{t_1(y-1) + 2t_s}{(y+1)} \quad (19)$$

Table 14 Weights and Thicknesses of Non-Ferrous Sheets

Aluminum Alloy Sheets		Copper Sheets	
Specified Thickness, Inches	Approx. Weight Lb Per Sq Ft	Specified Weight, Oz Per Sq Ft	Approximate Thickness, Inches
0.020	0.285	16	0.0216
0.025	0.356	20	0.0270
0.032	0.456	24	0.0323
0.040	0.570	32	0.0431
0.050	0.713	36	0.0486
0.063	0.898	48	0.0647

Table 15 Weights and Properties of Steel Angles

Size, Inches	Uncoated Steel Approx. Weight, Lb Per Ft	Galvanized Steel Approx. Weight, Lb Per Ft	Moment of Inertia, Inches[4]
1×1×16 Ga.	0.42	0.44	0.01
1×1×⅛	0.80	0.84	0.02
1½×1½×⅛	1.01	1.06	0.04
1½×1½×¼	1.23	1.29	0.08
1½×1½×5/16	1.80	1.89	0.11
2×2×¼	1.65	1.73	0.19
2×2×5/16	2.44	2.56	0.28
2×2×⅜	3.19	3.35	0.35
2½×2½×5/16	3.07	3.22	0.55

NOTE: Other shapes with equal or greater moment of inertia may be substituted where angles are specified.

where

$$y = \frac{28.8AV\rho}{UPl} \text{ for rectangular ducts or,}$$

$$y = \frac{7.2DV\rho}{Ul} \text{ for round ducts,}$$

A = cross-sectional area of duct, square feet.
ρ = density of air, pounds per cubic foot.
V = mean velocity of fluid, feet per minute.
D = diameter of round duct, feet.

If Equations 18 and 19 are used, one of the duct air temperatures will be unknown and can be obtained by substitution of the other known or assumed values.

Heat loss coefficients for insulated ducts with various conductivities are given in Fig. 17. The conductivities of various materials will be found in Table 4 of Chapter 24. For cases where the mean temperature is other than that at which the

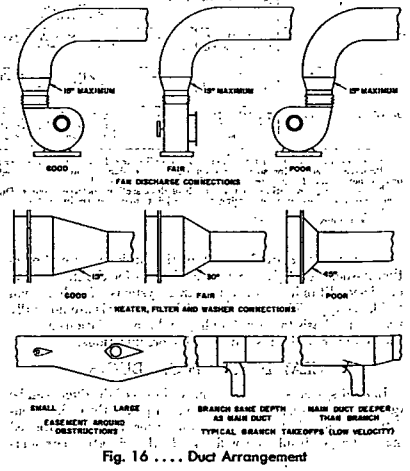
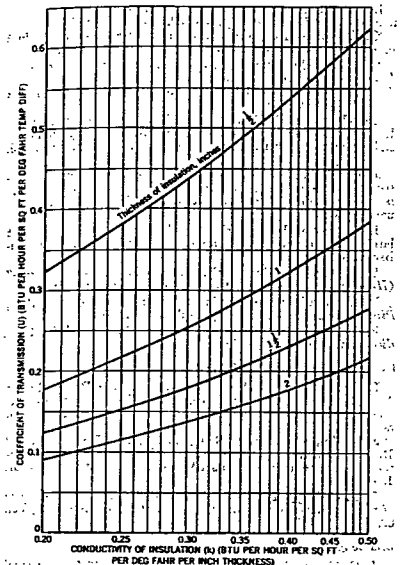


Fig. 16 Duct Arrangement



[a] For round ducts less than 30 in. diameter, increase heat transmission values by the percentages shown below.

Thickness of Insulation (inches)	½	1	1½	2
12- to 21-in. Duct Diameter	3%	5%	7%	9%
21- to 30-in. Duct Diameter	1%	2%	3%	4%

Fig. 17 Heat Loss Coefficients for Insulated Ducts[a]

test was conducted, a correction should be made. However, in most cases, the effect of this factor will be small and may be neglected.

Example 8: Determine the entering air temperature and heat loss for a duct 24 × 36 in. cross-section and 70 ft in length, insulated with ½-in. of a material having a conductivity of 0.35 Btu at 86 F mean temperature, carrying air at a velocity of 1200 fpm, measured at 70 F, to deliver air at 120 F with air surrounding the duct at 40 F.

Solution: Referring to Fig. 17, the overall heat transmission coefficient is found to be 0.49 Btu. From Table 1, Chapter 3, the density of air at 70 F and 29.921 in. Hg is found to be 1/13.348 = 0.0749 lb per cu ft. Substituting these and the other given values in Equation 19, y and t_1 will be as follows:

$$y = \frac{28.8 \times 6 \times 1200 \times 0.0749}{0.49 \times 10 \times 70} = 45.3$$

$$t_1 = \frac{120(45.3+1) - 80}{45.3 - 1} = 123.7 \text{ F}$$

Substituting in Equation 17:

$$Q_s = 0.49 \times 10 \times 70\left[\left(\frac{123.7 + 120}{2}\right) - 40\right]$$

$$= 28{,}100 \text{ Btu per hr.}$$

REFERENCES

[1] D. K. Wright, Jr.: ASHVE Research Report No. 1280—A new friction chart for round ducts (ASHVE Transactions, Vol. 51, 1945, p. 303).

[2] L. F. Moody: Friction factors for pipe flow (*ASME Transactions*, Vol. 66, 1944, p. 671).

[3] R. D. Madison and W. R. Elliot: Friction charts for gases including correction for temperature, viscosity and pipe roughness (ASHVE Journal Section, *Heating, Piping and Air Conditioning*, October 1946, p. 107).

[4] F. W. Hutchinson: ASHVE Research Report No. 1469—Friction losses in round aluminum ducts (ASHVE Transactions, Vol. 59, 1953, p. 127).

[5] R. G. Huebscher: Friction equivalents for round, square and rectangular ducts (ASHVE Transactions, Vol. 54, 1948, p. 101).

[6] D. W. Locklin: ASHVE Research Report No. 1405—Energy losses in 90-degree duct elbows: A survey and analysis of available information (ASHVE Transactions, Vol. 56, 1950, p. 479).

[7] J. R. Weske: *Pressure Loss in Ducts with Compound Elbows* (National Advisory Committee for Aeronautics, *Advance Restricted Report* W-39, February 1943).

[8] R. D. Madison and J. R. Parker: Pressure losses in rectangular elbows (*Heating, Piping and Air Conditioning*, July, p. 365; August, p. 427; September, p. 483; 1936).

[9] W. H. Carrier, R. E. Cherne, W. A. Grant and W. H. Roberts; *Modern Air Conditioning, Heating and Ventilating* (Pitman Publishing Corp., New York, 1959, 3rd ed., p. 256).

[10] M. C. Stuart, C. F. Warner, and W. C. Roberts: ASHVE Research Report No. 1216—Effect of vanes in reducing loss in elbows in seven-inch square ventilating duct (ASHVE Transactions, Vol. 48, 1942, p. 409).

[11] S. F. Gilman: Pressure losses of divided-flow fittings (ASHAE Transactions, Vol. 61, 1955, p. 281).

[12] G. E. McElroy: *Pressure Losses Due to Bends and Area Changes in Mine Airways* (*U. S. Bureau of Mines Information Circular* I.C. 6663, p. 4).

[13] A. P. Krats and J. R. Fellows: *Pressure Losses Resulting from Changes in Cross-Sectional Area in Air Ducts* (University of Illinois, *Engineering Experiment Station Bulletin* No. 300).

[14] R. D. Madison (ed.): *Fan Engineering* (Buffalo Forge Company, Buffalo, New York, 1948, 5th ed., p. 124).

[15] J. R. Henry: *Design of Power Plant Installations: Pressure-Loss Characteristics of Duct Components* (National Advisory Committee for Aeronautics, *Advance Restricted Report* L4F25, June 1944, L-208).

[16] L. O. Paul: Installing ducts for higher pressures, and Why higher duct velocities? (*Heating, Piping and Air Conditioning*, April 1953, p. 98 and February 1954, p. 109).

[17] R. D. Tutt: Modern trends in air distribution (Refrigerating Engineering, May 1953, p. 509).

[18] W. W. Kennedy: Design factors in high velocity air distribution (*Heating and Ventilating*, January 1954, p. 83).

[19] J. W. Kreuttner: Can air conditioning be simplified in large buildings? (*Heating, Piping and Air Conditioning*, August 1954, p. 94).

[20] Gardner Savage: Air conditioning an operating hotel (*Heating and Ventilating*, September 1954, p. 100).

[21] C. M. Wilson: Handbook on high velocity air distribution (*Heating, Piping and Air Conditioning*, November 1954, p. 94). Discussions (*Heating, Piping and Air Conditioning*, December 1954, p. 73; February 1955, p. 69; March 1955, p. 99; June 1955, p. 82).

[22] R. W. Waterfill: Air conditioning of multi-room buildings (ASHAE Transactions, Vol. 61, 1955, p. 233).

[23] P. B. Gordon: Air conditioning multi-story buildings (*Heating, Piping and Air Conditioning*, April 1955, p. 112). Discussion (*Heating, Piping and Air Conditioning*, May 1955, p. 103).