Table 13 .... Weights and Thicknesses of Standard Copper Sheets[a]

Rolled to Weight

Weight per Sq Ft		Thickness, Inches		Nearest Gage No.		
Oz	Lb	Decimal Equivalent	Nearest Fraction	B. & S.	Stubs	U. S. Std.
10	0.625	0.0135	1/64	27	29	29
12	0.750	0.0162	1/64	26	27	28
14	0.875	0.0189	1/64	25	26	26
16	1.000	0.0216	1/32	23	24	25
18	1.125	0.0243	1/32	22	23	24
20	1.250	0.0270	1/32	21	22	23
24	1.500	0.0324	1/32	20	21	22
28	1.750	0.0378	1/32	19	20	20
32	2.000	0.0432	3/64	17	19	19
36	2.250	0.0486	3/64	16	18	18
40	2.500	0.0540	3/64	15	17	17
44	2.750	0.0594	1/16	15	17	17
48	3.000	0.0648	1/16	14	16	16
56	3.500	0.0756	5/64	13	15	14
64	4.000	0.0864	5/64	11	14	13

[a] Variations from these weights must be expected in practice.

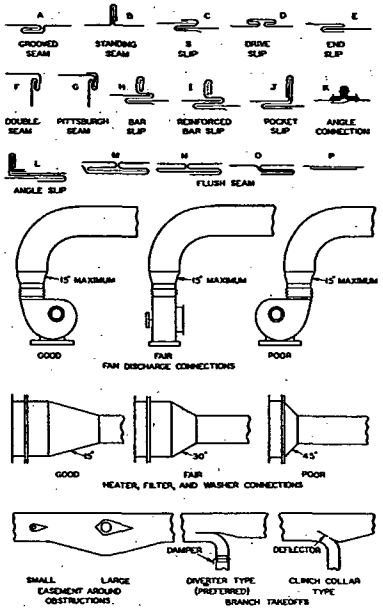


Fig. 16 .... Sheet-Metal Duct and Arrangement Details

countered in the field, but in 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. Self-vulcanising adhesive tapes are available for this purpose and for sealing joints in duct-work. Where a fire hazard exists, the material used must satisfy the requirements of any codes or authorities having jurisdiction. The fan discharge connections shown in Fig. 16 are marked *good*, *fair*, and *poor* in the order of the amount of turbulence produced. An inspection of the heater connections shown in Fig. 16 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 percent, 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.

Wherever ducts pass through fire walls or connect two fire areas of a building, automatic fire dampers should be provided. For design of such dampers and other fire-protective details, see Pamphlet No. 90A of the National Board of Fire Underwriters.[29]

HEAT LOSSES FROM DUCTS

In designing duct systems, the heat gains or losses of the ducts can be quite considerable, not only if the duct passes through unconditioned space, but also on long duct runs within conditioned space. Proper insulation will remedy this situation considerably, but sometimes a redistribution of the supply air is necessary in order to compensate for the heat exchanges that occur.

The heat loss from a given length of duct can be expressed by:

$$Q_w = UPl\left[\left(\frac{t_1 + t_2}{2}\right) - t_3\right] \qquad (14)$$

where

Q_w = heat loss through duct walls, Btu per hour.
U = overall coefficient of heat transfer for the duct wall, Btu per (hour) (square foot) (Fahrenheit degree).
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_3 = temperature of air surrounding duct, Fahrenheit.

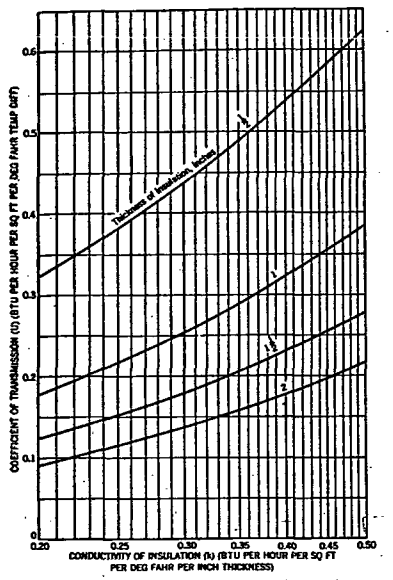
To obtain the temperature drop in warm air for a given distance of transmission, or the temperature rise if the duct carries air cooler than the room through which it passes, the following formulas can be used:

$$t_1 = \frac{t_3(y + 1) - 2t_3}{(y - 1)} \qquad (15)$$

$$t_2 = \frac{t_1(y - 1) + 2t_3}{(y + 1)} \qquad (16)$$

where

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



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

Thickness of Insulation (Inches)	1/2	1	1 1/2	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]

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

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.

In using Equations 15 and 16, one of the duct air temperatures will be unknown and will 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, which are based on mean temperatures, about 70 F, will be found in Table 4 of Chapter 9. For cases where the mean temperature is other than that at which the test was conducted, a correction should be made. However, in most cases the effect of this factor will be small and may be neglected.[a]

Example 8: Determine the entering air temperature and heat loss for a duct 24 x 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 2, 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 16, 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 14:

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

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

For special considerations which apply to insulation of ducts in marine installations see Chapter 48.

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