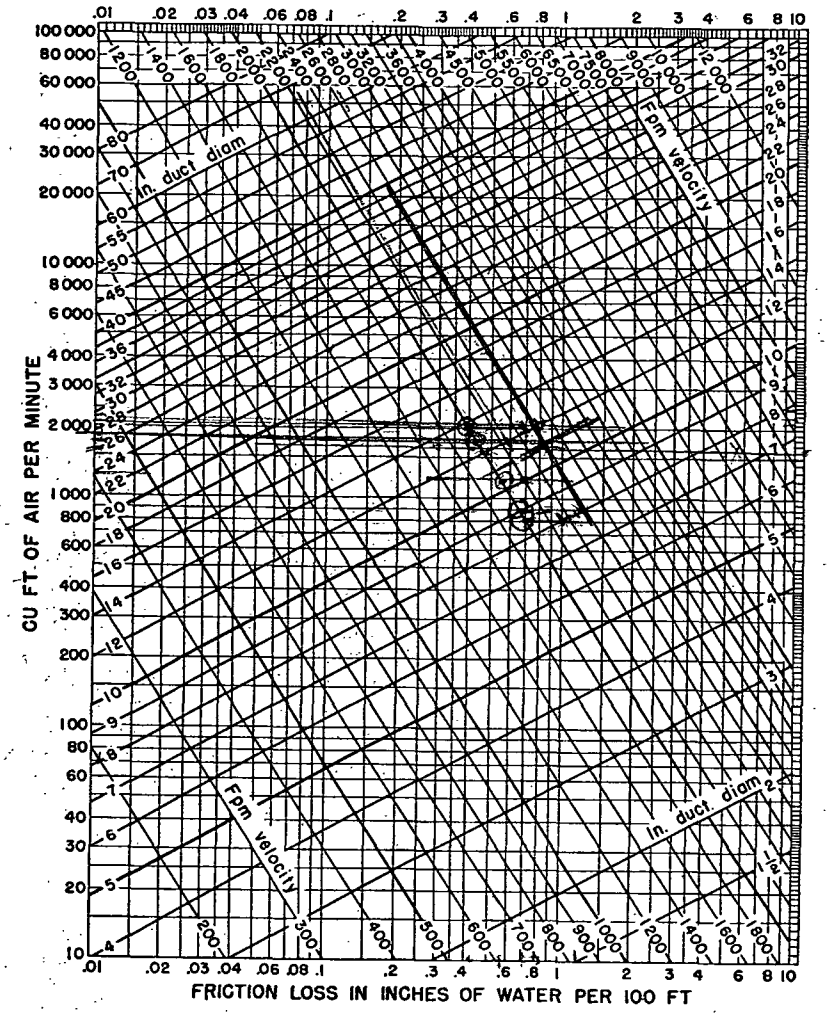

FIG. 1. FRICTION OF AIR IN STRAIGHT DUCTS

(Based on Standard Air of 0.075 lb per cu ft density flowing through average, clean, round, galvanized metal ducts having approximately 40 joints per 100 ft.) No safety factor included. Caution: Do not extrapolate below chart.

which was developed by the A.S.H.V.E. Research Laboratory[1]. The range of the chart has recently been modified to include smaller air capacities and duct sizes, and the upper limit of air capacity has been somewhat reduced.

The chart, Fig. 1, is constructed from the basic flow equation for the pressure loss in circular ducts (see Chapter 4):

$$h_f = f \frac{l}{D} \frac{V^2}{2g} \qquad (1)$$

where

h_f = head loss due to friction, in feet of fluid flowing.
l = length of conduit, feet.
D = inside diameter of conduit, feet.
V = fluid velocity, feet per second.
g = acceleration due to gravity, 32.17 fps per second.
f = a non-dimensional friction coefficient, which for ventilation work depends upon Reynolds Number and the relative roughness of the conduit. Appropriate values of f were taken from the work of Moody.[2] See Chapter 4, Fig. 4, Relation Between Friction Factor and Reynolds Number.

The air friction chart is based on standard air[3] with a density of 0.075 lb per cubic foot, flowing through average, clean, round, galvanized metal ducts having approximately 40 joints per 100 ft. Fig. 1 should not be used to obtain values below the chart by extrapolation because critical flow would occur in this region and values so obtained would be unreliable. For the average application, it should prove sufficiently accurate, without corrections, for any air temperature from 50 F to 90 F, for any relative humidity, and for any normal variation in barometric pressure. For widely varying air pressures or temperatures, or for unusual duct conditions, the friction values obtained from the chart should be corrected.[4]

For ordinary ventilating work, friction may be assumed to vary directly as the density without serious error, and therefore

$$h_o = h_s \left(\frac{\rho_o}{\rho_s} \right) \qquad (2)$$

where

h_o = friction loss under actual operating conditions, any consistent units
h_s = friction loss under standard conditions, any consistent units
ρ_o = density of air under actual operating conditions, any consistent units
ρ_s = density of air under standard conditions, any consistent units.

For ducts of other than standard sheet metal construction, correction factors may be obtained from Fig. 2[4]. The correction factors shown in Fig. 2 were computed for the values of ϵ, the roughness in feet, shown in Table 1[4]. The correct friction loss for such ducts may then be determined by multiplying the losses obtained from Fig. 1 by these factors.

Examples 1 and 2 illustrate the use of Fig. 1 to determine friction loss and the use of Fig. 2 to apply a correction for roughness.

Example 1. Assume that it is desired to circulate 10,000 cfm of air through 75 ft of 24 in. diameter galvanized duct. Find 10,000 cfm on the left scale of Fig. 1 and move horizontally right to the diagonal line marked 24 in. The other intersecting diagonal shows that the velocity in the pipe is 3200 fpm. Directly below the intersection it is found that the friction per 100 ft is 0.50 in.; then for 75 ft the friction will be 0.75 ×