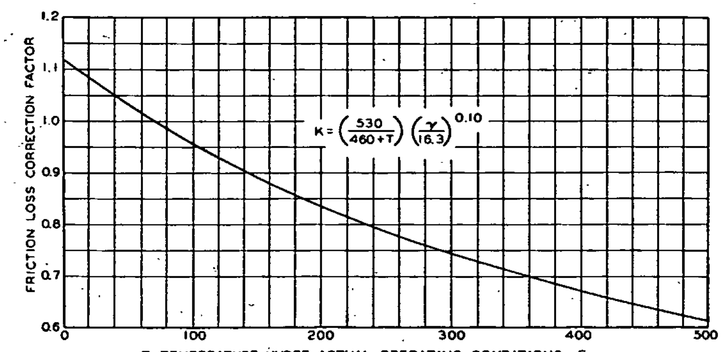

FIG. 4. CORRECTION FACTORS FOR DENSITY AND VISCOSITY

tion may be determined by multiplying the losses obtained from Figs. 2 and 3 by the factors found in Figs. 5 and 6.

Accurate experimental data on the absolute roughness for flexible tubing are not yet available. There is also little information on the friction loss in ducts lined with acoustical material. Until definite information is available, it is recommended to use the correction factor for very rough pipes for uncovered soft material, and for medium roughness for material behind perforated metal.

Example 1 illustrates the use of Fig. 3 to determine friction loss in a galvanized sheet-metal duct. *Examples 2, 3,* and *4* illustrate the use of

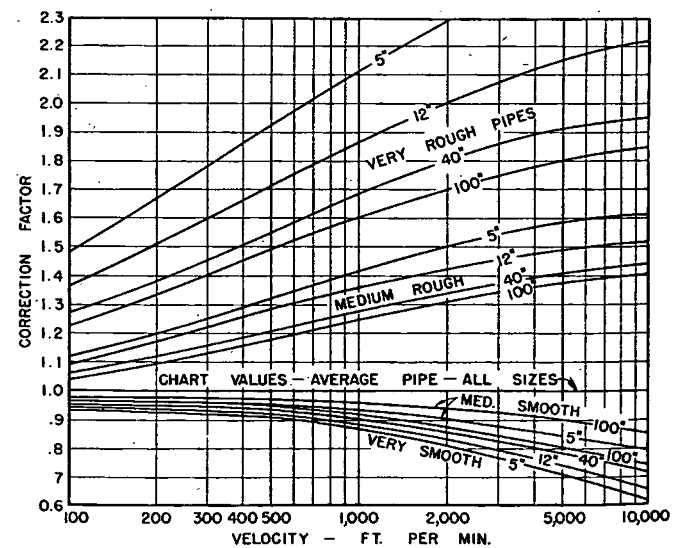

FIG. 5. CORRECTION FACTORS FOR PIPE ROUGHNESS

To correct for pipe roughness multiply friction loss obtained from Figs. 2 and 3 by correction factor obtained from Fig. 5.

Figs. 4, 5, and 6 in applying correction factors for ducts of other than sheet-metal construction and for air at high temperature.

Example 1: Determine the friction loss when circulating 10,000 cfm of air at standard density through 75 ft of 24 in. diameter galvanized duct.

Solution: Find 10,000 cfm on the left scale of Fig. 3 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 $0.75 \times 0.50 = 0.38$ in. In a like manner, any two variables may be determined by the intersection of the lines representing the other two variables.

Example 2: If the duct in *Example* 1 is very rough, instead of galvanized, with 40 joints per 100 ft, find the total friction.

Solution: On Fig. 5 find (by interpolation between 12 in. and 40 in. pipe) the intersection of the 24 in. *very rough pipe* line and the 3200 fpm velocity ordinate, and at the left margin read a correction factor of 2. The friction loss in the rough duct is therefore $2 \times 0.38 = 0.76$ in.

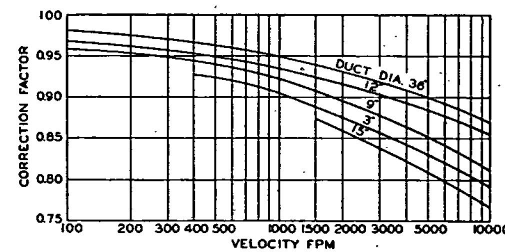

FIG. 6. CORRECTION FACTORS FOR ALUMINUM DUCT

Example 3: If the duct in *Example 1* is made of aluminum, instead of galvanized iron, find the total friction.

Solution: On Fig. 6 find (by interpolation between 12-in. and 36-in. pipe) the intersection of the 24-in. line and the 3200-fpm velocity ordinate, and at the left margin read a correction factor of 0.91. The friction loss in the aluminum duct is therefore $0.91 \times 0.38 = 0.35$ in.

Example 4: Determine the friction loss in the duct of *Example 1*, if the temperature of the air transmitted through the duct is 200 F.

Solution: For $t = 200$ F, the density of the air is $\rho_o = 0.060$ lb per cu ft. Hence, the actual air flow rate in the duct is

$$Q_o = \frac{10{,}000 \times 0.075}{0.060} = 12{,}500 \text{ cfm}$$

and the actual velocity

$$V = \frac{Q_o}{A} = \frac{12{,}500}{3.14} = 4{,}000 \text{ fpm}$$

With $Q_o = 12{,}500$ and $D = 24$ in., find $h_o = 0.77$ in. of water per 100 ft in Fig. 3 and $K = 0.835$ in Fig. 4. The friction loss under actual operating conditions is:

$$h_o = 0.835 \times 0.77 = 0.64 \text{ in. per 100 ft.}$$

The friction loss for 75 ft is then $0.75 \times 0.64 = 0.48$ in.