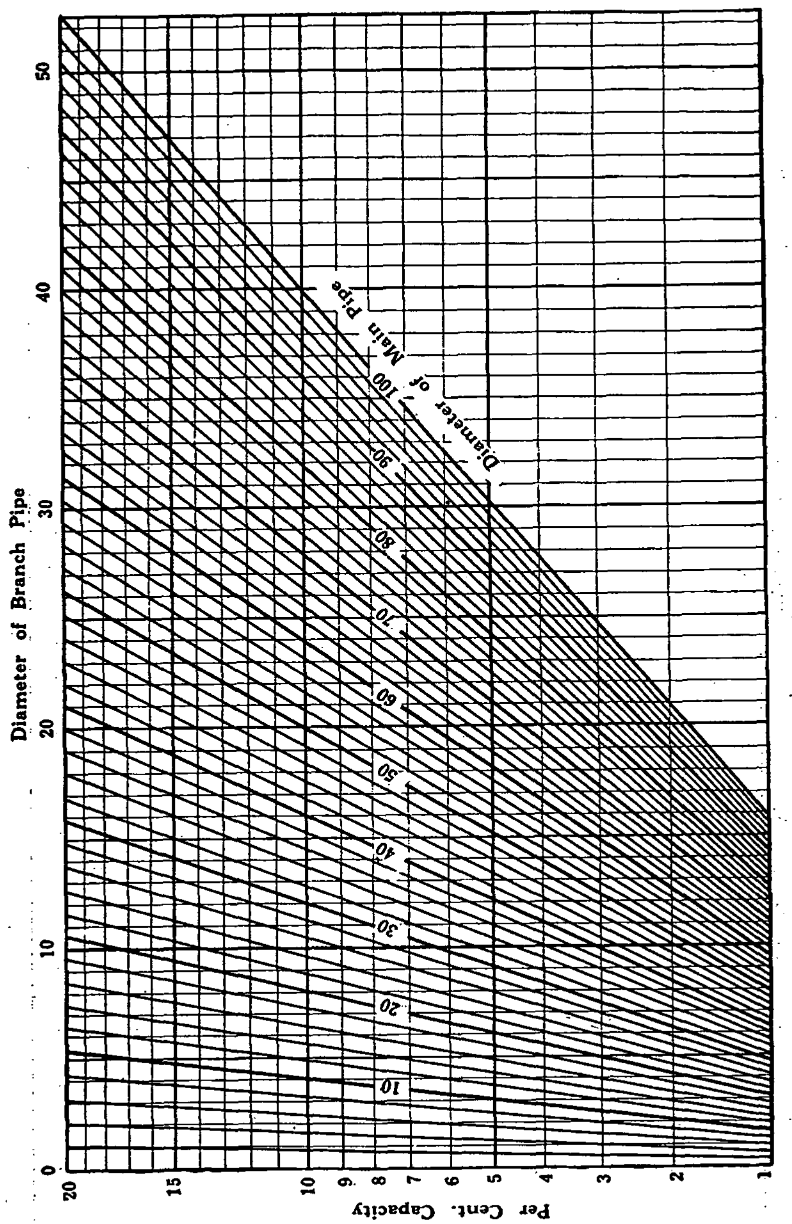

Fig. 2. Main and Branch Pipes for Equal Friction per Foot of Length

ducts; and $C = 45$ for smooth and 40 for rough conduits of tile, brick or concrete.

The value of f and C given, not only vary with the roughness of the inside surface of the pipe, but also with the diameter and velocity. The coefficient of friction f decreases with both increase of diameter and velocity. It should also be noted that the coefficient of friction varies directly with the air density and approximately inversely as the absolute temperature.

The chart shown (Fig. 1) will be found very convenient to determine the friction for a given air capacity in various size ducts at corresponding velocities. The coefficient of friction has been corrected for the various diameters and capacities, based on the rule that the coefficient of friction varies inversely as the 2/7 power of the diameter, and inversely as the 1/7 power of the capacity. This chart is based on a loss of one velocity head (at 2000 velocity) in a length equal to 50 diameters of 24-in. galvanized swedged pipe.

As an example of the use of the chart, assume that it is desired to pass 10,000 cu. ft. of air per minute through 75 ft. of 24-in. diameter pipe. Find 10,000 cu. ft. of air per minute on the right scale and move horizontally left to the diagonal line marked 24 in. The other intersecting diagonal shows that the velocity in the pipe is 3200 ft. per minute. Directly below the intersection it is found that the friction per 100 ft. is 0.59 in., then for 75 ft. it will be $0.75 \times 0.59 = 0.44$ in. In a like manner any two variables may be determined by the intersection of the lines representing the other two variables.

Other losses of pressure are at the entrance to the duct, through heater, air washer, etc. In ordinary practice it is usual to keep the sum of the piping losses ⅓ to ¼ and the loss through heater at less than ½ of the static pressure. The remainder is then available for producing velocity.

The ideal duct system will take all factors into consideration and proportion air velocities so that the resistance will be practically equal in all ducts regardless of length.

Friction in Elbows

Experience has shown that with an elbow of radius $R = 1\frac{1}{2}D$ fairly good results may be obtained. The loss with such an elbow will be about 17 per cent of a velocity head for round ducts and about 8 per cent of a velocity head for square ducts. It has been found of little or no advantage in making an elbow or radius greater than two diameters. If, however, a smaller radius than $1\frac{1}{2}D$ be used, the losses increase rapidly. For instance, the loss for an elbow of $R = 1\ D$ will be as high as 17.5 per cent of a velocity head for a square duct and 25.5 per cent for round ducts.

For ordinary calculations one easy long radius elbow ($R = 1\frac{1}{2}D$) in a circular pipe may be considered as equal in friction loss to 10 diameters of straight pipe.

Proportioning the Size for Friction

It is often found convenient to size pipes for different capacities but having the same friction per foot of length. Such a system may be used in any supply system, and is advantageous from the point of view that the