

Example 1. Assume that it is desired to circulate 10,000 cfm of air through 75 ft of 24 in. diameter pipe. Find 10,000 cfm on the right scale of Fig. 2 and move horizontally left 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 0.59 in.; then for 75 ft the friction 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.

Circular Equivalents of Rectangular Ducts

Where rectangular ducts are used it is frequently desirable to know the equivalent diameter of round pipe to carry the same capacity and have the same friction per foot of length. Table 1 gives directly the circular equivalents of rectangular ducts for equal friction and capacity, which are based on values determined from Formula 6:

$$d = 1.265 \sqrt{\frac{(ab)^2}{a+b}} \quad (6)$$

where

a = one side of rectangular pipe, feet or inches.

b = other side of rectangular pipe, feet or inches.

d = equivalent diameter of round pipe for equal friction per foot of length to carry the same capacity, feet or inches.

Rectangular equivalents of round ducts are also given in the curves of Fig. 3 which are plotted from data based on Formula 6. To use the chart, locate the curve giving the diameter of the round duct. The width and height of an equivalent rectangular duct may then be read as abscissa and ordinate of any point of the curve.

Since the friction chart, Fig. 2, and Table 1 were prepared, further research on duct friction under the direction of the A.S.H.V.E. Research Technical Advisory Committee on Air Distribution and Air Friction indicates lower pressure loss values than given in Fig. 2. Included in the work by this Committee is a revision of Fig. 2 and Table 1 to bring them into conformity with recent tests. Pending acceptance by the Society of the Committee's report, the friction chart and the table on circular equivalents of rectangular ducts for equal friction presented in earlier editions of the GUIDE have been retained.

Multiplying or dividing the length of each side of a pipe by a constant is the same as multiplying or dividing the equivalent round size by the same constant. Thus, if the circular equivalent of an 80 x 24-in. duct is required, it will be twice that of a 40 x 12-in. duct, or $2 \times 23.3 = 46.6$ in.

TABLE 1. CIRCULAR EQUIVALENTS OF RECTANGULAR DUCTS FOR EQUAL FRICTION

SIDE RECTANGULAR DUCT	8	8.5	9	9.5	10	10.5	11	11.5	12	12.5	13	13.5	14	14.5	15	15.5	16
3	5.2	5.4	5.5	5.7	5.8	5.9	6.0	6.2	6.3	6.4	6.5	6.6	6.7	6.8	6.9	7.0	7.1
3.5	5.7	5.9	6.0	6.2	6.3	6.5	6.6	6.7	6.9	7.0	7.1	7.3	7.4	7.5	7.6	7.7	7.8
4	6.1	6.3	6.5	6.7	6.8	7.0	7.1	7.2	7.4	7.5	7.7	7.8	7.9	8.1	8.2	8.3	8.4
4.5	6.5	6.7	6.9	7.1	7.2	7.4	7.6	7.7	7.9	8.0	8.2	8.4	8.5	8.6	8.7	8.9	9.0
5	6.9	7.1	7.3	7.5	7.7	7.8	8.0	8.2	8.3	8.5	8.7	8.8	8.9	9.1	9.2	9.4	9.5
5.5	7.3	7.5	7.7	7.8	8.1	8.3	8.5	8.6	8.8	9.0	9.2	9.4	9.5	9.6	9.8	9.9	10.1

Elbow Friction Losses

It is customary to express the dynamic and friction losses in elbows as equal to a number of diameters of round pipe or a number of widths of rectangular pipe. The curves in Fig. 4 are arranged to read the number of diameters or widths for determining the lineal feet of pipe having a frictional resistance equivalent to the pressure drop in the elbows. Curves B and C are based on tests of round and square elbows² of ordinary good sheet metal construction having a surface factor of $C = 50$.

Values obtained from Curve A should be used when there is any doubt as to quality of duct construction. It is suggested that this curve be used for rectangular elbows and five piece elbows as it will thus allow an additional factor of safety without seriously affecting the design.

As indicated on the chart, long radius elbows will offer much less resistance to the flow of air than short radius elbows. Experience has

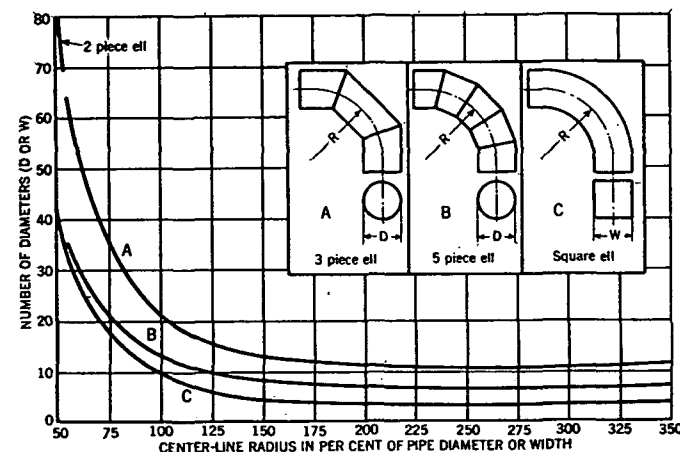


FIG. 4. LOSS OF PRESSURE IN ELBOWS

shown that good results may be expected when the radius to the center of the elbow is 1.5 times the pipe diameter or duct width parallel to the radius. Examination of the curve will indicate that little advantage is to be gained by selecting elbows having a centerline radius of more than two diameters³. Elbows having a radius of more than three diameters show a slightly increased resistance due to the increased length of pipe but, when used, they reduce the overall resistance of the system and therefore should not be avoided.

Where space conditions necessitate the use of short radius or square throat elbows in rectangular duct work, turning vanes should be used to reduce the pressure losses. Rough or raw edges on the vanes should be

¹Loss of Pressure Due to Elbows in the Transmission of Air Through Pipes or Ducts, by F. L. Busey (A.S.H.V.E. TRANSACTIONS, Vol. 19, 1913, p. 366).

²Pressure Losses in Rectangular Elbows, by R. D. Madison and J. R. Parker (Heating, Piping and Air Conditioning, July, p. 365, August, p. 427, September, p. 483, 1936).