

deducted, the available duct-work pressure loss is 0.08 in. Assuming that the branch take-off loss is equivalent to 10 ft of duct, the total equivalent length is 20 ft. The required friction loss is $0.08 \times (100/20) = 0.40$. With this unit friction loss and a flow rate of 750 cfm, Fig. 2 yields a diameter of 9.4 in. and a velocity of 1580 fpm. An equivalent rectangular size is 9×8 in.

Comparing these results with those in Table 7, it is evident that the modified method has reduced the size of Section D somewhat and that of Section E considerably. The reduced sizes accomplish more economically what would otherwise have to be done with dampers.

TABLE 7. TABULATION OF RESULTS (Example 6)

SECTION	FLOW RATE cfm	FRICTION PER 100 FT. IN. OF WATER	DUCT DIAM. INCHES	VELOCITY fpm	RECTANGULAR DUCT INCHES
A	2500	0.2	17.0	1600	20 x 12
B	1750	0.2	14.8	1480	15 x 12
C	1000	0.2	12.0	1290	15 x 8
D	750	0.2	10.7	1190	12 x 8
E	750	0.2	10.7	1190	12 x 8

Static Regain Method

Consider a straight run of duct with several branch take-offs attached. The flow rate of air along the run is progressively reduced by the amount diverted into each successive take-off. If, for example, the size of the run were the same throughout its length, the velocity would become progressively less in accordance with Equation 3. When velocities are reduced, a conversion of velocity pressure into static pressure occurs (as well as a loss in total pressure). The principle of the *static regain* method is to size a duct run so that the increase in static pressure (regain) at each take-off junction just offsets the pressure loss of the succeeding section of the run.

The method provides a convenient means of designing a long run of duct having several take-offs so that essentially the same static pressure exists at the entrance to each branch. If, instead of branch ducts, supply outlets are connected directly to the run, then essentially the same static pressure will exist behind each outlet. As a consequence, outlet selection and system balancing is simplified. The method is particularly suited to large installations having several long runs of duct, with each run having many take-offs or supply outlets attached. For this type of application, little or no dampening is ordinarily required to balance the system.

The initial velocity in the main duct is selected from noise and pressure loss considerations, and the branch ducts are sized by the modified equal friction method.

If the distance between branch take-offs is either very small or very great, it may not be feasible or economically desirable to design for the same static pressure at each junction. In such cases, the method can be used to size the main for either a progressively lower static pressure (net static pressure loss) or a progressively higher pressure (net static pressure gain).

If no friction or dynamic losses occurred at the junction, there would be no loss in total pressure, and the change in velocity pressure would be completely converted into a regain (rise) in static pressure, which for standard air would be:

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$$P_t = \left(\frac{V_1}{4005} \right)^2 - \left(\frac{V_2}{4005} \right)^2 \quad (12)$$

where

P_t = theoretical static pressure regain, inches of water.

V_1 = velocity in main upstream of branch, feet per minute.

V_2 = velocity in main downstream of branch, feet per minute.

Under the best practice, 0.7 to 0.8 of the change in velocity pressure is actually recovered, but for practical design an average recovery of 0.5 is assumed. Hence, the actual regain P_r is:

$$P_r = 0.5 \left[\left(\frac{V_1}{4005} \right)^2 - \left(\frac{V_2}{4005} \right)^2 \right] \quad (13)$$

Design charts based on Equation 13 and rectangular ducts having aspect ratios of 3 to 1 or less are presented in Figs. 14 and 15.

The *duct length* of any section should include the equivalent length of any elbows or transitions within the section. The charts apply to constructions where regain takes place unaccompanied by radical change in direction; namely, to *straight-through sections* of divided-flow fittings.

Example 7: (Static-Regain Method). The duct shown in Fig. 13 handles 8000 cfm. Determine the duct sizes in Section A, B, C, D, E, F and G, maintaining an operating pressure of 0.12 in. water in the duct behind each outlet. Find the total pressure loss of the system.

Solution: The following nine steps indicate the solution:

1. Assume the velocity in Section A to be 1500 fpm. This results in an initial duct size of 48×16 in. The 16 in. duct depth will be maintained throughout the system.
2. The circular equivalent of a 48×16 in. duct is 29.2 in. (from Table 2), and with 8000 cfm flowing in this duct, the friction loss from Fig. 3 is 0.13 in. per 100 ft.
3. To size the branch ducts, determine the shortest equivalent length of duct up to the first outlet. Section B = 25 ft; Section F = 10 + equivalent length of elbow. Assume the width of the duct in Section F to be 15 in.; therefore $H/W = 15/16 = 0.94$. Also the radius of the elbow should not be less than the width ($R/W = 1.00$), resulting in an equivalent length L , from Fig. 8, of $10 \times 15/12 = 12.5$ ft. Equivalent length of Section F = $10 + 12.5 = 22.5$ ft. Therefore, Section F being shorter than Section B, size Section F first, using the same friction rate as in Section A, 0.13 in. per 100 ft. In Fig. 2, with 2000 cfm and a friction rate of 0.13 in., find an equivalent diameter of 17 in. for Section F. The rectangular equivalent of a 17 in. duct is 15×16 in. (from Table 2), resulting in a velocity of 1200 fpm.

Note: The shorter equivalent length line is sized first to prevent velocities in other branches from exceeding recommended values.

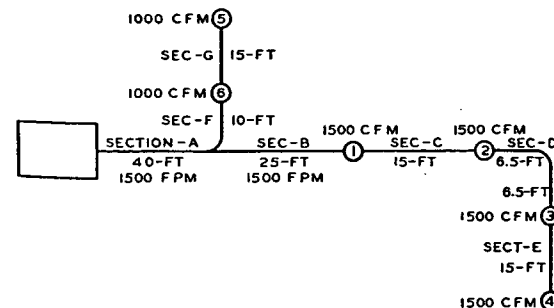


FIG. 13. DUCT LAYOUT FOR EXAMPLE 7