duct runs containing numerous successive outlets (usually designated the *outlet run*). An outlet run is typified by Sections C–D–E in Fig. 12. On larger systems several methods of duct sizing may be combined to secure equal or approximately equal pressures at all outlets. Example 5 shows the method of approach as applied to a very small system.

As with any other method of duct design, balancing dampers should be installed in each branch, and each outlet should be equipped with means of regulating air volume.

Example 5. (Static Regain Method). A duct layout is shown in Fig. 12. The fan delivers 8000 cfm. Outlets 1, 2, 3 and 4 deliver 1500 cfm each, and outlets 5 and 6, 1000 cfm each. The operating pressure loss at all outlets is 0.12 in. water. Initial trunk velocity is assumed as 1500 fpm; the area of the trunk duct will then be 5.33 sq ft, and the size will be 48 x 16 in. It is assumed that for this example it is desirable to maintain a 16 in. depth on all duct sections. Determine the sizes of duct sections B, C, D, E, F and G so that substantially the same static pressure will be obtained at each of the outlets, and find the total pressure loss of the system.

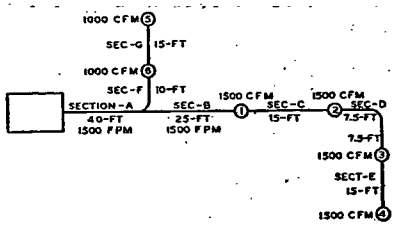


FIG. 12. DUCT LAYOUT FOR EXAMPLE 5

Solution.

1. Size Section F by the equal friction method so that it has the same rate of friction loss as Section A. Section A is equivalent to a 29.2 in. round duct (Table 2) and the pressure loss from Fig. 2 is 0.13 in. per 100 ft. For 2000 cfm flowing at this rate of pressure loss, the indicated round duct diameter for Section F is approximately 17 in. (Fig. 2). This is equivalent to a 15 x 16 in. duct, which will be used for Section F. The velocity in Section F will be 1200 fpm.

2. Determine the pressure loss in Section F. Actual length of duct is 10 ft; equivalent length of elbow take-off is assumed (Fig. 5) as 10 W, or 12.5 ft. Therefore, total equivalent length is 22.5 ft. The pressure loss in F = 0.13 in. $\times \frac{22.5}{100}$ = 0.03 in. water.

3. Using Static Regain Chart, Fig. 11, size Section B for a net pressure loss equal to the loss in F, or 0.03 in. water as follows:

The operation is indicated by arrow heads on the dotted line on Fig. 11. On Fig. 11, start at the velocity in Section A (1500 fpm) at left margin. Proceed horizontally to 6000 cfm ordinate, and then run parallel to the curved lines to intersect the diagonal Base Line. From this point, rise vertically to the 0.03 net static pressure loss line, and from this intersection proceed horizontally to the Air Velocity Base Line. Proceed parallel to curved lines to intersect ordinate for 25 ft equivalent duct length, and then move horizontally to left margin and read the velocity (1500 fpm).

Since Section B carries 6000 cfm, the area required will be $\frac{6000}{1500}$ = 4 sq ft, and the size of duct will be 36 x 16 in.

4. Using Static Regain Charts (Figs. 10 and 11) determine size of Sections C, D, E and G, but instead of allowing 0.03 in. net loss, which was used for Section B, proceed from the diagonal Base Line vertically to the *no gain or loss* diagonal. The procedure for Section E is shown by the dotted line and arrows on Fig. 10: starting from 1040 fpm velocity, which is the velocity in Section D.

Table 7 is a tabulation of the duct sizes as determined.

TABLE 7. TABULATION OF RESULTS (EXAMPLE 5)

Section	Air Volume cfm	Equivalent Length ft	Velocity fpm	Rectangular Duct in.	Diam. in.	Friction Per 100 ft in. H_2O	Net Pressure Loss in. H_2O
A	8000	40	1500	48 x 16	29.2	0.13	.05
B	6000	25	1500	36 x 16	—	—	.03
C	4500	15	1300	31 x 16	—	—	0
D	3000	26[a]	1040	26 x 16	—	—	0
E	1500	15	860	16 x 16	—	—	0
F	2000	22.5	1200	15 x 16	17.	0.13	.03
G	1000	15	900	10 x 16	—	—	0

[a] Includes equivalent length of elbow between outlets 2 and 3, which is assumed (see Fig. 5) as 5.5 W, or 11 ft equivalent length of duct. (Based on 3000 cfm at estimated velocity of 1100 fpm).

5. Total pressure loss of the system is the loss in Section A, plus the loss in Section F (or B), plus the loss in the outlet.

Loss in Section A = 0.13 in. $\times \frac{40}{100}$ = 0.05
Loss in Section F (or B) = 0.03
Outlet Loss = 0.12
Total Pressure Loss = 0.20 in.

DUCT CONSTRUCTION DETAILS

Straight sections of round duct are usually formed by rolling the sheets to the proper radius and grooving the longitudinal seam. Rectangular ducts are generally constructed by breaking the corners and grooving the longitudinal seam, although some fabricators still use the standing seam due to lack of equipment. Elbows and transformation sections are generally formed with *Pittsburgh* corner seams because this seam is easier to lock in place than the double seam, but complicated fittings such as double compounded elbows are usually constructed with double seam corners. The construction of these various seams, as well as the types of girth connections, are shown in Fig. 13. The application of the various slips and connections is outlined in Table 8. The end slip may be used wherever *S* slips are recommended. Where drive slips are used, the end slip may be applied on the narrow side of the duct, and the drive slips on only the maximum side. Ducts 25 to 30 in. in size should be reinforced between the joints, but not necessarily at the joint. Ducts 31 in. and up should be reinforced at the joint and between the joints; if drive slips are used the angles are usually riveted to the duct about 2 in. from the slips. It is good practice to cross-break or kink all flat surfaces to prevent vibration or buckling due to the air flow and accompanying variations in internal pressure.

The construction of elbows and changes of shape cannot be definitely outlined because of the varied conditions encountered in the field, but in general, long radius elbows and gradual changes in shape tend to maintain uniform velocities accompanied by decreased turbulence, lower resistance and a minimum of noise.

Heavy canvas connections (asbestos cloth if there is a fire hazard) are recommended on both the inlet and outlet to all fans. Self-vulcanizing adhesive tapes are available for this purpose and for sealing joints in duct work. The fan discharge connections shown in Fig. 13 are marked *good*, *fair*, and *poor* in the order of the amount of turbulence produced. An