

The pressure at the outlets nearest the fan will be greater than at the pipes farther along the run so that the former will tend to deliver more than the calculated amount of air. To remedy this condition, volume regulating dampers should be located at the base of each riser and adjusted for proper distribution. At points where branches leave the main it may be advisable, depending upon the nature of the installation, to install adjustable splitters similar to that shown in Fig. 6 where the main duct divides into the 58 in. $\times$ 30 in. and 50 in. $\times$ 30 in. branches.

The rectangular equivalents are selected from Table 1; the width to depth proportion will be determined by construction requirements and ease of fabrication. The calculation of the friction is as follows:

The longest run from the fan outlet to diffuser is 150 ft 0 in.; 150 ft of 56-in. pipe is equivalent to $\frac{150 \times 12}{56}$ 32.2 dia.

Two 45-in., 90-deg elbows ($2 \times \frac{45}{56} \times 8.5$) 13.7 dia.

(Assume each elbow equivalent to 8.5 diameters of duct, Fig. 1.)

Two 23-in., 90-deg elbows ($2 \times \frac{23}{56} \times 8.5$) 7.0 dia.

Two 23-in., 90-deg elbows in riser ($2 \times \frac{23}{56} \times 30$) 24.7 dia.

(Two bad elbows in riser, each equivalent to 30 diameters of duct).

Total diameter of 56-in. pipe 77.6

The velocity head corresponding to a velocity of 1340 fpm is $\left(\frac{1340}{4005}\right)^2 = 0.112$ in.

Taking 50 diameters as one head loss, then $\frac{77.6}{50} \times 0.112 = 0.174$ in. static loss in duct.

Where the connection pieces are made with long easy slopes and the general workmanship is good, a regain in static pressure may be deducted from the foregoing pressure loss. This can be taken as approximately two-thirds the difference in velocity pressures at the fan outlet and the last run of pipe. The velocity in the riser is 667 fpm with a corresponding velocity pressure of 0.027 in. The fan outlet velocity is 1400 fpm with a corresponding velocity pressure of 0.122 in. The regain equals $\frac{2}{3} (0.122 - 0.027) = 0.063$ in.

The net static pressure loss in the duct is:

0.174 in. - 0.063 in. 0.111 in.

Other friction losses are as follows:

- (1) Fresh air intake 1000-fpm velocity ($1\frac{1}{2}$ heads $\times$ 0.0625) 0.094 in.
- (2) Tempering coil loss (from manufacturer's tables) 0.100 in.
- (3) Air washer loss (from manufacturer's tables) 0.250 in.
- (4) Reheating coil loss (from manufacturer's tables) 0.100 in.
- (5) Allowance for regulating dampers and diffusers 0.100 in.

Static pressure loss of system 0.755 in.

The fan should be selected from the manufacturer's ratings which, according to the Standard Test Code for Disc and Propeller Fans, Centrifugal Fans and Blowers¹, will deliver 22,935 cfm at a static pressure of 0.755 in. and which has an outlet area of 16 $\frac{1}{2}$ sq ft.

The method of design used in Example 3 is the *equal friction method* described under the heading Procedure for Duct Design. This involves

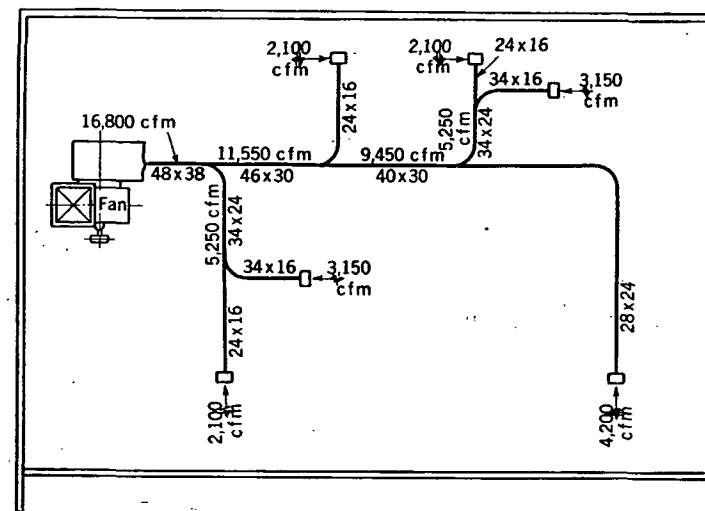


FIG. 7. EXHAUST SYSTEM LAYOUT

the arbitrary reduction of velocity from the fan outlet to the point of discharge to the room, and the friction is calculated by adding the pressure losses of each section of duct. This method requires dampening in the risers and supply branches in order that equalization of air flow can be attained.

Example 4. Fig. 7 shows an exhaust system layout for exhausting from buildings of the same type as in Example 3. Assume the air requirements based on the number of air changes per hour to be 16,800 cfm. Using a velocity of 1400 fpm in the main duct at the fan inlet, which is an average velocity for this type of system, the area of the main is 12 sq ft, which corresponds to a 47-in. pipe. Referring to Example 3, and using the charts, Figs. 4 and 5, the pipe sizes are as indicated in Table 3 for both round and rectangular ducts.

TABLE 3. PIPE SIZES FOR EXAMPLE 4^a

VOLUME OF AIR (CFM)	PER CENT OF TOTAL VOLUME	DIAMETER OF PIPE (INCHES)	EQUIVALENT SIZE OF RECTANGULAR DUCT (INCHES)
16,800	100.0	47	38 x 48
11,550	68.8	41	30 x 46
9,450	56.2	38	30 x 40
5,250	31.3	31	24 x 34
4,200	25.0	28.5	24 x 28
3,150	18.8	25.3	16 x 34
2,100	12.5	21.6	16 x 24

^aVelocity through intake grilles (not shown) to be approximately 400 fpm.

¹See Chapters 27 and 45.