

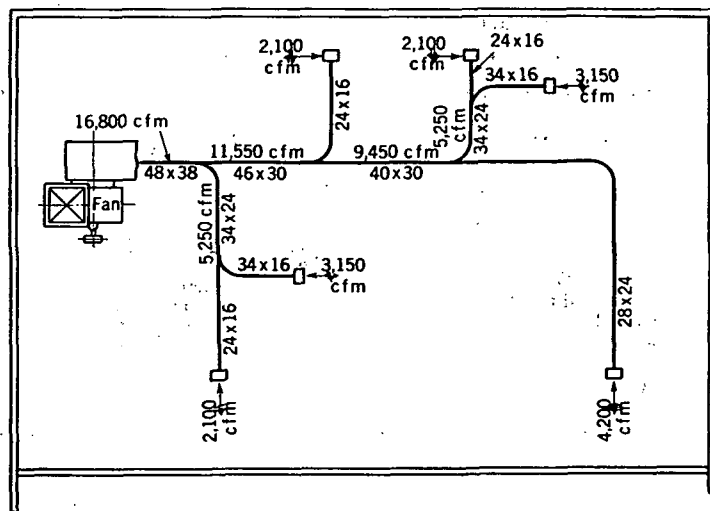


FIG. 5. EXHAUST SYSTEM LAYOUT

All risers will require dampering as in Example 3. The calculation of the friction is as follows:

The longest run from the intake grille to fan inlet is 100 ft.

(1) Duct friction 100 ft of 47-in. pipe $\left(\frac{100 \times 12}{47}\right)$	25.6 diam
Two 28½-in., 90-deg elbows in riser $\left(\frac{2 \times 28.5 \times 30}{47}\right)$	36.4 diam
(Two bad elbows in riser each equivalent to 30 diameters of duct.)	
One 28½-in., 90-deg elbow in horizontal run $\left(\frac{28.5 \times 8.5}{47}\right)$	5.2 diam
Total diameter of 47-in. pipe	67.2 diam

Velocity head corresponding to 1400 fpm is $\left(\frac{1400}{4005}\right)^2 = 0.122$ in.

Taking 50 diameters as one head loss, then $\frac{67.2 \times 0.122}{50}$ 0.164 in.

(2) Intake loss from grille (1½ heads at a 400 fpm velocity $1\frac{1}{2} \times 0.01$)	0.015 in.
(3) Loss occasioned by step-up of velocity (0.20×0.122)	0.024 in.
(This loss varies from 0.05 to 0.40 velocity head depending upon the nature of the change. For average systems 0.20 velocity head is a close approximation.)	
(4) Square elbow turned into fan (1.0 head at 1400 fpm velocity)	0.122 in.

Static pressure loss on inlet side 0.325 in.

To this must be added the resistance on the discharge side of the fan. A fan outlet velocity of approximately 1500 to 1600 fpm may be used. Assuming the fan outlet to be equivalent in area to a 45-in. pipe, the velocity is 1525 fpm.

Loss on discharge (15 ft from fan outlet to discharge):

$$\frac{15 \times 12}{45} = 4 \text{ diam of 45-in. pipe.}$$

The velocity head corresponding to a velocity of 1525 fpm is 0.145 and the discharge-side loss is $\frac{0.145 \times 4}{50} = 0.012$ in. The total static pressure loss of the system is then:

$$0.012 + 0.325 = 0.337 \text{ in.}$$

The fan will be selected to handle 16,800 cfm at a static pressure of 0.337 in. and to have an outlet velocity of 1525 fpm. Outlet area 11 sq ft.

The method of design used in Examples 3 and 4 is the equal friction method described under the heading Procedure for Duct Design. After the friction for the longest run of duct is determined, the size of the sub-branches may then be calculated based on the friction for the longest length of run to approach equal friction for all lengths of run.

After the total air quantity and the size of fan are ascertained, the main duct is usually fixed as being at least equal in area to the fan outlet, or perhaps 10 per cent greater. From this main pipe all others are proportioned. For example, if the main duct is 30 in. in diameter, a branch to carry 10 per cent of the total capacity should be 12.7 in. in diameter (see Fig. 3) in order to have the same friction per foot of length, while one carrying one-half the total capacity of a 30-in. main with the same friction loss per foot would be 23.4 in. in diameter. By this method of equalizing friction it is unnecessary to consider the resistance of each section of pipe independently, but only to know the distance from the fan outlet to the end of the longest run of pipe, the number and size of elbows, and the diameter and velocity in the largest pipe.

Frequently the problem of sound prevention in a heating, ventilating or air conditioning system imposes more severe restrictions than the prevention of excessive pressure drop. Tendencies toward higher duct velocities have produced noise control problems which require consideration of enumerable factors in air duct design. Naturally some types of occupancy and application permit relatively higher sound levels to be maintained than others, but the design trend is progressively directed towards noise reduction wherever possible. Sound absorbent materials have been successfully applied to duct construction to reduce noise. The basis used for the selection of the proper amounts of absorbent materials will be found in Chapter 31.

DUCT CONSTRUCTION DETAILS

If panel construction is used with standing seams or similar reinforcement, and the panels are cross-broken to give rigidity, there is less likelihood of vibration due to air flow, or deflection due to air pressure. Elbows made without splitters, and improperly shaped transformation sections produce high local velocities which are the cause of noise in duct work. The use of first class duct construction with well designed transformation sections and splitters in elbows tends to maintain relatively uniform velocities with decrease in turbulence and in the noise produced.