

the system to secure the desired amount of air in each space. There are a number of ways in which this may be accomplished, some of which are:

1. Dampers on the supply and return faces.
2. Dampers in the supply and return ducts.
3. Reducing the effective area of some supply openings by blank-offs.
4. Combinations of dampers in both supply and return air.

Dampers on the supply faces themselves are objectionable unless of special design, because of their effect on the air stream and noise. Dampers on the return faces are frequently objectionable because of noise. A damper in the supply duct at some distance back of the supply opening forms a very satisfactory means of regulating the flow without disturbing distribution across the supply opening face. A damper in the return air duct has the advantage over one immediately behind the face in that it does not tend to create high localized velocities through the face as the latter might do if nearly closed. Blank-offs consisting of pieces of sheet metal covering a portion of the supply opening face are frequently used. Results are often unsatisfactory due to high velocity through the remaining open portion of the grille. Determination of just what is required is a matter of experiment, and the balancing of the system is not nearly so conveniently accomplished as with dampers. Dampers in both supply and return air form the most flexible means of controlling the supply to the room and the static pressure within the room. When feasible, these dampers, particularly those in the supply ducts, should be a substantial distance from the supply opening, and ahead of the acoustical duct lining if used. Due consideration should also be given to the use of the several volume control and uniform distribution devices now available. See *Catalog Data Section*.

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Air Duct Design

Pressure Losses, Friction Losses, Friction Loss Chart, Equivalent Circular and Rectangular Ducts, Elbow Friction Losses, Proportioning the Losses, Duct Sizes, Procedure for Duct Design, Velocities, Main Trunk Ducts, Velocity Method, Equal Friction Method, Duct Construction Details, Duct Heat Loss and Insulation

THE theoretical resistance of an air handling system can be computed from the methods and data given in this chapter. The actual resistance for any given installation, however, may vary considerably from the calculated resistance because of variation in the smoothness of materials, the type of joints used and the ability of the mechanics to fabricate in accordance with the design. It is best to select fans and motors of sufficient size to allow a factor of safety. Volume dampers should be installed in each branch outlet to balance the system, and the necessary allowance for this balancing should be made in calculating the pressure loss in the system.

The flow of air due to large pressure differences is most accurately stated by thermodynamic formulae for air discharge under conditions of adiabatic flow, but such formulae are complicated, and the error occasioned by the assumption that the gas density remains constant throughout the flow may be considered negligible when only such pressure differences are involved as occur in ordinary heating and ventilating practice.

The rate of flow of air in a duct may be obtained from Equation 1, which is developed as Equation 70 in Chapter 4:

$$V_m = 1096.5 \sqrt{\frac{h_w}{\rho_a}} \quad (1)$$

where

V_m = velocity of fluid, feet per minute.

h_w = velocity head or pressure, inches of water.

ρ_a = density of air, pounds per cubic foot.

For dry air (69.41 F and 29.921 in. Hg barometer) $\rho_a = 0.075$ lb per cubic foot¹. Substituting this value in Equation 1:

$$V_m = 1096.5 \sqrt{\frac{h_w}{0.075}} = 4005 \sqrt{h_w} \quad (2)$$

The relation of air velocity and velocity head expressed in Equation 2 is shown diagrammatically in Fig. 1 for dry air at 69.41 F and 29.921 in. Hg barometer.

The drop in pressure in air distributing systems is due to the *dynamic* losses and the *friction* losses. The friction losses for turbulent flow (which occur in all practical air flow problems) are due to the friction of air against the sides of the duct and to internal friction between air molecules. The dynamic losses are those due to the change in the direction or in the velocity of air flow.

Dynamic losses occur principally at the entrance to the piping, in the elbows, and wherever a change in velocity occurs. The entrance loss is the difference between the actual pressure required to produce flow and the pressure corresponding to the flow produced; it may vary from 0.1 to