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CHAPTER 31

AIR DUCT DESIGN

Pressure Changes, Friction Losses, Circular Equivalents of Rectangular Ducts, Dynamic Losses, Pressure Losses in Elbows, Pressure Losses in Divided-Flow Fittings, Losses Due to Area Changes, Duct Design Methods and Examples, High-Velocity Duct Design, Duct Construction Details, Heat Losses from Ducts

IN THE design of air duct systems, the objective is to provide a system that, within prescribed limits of noise and space available for ducts, efficiently transmits the required flow rate of air (cfm) to each space while maintaining a proper balance between investment and operating cost. When the heating, cooling or ventilation load is established, the total flow rate of air required can be determined by methods shown in Chapters 12 and 13. The problem is then to distribute the supply air properly among the spaces.

PRESSURE CHANGES

Ductwork imposes resistance to air flow which must be overcome by the expenditure of mechanical energy; this energy is ordinarily supplied by a fan. The portion of the air flow rate from the fan that is transmitted to a particular space is governed by the law that the loss in total pressure from the fan outlet must be the same along each air path. This also holds for the return-air system except that the loss in total pressure refers to the fan inlet. In air conditioning and ventilating work the pressure differences are ordinarily so small that the equations for incompressible flow can be applied. Additional simplicity is obtained by considering the air to be at the standard density of 0.075 lb per cu ft.

At any cross section in a duct the total pressure H is the sum of the static pressure P and the velocity pressure H_v. Thus,

$$H = P + H_v \tag{1}$$

Pressures are considered in units of inches of water. The velocity pressure is then given by

$$H_v = \left(\frac{V}{4005}\right)^2 \tag{2}$$

where V is defined by the equation

$$V = \frac{Q}{A} \tag{3}$$

where

V = mean velocity of flow, feet per minute.
Q = air flow rate, cubic feet per minute.
A = cross-sectional area of duct, square feet.

The total pressure H is a measure of the total mechanical energy at a cross section. In any duct system, the total pressure always decreases in