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CHAPTER 31

AIR DUCT DESIGN

Pressure Losses, Friction Losses, Circular Equivalents of Rectangular Ducts, Dynamic or Shock Losses, Pressure Loss in Elbows, Losses Due to Area Changes, Pressure Changes, Duct Design, Methods and Examples, Duct Construction Details, Heat Losses from Ducts, Maintenance

AIR ducts for the transmission of the air in forced air heating, ventilating, cooling or air conditioning systems must be carefully designed for functional as well as economical reasons. The design should be based upon the fundamental laws of fluid flow in pipes, and should take into account recent analytical and experimental studies which complement and substantiate the fundamental laws. The basic equations of the flow of fluids will be found in Chapter 4, Fluid Flow.

PRESSURE LOSSES

Air ducts impose resistances to air flow which must be overcome by pressure differences resulting from the expenditure of energy in maintaining the flow. In ventilating and air conditioning work the flow of air takes place under very small pressure differences, and the assumption that the gas density remains constant throughout the flow will cause only a negligible error. It is therefore possible to use the equation for incompressible fluids (liquids) for the flow of air in a duct, instead of the complicated thermodynamic formulas for air discharge under conditions of adiabatic flow which would be necessary for large pressure differences.

A reasonably accurate estimate of the flow resistances offered by the system is essential for satisfactory duct design. 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 workmen to manufacture the system in accordance with the design. It is best to select fans and motors of sufficient size to allow a factor of safety. Dampers should be installed in each branch outlet to balance the system.

The drop in pressure in air transmission systems is due to *friction* losses and *dynamic* (shock) losses. Pressure increases and decreases may also be effected by changes in duct areas with resulting conversion of velocity pressure to static pressure, and vice versa. 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 the molecules. The dynamic losses are caused by changes in the direction or in the velocity of air flow, such as caused by changes in size and shape of the cross-section of the duct, bends (elbows), and to obstructions to flow offered by dampers.

FRICTION LOSSES

Pressure drop in a *straight* duct is caused by surface friction, and this friction loss is most readily calculated by means of the Air Friction Charts,