With the conventional side wall inlet using velocities of 300 to 400 fpm the discharged air quickly loses its velocity and drops, causing drafts in the occupied zone.

**5 ● What method of side wall introduction is satisfactory for cooling purposes with a 12-ft ceiling height?**

The methods shown in Figs. 1 and 3 can satisfactorily circulate air as much as 10 to 15 F below room temperature, provided (1) each jet is limited to 400 cfm, (2) the outlet velocity is high, (3) the air is directed toward but not striking the ceiling, and (4) there are no beams on the ceiling. In order to employ this method in a classroom it is usually necessary to have at least three inlets, but even with three inlets the cooling capacity is limited to that obtained by circulating air at 10 to 15 F below room temperature.

**6 ● Should unit ventilators be considered as heating units or as cooling units?**

Experience has shown that approximately 75 per cent of the time a classroom is occupied the problem is one of cooling rather than one of heating. For this reason unit ventilators should be considered as cooling units.

**7 ● What method of air distribution is usually employed with unit ventilators?**

Most unit ventilators employ a unique method of air distribution in which the air is discharged at a high velocity toward the ceiling. The air stream is usually inclined toward the room.

**8 ● How should a unit ventilator be located in a room that has ceiling beams?**

When there are ceiling beams the unit ventilator should be so located that the beams will be parallel with the direction of the air discharge in order that the beams will not deflect the air downward.

**9 ● What is the minimum temperature at which unit ventilators can distribute air in a classroom without causing drafts?**

Some manufacturers recommend a minimum outlet temperature of 60 F. Others recommend no limitation of the outlet temperature, providing the unit is properly located and installed.

**10 ● What is the usual method of ventilating school auditoriums and gymnasiums when unit ventilators are used in the classrooms?**

If unit ventilators are used in classrooms the usual method of ventilating the auditorium or gymnasium is to use one or more large units located above and on either side of the stage.

**11 ● What is the maximum amount of air which should be discharged from one point in a school auditorium or gymnasium?**

The maximum amount of air which should be discharged from one point is 5000 cfm. This limitation applies whether the air is supplied by units or by a central fan from a distant point.

**12 ● Are vents required in school classrooms, auditoriums, and gymnasiums?**

Many states require vents in school classrooms, auditoriums and gymnasiums. Most engineers recommend them for central fan systems. Many engineers recommend the elimination of all vents when unit ventilators are used. If vents are installed they should be provided with dampers in order that they may be throttled and with back draft dampers to prevent cool air from entering the building at night and during holidays.

**13 ● What type of system is generally used in large continuously operated theaters?**

Most large continuously operated theaters are provided with complete downward systems of air distribution similar to the one shown in Fig. 7. With this system a large number of inlet openings is provided, each of which discharges air in a thin horizontal stream at high velocity in order that the cool air will be mixed with the air in the theater before it reaches the patrons.



Chapter 20

# AIR DUCT DESIGN

***Pressure Losses, Friction Losses, Friction Loss Chart, Proportioning the Losses, Sizes of Ducts, General Rules, Procedure for Duct Design, Air Velocities, Proportioning the Size for Friction, Main Trunk Ducts with Branches for Public Buildings, Equal Friction Method, Details of Duct Construction***

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.

In the development of the formulae, diagrams, and tables for the flow of air, use is made of the following basic equation for the flow of fluids:

If $H_v$ be the velocity head in feet of a fluid, and the velocity, $V$, be expressed in feet per minute, the fundamental equation is

$$V = 60\sqrt{2g\,H_v}$$

The factor g is the acceleration due to gravity, or 32.16 ft per second per second.

It is usual to express the head in inches of water for ventilating work and, since the heads are inversely proportional to the densities of the fluids,

$$\frac{H_v}{\frac{h_v}{12}} = \frac{62.4}{d}$$

or

$$H_v = 5.2\,\frac{h_v}{d}$$

therefore,

$$V = 1096.5\sqrt{\frac{h_v}{d}} \qquad (1)$$

*where*

$V$ = velocity in feet per minute.
$h_v$ = velocity head or pressure in inches of water.
$d$ = weight of air in pounds per cubic foot.

For standard air (70 F and 29.92 in. barometer) $d = 0.07495$ lb per cubic foot. Substituting this value in Equation 1:

$$V = 1096.5\sqrt{\frac{h_v}{0.07495}} = 4005\sqrt{h_v} \qquad (2)$$