occur wherever velocities are stepped up or down. One recent trend in grille design is toward the use of much higher grille and branch duct velocities. Some installations have been made with velocities as high as 1600 fpm in branches and through the net area of grilles, but many of these have proven unsatisfactory because of noise and drafts.

Grille manufacturers publish selection tables which size the grilles for volume of air, temperature differential, and distance of throw. In following these tables, maximums should be avoided and the manner in which the duct connects to the grille should be given careful consideration. Most of the selection tables are based on straight approach to the grille. Elbow connections to supply grilles should be provided with turning vanes to equalize the face velocity. See Chapter 40 for a discussion of grilles.

TABLE 4. RECOMMENDED AND MAXIMUM DUCT VELOCITIES

Designation	Recommended Velocities, fpm			Maximum Velocities, fpm		
	Residences	Schools, Theaters, Public Buildings	Industrial Buildings	Residences	Schools, Theaters, Public Buildings	Industrial Buildings
Outside Air Intakes[a]	700	800	1000	800	900	1200
Filters[a]	250	300	350	300	350	350
Heating Coils[a]	450	500	600	500	600	700
Air Washers	500	500	500	500	500	500
Suction Connections	700	800	1000	900	1000	1400
Fan Outlets	1000–1600	1300–2000	1600–2400	1700	1500–2200	1700–2800
Main Ducts	700–900	1000–1300	1200–1800	800–1000	1100–1400	1300–2000
Branch Ducts	600	600–900	800–1000	700	800–1000	1000–1200
Branch Risers	500	600–700	800	650	800–900	1000

[a]These velocities are for total face area, not the net free area.

Fan outlet velocities are discussed in Chapter 32 and will not be dealt with here except to indicate that fan noises should be given proper consideration.

Main Trunk Ducts

Main trunk ducts with branches are commonly used to convey the air from the fan to the grille or register outlets in preference to individual ducts from the fan to these outlets. The velocities in these ducts and branches vary according to the nature of the installation and the degree of quietness desired. The recommended velocities in Table 4, with good construction, should give satisfactory results. The maximum velocities indicated should not be used except where noise is not a deciding factor.

Velocity Method

The velocity method of designing a duct system involves the arbitrary selection of velocities for various sections of the duct system with the

highest velocities at the fan and progressively lower velocities toward the duct openings to the room. To find the total static pressure against which the fan must operate, the static pressure loss of each section must be calculated separately and the total loss found by adding the individual losses of the various sections of the run having the highest resistance. Usually this is the longest run but in some cases a shorter run may have more elbows, transformations, booster heaters, etc., which will cause it to have a higher resistance pressure. This method requires judgment and experience in choosing the proper velocities to approach equal friction for all lengths of run but many engineers believe that the velocity method is handier to use than other methods and will give satisfactory results for most practical applications. The air velocities given earlier in this chapter are helpful in choosing proper velocities. Adjustable dampers or splitters are used to regulate air quantities delivered.

Equal Friction Method

The equal friction method of design is sometimes preferred because it does not require nearly so much judgment and experience in selecting the proper velocities in the various sections of a system. The usual procedure in this method of design is to select the main duct velocity to be consistent with good practice from a standpoint of noise for a particular type of building. This velocity should be less than the fan outlet velocity. All main ducts and branch ducts are sized for equal friction per unit length by the use of Fig. 2, and Table 2 or Fig. 5.

In cases where the fan or factory assembled air conditioning unit has a limited external resistance, it is necessary to divide the available resistance by the total equivalent length of the longest or most complicated run of duct to determine the resistance per 100 ft and then to size all ducts at this resistance value. This will automatically determine the duct velocities and give the desired total duct resistance. A further refinement, which is sometimes used in large systems, is to size each branch duct so that it has a resistance equal to the resistance of the main system at the point of juncture. Even when this refinement is added, regulating dampers are recommended in each branch.

After the duct system is designed the frictional resistance is calculated and tabulated together with the resistance of all component parts. The fan is then selected for the required volume of air, static pressure and outlet velocity.

Typical calculations for design of an air distribution system are given in Examples 3 and 4.

Example 3. Fig. 7 shows a typical layout of an air distribution system which is applicable for ventilation of hotel dining rooms and offices. The volume of air in cubic feet per minute for the room is determined on the basis of the number of air changes per hour required. In the example shown, the room ventilated is a hotel dining room 135 ft x 85 ft x 15 ft. A 7½-*min* air change (8 air changes per hour) is assumed for proper ventilation, giving 22,935 cfm as the air required.

The free area of the outdoor air inlet is based on a velocity of 1000 fpm or 22,935 ÷ 1000 = 22.94 sq ft. The main duct velocity selected from Table 4 is 1250 fpm which gives a main duct area of 22,935 ÷ 1250 = 18.354 sq ft (60 × 44 in.). From Table 2 a 60 × 44 in. duct is approximately equivalent to 56 in. diameter.

Referring to Fig. 2, a volume of 22,935 cfm through a 56 in. diameter duct gives a resistance of 0.033 in. per 100 ft. The amount of air to be handled by each section of pipe is shown in Fig. 7, and by locating each of these values on the 0.033 in. friction line,