

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, which 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.

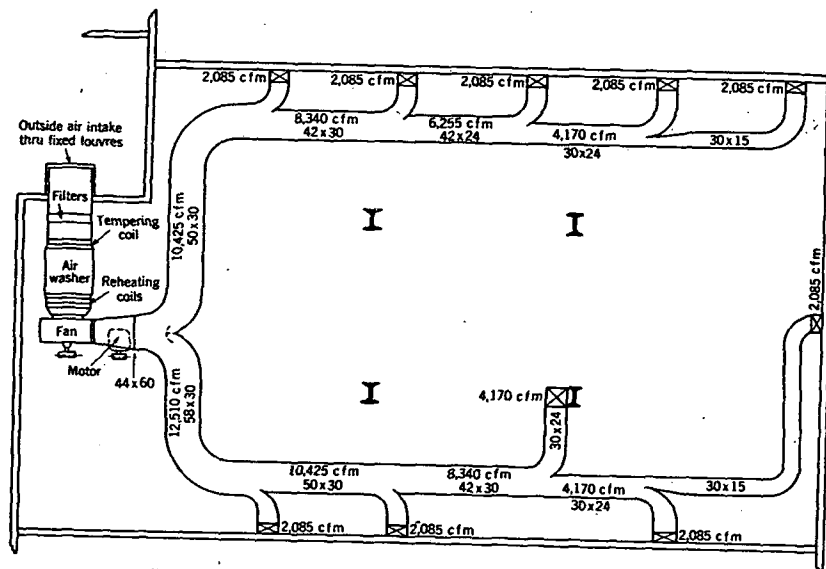


FIG. 6. TYPICAL LAYOUT OF AIR DISTRIBUTION SYSTEM

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.

Example 2. Fig. 6 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 $7\frac{1}{2}$ -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 fresh air inlet is based on a velocity of 1000 fpm or $22,935 \div 1000 = 22.94$ sq ft. If the air washer is provided with automatic humidity control, the tempering coil should raise the temperature of the entering air to 32 F. The washer with its automatic control will then raise the temperature from 32 F to 42 F. If the washer is not provided with automatic humidity control, the tempering coil must raise the temperature of the entering air to at least 55 F to allow for some temperature drop in the washer due to evaporation. The reheating coil is selected to raise the temperature of the

air from that leaving the air washer to 70 F. The air washer should have a maximum velocity of 500 fpm through the clear area, which, in this case, is 46 sq ft. For more detailed information on tempering coil and air washer control, see Chapter 33.

The main duct velocity selected from Table 2 is 1250 fpm which gives a fan outlet area of $22,935 \div 1250 = 18.354$ sq ft (60 x 44 in.). From Table 1 a 60 x 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 velocity of 1340 fpm and a resistance of 0.041 in. per 100 ft. The amount of air to be handled by each section of pipe is shown in Fig. 6, and by locating each of these values on the 0.041 in. line, the round pipe sizes are obtained and then, referring to Table 1, the equivalent rectangular sizes are selected as shown in Table 3.

The pressure at the outlets nearest the fan will be greater than at the pipes farther along the run so that the former will tend to deliver more than the calculated amount of air. To remedy this condition, volume regulating dampers should be located at the base of each riser, or in each branch duct, and adjusted for proper distribution. At points where branches leave the main it may be advisable, depending upon the nature of the installation, to install adjustable splitters similar to that shown in Fig. 6 where the main duct divides into the 58 x 30 in. and 50 x 30 in. branches.

TABLE 3. PIPE SIZES FOR EXAMPLE 2^a

VOLUME OF AIR (CFM)	DIAMETER OF PIPE (INCHES)	EQUIVALENT SIZE OF RECTANGULAR DUCT (INCHES)
22,935	56	60 x 44
12,510	45	58 x 30
10,425	42	50 x 30
8,340	39	42 x 30
6,255	35	42 x 24
4,170	29½	30 x 24
2,085	23	30 x 15

^aVelocity through grilles (not shown) to be approximately 300 fpm.

Resistance Losses for the System

(1) Fresh air intake, 1000 fpm velocity (1.5 heads $\times$ 0.0625).....	0.094 in.
(2) Filters (from manufacturer's tables).....	0.250 in.
(3) Tempering coil loss (from manufacturer's tables).....	0.074 in.
(4) Air washer loss (from manufacturer's tables).....	0.250 in.
(5) Reheating coil loss (from manufacturer's tables).....	0.083 in.
(6) Duct resistance:	
The longest run is.....	150 ft
Two 58 x 30 in. elbows (150% ratio) $\frac{2 \times 13 \times 58}{12}$	= 126 ft
Two 30 x 15 in. elbows (150% ratio) $\frac{2 \times 13 \times 30}{12}$	= 65 ft
Three 15 x 30 in. elbows (75% ratio) $\frac{3 \times 35 \times 15}{12}$	= 131 ft
Total equivalent run.....	472 ft
472 ft at 0.041 in. per 100 ft.....	0.194 in.
(7) Allowance for damper adjustment, 25% of 0.194.....	0.049 in.
(8) Supply grille resistance (from manufacturer's tables).....	0.036 in.
Total static pressure loss of system.....	1.030 in.

The fan is selected from the manufacturer's ratings to deliver 22,935 cfm at a static pressure of 1.03 in. and an outlet velocity exceeding 1250 fpm as outlined in Chapter 29.