The cubic feet of air of standard density taken into the system at each connection is given by the formula:

$$Q = 4000\,A\,f\sqrt{i}$$

where

Q = Cubic feet of air per minute;
A = Area of connection in square feet;
f = Orifice or restriction coefficient;
i = Static suction measured in inches of water.

The orifice coefficient f is dependent upon the shape and construction of the hood and will range from 60 to 90 per cent. An average value is 70 per cent.

Knowing the suction at each hood and the diameter of each connection, the volume of air passing up each branch can be taken from the accompanying Table 107. The sum of all these volumes gives the total volume to be handled by the exhaust fan.

TABLE 107. CUBIC FEET OF AIR HANDLED PER MINUTE THROUGH AVERAGE COLLECTING HOODS

Based on Coefficient of Orifice of 0.71 with 10 Per Cent Added for Leakage

Diameter of Connection Pipe In.	Maintained Suction—In. Water Gage						
	1	1½	2	2½	3	4	5
1½	38	47	54	61	67	76	86
2	68	84	97	108	118	136	153
2½	107	131	161	168	185	214	238
3	153	188	217	243	266	306	343
3½	209	256	296	330	362	418	466
4	273	334	386	431	473	546	609
4½	345	423	488	546	598	690	775
5	427	523	605	676	741	854	955
6	614	751	867	970	1062	1228	1373
7	835	1023	1181	1322	1448	1670	1870
8	1092	1337	1546	1727	1892	2184	2440
9	1381	1694	1953	2184	2387	2762	3091
10	1705	2090	2409	2695	2959	3410	3806

Common practice is to provide a main suction pipe having an area 20 to 25 per cent in excess of the sum of the areas of the branches entering it between the point in question and the dead end of the main. Similarly the discharge pipe leading from the fan outlet to collector is frequently made the same diameter as the large end of the main suction pipe. The reason for this increase in size is that a considerable power saving results from the lower air velocity. However, there is no technical reason why mains should be a certain percentage greater area than the sum of the connections, and still lower power consumption can be obtained by using larger branches and mains of equal area. While the rule

of thumb method of determining size of mains works very well in many cases, yet it is always desirable to figure the mains and branches of the proper size to give the velocity which has been found best suited to the work to be done.

In certain special cases where explosive or poisonous dusts such as aluminum buffings, grain dust, powdered sugar, or lead dust are handled, increasing the size of the mains unduly would introduce a serious hazard.

An exhaust system to be effective must remove a certain amount of air from each hood or other connection, and in addition must maintain sufficient velocity throughout the piping system to convey the dust or refuse material to the separator. Any system which is mechanically well constructed and handles the requisite air at the connections and maintains sufficiently high velocities, is an effective system from the standpoint of the work done. However, to keep the operating cost low it is advantageous to do the work with as low velocities as the characteristics of the material will permit. The skilled designer will keep both of these requirements in mind and produce a system which is both effective and economical of power.

The maintained resistance of the exhaust system is composed of three factors: (1) Loss through the hoods; (2) Collector drop; and (3) Friction drop in the pipes.

A. Suction at the various hoods must be chosen from experience. Loss through the hoods can be calculated by an experienced engineer but may be taken very roughly at one-half the suction.

B. Collector drop in inches of water is given by the following formula:

$$\text{Drop} = C\left(\frac{V}{1000}\right)^2$$

where

C = a constant which depends upon the type of collector and is found to range from 0.25 to 0.75;
V = velocity in feet per minute of air entering the collector.

C. Friction drop in the pipes must be computed for each section where there is a change in area or in velocity. Find the velocities in each section of pipe starting with the branch furtherest from the fan. The friction drop for these sections can be determined by reference to Table 108. Total friction loss in the piping system is the friction drop in furthest branch plus the drop in the various sections of the main, plus the drop in the discharge pipe.

The total maintained resistance of the system—or static head required at the fan $= A + B + C$.

SELECTING THE FAN

Having determined the volume of air and static head required, the size of exhaust fan, speed and horse-power can be found by reference to the manufacturers performance tables or charts covering the type of exhaust fan selected.