The next step is to determine the size of the main, which varies in diameter, increasing from its dead end towards the fan, as necessitated by the branch pipes entering it. Its exact diameter at any point is determined according to the following rule:

The area of the main at any point should be 20 per cent 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. Floor sweeps, if equipped with efficient blast gates, need not be included in computing the area of the main.

According to Table 3, 2 in. suction at the hoods is suitable for exhausting from wood-working machinery where the duty is light, as would be the case in this problem.

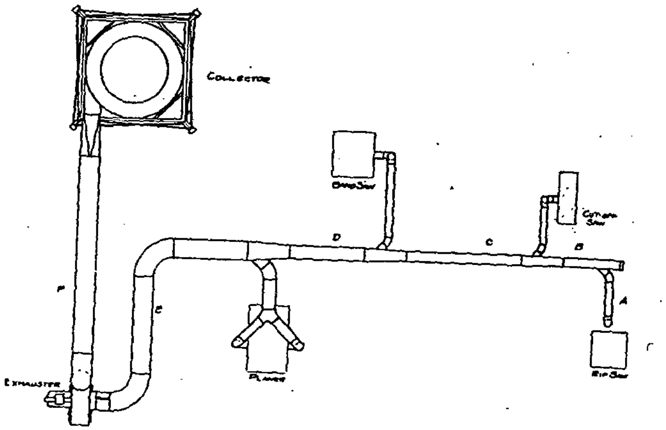

FIG. 1. TYPICAL EXHAUST SYSTEM

The volume of air to be handled by the system is determined from Table 4.

1 to 5 in. connection, 2 in. suction, (from Table 4) 605 × 1 equals		605 c.f.m.
1 to 4 in. connection, 2 in. suction, (from Table 4) 386 × 1 equals		386 c.f.m.
1 to 5 in. connection, 2 in. suction, (from Table 4) 605 × 1 equals		605 c.f.m.
2 to 6 in. connection, 2 in. suction, (from Table 4) 867 × 2 equals		1,734 c.f.m.
TOTAL		3,330 c.f.m.

The next step in the calculations is to determine the maintained resistance of the system, which corresponds to the static pressure that the exhaust fan must produce to obtain the proper volume of air and suction at the hoods.

This maintained resistance is composed of the following elements:

1. Loss through the hoods. This is usually assumed as equal to the suction maintained at the hoods, in this problem 2 in.

2. Frictional resistance or loss in piping system. This is a function of the pipe diameter and the velocity of flow and accordingly it is necessary to compute the friction for each section and to add the components together.

TABLE 6. DIAMETERS OF BRANCH PIPES AND CALCULATIONS OF MAIN FOR TYPICAL EXHAUST SYSTEM ILLUSTRATED IN FIG. 1

MACHINE	DIAMETER OF BRANCH PIPES	AREA SQ. INCHES	TOTAL LOAD AREA SQ. INCHES	TOTAL LOAD AREA SQ. INCHES + 25%	SECTION OF MAIN	DIAMETER OF MAIN IN EVEN INCHES
Rip Saw	5 in.	19.6	19.6	25	*B*	6 in.
Cut-off Saw	4 in.	12.6	32.2	40	*C*	7 in.
Band Saw	5 in.	19.6	51.8	65	*D*	9 in.
Planer Top Connection	6 in.	28.3	80.1	100		
Planer Bottom Connection	6 in.	28.3	108.4	135	*E & F*	13 in.

3. Pressure drop or loss through the collector. For an exhaust system such as the one under consideration it is customary to choose a collector having an inlet of the same, or slightly greater, diameter than the main discharge pipe leading to the collector.

The friction per 100 ft. of length for various pipe diameters and velocities can be read from Table 5.

The friction for intermediate pipe sizes not given in the table can be computed from the table values, from the relation that the friction in two pipes, the velocity remaining constant, is inversely proportional to the ratio of the diameters. This can be written:

$$z_2 = z_1 \frac{d_1}{d_2} \qquad (3)$$

z_1 = friction in pipe of d_1 diameter.
z_2 = friction in pipe of d_2 diameter.

The total pipe friction is calculated to be 3.49 in. of water. The individual steps in the calculation are given in Table 7.

The effective length of pipe is determined by adding to the actual length a sum to compensate for the effect of elbows as given in the note at the bottom of Table 5.

In this problem the main discharge pipe is 13 in. in diameter and a collector having a 14 in. inlet is selected. The area of the collector inlet is 1.069 sq. ft.

TABLE 7. DETAILS OF CALCULATION OF FRICTION OF PIPING SYSTEM ILLUSTRATED IN FIG. 1

SECTION OF PIPING	EFFECTIVE LENGTH OF PIPE TAKEN AS:	DIAMETER OF PIPE IN INCHES	AREA OF PIPE IN SQ. FT.	C. F. M.	VELOCITY OF AIR FLOW, FEET PER MINUTE	FRICTION PER 100 FT. OF LENGTH	PIPE FRICTION
A	20 ft.	5	0.136	605	4450	7.4	1.48
B	10 ft.	6	0.195	605	3100	3.1	0.31
C	10 ft.	7	0.267	991	3700	3.8	0.38
D	15 ft.	9	0.442	1,596	3600	2.8	0.42
E	20 ft.	13	0.922	3,330	3600	2.0	0.40
F	25 ft.	13	0.922	3,330	3600	2.0	0.50
TOTAL pipe friction							3.49