Table 1. Pressures and Corresponding Velocities of Dry Air at 70 Deg. and 29.92 In. Barometer

Inches of Water	Ounces per Sq. In.	Velocity Ft. per Min.	Inches of Water	Ounces per Sq. In.	Velocity Ft. per Min.
0.05	0.0289	896	4.77	2.750	8745
0.10	0.577	1266	5.00	2.884	8943
0.20	0.1154	1791	5.20	3.000	9134
0.25	0.1443	2003	5.50	3.172	9392
0.30	0.1730	2193	6.00	3.460	9810
0.40	0.2308	2533	6.07	3.500	9864
0.43	0.2500	2637	6.50	3.749	10210
0.50	0.2884	2832	6.94	4.000	10545
0.60	0.3460	3102	7.00	4.037	10595
0.70	0.4037	3351	7.50	4.326	10968
0.75	0.4326	3468	7.80	4.500	11187
0.80	0.4614	3582	8.00	4.614	11328
0.87	0.5000	3729	8.67	5.000	11792
0.90	0.5190	3800	9.00	5.190	12015
1.00	0.5768	4005	9.54	5.500	12367
1.25	0.7209	4478	10.00	5.768	12665
1.30	0.7500	4566	10.40	6.000	12915
1.50	0.8650	4905	11.00	6.344	13282
1.73	1.0000	5273	11.27	6.500	13445
1.75	1.0092	5298	12.00	6.921	13875
2.00	1.1535	5664	12.14	7.000	13950
2.17	1.2500	5895	13.00	7.497	14440
2.25	1.2975	6007	13.87	8.000	14913
2.50	1.4418	6332	14.00	8.074	14985
2.60	1.5000	6457	15.00	8.650	15510
2.75	1.5860	6641	15.61	9.000	15820
3.00	1.7300	6937	16.00	9.227	16020
3.03	1.7500	6976	17.00	9.805	16513
3.25	1.8740	7220	17.34	10.000	16675
3.47	2.0000	7457	18.00	10.380	16990
3.50	2.0185	7492	19.00	10.960	17456
3.75	2.1630	7756	19.07	11.000	17488
3.90	2.2500	7910	20.00	11.535	17910
4.00	2.3070	8010	20.81	12.000	18265
4.25	2.4510	8256	22.54	13.000	19012
4.34	2.5000	8337	24.28	14.000	19730
4.50	2.5950	8496	26.01	15.000	20420
4.75	2.7395	8729	27.74	16.000	21090

Table 2. Velocities of Dry Air at Various Pressures and Temperatures and 29.92 In. Barometer

Pressure		50°	60°	70°	100°	150°	300°	500°	550°
Inches	Ounces								
0.25	0.1443	1965	1986	2003	2059	2149	2399	2696	2895
0.5	0.2884	2778	2808	2832	2911	3038	3391	3812	4095
0.75	0.4326	3402	3439	3468	3565	3720	4153	4668	5020
1.00	0.5768	3929	3971	4005	4117	4296	4796	5390	5795
1.25	0.7209	4393	4440	4478	4602	4804	5362	6027	6470
1.50	0.8650	4812	4864	4905	5042	5262	5874	6602	7100
1.75	1.0092	5197	5254	5298	5446	5683	6344	7131	7655
2.00	1.1535	5556	5616	5664	5822	6076	6783	7624	8195
2.25	1.2975	5892	5956	6007	6174	6443	7193	8085	8690

1. Arbitrarily select sizes from assumed velocities, depending upon velocity of air at fan outlet.

2. Determine the velocity which will give an assumed resistance within fan capacity at noiseless operating speed.

By decreasing the velocity in main duct as air is delivered through branch outlets: (1) more uniform air delivery through outlets is accomplished, (2) friction in smaller pipes is reduced, (3) portion of velocity head is converted into static pressure.

FRICTION LOSSES

The two greatest losses in duct systems are the dynamic losses and the friction losses. The former are chiefly caused by changes in direction or in velocity of air flow and are expressed as pressure in inches of water gage—see Tables 1 and 2.

The loss of head caused by friction, which is numerically equal to the pressure required to maintain a given velocity, may be most easily expressed by the modification of the Fanning formula, when, dealing with round pipe and standard air (70 deg. fahr. — 29.92 in. Barometer).

$$h = z\,\frac{L}{D}\,h_v = \frac{L}{ED}\left(\frac{V}{4005}\right)^2 \qquad (1)$$

When dealing with rectangular ducts and standard air,

$$h = z\,L\left(\frac{a+b}{2ab}\right)h_v = \frac{L}{E}\left(\frac{a+b}{2ab}\right)\left(\frac{V}{4005}\right)^2 \qquad (2)$$

where

h = loss of head in inches of water.
V = velocity of air in feet per minute.
L = length of pipe.
D = diameter of pipe.
a = one side of rectangular duct.
b = other side of rectangular duct.
(L, D, a, b:) All in feet or inches.
z = coefficient of friction which varies from about 0.01 to 0.03.
E = length of pipe in diameters for one head loss.

It will simplify calculations to consider that the values of z and E vary only with the nature of the pipe surface. Thus, E may be taken as about 60 for smooth pipe, such as used in planing mill exhaust systems; E = 50 for ordinary galvanized iron heating and ventilating ducts; and E = 45 for smooth and 40 for rough conduits of tile, brick or concrete.

The values of z and E not only vary with the roughness of the inside surface of the pipe, but also with the diameter and velocity. The coefficient of friction z decreases with both increase of diameter and velocity. It also varies directly with the air density and approximately inversely as the absolute temperature.

Fig. 1 will be found very convenient for determining the friction for a given air capacity in various size ducts at corresponding velocities. The coefficient of friction has been corrected for the various diameters and capacities, based on the rule that the coefficient of friction varies inversely as the 2/7 power of the diameter, and inversely as the 1/7 power of the capacity. This chart is based on a loss of one velocity head