The area of the plenum should be at least ten times as great as the fan discharge area. The plenum should be lined with 2 in. of muslin covered rock wool blanket or 1 in. sound absorbing board preferably nailed to wood strips on the inside of the plenum. (With such a lining the plenum is particularly effective in reducing low frequency fan noise.) The absorption of the plenum in sabines is the sum of the products of each interior area of the plenum measured in square feet multiplied by its corresponding absorption coefficient.

Plate Cells

One of the most economical methods of applying sound absorbent material from the standpoint of both labor and material is the plate cell. The plate cell illustrated in Fig. 2 consists of ½ or 1 in. sound absorbent board, spaced on 2, 3 or 4 in. centers. The attenuation given in Table 6 depends on the spacing, depth, and the absorption of the material. At each end of the cell further attenuation results from the reflection of sound

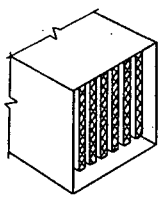

FIG. 2. PLATE CELL INSTALLED IN DUCT

from the face of the cell. An important objection to the plate cell is the increase in duct cross sectional area required. Often on the fan discharge, particularly with unitary equipment, where a number of branch ducts take off, the plate cell may be installed with little or no difficulty. The attenuation per foot of length for 1 in. board neglecting the end effect is given approximately by Equation 6.

$$R = \frac{7L\alpha^{1.4}}{S} \qquad (6)$$

where

R = attenuation, decibels.
L = length of duct in linear, feet.
S = spacing between plates up to 3 in.
α = absorption coefficient of plates. For value of α see Table 7.

Duct Lining or Rectangular Cells

One series of experiments[5] made on a commonly used type of duct lining material (1 in. rock wool sheet) has shown that, subject to certain

[5]The Absorption of Noise in Ventilating Ducts, by Hale J. Sabine (*Journal Acoustical Society of America*, Vol. 12, p. 53, 1940).

TABLE 6. END REFLECTION OF PLATE ABSORBERS

PERCENTAGE FREE AREA OF ABSORBER	ATTENUATION, db
50	1
40	2
30	4
25	5
20	6

restrictions, the attenuation of single-frequency sounds may be expressed by the approximate Equation 7.

$$R = 12.6\, L \frac{P}{A}\, a^{1.4} \qquad (7)$$

where

R = reduction, in decibels.
L = length of lined duct, feet.
P = perimeter of duct, inches.
A = cross sectional area of duct, square inches.
a = absorption coefficient of lining.

This formula is accurate within plus or minus 10 per cent for duct sizes ranging from 9 x 9 in. to 18 x 18 in., for cross-sectional dimension ratios of 1:1 to 2:1, for frequencies between 256 and 2048 cycles, and for absorption coefficients between 0.20 and 0.80. In Table 7, the absorption coefficients at different frequencies of a material of the above mentioned type are listed, together with the corresponding values of Equation 7.

Results of other experiments indicate, however, that Equation 7 may be in error when applied to other types of duct lining material and to duct sizes and shapes outside of the range specified. An empirically derived chart[6] representing the average experimental data on a number of different types of materials including the rock wool sheet mentioned as applicable to Equation 7 is shown in Fig. 3. Since individual materials vary somewhat, the curves in Fig. 3 are given only as representing the best available averages for duct sizes of square cross-sections from 6 x 6 in. to 48 x 48 in. As an illustration, the dotted lines in the chart show values calculated from Equation 7 which indicate that the slope for this particular material is somewhat different than from the average curves. The curves in Fig. 3, as well as Equation 7, show that the reduction in decibels is

TABLE 7. DECIBEL ATTENUATION FORMULAE FOR TYPICAL DUCT LINING MATERIAL

FREQUENCY	ABSORPTION COEFFICIENT	REDUCTION, db
256	0.37	3.0 L P/A
512	0.69	7.5 L P/A
1024	0.78	9.5 L P/A
2048	0.78	9.5 L P/A

[6]The Prediction of Noise Levels from Mechanical Equipment, by J. S. Parkinson (*Heating and Ventilating*, March, 1939, pp. 23-26).