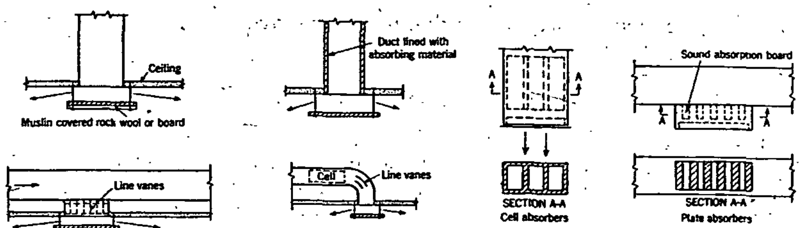

FIG. 2. OUTLET CELLS FOR PAN OUTLETS OR GRILLES

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 consists of ½ or 1 in. sound absorbent board, spaced on 2, 3 or 4 in. centers. The attenuation due to the plate cell may be divided into two parts. There is reflection at each end due to the change in area and the absorption at the ends. Values for this attenuation are given in Table 6 which depend on the spacing. There is also attenuation due to absorption of sound within the passages of the cell, which depends on the length and the spacing. The attenuation within the cell for 1 in. board neglecting the end effect is given approximately by Equation 5.

$$R = \frac{10La^{1.4}}{S} \qquad (5)$$

where

R = attenuation, decibels.
L = linear length of duct, feet.
S = spacing in inches between plates up to 3 in.
a = absorption coefficient for the full thickness of the cell material. For typical value of a see Table 7.

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.

Outlet Sound Absorbers

Outlet sound absorbers are rectangular or plate cells installed directly behind an outlet or they may be the lining of a pan or plaque outlet. They are particularly effective in the elimination of high frequency

TABLE 7. ATTENUATION FORMULAE FOR 1 IN. THICK TYPICAL DUCT LINING BOARD

FREQUENCY	ABSORPTION COEFFICIENT	ATTENUATION 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

whistles which are generated by air flow in the ducts. They are also employed in large systems with long runs where only a few outlets near the fan require treatment. Frequently outlet cells are the only means of correcting existing noisy installations, as the duct sections directly behind the outlets may be the only sections accessible for treatment. (See Fig. 2.)

Duct Lining or Rectangular Cells

One series of experiments[10] made on a commonly used type of duct lining material (1 in. rock wool sheet) has shown that, subject to certain restrictions, the attenuation of single-frequency sounds may be expressed by the approximate Equation 6. This equation is accurate within plus or minus 10 per cent for duct sizes ranging from 9 x 9 in. to 18 x 18 in., for

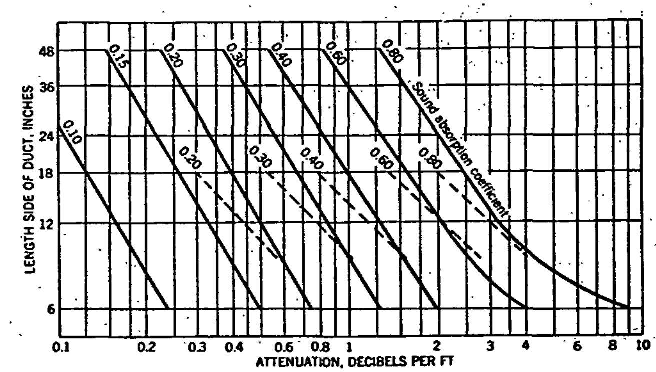

FIG. 3. SOUND ATTENUATION FOR VARIOUS ABSORBING DUCT LINERS

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.

$$R = 12.6\, L \frac{P}{A}\, a^{1.4} \qquad (6)$$

where

R = attenuation, 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.

In Table 7, the absorption coefficients at different frequencies of a material of the previously mentioned type are listed, together with the corresponding values for Equation 6.

Results of other experiments indicate, however, that Equation 6 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[11] representing the *average* experimental data on a number of different types of materials including the rock wool sheet mentioned as applicable to Equation 6 is shown in Fig. 3. Since individual materials vary, 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 6 which indicate that the slope for this particular material is somewhat different than from the average curves. The curves in Fig. 3,