directly proportional to the length of duct lined, and that the larger the duct the greater will be the length which must be lined in order to obtain a given noise reduction.

If, as is often the case, the length of duct from the main duct to a grille is shorter than the length of lining indicated by the calculations, this duct may be sub-divided into smaller ducts, as shown in Fig. 4. The increase in noise reduction thus obtained may be calculated from Equation 8, providing the splitters are installed parallel to the long side of the duct:

$$R_s = R_o \frac{a + bn}{a + b} \qquad (8)$$

where

R_s = reduction with splitters, decibels.
R_o = reduction in same length of duct, without splitters, decibels.
a = dimension of short side of duct, inches or feet.
b = dimension of long side of duct, inches or feet.
n = number of channels formed by splitters.

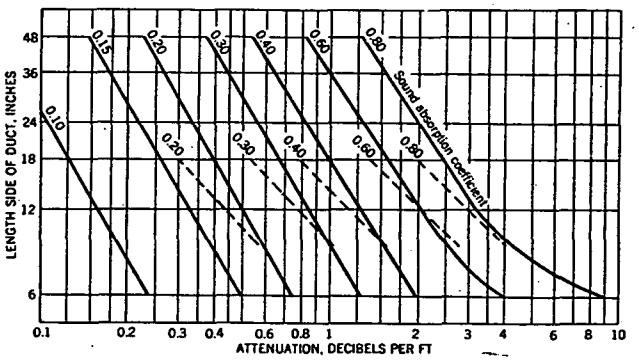

FIG. 3. SOUND ATTENUATION FOR VARIOUS ABSORBING DUCT LINERS

Example 1. An air conditioning installation is to be installed in a small theatre Determine the necessary sound treatment for the air distribution system to provide a satisfactory noise level in the theatre utilizing these conditions:

Fan tip speed 4000 fpm, total pressure 1.25 in	77 db
Acceptable room noise level (Table 1)	40 db
Required attenuation	37 db

Solution: Natural attenuation of supply duct.

Sheet metal duct 50 ft long 48 in. x 36 in. (Table 2) 50 x 0.01	0.5 db
Elbows, two size 48 in. x 36 in. (Table 3) 2 x 1	2.0 db
Attenuation grilles to theatre air change 10 min (Table 5) outlet velocity 1000 fpm	22.0 db
Total natural attenuation	24.5 db

Difference between required and natural attenuation, 37 minus 24.5, is 12.5 db. This attenuation must be supplied by sound treatment in the duct, either in the form of duct lining or plate cells.

A similar analysis of the return duct system, shows that 15 db attenuation are to be furnished by absorptive material. An inspection of the installation shows that the lining of the plenum on the suction side of the fan would prove the most economical, where it would secure the dual function of heat insulation and sound absorption.

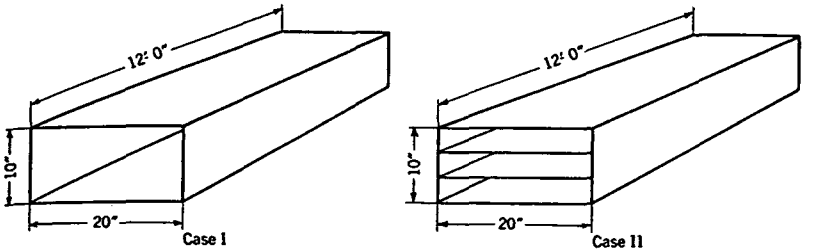

FIG. 4. DIAGRAM OF BRANCH DUCT TREATMENT WHERE LENGTH IS INSUFFICIENT FOR ADEQUATE ABSORPTION

Example 2. A 10 x 20 in. duct is connected to a private office space in a quiet location. Determine the length of lining necessary to attenuate average fan noise satisfactorily, using a lining material of a type to which Equation 7 applies, and having an absorption coefficient of 0.40 at 256 cycles. Assume that the duct is only 12 ft long, and that a 30 db reduction is required in this length.

Solution:

Case 1. (No splitters).

From Equation 7,

$$R_o = 12.6 \times 12 \times \frac{60}{200} \times 0.40^{1.4} = 12.6 \text{ db}$$

Case 2. (Two splitters, three channels).

From Equation 8,

$$R_s = 12.6 \times \frac{10 + (20 \times 3)}{10 + 20} = 29.6 \text{ db}$$

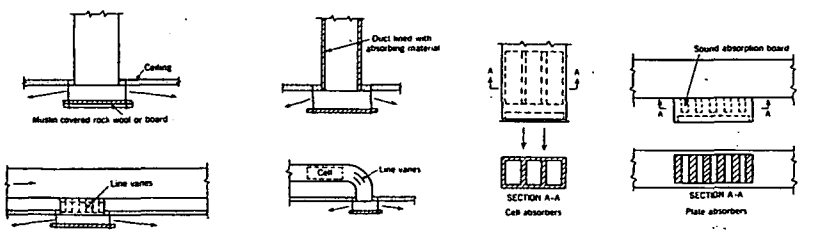

FIG. 5. OUTLET CELLS FOR PAN OUTLETS OR GRILLES

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 whistles which are generated by air flow in the ducts. They are also