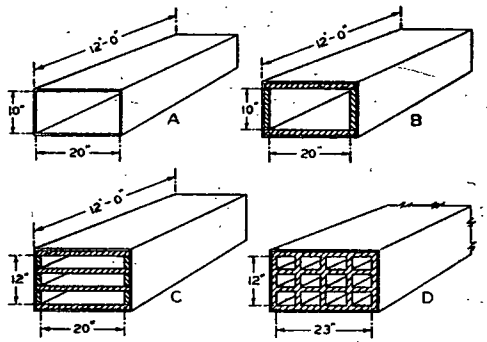

FIG. 6. ACOUSTIC TREATMENT OF DUCTS

A. Unlined metal duct.
B. Absorption lined duct (Case 1).
C. Splitter plate type absorber (Case 2). (Channels 20 in. x 3.33 in. inside).
D. Cell type absorber. (Cells 5 in. x 3.33 in. inside).
1 in. thick absorption material in all cases.

Sample Calculations for Duct Treatment

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

Fan tip speed 4000 fpm, total pressure 1.25 in.	77	db
Acceptable room noise level (Table 2)	40	db
Required attenuation	37	db

Solution: Natural attenuation of supply duct.

Sheet metal duct 50 ft long 48 in. x 36 in. (Table 4) 50 x 0.01	0.5 db
Elbows, two size 48 in. x 36 in. (Table 5) 2 x 1	2.0 db
Attenuation grilles to theater air change 10 min (Table 7) 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 wall lining or rectangular cells of the plate or cell absorber arrangement.

A similar analysis of the return duct system shows that 15 db attenuation is 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.

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 6 applies, and having an absorption coefficient of 0.40 at 256 cycles. Assume that the duct is only 12 ft long as shown in Fig. 6, and that a 30 db reduction is required in this length.

Solution:

Case 1. (No splitters, duct lining only). From Equation 6,

$$R = 12.6 \times 12 \times \frac{60}{200} \times 0.40^{1.4} = 13 \text{ db.}$$

TABLE 9. END REFLECTION OF PLATE OR CELL ABSORBERS

Percentage free area of absorber	50	40	30	25	20
Attenuation db	1	2	4	5	6

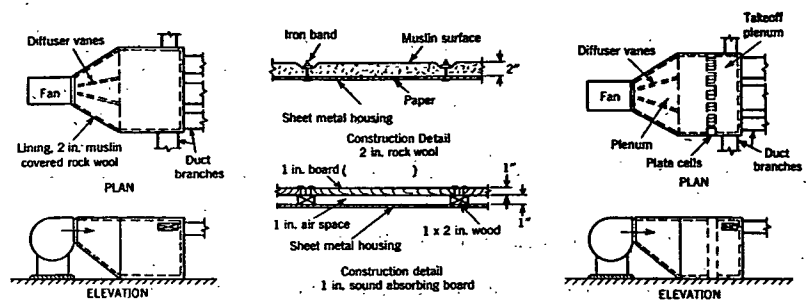

FIG. 7. ABSORPTION PLENUMS WITH AND WITHOUT SOUND CELLS

Case 2. (Two 1 in. splitter plates, 3 channels each 20 in. $\times$ $\frac{10}{3}$ in.). From Equation 6,

$$R = 12.6 \times 12 \times \frac{46.7}{66.7} \times 0.40^{1.4} = 29 \text{ db.}$$

Additional attenuation may be obtained by using additional splitter plates or use of egg-crate arrangement of absorbing material and application of Equation 6.

Plenum Absorption

In systems where individual ducts are directed to a number of rooms, and sound treatment is required in every duct, a sound absorption plenum on the fan discharge as shown in Fig. 7 will often prove the most economical arrangement. The absorption in the plenum may be approximated by Equation 7.

$$db \text{ (Attenuation)} = 10 \log_{10} \frac{\text{Plenum Absorption in Sabins}}{\text{Area Fan Discharge}} \qquad (7)$$

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 sabins is the sum of the products of each interior area of the plenum measured in square feet multiplied by its corresponding absorption coefficient.

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 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. 8).

AIR SUPPLY OPENING NOISES

When air is introduced into a room through a grille or register at a constant velocity, sound energy is being introduced into the enclosure at