the noise level which will be produced in the room and the manufacturer's method of rating must be considered before allowances previously mentioned are accepted.

To use Fig. 2, proceed by consulting Table 1 and determine the probable noise level already existing in the room, and, as suggested, assume that this level is satisfactory for current practice. This gives a noise level in decibels and with this enter the chart of Fig. 2. Read across the chart and determine the value of the duct lining factor (f) in the column at the left. Then multiply the smallest cross sectional dimension (inches) of the duct by this factor. The result will be the length of duct in inches to be lined to attenuate an average fan noise. If circular ducts are used, the length to be lined will be (f) $\times$ diameter of duct.

Example 2. A 7 x 30 in. duct is connected to a private office space in a quiet location. Determine the length of lining necessary to attenuate a fan noise satisfactorily.

From Table 1 the noise level in this office will be 35 db.

Length to be lined for noisy equipment is $22 \times 7 = 154$ in.
Length to be lined for average equipment is $17 \times 7 = 119$ in.
Length to be lined for quiet equipment is $12 \times 7 = 84$ in.

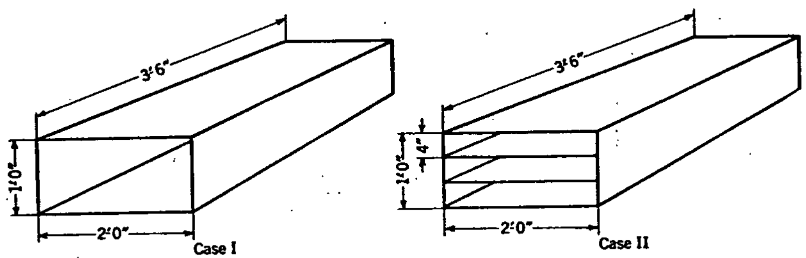

FIG. 3. DIAGRAM OF BRANCH DUCT CONNECTION

The sound absorbent properties of duct lining are extremely important and materials which have coefficients as high as possible should be used. This is particularly true of the coefficients at the low frequencies. Fig. 2 is based on materials having a noise quieting coefficient of 0.60 or more. For materials which are less efficient a factor of safety should be added[4].

Only certain sound absorbent materials among those listed in various publications will be found to be suitable for duct lining. In addition to a high sound absorbent coefficient a duct lining material should have a low surface coefficient of friction, high resistance to moisture absorption, and should be fireproof and vermin proof. A number of building codes now specify that any sound absorbent material used for duct lining shall have no fire hazard. There are no existing specifications on moisture resistance but the manufacturer should be required to show that the material will not absorb sufficient moisture to cause deterioration or to decrease the sound absorbing efficiency.

[4]For coefficients of commercial sound absorbent materials see Bulletin *Acoustical Manufacturers' Association*, 919 No. Michigan Ave., Chicago, Ill.

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 using the factor found, this duct may be sub-divided[5] into smaller ducts, so that the value found may be used as shown in Fig. 3.

Example 3. Assume a branch duct, as shown in Fig. 3, is 24 in. wide by 12 in. high and 42 in. long. Use a duct lining factor of 10.

Case I. (No splitters).

Length of lining $= f \times$ minimum dimension $= 10 \times 12 = 120$ in.
In this case the duct should be lined for 120 in. which is obviously impossible.

Case II. (Two splitters).

Results in 3 ducts 24 in. wide and 4 in. high.
Length of lining $= f \times$ minimum dimension $= 10 \times 4 = 40$ in.
This length of lining fulfills the space limitations of the branch duct which is 42 in. long.

General Suggestions

In some instances where high velocity air is used, a considerable amount of whistle is generated at the grille. This noise is obviously produced after the air leaves the duct and there is no treatment which can be installed in the duct that will reduce this noise. The engineer must take into consideration the type of grille which he intends to use and provide sufficient grille area so that the velocity through the grille is reduced to a point where the grille is not too noisy.

Ducts serving more than one room permit cross talk between the rooms and should be lined with acoustical material. Where the rooms are close together and the ducts short, the ducts should be sub-divided to provide ample acoustical treatment.

Very often in ventilating duct work the engineer feels that it will not be necessary to line ducts if the sound is travelling against the airflow. This, however, is untrue since sound travels so much more rapidly than does the air in even high velocity systems, that it will travel as easily against the airflow as it does with it.

Sounds which are low in pitch are much harder to eliminate from a duct system than sound which is high in pitch, consequently equipment which produces low pitched sounds should be avoided as much as possible.

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[5]Patents exist covering the sub-dividing of ducts for installing sound absorbent materials.