necessary to treat acoustically the walls and ceiling of the equipment room. If the equipment room is not entirely closed, partition walls may be necessary.

NOISE TRANSMITTED THROUGH THE DUCTS

After noise reaches the air stream in the ducts it can be controlled by lining the ducts on the inside with a sufficient quantity of sound absorbing material. Lagging material of similar characteristics placed on the outside of ducts serves to prevent noise originating outside the ducts being carried inside the ducts and into the air stream.

A case where outside lagging is desirable occurs when ducts originate at the fan in the equipment room and pass through this room on the way to the room being conditioned or ventilated. Unless the ducts are lined some of the mechanical noise from the equipment room air may be transmitted through the wall of the duct, thus reaching the air stream and be carried into the room. In such cases, that portion of the duct which is exposed to the sounds in the equipment room should be lagged with material such as cork, pipe covering or other sound damping material to prevent the sound from entering the duct at this point. Numerical data are not available to permit a simple and practical calculating procedure to determine thickness of covering which should be used for this purpose.

Inside lining material used in the case previously mentioned would serve as an absorber of the sound transmitted through the duct walls, and thus act as a means of preventing the transfer of noise into the air stream.

Inside lining may also be used in ducts to absorb noise which reaches the air stream from equipment such as fans, sprays and coils; noise due to eddying currents set up by elbows, dampers and similar obstructions; and noise transmitted from room to room where there is a common duct system.

To use the lining effectively it must be properly located, well installed and be applied in sufficient quantity to reduce the noise level of the air stream to the level desired.

At present there are no wholly rational or generally recognized methods of calculating the amount of duct lining necessary to accomplish a given reduction of noise level in the air travelling in a duct system; consequently some empirical method has to be used. One empirical method is to use direct trial and error. Another empirical method uses a duct lining factor evaluated by experience. In the present state of the data on sound control for ducts, the latter method is convenient for making estimates, but attention is specifically called to its empirical nature and to the necessity of exercising judgment in applying it.

Use of Duct Lining Factor

A duct lining factor (*f*) giving numerical values for use at various equipment noise levels is shown in Fig. 2. When properly used with Table 1 this chart (Fig. 2) provides a solution which may be both useful and simple. It is important to understand that the levels referred to in this chart are the *average* noise levels set up in the room by the ventilating or air conditioning equipment. In the case of a piece of equipment which generates a noise level of 95 db, when the noise is measured immediately

next to the machine, there might be a reduction of 15 db in passing through the duct, and a further difference of 15 db between the noise at the outlet supply grille and the average level in the room, leaving an effective level of 65 db in the room. Reductions of noise level ranging from 5 to 25 db through duct systems have been encountered without the use of sound absorbing linings and the drop from supply opening to average room level may vary from 5 to 20 db.

Duct lining factor f	Equipment Noisy	Average	Quiet
0	75	65	55
5	65	55	45
10	55	45	35
15	45	35	25
20	35	25	15
25	25	15	5
30	15	5	-5

FIG. 2. CHART FOR DETERMINING NOISE REDUCTION IN DECIBELS FROM DUCT LINING FACTOR[a]

[a]Values for equipment noise are only general. Wherever possible substitute actual values as supplied by equipment manufacturer or as measured.

To determine whether to use column 1, 2, or 3 in Fig. 2, in forming an estimate of the relative amount of noise generated by the system, the length of the untreated duct system and the number of bends or elbows or splitters should be considered, since the longer and the more complex the system, the more reduction of noise level will occur before the sound reaches the room grilles. Also the sound absorbing power of the room should be taken into account, since in rooms where there is a great deal of absorptive material, such as rugs, draperies, curtains and furniture, there will be a higher loss between the outlet grille noise and the average room level. The ventilating engineer will have to judge whether the conditions deviate from the typical.

Manufacturers ratings on equipment should be considered in connection with the foregoing discussion. The quantity determined involves