

If the amount of cork be reduced so that it is loaded to 10 lb per square inch, the total area of the supporting cork will be only 100 sq in. or 645 sq cm. The compliance of the entire support will now be $0.25 \times 10^{-6} \times \frac{1}{645} = 0.39 \times 10^{-9}$ cm per dyne.

$$n_o = \frac{1}{2\pi} \sqrt{\frac{1}{4.54 \times 10^5 \times 0.39 \times 10^{-9}}} = 11.98 \text{ cps}$$

by Equation 2:

$$\tau = \frac{1}{\frac{100^2}{11.98^2} - 1} = \frac{1}{69} = 0.0145.$$

In the first case the decibel reduction produced by the mounting, as compared with the vibration transmitted with the machine mounted directly on the floor is:

$$10 \log_{10} \frac{1}{\tau^2} = 10 \log_{10} \frac{2}{1} = 3 \text{ db.}$$

Dividing by 2 to allow a suitable factor of safety, the gain is 1.5 db which is negligible.

In the second case, the decibel reduction is:

$$10 \log_{10} \tau^2 = 10 \log_{10} \frac{4761}{1} = 36.8 \text{ db.}$$

Dividing by 2, the probable isolation is of the order of 18.4 db, which is an acceptable figure.

These two numerical examples will serve to show not only the manner of making the calculations, but also the importance of selecting the proper type and design of flexible supports for insulating the vibrations of a machine from the rigid structure of a building.

Controlling Noise Through Room Wall Surfaces

The ventilating equipment is usually housed in a separate room where the noise produced by the mechanical operation of the equipment can be isolated from the rest of the building. If the vibration of the machinery is absorbed by flexible mounting and is not transmitted to the building, the only noise to be eliminated by the walls of the room will be the air-borne mechanical noise. Acoustical measurements on average brick, tile, lath, and plaster walls indicate that the usual wall of these types is sufficient to satisfactorily attenuate this air-borne mechanical noise⁴.

Attention should be given to the equipment room door, since this door may leak badly and allow sound to escape into parts of the building which should be quiet. Where the equipment noise is particularly severe, double doors should be used and in all cases, the doors of the equipment room should be fitted with tight thresholds and weather-stripping. The door itself may transmit considerable sound if it is thin but it will not transmit a tenth as much as will be transmitted by a $\frac{1}{4}$ -in. crack between the door and the threshold.

In cases where the equipment noise is extraordinarily high, it may be 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.

⁴Acoustical Problems in the Heating and Ventilating of Buildings, by V. O. Knudsen (A.S.H.V.E. TRANSACTIONS, Vol. 37, 1932, p. 211).

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.

Measurements in one laboratory have shown that the loss through a sheet of No. 22 gage metal is 24 db. When a sheet of rock wool insulation 1 in. thick and weighing 1.4 lb per square foot is added to this, the insulation value is increased to 29 db. In general, however, adding a layer of insulation or pipe covering does not materially increase the sound insulation value unless the material is dense, or unless it is surfaced with another sound impervious layer such as metal or board. 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 traveling in a duct system; consequently some empirical method has been used.

Perhaps the commonest *rule of thumb* is that a length of duct should be lined which is equivalent to 10 to 15 diameters. If the duct is not square, this may be interpreted to mean 10 times the average dimension. Tests have shown that this amount of lining will usually suffice to eliminate the majority of the high frequency noise which is prevalent. Since this is the more objectionable component of the noise, and since much of the low frequency noise is usually eliminated in passing through any extended supply system, this procedure is usually satisfactory except in severe conditions. It should be noted that the lining should be installed at or near the outlet, in order to effectively reduce all sounds which may be generated in the system up to this point. A more complete method of determining the necessary length of lining material has been described