mately because the resistance will be inversely proportional to the thickness and directly proportional to the area of cross-section of the flexible support. Thus, if the values of c and r for a flexible material be known, it is possible to calculate, by means of Equation 1, the amount of insulation that will be obtained from the use of this material as a flexible support for a piece of equipment having a mass m. For the routine calculations in practice, r may be neglected with only a slight sacrifice of accuracy. Table 2 gives the values of c and r for a number of commonly used flexible materials.

Example 1. A machine weighing 1000 lb has a base area of 20 sq ft. Assume that the principal vibration of the machine has a frequency of 100 cycles per second (most machinery vibrations are less than 150 vibrations per second, and the assumed frequency of 100 is quite representative of typical machines). Suppose that a 1-in. slab of corkboard weighing 1.10 lb per board foot be placed between the machine and the floor. The loading on the cork will then be only 50 lb per square foot, or slightly more than ⅓ lb per square inch. (It is assumed that the compliance c in centimeters per dyne for a specimen 1 in. thick and 1 sq cm in cross-section is 0.25×10^{-6} and the resistance r in mechanical ohms is 0.15×10^{5}.)

The *transmissibility* is calculated in the following manner:

Mass of machine in grams $= 1000 \times 454 = 4.54 \times 10^{5}$.
Area of base in square centimeters $= 20 \times 144 \times 2.54 \times 2.54 = 1.86 \times 10^{4}$.

Therefore, the compliance of the entire support, 1 in. thick and 20 sq ft in cross section, is $0.25 \times 10^{-6} \times \dfrac{1}{1.86 \times 10^{4}} = 0.134 \times 10^{-10}$ cm per dyne, and the resistance of the entire support is $0.15 \times 10^{5} \times 1.86 \times 10^{4} = 0.28 \times 10^{9}$ mechanical ohms (or absolute units). Therefore,

$$\tau' = \sqrt{\frac{(0.28 \times 10^{9})^2 + \dfrac{1}{4\pi^2 \times 100^2 \times (0.134 \times 10^{-10})^2}}{(0.28 \times 10^{9})^2 + \left((2\pi \times 100 \times 4.54 \times 10^{5} - \dfrac{1}{2\pi \times 100 \times (0.134 \times 10^{-10})}\right)^2}}$$

$$= \sqrt{\frac{0.0784 \times 10^{18} + \dfrac{10^{18}}{4\pi^2 \times 10^{2} \times 0.018}}{0.0784 \times 10^{18} + \left(2\pi \times 4.54 \times 10^{7} - \dfrac{10^{8}}{2\pi \times 0.134}\right)^2}} = 0.935$$

Consequently, it is seen that the *transmissibility* is nearly equal to unity, and that the support therefore is not satisfactory for insulating 100 or fewer vibrations per second.

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 $0.25 \times 10^{-6} \times \dfrac{1}{645} = 0.39 \times 10^{-9}$ cm per dyne, and the resistance will be $0.15 \times 10^{5} \times 645 = 0.97 \times 10^{7}$ mechanical ohms (or absolute units). Therefore

$$\tau'' = \sqrt{\frac{(0.97 \times 10^{7})^2 + \dfrac{1}{4\pi^2 \times 100^2 \times (0.39 \times 10^{-9})^2}}{(0.97 \times 10^{7})^2 + \left(2\pi \times 100 \times 4.54 \times 10^{5} - \dfrac{1}{2\pi \times 100 \times (0.39 \times 10^{-9})}\right)^2}}$$

$$= \sqrt{\frac{0.94 \times 10^{14} + \dfrac{10^{14}}{4\pi^2 \times 0.1521}}{0.94 \times 10^{14} + \left(2\pi \times 4.54 \times 10^{7} - \dfrac{10^{7}}{2\pi \times 0.39)}\right)^2}} = 0.0375$$

It is seen, therefore, that with the bearing surface on the cork reduced to 100 sq in. (that is, with the cork loaded to 10 lb per square inch), the *transmissibility* is reduced to 0.0375, or the amplitude of vibration transmitted to the floor will be only about 1/27 of what it would be if the machine were mounted directly upon the floor. 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,

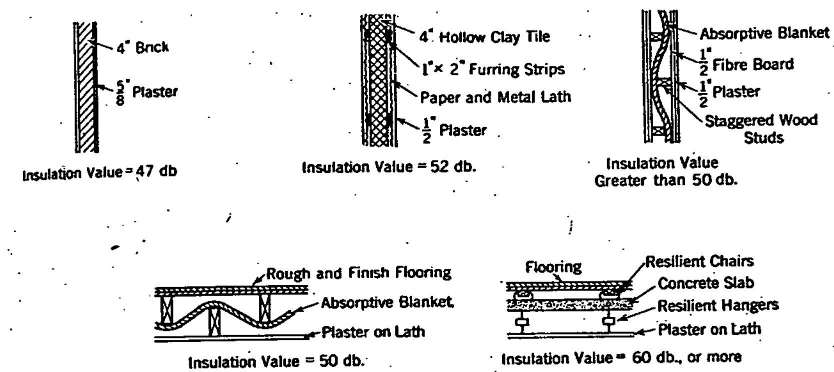

FIG. 1. THREE WALL SECTIONS AND TWO FLOOR AND CEILING SECTIONS WHICH ARE SUITABLE FOR THE INSULATION OF EQUIPMENT ROOMS[a]

[a]Acoustical Problems in the Heating and Ventilating of Buildings, by V. O. Knudsen (A.S.H.V.E. TRANSACTIONS, Vol. 37, 1931).

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 noise.

Three wall sections and two floor and ceiling sections which are satisfactory for the wall insulation of the equipment room are shown in Fig. 1.

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 ¼-in. crack between the door and the threshold.

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