ceiling of the equipment room, or the inner walls of the ducts, with sound-absorptive materials. The intensity I of a continuous sound in a room is

$$I = \frac{E}{a} \text{ or } \frac{I' S'}{a} \tag{2}$$

where

E = the rate of emission of the noise source = $I' S'$. (The intensities of noises entering the room times the areas through which they enter.)

a = the total amount of absorption supplied by the boundaries and contents of the room.

$= \alpha_1 S_1 + \alpha_2 S_2 + \alpha_3 S_3 + \ldots\ldots$, *where* $S_1, S_2, S_3, \ldots\ldots$ are the areas of the boundary materials for the room, *and* $\alpha_1, \alpha_2, \alpha_3, \ldots\ldots$ are the corresponding coefficients of absorption.

Hence, by increasing tenfold the absorptivity of the boundaries of a room it is possible to reduce tenfold the average intensity of sound in the room; that is, the intensity level would be reduced 10 db.

Thus it is possible to compute the noise level in the room if the intensity of noises entering the room or generated in it are known.

It will be seen that the noise intensity reduction is dependent upon the amount of sound absorption in the room, and that the first units of absorption are more effective than succeeding units. In general, the room noise level will be from 10 to 20 db lower than the air inlet or outlet noise intensity, the 10 db being in the case of bare rooms having large ventilating or air conditioning openings in relation to their size, and the 20 db in the case of rooms having large amounts of absorptive material with small openings. In some cases, the noise level reduction may run up to as much as 30 db, but then the higher sound intensity adjacent to the openings tends to nullify the effects of the extra reduction. Where these openings are large, the local effect on the noise intensity extends some distance from the opening; for instance, a four-square-feet opening might have a local effect within ten feet, while a one-half-square-foot opening would have a local effect within only five feet.

The coefficients of sound-absorption for a number of standard absorptive materials used, or suitable for use, in equipment rooms are given in Table 2. Coefficients are given for frequencies of 128, 512, and 2048 cycles. Where the frequency of the noise is not known, the values for 512 or 128 cycles are usually used.

INSULATION OF AIR-BORNE SOUND

The transmission of air-borne sounds through rigid partitions is accomplished primarily by the diaphragm-like vibrations of the partition. The weight per square foot of the wall is the determining factor, and the insulation value of a wall, in terms of the transmission loss in decibels, is proportional to the logarithm of the weight per square foot. Other factors, such as size, stiffness, composition, manner of mounting, and the use of multiple structures separated by air spaces or flexible connectors, contribute to the effective insulation. If the coefficients of sound transmission of different types of structures and the noise intensity in the space adjoining a room are known, it is possible to calculate the noise intensity in a room by the use of formula 1 and the following formula:

$$I' = I''\tau \tag{3}$$

where

I'' = noise intensity in space adjacent to room.

τ = coefficient of sound transmission.

Coefficients of sound transmission for some common walls are shown in Table 3.

Example 1. Suppose the brick wall between an equipment room and an adjacent auditorium has an area of 200 sq ft and a coefficient of sound of 0.00001 (see Table 3); that the auditorium contains 2000 sabines[2] of absorption; and that the noise level in the equipment room is 70 db above zero level.

$$70 - 0 = 10 \log_{10} \frac{I''}{I_o} \text{ (from Formula 1)}$$

$$\frac{I''}{I_o} = 10^7$$

$$\frac{I'}{I_o} = 10^7 \times 0.00001 = 100 \text{ (from Formula 3)}$$

$$\frac{I}{I_o} = 100 \times \frac{200}{2000} = 10 \text{ (from Formula 2)}$$

TABLE 2. COEFFICIENTS OF SOUND ABSORPTION[a]

MATERIAL	THICKNESS (INCHES)	COEFFICIENTS OF SOUND ABSORPTION		
		128 Cycles	512 Cycles	2048 Cycles
Acoustex 60, spray painted	1	0.16	0.51	0.72
Acousti-Celotex, Single *B*	⅝	0.11	0.45	0.68
Acousti-Celotex, Triple *B*	1¼	0.20	0.75	0.67
Acoustic Flexfelt	....	0.27	0.56	0.68
Acoustone	1	....	0.66	0.69
Akoustolith plaster	½	0.21	0.29	0.37
Akoustolith *A*, Tile	1	0.14	0.48	0.83
Brick wall, unpainted	18	0.024	0.031	0.049
Calicel	1	0.23	0.72	0.71
Corkoustic, Type C	1½	0.08	0.61	0.64
Glass	....	0.035	0.027	0.020
Insulite Acoustile, Type 44	1⅜	0.26	0.50	0.61
Kalite, with three coats lacquer	¾	0.35	0.43	0.45
Macoustic Plaster, stippled to depth of ½ in.	½	0.13	0.31	0.58
Masonite	7/16	0.18	0.32	0.33
Plaster, gypsum on hollow tile	....	0.013	0.020	0.040
Plaster, gypsum, scratch and brown coats on metal lath on wood studs	....	0.020	0.040	0.058
Plaster, lime, sand finish, on metal lath	¾	0.038	0.060	0.043
Poured concrete, unpainted	....	0.010	0.016	0.023
Rockoustile	1	0.18	0.57	0.72
Sabinite	½	....	0.34	0.49
Sanacoustic Tile	1¼	0.19	0.79	0.74
Stuccoustic Plaster, Type XB	¾	0.29	0.59	0.72
Transite Tile	1	0.19	0.81	0.72
Trutone Tile	1⅛	0.31	0.57	0.64
Wood sheathing, pine	¾	0.098	0.10	0.082
Wood, varnished	....	0.05	0.03	0.03

[a] *Architectural Acoustics*, by V. O. Knudsen, pp. 219, 220, 240-251.

[2] A *sabine* is 1 sq ft of totally absorptive surface.