Nov. 6, 1962 B. G. WATTERS 3,062,316

APPARATUS FOR PRODUCING INCREASED TRANSMISSION LOSS

Filed May 11, 1959

Fig. 1

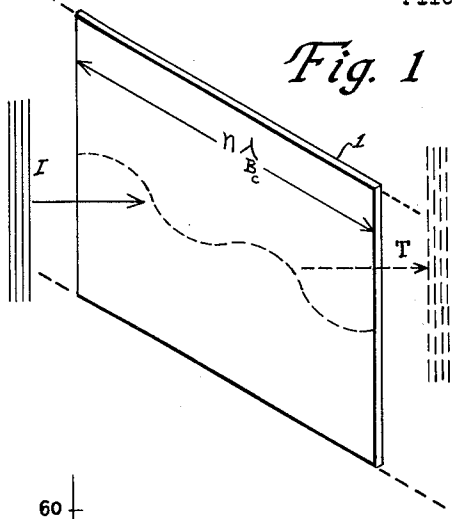
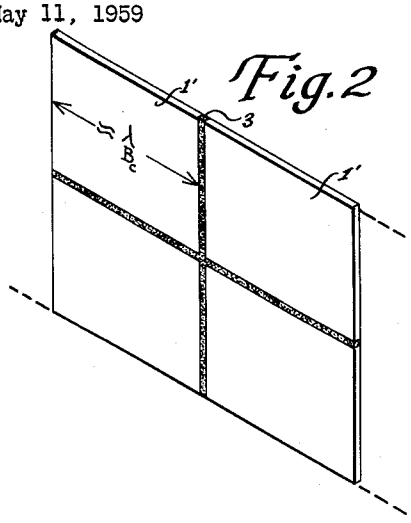


Fig. 2



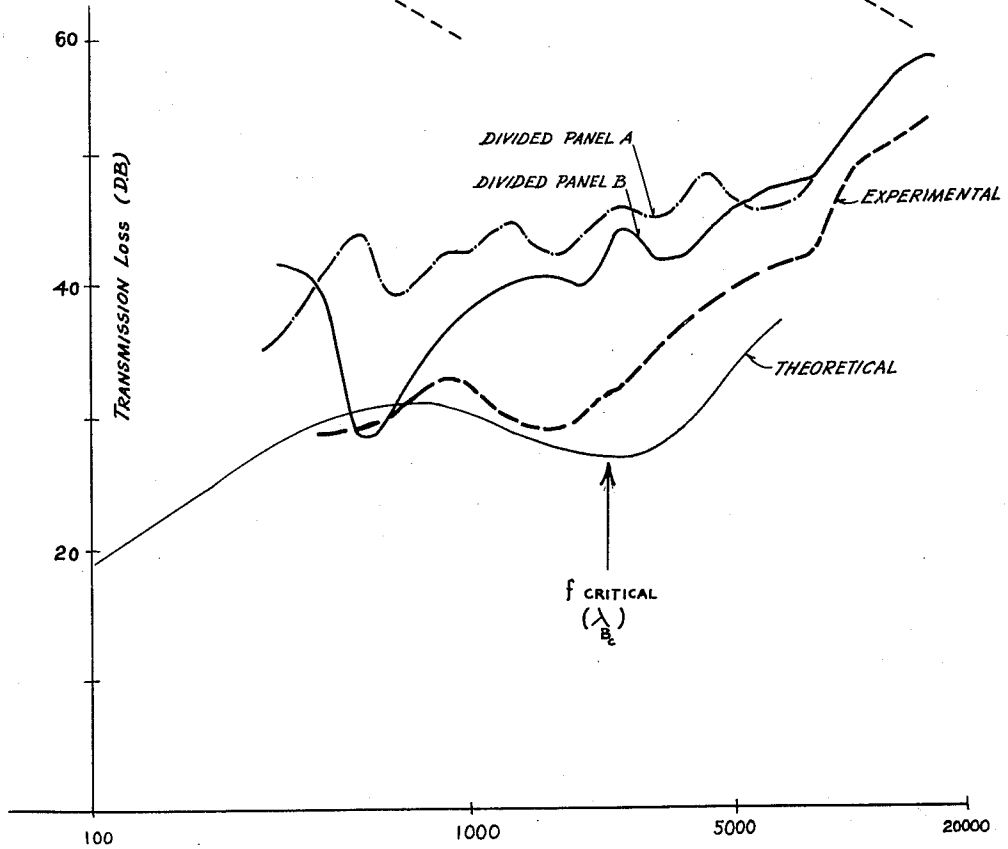


Fig. 3

INVENTOR.
BILL G. WATTERS

BY Rines and Rines

ATTORNEYS

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APPARATUS FOR PRODUCING INCREASED TRANSMISSION LOSS

Bill G. Watters, Nahant, Mass., assignor to Bolt Beranek and Newman Inc., Cambridge, Mass., a corporation of Massachusetts

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The present invention relates to methods of and apparatus for improving the acoustic transmission loss of panels and other similar structures.

Control of the transmission loss of space-subdividing structures, such as wall panels, separators, partitions and similar structures, all hereinafter referred to as "panels and the like," has heretofore been effected by modifying the unit weight, thickness and composition of the material of the panel and the like, or by applying acoustically impervious coatings or reflecting materials thereto. Such techniques are limited in the degree of obtainable modification of transmission loss, and are costly to effectuate.

An object of the present invention, however, is to provide a new and improved method of and apparatus for improving the transmission-loss characteristic of a panel and the like, that utilizes a discovery relating to the dimensions of the portions of the panel and the like that are permitted freely to flex.

A further object is to provide a new and improved acoustic panel structure and the like.

Other and further objects will be explained hereinafter and will be more particularly pointed out in the appended claim.

The invention will now be described in connection with the accompanying drawing, FIG. 1 of which is a perspective view illustrating the flexural effects in conventional panels and the like, that give rise to the undesirable transmission of acoustic energy from one side of the panel to the other;

FIG. 2 is a similar view of the structure of FIG. 1 modified to take advantage of the principles underlying the present invention; and

FIG. 3 is a graph plotting transmission loss along the ordinate, in units of decibels, and frequency along the abscissa, in units of cycles per second, and illustrating the performance of panels constructed in accordance with the present invention.

A conventional panel **1**, as of metal, composition material, concrete, or other construction, is diagrammatically illustrated, by the dotted lines at the periphery thereof, as mounted in a room or other space to subdivide the space into separate units. Incident sound energy I, impinging at an appropriate angle upon the left-hand surface of the panel **1**, will set the panel **1** into flexural vibration, as illustrated by the dotted sinusoidal transverse-wave line, thereby causing re-radiating of the acoustic energy at the right-hand surface of the panel, as indicated by the dotted wavefront T. The criterion for such acoustic-energy transmission between the left- and right-hand surfaces of the panel **1**, is that, at a particular critical acoustic frequency, the flexural wavelength of the vibrations set up in the panel is substantially equal to the wavelength of the acoustic energy I in the air or other medium surrounding the panel that is incident thereupon, at the Pierce angle. The dimensions of the panel **1** will be large compared with the said flexural wavelength. This large dimension is indicated by the symbols $n\lambda_{B_c}$, where n is a number greater than unity, and λ_{B_c} is the bending or flexural wavelength in the plate **1** at the before-mentioned critical frequency. The re-radiating criterion above-expressed, is mathematically determinable as follows:

$$\sin\theta = V_B/V_0$$

where θ is the said Pierce angle, V_B is the velocity of the vibrations in the panel and V_0 is the velocity of the vibrations in air. For normal incidence and transmission, $\sin\theta=1$, and the velocities are equal.

The theoretical transmission-loss characteristic of such a panel **1** and the like, is shown in the lower solid-line curve of FIG. 3, labelled "Theoretical." It will be observed that, at the before-mentioned critical frequency "f critical," (corresponding to the wavelength λ_{B_c}), the transmission loss drops down as a result of the flexural resonance of the panel **1**, and the re-radiation at T. Experimental verification is shown by the heavy dash-line curve labelled "Experimental." These curves illustrate the example of an aluminum panel two feet tall and three feet long. These dimensions are considerably larger than the wavelength λ_{B_c} at the critical frequency of about 2500 cycles.

It has been found that, by sub-dividing the panel **1** into sections or portions **1'**, FIG. 2, having dimensions that are more comparable with the said wavelength λ_{B_c} at the critical frequency, preferably just slightly higher or lower than the same, markedly improved transmission loss can be obtained in the region of the critical frequency and for a considerable broad-band region on either side thereof. Thus, in FIG. 2, the subdivided panel dimensions of the portions **1'** are shown as substantially equal to the wavelength λ_{B_c}. The uppermost dash-dot-line and solid-line curves of FIG. 3, labelled, respectively, "Divided Panel A" and "Divided Panel B," are experimental curves illustrating the transmission loss of similar aluminum panels having reduced dimensions of 4.3 x 6.4 inches, slightly less than the appropriate wavelength λ_{B_c}, and 7.6 x 11.4 inches, slightly greater than λ_{B_c}. It will be observed that in the region of the critical frequency "f critical," and for a broad band of frequencies on either side thereof, a very material increase in transmission loss of from 10 to 20 decibels is obtained.

It is essential, however, that the free flexural movement of the individual sub-divided panel portions **1'** be vibrationally isolated from one another, as by the aid of isolating mounts **3**, such as rubber gasketing, cork separators, or other vibration-isolating devices. The curves of FIG. 3 describe, also, the nature of the performance of a similarly subdivided concrete wall, though the curves will be relatively shifted to left.

Further modifications will occur to those skilled in the art, and all such are considered to fall within the spirit and scope of the invention, as defined in the appended claim.

What is claimed is:

A structure of the type described, comprising a flexural wall panel having its opposite sides exposed to the surrounding medium, the overall dimensions of said panel being substantially greater than the wavelength of free flexural waves which could be induced in said panel, if continuous, at the critical frequency at which said wavelength is substantially equal to the wavelength of acoustic energy in said medium incident upon said panel at the Pierce angle, said panel being subdivided into a plurality of adjacent portions interconnected by vibration isolating means, the major dimension of each of said portions being substantially equal to said wavelength, whereby the acoustic transmission loss of said subdivided panel is substantially greater than the transmission loss of a comparable continuous panel.

References Cited in the file of this patent

UNITED STATES PATENTS

1,573,475 Berliner ---------- Feb. 16, 1926

(Other references on following page)

UNITED STATES PATENTS

1,782,399	Amy	Nov. 25, 1930
2,101,568	Woodbury	Dec. 7, 1937
2,114,710	Holcomb	Apr. 19, 1938
2,361,205	Hoover	Oct. 24, 1944
2,796,636	Heerwagen	June 25, 1957
2,852,932	Cable	Sept. 23, 1958

OTHER REFERENCES

Edwin H. Barton, "A Text-Book on Sound" (London: MacMillan and Co., Limited, 1914), pp. 262 to 266, 302 and 303.

Floyd R. Watson, "Acoustics of Buildings" (New York: John Wiley and Sons, Inc., 1923) pp. 107 and 108.

Scientific Papers of the Bureau of Standards, No. 506, "Theory and Interpretation of Experiments on the Transmission of Sound Through Partition Walls," by Edgar Buckingham (Washington: Government Printing Office, May 26, 1925), pp. 205 to 208.

Albert B. Wood, "A Textbook of Sound" (London: G. Bell and Sons Ltd., 1946), p. 172.