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ACOUSTICAL BARRIER TREATMENT

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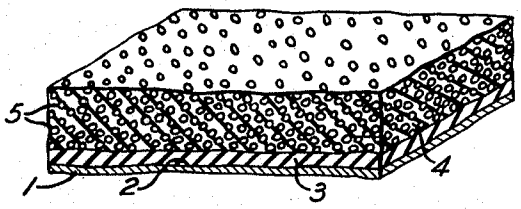


Fig. 1

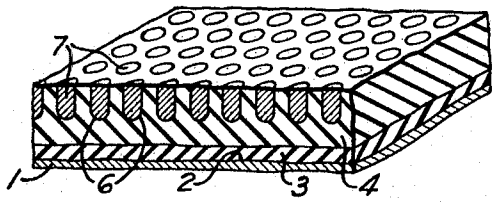


Fig. 2

INVENTOR.
GLENN E. WARNAKA
BY
Brown, Critchlow, Flick & Peckham.
ATTORNEYS.

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ACOUSTICAL BARRIER TREATMENT

Glenn E. Warnaka, Erie, Pa., assignor to Lord Corporation, a corporation of Pennsylvania

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This invention relates to means for rendering metal structures substantially opaque to a wide range of acoustic vibrations. Although not limited thereto, the invention is particularly applicable to the treatment of the sheet metal walls of housings or containers for delicate electronic and electromechanical equipment to protect such equipment from malfunction and failure from vibrations produced by ambient high intensity acoustic fields. Broad spectrum, high intensity sound waves readily penetrate most conventional sheet metal enclosures, which may be said to be acoustically transparent to such waves. One reason for such transparency is that the sound waves induce resonant vibrations of the container structure itself, which then transmits those vibrations (often intensified) to the equipment inside. Another reason is that the walls of such containers are just not heavy enough to block sound waves effectively, particularly sound waves of lower frequencies. It is accordingly among the objects of this invention to provide means for treating metal structures to make them an effective barrier to acoustic vibrations not only in those frequencies at which the structure is resonant, but also in other and lower frequencies. A further object is to accomplish the foregoing treatment most economically and efficiently.

Other objects will be apparent from the following description of a preferred embodiment of the invention, in connection with the attached drawings, in which

FIG. 1 is a sectional elevation of a fragmentary isometric view of one wall of sheet metal enclosure that has been treated in accordance with this invention; and

FIG. 2 is a similar elevation showing a modified form of treatment.

In accordance with this invention, a structural sheet metal member, which is subject to high intensity acoustic vibrations from a source located to one side of the member, has applied thereto an adherent first layer of relatively stiff viscoelastic material having a Young's modulus of elasticity that is substantially less than that of the metal sheet. This first layer, by a combination of extension and compression of its viscoelastic material, strongly damps the resonances of the underlying metal sheet. To the outer surface of this first layer is adhered a second layer of a relatively soft, compliant material having a modulus of elasticity that is substantially less than that of the first layer and having dispersed or suspended therein particulate material of high density. This second damping layer provides a highly compliant inertial mass that blocks the transmission of other frequencies of vibrations, particularly the lower frequencies.

Referring to the drawings, a base member **1** in the form of a thin, stiff metal sheet, which may be a wall of an enclosure housing delicate electronic equipment and which it is desired to render acoustically opaque, has adhered to its surface **2** a first damping layer **3** of viscoelastic material that is relatively stiff and that has Young's modulus of elasticity substantially less than that of the base member **1**. Various well known damping materials of this type may be used, such as asphalts, waxes, rubber and rubber-like polymers, as well as other polymeric materials characterized by high mechanical hysteresis or high internal friction. This layer has sufficient thickness, depending upon the type of vibration to be damped and the vibration characteristics of the base member **1**, to provide substantial damping of vibrations of the base

member (particularly at its resonant frequencies), such damping being effected predominantly through extension and compression of the viscoelastic material.

To the outer surface of this first layer of damping material is adhered a second layer **4** of a quite soft and compliant material having a Young's modulus of elasticity that is substantially less than that of the first layer. In fact, the second layer has preferably negligible stiffness and may consist of the same general type of material referred to in connection with the first layer but differing therefrom in being much less stiff. In other words, the second layer does not act as a substantial constraining layer, but merely as a limp support for high density material that may be dispersed throughout the second layer or locally concentrated in discrete pockets therein. In either case, the high density material may desirably consist of lead, iron, or some other metal, or even sand and the like. When uniformly dispersed throughout the second layer, the high density material is preferably in the form of small particles **5**, as shown in FIG. 1; but, when the high density material is concentrated in pockets **6** in the second layer, it may be in the form of shaped aggregates **7** filling those pockets.

Adherence between the first layer and the base member and between the first and second layers is obtained by the intrinsic adhesiveness of the layers in question or by the use of well known adhesives suitable for this purpose.

It is among the feaures of the present invention that the damping and inertial functions of the treatment described herein are separated into discrete laminated layers, which permits the most efficient utilization of the best damping materials as well as of the best inertial materials. Another feature is that the layers are arranged in a particular order, the damping layer being adhered directly to the surface of the base member and the inertial layer to the outer surface of the damping layer, an arrangement that permits the use of the least amount of damping material and the least amount of inertial material. In comparision, if the stiff damping layer were applied on the base member to a great thickness so as to fulfill both the damping and inertial requirements, the layer would tend to overstiffen the structure; and acoustically excited bending or flexural waves in the structure would travel at sonic or supersonic speeds and would be readily transmitted through the barrier in spite of the high inertial and high damping characteristics of the composite single layer treatment. Of course, if a soft massive layer having relatively small damping capabilities were alone applied to the structure, there would be insufficient damping to suppress structural resonances. Again, if the described order of the layers were reversed, so that the inertial layer was adhered directly to the surface of the base member and the damping layer adhered to the outer surface of the inertial layer, then the effectiveness of the damping layer would be greatly reduced because the soft inertial layer would provide full shear compliance between the metal sheet and the outer damping layer and there would be ineffective coupling of that layer with the sheet.

According to the provision of the patent statutes, I have explained the principle of my invention and have illustrated and described what I now consider to represent its best embodiment. However, I desire to have it understood that, within the scope of the appended claims, the invention may be practiced otherwise than as specifically illustrated and described.

I claim:

1. An acoustic barrier structure comprising a sheet metal base member having a surface subject to a field of intense acoustic vibration, a first layer of relatively

stiff viscoelastic damping material adhered to said surface, said material having a Young's modulus of elasticity that is substantially less than that of the base member, a second layer of relatively soft compliant material adhered to the outer surface of the first layer, the material of the second layer having a modulus of elasticity that is substantially less than that of the damping material of the first layer and supporting therein particulate material of relatively high specific gravity.

2. A structure according to claim 1, in which the particulate material is dispersed uniformly throughout the second layer.

3. A structure according to claim 1, in which the particulate material is segregated in localized pockets in the second layer.

4. A structure according to claim 1, in which the particulate material consists of at least one of the class of compounds that includes sand, lead, and iron.

5. A structure according to claim 1, in which the first layer has sufficient thickness to provide effective damping of resonant vibrations of the base member.

6. A structure according to claim 1, in which the compliant material of the second layer has negligible stiffness.

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RICHARD B. WILKINSON, *Primary Examiner.*

R. S. WARD, *Assistant Examiner.*