

April 30, 1963

J. J. BARUCH ETAL

3,087,572

ACOUSTIC ABSORBER

Filed May 29, 1959

2 Sheets-Sheet 1

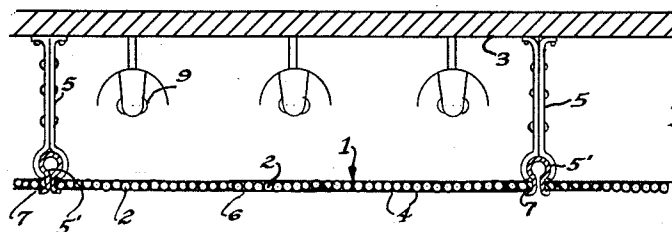


Fig. 1

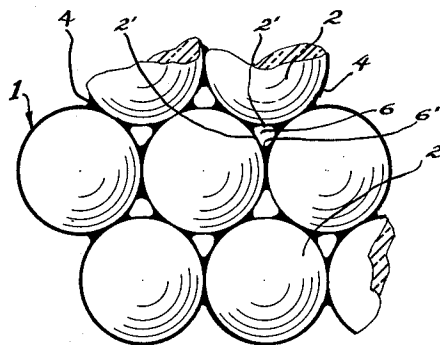


Fig. 2

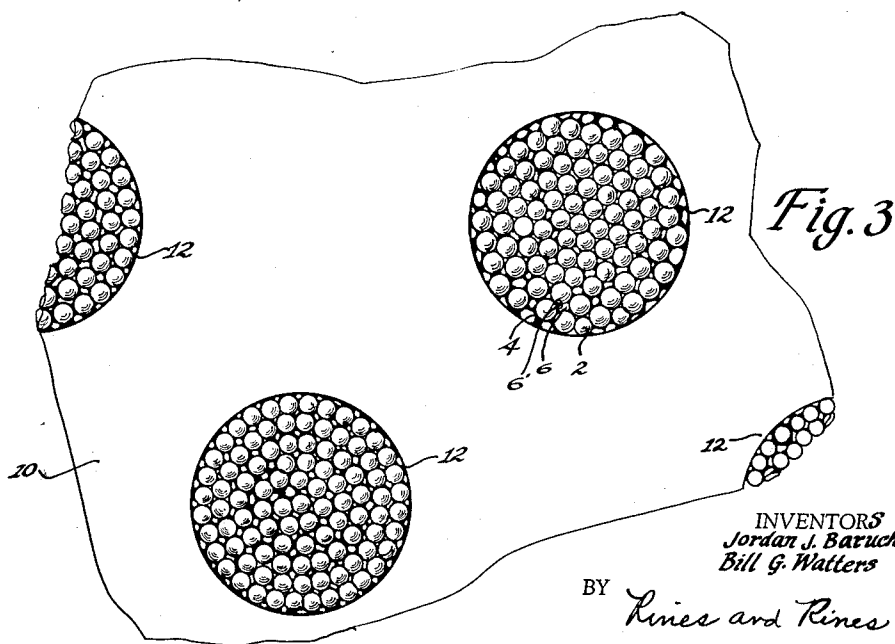


Fig. 3

INVENTORS  
Jordan J. Baruch  
Bill G. Watters

BY Rines and Rines

ATTORNEYS

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2 Sheets-Sheet 2

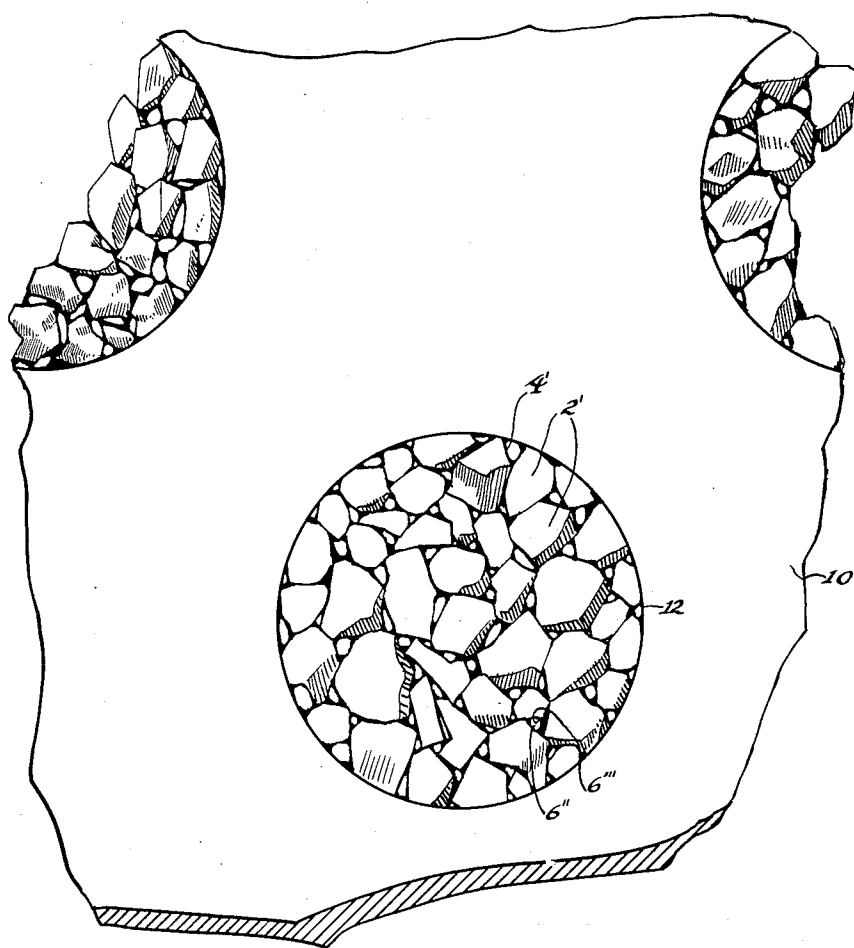


Fig. 4

INVENTORS  
Jordan J. Baruch  
Bill G. Walters  
BY *Rines and Rines*  
ATTORNEYS

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ACOUSTIC ABSORBER

Jordan J. Baruch, Newton, and Bill G. Watters, Nahant, Mass., assignors to Bolt Beranek and Newman, Inc., Cambridge, Mass., a corporation of Massachusetts  
Filed May 29, 1959, Ser. No. 816,844  
7 Claims. (Cl. 181-33)

The present invention relates to acoustic absorbers and, more particularly, to acoustically resistive sheets and the like.

It has previously been proposed to provide a laminated light-transmitting acoustically resistive sheet that provides a uniform light-transmitting surface obviating the necessity for interrupting ceiling and other acoustically reflective walls or surfaces with sound-absorbing tiles, baffles and the like. While this has been found to work admirably well in practice, in some cases, for reasons of cost or environmental conditions, such as very high temperatures and pressures, such a laminated structure may not be so desirable as a more rugged construction.

It is accordingly an object of the present invention to provide a novel, mechanically strong, unitary acoustically absorptive member that may still be imbued with light-transmitting qualities, as well.

A further object is to provide a novel acoustic absorber of more general utility, as where light-transmission is not required.

In summary, the invention resides, from a broad aspect, in providing a plurality of non-porous discreet solid units, such as beads and the like, that are mechanically bound closely together with finite spaces defined therebetween, the position of the spaces being aligned with openings in the binder for permitting the propagation of acoustic energy through the said spaces and openings.

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

The invention will now be described in connection with the accompanying drawing, FIG. 1 of which is a longitudinal section illustrating the application of the invention as a light-transmitting acoustic absorber;

FIG. 2 is an enlarged fragmentary detail of the absorbing member of FIG. 1;

FIG. 3 is a fragmentary plan view of a modification; and

FIG. 4 is a view similar to FIG. 2 of still a further modification.

Referring to FIG. 1, the invention is shown constructed to serve as a light-transmitting, acoustically absorptive sheet member 1, held spaced below a reflective ceiling, or other surface or wall 3 of a room, as by suspension struts 5. The ends of the sections of the member 1 may, as an illustration, rest upon flanges 7 along the edges of beams 5' carried by the struts 5. Any other supporting means may also be employed, as discussed, for example, in the said copending application. Illuminating fixtures 9 may be disposed in the space between the ceiling, wall or other surface 3 and the member 1.

In accordance with the present invention, the member is formed of a plurality of discrete non-porous solid units 2, such as light-transmitting glass beads and the like, illustrated more particularly in FIG. 2 as of preferably substantially spherical shape. Irregularly shaped beads may also be employed, though the use of substantially spherical beads 2 enables a precise control over the number, dimensions and separation of the beads when bound closely together with, for example, a binding covering 4, as of light-transmitting glass, vinyl plastic, ceramic or other similar binder material, applied in liquid or plastic state. The term "light-transmitting," as employed

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herein, is intended to embrace both light transparency and various degrees of translucency, as well.

By forcing a layer of the beads 2 preferably into contact with another, as shown, controlled spaces 6 are defined between adjacent beads 2, bounded by portions 2' of the walls of the adjacent beads 2. The binder covering 4 may be applied in a physically relatively thin layer (or layers) so that the layer terminates at the portions 2' of the beads defining the spaces 6 therebetween, leaving openings 6' therein, aligned with the spaces 6.

If the beads 2 and spaces 6 are of appropriate dimensions, preferably with the latter restricted to dimensions sufficient to prevent appreciable clogging of dirt and the like, and yet insufficient to produce esthetically undesirable prominent "pin-holing" effects and the markedly limited resistance to acoustic energy in the audible spectrum inherent in large-sized openings or spaces, extremely successful absorption of the acoustic energy propagated through the aligned openings 6' and spaces 6 will occur.

Analysis has shown that, in the case of the sheet 1 of FIG. 3, the flow resistance of the sheet may lie within the limits of from about

$$\frac{4.93 \times 10^{-6}}{Sr^3}$$

rayls (where  $r$  is the radius of the bead expressed in meters and  $S$  is the percent of open area of the sheet) to about

$$\frac{5.62 \times 10^{-7}}{Sr^3}$$

rayls, for successful operation. For multiple layers  $n$  of beads, these limits will be multiplied by the factor  $n$ . As an example, single-layer beads 2 of about three millimeters radius, having spaces 6 about half a millimeter across, formed within a sheet 1 having twenty percent of open area, will produce a flow resistance of about 420  $\rho c$ , where  $\rho$  is the density of air, and  $c$  the velocity of sound therein, having an optimum value  $\rho c=1.8$ .

The mass of the solid beads 2 assists in improving the low-frequency absorption of the composite member 1, and the use of a relatively more flexible binder material 4 will permit the bending or shaping of the member 1 into predetermined forms, without fracture. More than one layer, not shown, of beads 2 may also, if desired, be used. The use of such binder materials, as before mentioned, moreover, provides the member 1 with strong resistance to physical stresses and pressures, and to elevated temperatures, as well. Where the light-transmitting qualities are not required, furthermore, the beads 2 may be constituted of other materials than previously described, such as fritted aggregates, metal-grain units and the like, and the binder 4 may comprise a solder, or a ceramic cement or the like.

As a further illustration, a sheet member 10 is shown in FIG. 3, constituted, for example, of steel or other similar material if light-transmission is not desired, or of appropriate light-transmitting thin-sheet vinyl plastic and the like, if desired, perforated to provide a plurality of openings 12. Each of the openings 12 is shown fitted with a plurality of discrete units 2, as in FIGS. 1 and 2, bound therein and together by a binder 4. In the case of applications not requiring light-transmission, as for example, in an engine test cell duct, the beads 2 may be stainless steel or similar beads or grains bonded together at 4 to fill the openings 12, but the bond having openings 6' aligned with the spaces 6 between adjacent beads 2, as before discussed, that permit the acoustic energy to pass through the spaces 6 and the aligned openings 12 and 6 in order to dissipate the same through resistive action.

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As before stated, the units 2 need not be spherical or even of the same shape, though it is then more difficult to control the number of spaces and their distribution, and hence the acoustic performance. Thus, in FIG. 4, grains 2' of steel or other metal or similar material are shown bonded together at 4' by sintering the same; providing, again, the exposed aligned spaces 6'' and binder openings 6''', as previously described.

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 claims. The term "bead-like elements" employed in the claims is intended to embrace elements which are like beads with respect to the function performed in the acoustic absorber of the invention. For example, the elements may be grains or other such particles which may or may not be round or regular in shape.

What is claimed is:

1. An acoustic absorber comprising a thin sheet having a plurality of contiguous bead-like elements defining spaces therebetween which extend through said sheet, and having a binder joining said elements into a unitary layer of thickness substantially the same as said elements, said binder having spaces therein aligned with the first-mentioned spaces whereby acoustic waves may be propagated through said sheet, said sheet having a flow resistance substantially within the range from

$$\frac{4.93 \times 10^{-6}}{Sr^3}$$

rayls to

$$\frac{5.62 \times 10^{-7}}{Sr^3}$$

rayls, where  $r$  is the radius of the bead-like elements expressed in meters and  $S$  is the percent of open area of the sheet.

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2. The acoustic absorber of claim 1, wherein said bead-like elements and said binder are of light-transmitting material.

3. The acoustic absorber of claim 1, wherein the binder comprises a sinter of said bead-like elements.

4. The acoustic absorber of claim 1, wherein the binder is relatively flexible compared to said bead-like elements in order to permit shaping of the sheet.

5. The acoustic absorber of claim 1, wherein said sheet has a plurality of spaced openings containing said bead-like elements.

6. The acoustic absorber of claim 1, in which said binder comprises a covering for said bead-like elements.

7. The acoustic absorber of claim 1, further comprising means for mounting said sheet in proximity to an acoustically reflective wall.

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