April 30, 1968 R. G. BARNETT 3,380,206

LAY-IN ACOUSTICAL CEILING PANEL WITH FLEXIBLE DIAPHRAGMS

Filed Sept. 29, 1965 2 Sheets-Sheet 1

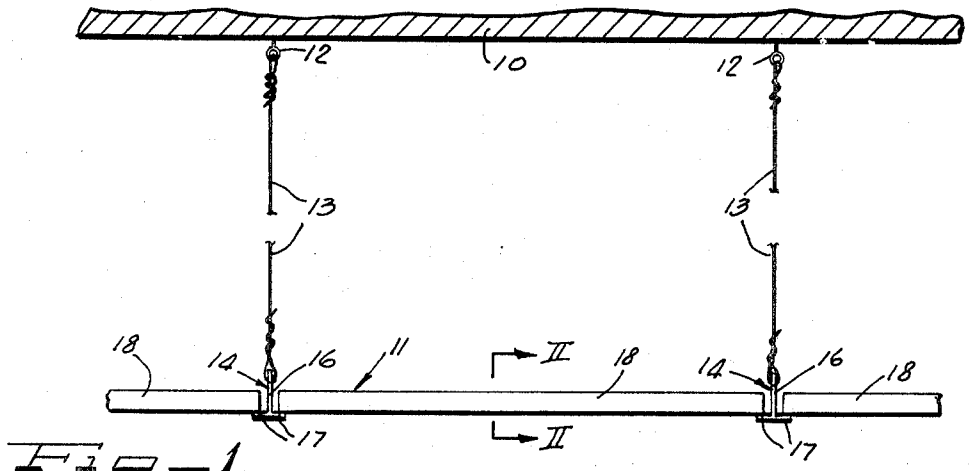


Fig. 1

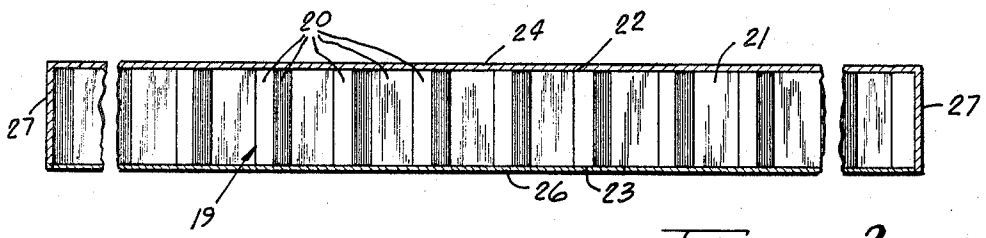


Fig. 2

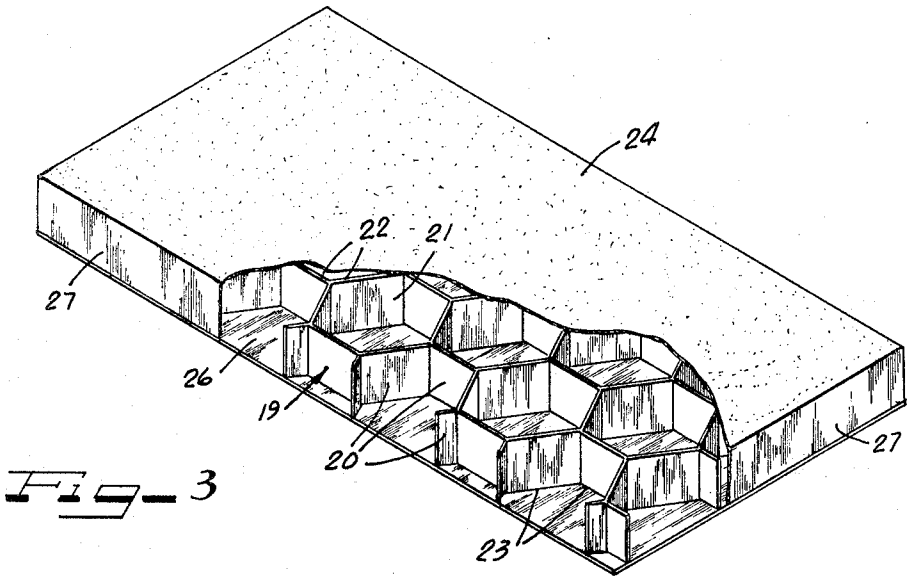


Fig. 3

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Fig. 4

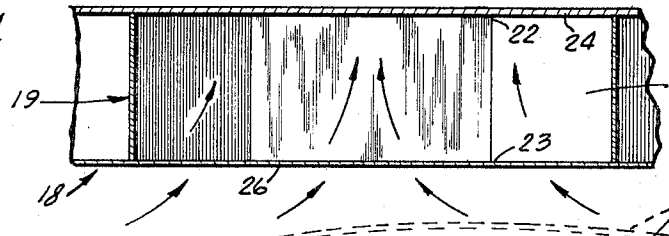


Fig. 5

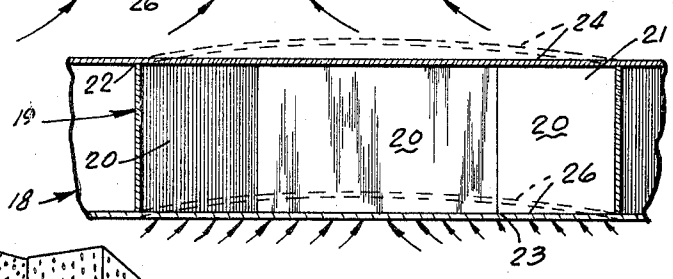


Fig. 6

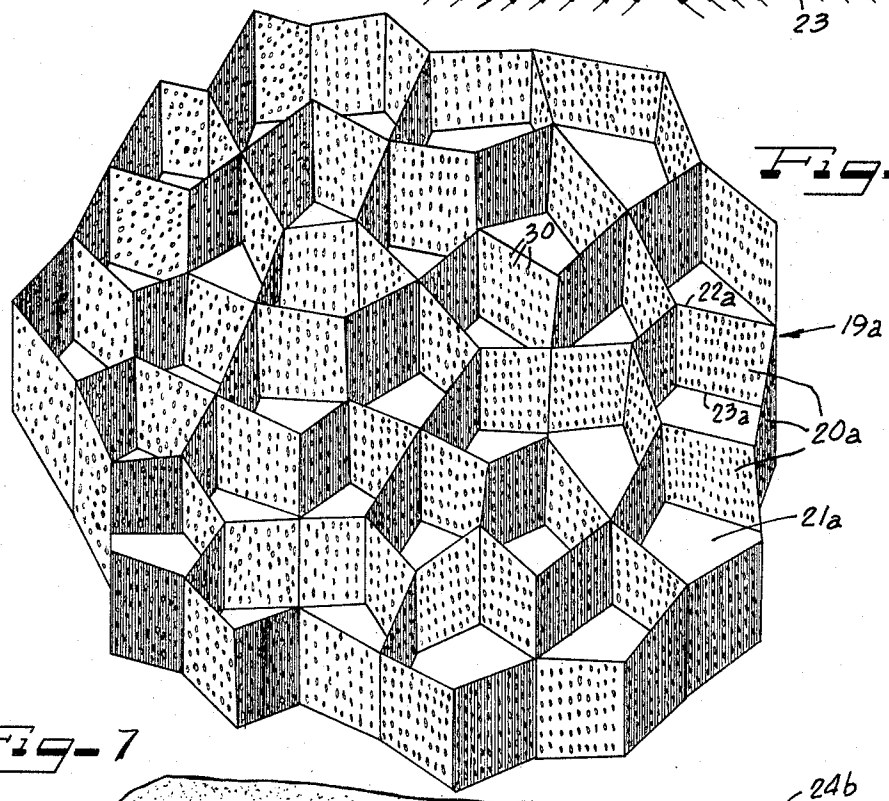
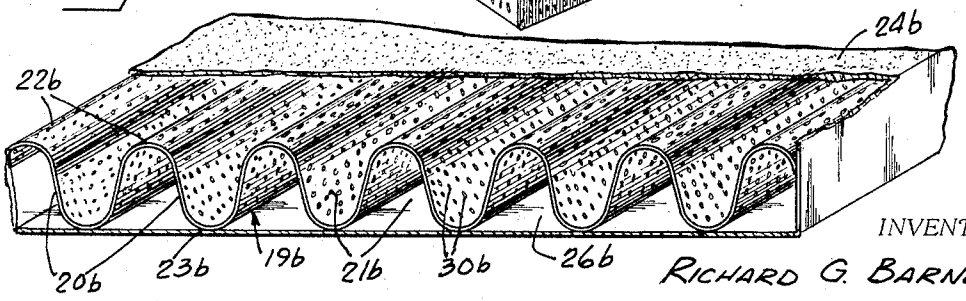


Fig. 7



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LAY-IN ACOUSTICAL CEILING PANEL WITH FLEXIBLE DIAPHRAGMS

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11 Claims. (Cl. 52—145)

ABSTRACT OF THE DISCLOSURE

A lay-in acoustical panel for use with a suspended ceiling in which a core stock comprising a section of wall portions is sandwiched between first and second sections of flat, thin flexible facing sheets, the wall portion section forming cells which are sized and the flexibility of the facing sheets being selected to form flexible diaphragms for each individual cell responsive in unison to audible sound frequencies with a diaphragmatic action, thereby permitting the lay-in panel to function as an acoustical unit.

This invention relates generally to suspended ceiling constructions and more particularly relates to an improved lay-in panel for such a ceiling wherein a core stock comprising a section of wall portions is sandwiched between first and second sections of flat, thin flexible facing sheets, the wall portion section forming cells which are sized and the flexibility of the facing sheets being selected to form flexible diaphragms for each individual cell responsive to audible sound frequencies with a diaphragmatic action, thereby permitting the lay-in panel to function as an acoustical unit.

It is an object of the present invention to provide an improved suspended ceiling construction.

Yet another object of the present invention is to provide an improved lay-in acoustical ceiling panel which functions as an acoustical unit by virtue of a diaphragmatic action.

Yet another object of the present invention is to provide a lay-in acoustical ceiling panel which may be economically constructed from lightweight materials such as vinyl film or vinyl treated paper applied to a core stock by the stressed skin technique, thereby providing a structure which is attractive in appearance and easy to maintain.

A still further object of the present invention is to provide a lay-in acoustical ceiling panel which will function as a sound unit without requiring intermediate sound-absorbing substances.

Many other features, advantages and additional objects of the present invention will become manifest to those versed in the art upon making reference to the detailed description which follows and the accompanying sheets of drawings in which a preferred structural embodiment of a suspended ceiling construction utilizing lay-in acoustical ceiling panels of the present invention is shown by way of illustrative example.

On the drawings:

FIGURE 1 is a cross-sectional view somewhat diagrammatic illustrating a suspended ceiling construction provided in accordance with the principles of the present invention;

FIGURE 2 is a fragmentary cross-sectional view taken on line II—II of FIGURE 1;

FIGURE 3 is a fragmentary perspective view with parts broken away to illustrate additional details of the lay-in acoustical ceiling panel of FIGURE 2;

FIGURES 4 and 5 are fragmentary cross-sectional views demonstrating the diaphragmatic action which occurs in the individual cells of the lay-in acoustical ceiling panel provided in accordance with the principles of the present invention;

FIGURE 6 is an isometric view of an alternative core stock which may be utilized in connection with the practice of the present invention; and

FIGURE 7 shows an alternative construction for an acoustical ceiling panel incorporating the principles of the present invention.

As shown on the drawings:

Because the principles of the present invention involve exploitation of a diaphragmatic action, the lay-in acoustical ceiling panel herein disclosed finds a particular utility in a suspended ceiling construction. Thus, there is shown in FIGURE 1 a ceiling of an architectural structure which is depicted at **10** and the suspended ceiling or false ceiling is shown generally at **11** in spaced relation to the main ceiling **10**. To accomplish such suspension, there is provided suitable anchoring or fastening means **12** which are connected to the main ceiling **10** and to which are attached plural suspension wires **13**. A the ends of the suspension wires **13** there is provided a grid which is formed by inverted T runners shown generally at **14**, it being understood that each T runner includes an upstanding body section **16** and outwardly projecting flanges **17** forming support surfaces for engaging and supporting the lay-in acoustical ceiling panels of the present invention. Each panel is designated generally at **18** and the details of the lay-in panels **18** are illustrated in the drawing FIGURES 2–7, inclusive.

It may be noted that in practicing the principles of the present invention, the lay-in panels **18** can be constructed of a size which is generally larger than the panel units currently available since the lay-in panels **18** of the present invention exhibit particularly good beam strength and do not bow or belly downwardly, thereby eliminating excessive grid work and reducing the overall cost of the suspended ceiling construction.

While it is contemplated that the core stock of the laminated ceiling panel provided herein may taken different physical forms, it is contemplated by the present invention that in each instance, the core stock will include a core member having plural wall portions extending between oppositely facing terminations of the wall portions which are disposed in a common plane and form a plurality of cells between the wall portions. Thus, a facing sheet may be placed on each side of the core member co-extensive therewith and securely fastened to the terminations to bridge the cells disposed between the wall portions and form flexible diaphragms for such individual cells which respond to audible sound frequencies with a diaphragmatic action.

Referring, first of all, to the form of the invention illustrated in FIGURES 2–5, it will be noted that the core stock comprises a core member **19** having multiple walls **20** forming a honeycomb core with a plurality of honeycomb cells **21** disposed between the walls **20**.

The walls **20** have edges **22** and edges **23** which are disposed in spaced parallel planes.

A facing sheet **24** is disposed on one side of the honeycomb core **19** and is co-extensive therewith and securely fastened to the edges **22**, for example, by a suitable adhesive, thereby to individually bridge each honeycomb cell **21**.

A facing sheet **26** is disposed on the opposite side of the honeycomb core **19** and is also co-extensive therewith and securely fastened to the edges **23** by a suitable adhesive or the like, thereby to individually bridge the opposite side of each honeycomb cell **21**.

If desired and in order to provide a completely finished panel unit, side walls are formed to extend between the facing sheets **24** and **26** and which side walls are shown at **27**.

It is contemplated by the present invention the facing sheets **24** and **26** will be made of flat, thin flexible material. In this regard, suitable materials constitute vinyl film, matte paper, glass matte or vinyl treated paper.

Lay-in acoustical ceiling panels can be provided in different thicknesses, for example, one-half inch, three-quarters inch or one inch thicknesses. Thus, the core member **19** provided for each respective thickness may have individual cells **21** of correspondingly varying size. In any event, in accordance with the principles of the present invention, it is contemplated that the cells **21** be sized and the flexibility of the facing sheets **24** and **26** be selected to be in such relationship as to form flexible diaphragms individually bridging each cell **21** and responsive to audible sound frequencies with a diaphragmatic action. Such diaphragramatic action is illustrated in FIGURES 4 and 5 wherein a small section of one of the acoustical panels **18** of the present invention is illustrated and the arrows identify sound waves which are moving upwardly from the space below the suspended ceiling **11** and against the facing sheet **26** which faces the interior of the space below the suspended ceiling **11**. In FIGURE 5, the facing sheets **24** and **26** are shown bowed upwardly or "diaphragmed" upwardly, thereby developing an attenuating function with respect to the sound waves depicted by the arrows and permitting the lay-in acoustical panel **18** to function as an acoustical unit.

While selections of the facings **24** and **26** may be in part dictated by the necessity of enhancing the decorative aspects of the panel **18**, it will also be appreciated that the facing sheet **26** which is displayed toward the interior of the space below the suspended ceiling **11** may either be porous or foraminous or perforated. Thus, sound energy will enter the individual cells **21** with such a facing sheet and the diaphragmatic action will be developed in accordance with the principles of the present invention. In the event the facing sheet **26** is continuous or non-porous, the diaphragmatic action is still developed as illustrated in FIGURE 5.

It will also be understood that the entire lay-in panel unit **18**, i.e., the core stock as well as the facing sections may be rendered fire-resistant either chemically or by other known means, even though such components may conveniently and economically comprise paper or other cellulosic materials.

It is further contemplated by the present invention that the core member forming the core stock may have air passages extending through the walls and intercommunicating the cells in order to further assist the attenuation of the sound waves. In this connection, reference should be made to FIGURE 6 wherein is shown an alternative form of core stock **19*a*** including plural walls **20*a*** forming multiple cells **21*a*** therebetween. The walls **20*a*** have upper edges **22*a*** and lower edges **23*a*** in parallel spaced relationship and to which the facing sheets may be secured.

It will be noted that all of the walls **20*a*** are particularly characterized in the embodiment of FIGURE 6 by the provision of air passages **30** intercommunicating the cells **21*a***, thereby to assist in the attenuation of sound. The air passages **30** may be conveniently provided through perforations or other foraminous openings.

The illustration of FIGURE 6 also illustrates the fact that the cells **21*a*** are not necessarily uniform in shape, however, in accordance with the principles of the present invention, the cell sizes are related to the thickness characteristics of the facing sheets so that each cell is bridged by a separate thin flexible diaphragm in order to develop the diaphragmatic sound attenuation contemplated by the present invention.

In FIGURE 7, still another core structure is provided and is shown generally at **19*b***. The core member **19*b*** is corrugated, that is, it has a plurality of curved wall portions **20*b*** with the termination portions thereof constituting spaced ridges **22*b*** on the top side and **23*b*** on the bottom side, the ridges **22*b*** and **23*b*** being disposed in spaced parallel relation and in co-planar relation with respect to one another so that facing sheets may be securely fastened thereto on opposite sides of the core member **19*b***.

Between the ridges are hollows forming the cells **21*b***, each of which is bridged by a corresponding facing sheet **24*b*** and **26*b***.

As in the form of the invention illustrated in FIGURE 6, the walls **20*b*** of the core member **19*b*** may be provided with air passages in the form of perforations **30*b***, thereby to intercommunicate the cells **21*b*** and further assist in the sound attenuation.

Although minor modifications might be suggested by those versed in the art, it should be understood that I wish to embody within the scope of the patent warranted hereon, all such modifications as reasonably and properly come within the scope of my contribution to the art.

I claim as my invention:

1. A lay-in acoustical ceiling panel comprising,
a core member having plural wall portions extending between oppositely facing terminations of said wall portions disposed in a common plane and forming a plurality of cells,
a facing sheet on each side of said core member coextensive with said core member and securely fastened to said terminations and bridging the cells disposed between said wall portions,
each said facing sheet being made of a thin flexible material,
the cells being sized and the flexibility of the facing sheets being selected to be in such relationship as to form opposed coextensive flexible diaphragms which respond in unison to audible sound frequencies with a diaphragmatic action,
whereby said panel functions as an acoustical unit.

2. A lay-in acoustical ceiling panel comprising,
a member including multiple walls forming a honeycomb core and having a plurality of honeycomb cells disposed between said walls,
the edges of said walls being disposed in spaced parallel planes,
a facing sheet on each side of said honeycomb core and co-extensive therewith and securely fastened to said edges of said walls to individually bridge each honeycomb cell,
each said facing sheet being made of a thin flexible material,
the cells being sized and the flexibility of said facing sheets being selected to be in such relationship as to form spaced co-extensive flexible diaphragms on opposite sides of each cell which respond in unison to audible sound frequencies with a diaphragmatic action,
whereby said panel functions as an acoustical unit.

3. A lay-in acoustical ceiling panel as defined in claim **2** and
further characterized by said multiple walls having plural air passages formed therein between said cells to further assist in sound attenuation.

4. A lay-in acoustical ceiling panel comprising,
a corrugated core member having plural spaced ridges disposed in spaced parallel planes and hollows between said ridges forming cells therebetween,
a facing sheet on each side of said core member and co-extensive therewith and securely fastened to said ridges to individually bridge each cell,
each said facing sheet being made of a thin flexible material,
the cells being sized and the flexibility of said facing sheets being selected to be in such relationship as to form flexible diaphragms on opposite sides of each cell which respond to audible sound frequencies with a diaphragmatic action,

whereby said panel functions as an acoustical unit.

5. A lay-in acoustical ceiling panel as defined in claim 4 and further characterized by each said corrugation having plural air passages formed therein between said cells to further assist in sound attenuation.

6. A lay-in panel for a suspended ceiling comprising,
a core stock comprising a section of wall portion sandwiched between first and second sections of flat thin flexible facing sheets,
said section of core stock and said first and second sections of facing sheets being co-extensive in area and laminated together in coplanar relationship,
said wall portions having a plurality of cells each extending between said facing sheets and each individually bridged to form a plurality of diaphragms,
the cells being sized and the flexibility of said facing sheets being selected to form flexible diaphragms responsive in unison to audible sound frequencies with a diaphragmatic action,
whereby said panel functions as an acoustical unit.

7. A lay-in panel for a suspended ceiling as defined in claim 6 and
further characterized by one of said sections of facing sheets being made of a porous material,
thereby to have pasage means extending therethrough.

8. A lay-in panel for a suspended ceiling construction as defined in claim 6 wherein said core stock comprises multiple wall portions forming a honeycomb core with a plurality of honeycomb cells disposed between said wall portions,
the edges of said wall portions being disposed in spaced parallel planes for engagement with said facing sheets.

9. A lay-in panel for a suspended ceiling construction as defined in claim 6 wherein said core stock comprises corrugated wall portions having plural spaced ridges disposed in spaced parallel planes and hollows between said ridges forming cells therebetween and said facing sheets engaging and connected to said ridges.

10. A lay-in panel for a suspended ceiling construction as defined in claim 6 wherein said wall portions of said core stock have passages extending therethrough to assist in sound attenuation.

11. In combination, a suspended ceiling comprising
inverted T runners forming a grid below the level of the ceiling of an architectural structure,
and a plurality of lay-in ceiling panels supported on said grid,
each said ceiling panel comprising a core stock having plural wall portions extending between oppositely facing terminations of said wall portions disposed in a common plane and forming a plurality of cells,
a facing sheet on each side of said core stock coextensive therewith and securely fastened to said terminations and bridging the cells disposed between said wall portions,
the cells being sized and the flexibility of said facing sheets being selected to form flexible diaphragms responsive in unison to audible sound frequencies with a diaphragmatic action,
whereby said suspended ceiling absorbs sound.

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