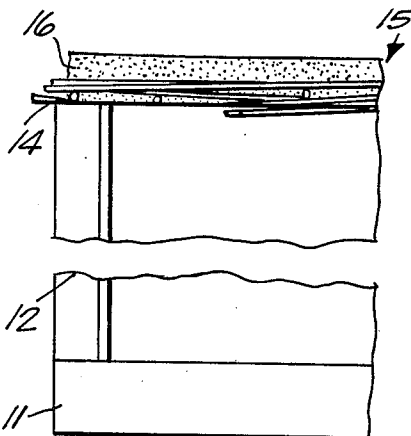
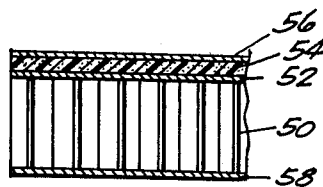
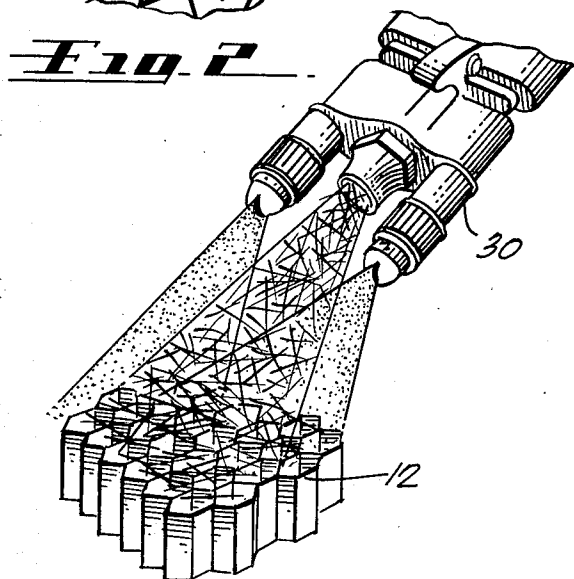
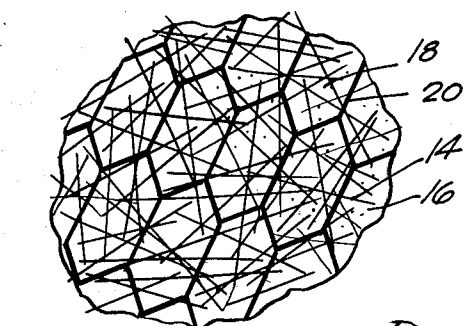
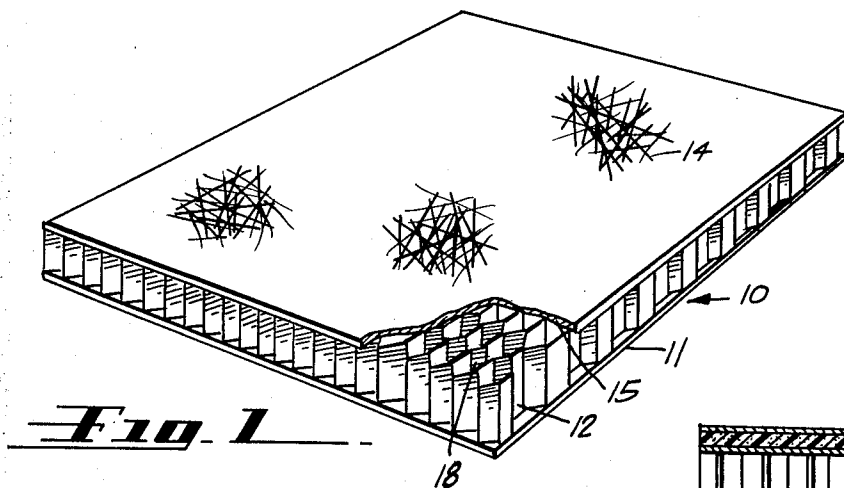


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FACE THEREOF COATED WITH FIBERS BRIDGING THE CELLS
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3,211,253

ACOUSTICAL PANEL COMPRISING A CELLULAR CORE HAVING A FACE THEREOF COATED WITH FIBERS BRIDGING THE CELLS

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This invention relates to the construction of panels for application to walls and ceilings, especially acoustical panels, and to methods for producing such panels.

Sound absorbent panels are frequently applied to the walls and ceilings of various types of buildings, business offices, aircraft interiors, auditoriums and other constructions to reduce noise and control acoustical characteristics, to provide a decorative effect, and for other purposes. Fiberboard panels made of bagasse have been commonly used for these purposes. However, this type of panel generally contains perforations which collect dust and which make the cleaning of the panels difficult. These panels and other similar types have generally been structurally weak, difficult to install, and expensive. Additionally, most of the available panels have been of generally similar construction and appearance, and since the application of paint, wallpaper, or other coatings would seriously affect acoustical properties, almost all panels have had the same general appearance. Interior designers and architects have been desirous of obtaining acoustical panels which presented an appearance totally different from that of the perforated fiberboards. An effective acoustical panel of attractively different appearance which also was strong, light, easy to clean, easy to install, and of low cost would be of very great value. This invention provides such panels and methods for producing them.

The panels of this invention are generally constructed of a multicellular core such as honeycomb, on the face of which is bonded a very thin layer of resin impregnated fibers. The honeycomb supplies large strength and low weight, as is widely known. The honeycomb cells also provide very good sound absorption because there is very little surface to directly reflect sound waves; waves which enter an opening of a honeycomb core are largely reflected between the core walls and absorbed before they can pass back to the interior of a paneled room. The open spaces of the core generally cannot be used to line the interior of a room because of the poor appearance and the difficulty of cleaning. However, the thin coating of resin impregnated fibers over the face of the core serves as a durable and attractive finish which covers the honeycomb cores but which allows sound to pass through with extremely small reflection. The covering is thin but tough and it serves to strengthen the honeycomb core so that a very strong and rigid panel is obtained. Such a panel is useful where a covered honeycomb panel is desired regardless of its acoustical properties and is especially desirable where sound absorption is needed. Thus, the invention provides panels and especially acoustical panels of superior qualities than obtainable heretofore.

The method by which the panels are produced is economical and capable of high production rates, thus enabling the manufacturer of panels which can be sold at low cost. The method includes spraying a honeycomb

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core with a mixture of long fibers and resin. A large proportion of the sprayed fibers lie between and bridge the edges of the honeycomb core, thereby providing a continuous covering over the cells, the small opening between fibers being filled with resin. The covering is generally rolled to assure a smooth surface. The method lends itself to high production with relatively simple equipment and utilizes stock and raw materials of a simple and economical form.

Accordingly, one object of the present invention is to provide an efficient panel with a multicellular core, and especially acoustical panels of that type.

Another object is to provide panels having a multicellular base of high strength, good cleanability, good appearance, and low cost.

A further object is to provide efficient methods for manufacturing acoustical panels.

A still further object is to provide a method for economically manufacturing acoustical panels using a base of honeycomb core.

These and other objects of the invention and a more complete understanding thereof may be had by reference to the following description and claims taken in conjunction with the accompanying drawings in which:

FIGURE 1 is a partially sectional pictorial view of a panel constructed in accordance with the present invention;

FIG. 2 is a partial plan view of the panel of FIG. 1; FIG. 3 is a partial, sectional, side elevation view of the panel of FIG. 1;

FIG. 4 is a pictorial view of a fiber and resin spraying apparatus shown spraying a honeycomb sheet in accordance with the method of this invention; and

FIG. 5 is a partial sectional view of an embodiment of the invention in which a foam covering is applied over the fiber-resin coating.

With reference to the drawings wherein like numerals refer to like references, and more particularly to FIGS. 1, 2 and 3 which illustrate a panel 10 constructed in accordance with the invention, the invention comprises a core 12 of paper formed into numerous cells 18 in a honeycomb arrangement, a base of resin impregnated fiberglass cloth 11, a front coating 15 comprising fibers 14 of a material such as glass in a matrix of a resin 16 such as polyester resin. The honeycomb core 12 provides the structural strength of the panel while contributing only a small weight, and also provides numerous cells 18 which absorb sound. The base 11 backs up the panel to cover the honeycomb cells 18 and enable the attachment of the panel 10 to a wall, and also stiffens the core 12. The front coating 15 provides a continuous covering for the honeycomb core so that the panel is attractive and is easily cleaned, yet the coating allows sound to pass through to the core 12 and its cells 18. The covering 15 also strengthens and rigidizes the panel by holding the edges of the cells in a fixed relationship.

The panel 10 can be manufactured by using a large panel of honeycomb core 12, such as the type produced by the method described in United States Patent Number 2,581,421 of Nathaniel Lombard. In the manufacture of the panel, it is positioned on a table under a fiber-resin spray gun 30, as shown in FIG. 4, the gun being mounted on a mechanism for moving it back and forth across the panel. The gun is of a well known type such as the Rand Spray-up Gun manufactured by the Sealzit Com-

pany of America, of Riverside, California, or a gun of the type described in United States Patents 2,933,125 or 2,787,314, both of David F. Anderson.

The gun 30 is provided with a resin such as polyester, vinyl, or epoxy and adjusted so that it sprays a thin coating of resin only. A first pass is then made of the gun 30 over the core 12 to spray a thin coating of about one-quarter mill on the edges of the cells. A mill as used herein is defined as a thousandth of an inch. Most of the first coat of resin spray goes through the open cells of the core, but a small amount settles on the front surface edges. This coating is useful to "catch" fibers which are sprayed in a second pass.

The spray gun 30 is then set to cut fibers and spray them with resin. Fibers of glass having a diameter of the order of magnitude of three hundred-thousandths of an inch (.00003") have been found satisfactory, though fibers of other diameters can be used. Generally fibers having a diameter of less than about one ten-thousandth of an inch (.0001") should be used to assure that they will be very flexible and lie on the edges of the cells, and to assure that many fibers will cover each cell even for the thin coverings used, so there is only a small space between fibers. The gun 30 is set to cut the fibers into lengths which will cover several honeycomb cells, such as one and a half inch of length for a core with cells of about one-half inch width.

The spray of the second pass of the gun 30 over the fibers is adjusted so that it consists of about 80% glass fibers and 20% resin by weight. This mixture is then sprayed in a second pass so as to provide a second coating of about 2 mils thickness.

The fibers of the second coating generally lie upon the edges of the core rather than filling the honeycomb cells partly because of their length which spans several cells. The resin of the first coating and the resin with which the fibers are mixed holds them in place against the edges of the cells. The fibers provide a thick network which covers the cells and which has only very small spaces between adjacent fibers. Most of these small spaces are filled with resin.

After the second coat is sprayed on, the gun 30 is generally set to spray a coating of only resin. The gun is then used to spray a third coating of only resin, of about 2 mils thickness. A major purpose of the third coating is to fill the remaining spaces between the fibers so that a continuous, impervious coating is obtained.

After being sprayed, the third coating is allowed to set until it is only partially hardened and has a thick, tacky texture. It is then rolled with a roller of Teflon, a trade name for polytetrafluoroethylene plastic, using light pressure, to assure that no fibers stick out and the surface is smooth. A Teflon roller is used because the resin does not stick to Teflon. After rolling, the coated sheet is allowed to dry until hardened, this generally requiring about eight hours.

After the front surface dries, the back surface or base 11 may be applied. It generally makes no difference whether the base is applied before or after the front coating 15. Any of a variety of bases may be used, including fiber sprayed coatings similar to or identical with the front surface. Finally, the coated large panel is cut into smaller panels of the desired shape.

The sound absorption characteristics of the panels are among their most important characteristics. These qualities are largely due to the honeycomb core 12. When sound waves impinge on the front surface of the core, they meet with only the material of the edges of the honeycomb cells and only a minute amount of sound is reflected. Most of the sound wave energy proceeds through the cells where it is gradually absorbed by the walls of the cells. Typically, materials such as kraft paper are used for the honeycomb core, and such materials are fairly efficient absorbers of sound. When the waves reach the back side of the core 12, much of the

energy continues in the same direction, and only a part of the energy is reflected. The reflected energy must again pass through the length of the cells wherein additional absorption occurs, so that only a small portion of the sound energy re-enters the room.

An ideal covering for the honeycomb core is an absorptive and/or sound transparent surface. Sound absorptive coverings must generally be thick and heavy but have some uses as will be explained hereinafter. Sound transparent surfaces such as the described resin-impregnated glass fiber coating, generally can be more easily made that are light and economical.

The thickness of coatings which are to be sound transparent is generally of importance. Acoustical tests have been performed which show that plastic films of up to about 5 mils thickness are almost transparent to sound. Accordingly, the coatings used on the above described panels are less than about 5 mils thickness, and the panels have excellent sound transmitting characteristics.

The appearance of the panels can be varied by adding pigments or dyes to the resin. If no dye is used, the fibers and honeycomb core will show. This may be desirable in some applications for an unusual effect, but generally it is undesirable. If heavy pigmentation is used in the resin, the fibers and honeycomb core are almost hidden and a solid colored panel is obtained.

The resin and glass fiber coating is generally hard and smooth, although somewhat flexible coatings are available which may also be used. The panels do not accumulate dirt, because the surface does not contain holes or cracks such as are often found in prior acoustical panels, and the resin coating is abrasion and stain resistant so that it wears well and can easily be cleaned. The fibers and resin are not relatively expensive and the very thin coating used requires only a minimum of coating materials. The coating process is relatively simple and adapted for high production, so the cost of the panels is low. Thus, a panel of desirable properties and low cost is attainable by the present invention.

There are some applications where it is desirable to use a panel with a honeycomb core and a surface other than the described resin-fiber coating. For example, it is sometimes desirable to use a cloth or fabric coating, or a soft foam covering for cushioning persons when they contact a wall. Polyurethane foam and other flexible materials have been applied directly to the surface of honeycomb core, but it is found that a weak panel results. The very flexible covering does not rigidly hold the edges of the honeycomb cells in a fixed spacial relationship to resist bending forces. A rigid panel is desirable to assure dimensional stability, to enable the withstanding of loads, and to assure that there will not be appreciable sagging. A resin-fiber coating of the type described, applied over a honeycomb core, rigidizes the core so that a flexible covering such as polyurethane foam or fabric may be applied over the resin-fiber coating and a strong, rigid panel is obtained. Accordingly, a panel of the type shown in FIG. 5 may be obtained by using a honeycomb core 50 on which is applied a thin fiber-resin coating 52, covered with a sheet of polyurethane foam 54 or other cushioning material and a fabric 56.

The thickness of the front fiber-resin coating 52 is not especially important in panels constructed in a manner shown in FIG. 5 inasmuch as the coating is used primarily to rigidize. A smaller proportion of fibers often may be used in such panels; for example, a mixture of 50% fiber and 50% resin by weight has been used for applications where the coating is meant to just rigidize the panel. The back surface or base 58, can be constructed of any of a variety of backing materials, including a sprayed glass fiber-resin coating. The foam or other coating 54 on the front surface can be applied with a gluing substance after the front fiber-resin coating 52 dries, or may be applied before the fiber-resin coating dries so that no additional glue is needed.

Where the optimum in acoustic absorption is not required, a thick coating of fiber and resin may be applied over a honeycomb core to obtain a strong, light panel. Often such a thick coating—perhaps one-eighth inch thick—is obtained by several passes of a fiber-resin spray gun over the core material.

Where the optimum in acoustic absorption is desired, the cells may be filled with fibers before the coating is applied to absorb sound so that less sound is reflected back through the fiber-glass coating. The fibers may be applied with the same fiber-resin gun, no resin, of course, being used.

Although the term honeycomb has been mentioned as the core for the described panels, this term is not meant to be restricted to core material with six-sided cells, but instead, is herein defined as any multicellular structure. Obviously, cells of square or other shape may be used to obtain a strong lightweight panel having essentially the same acoustical properties as panels with cores of six-sided cells, and such cells are conveniently covered by a glass fiber and resin coating applied in the manner described hereinabove.

While certain advantageous embodiments of the invention have been chosen for illustration, it will be understood by those skilled in the art that various changes and modifications therein can be made without departing from the scope of the invention as defined in the appended claims.

I claim:

1. A panel comprising:

a core of multiple cell construction of sound absorbent material, each cell extending through the thickness of the core;

a coating on a face of said core comprising numerous fibers or threads in a matrix of hardenable binding or gluing substances, said fibers having a length greater than the width of said cells, and positioned on the edges of said cells to form bridges between said cell edges.

2. A panel as defined in claim 1 wherein:

the thickness of said coating is less than about 5 mils, whereby sound penetrates said coating without appreciable reflection to enhance the acoustical properties of said panel.

3. A panel comprising:

a core of multiple cell construction of sound absorbent material, each cell extending through the thickness of the core; and

a coating on a face of said core comprising numerous fibers or threads in a matrix of hardened resin material, said fibers having a length greater than the width of said cells and positioned on the edges of said cells to form bridges between said cell edges.

4. A panel comprising:

a core of multiple cell construction of sound absorbent material, each cell extending through the thickness of the core; and

a coating disposed on a face of said core comprising numerous fibers or threads in a matrix of hardenable binding or gluing substances, said fibers being of sufficient length to simultaneously bridge at least three of said cells and said fibers positioned on the edges of said cells to form bridges between said cell edges.

5. A panel comprising:

a core of multiple cell construction of sound absorbent material, each cell extending through the thickness of the core; and

a coating on a face of said core comprising numerous fibers in a matrix of hardened resin, said fibers comprising of the order of magnitude of 40% by weight of said coating, said fibers having a length greater

than the width of said cells and positioned on the edges of said cells to form bridges between said cell edges.

6. A panel as defined in claim 1 wherein:

said fibers have a diameter smaller than about one-tenth thousandth of an inch.

7. A panel as defined in claim 1 wherein:

said coating comprises a first layer nearest said core composed primarily of fibers, and a second layer on top of said first layer composed primarily of binding type material, whereby said coating has a smooth surface.

8. A panel comprising:

a core of multiple cell construction of sound absorbent material, each cell extending through the thickness of the core; and

a coating having the thickness of the order of magnitude of 2 mils, said coating disposed on a face of said core and including numerous fibers or threads in a matrix of hardenable binding or gluing substances, said fibers of said coating having a length greater than the width of said cells and positioned on the edges of said cells to form bridges between cell edges.

9. A panel comprising:

a core of kraft paper type honeycomb formed as multiple cells each of which forms a tube extending between opposite faces of said panel, each of said tubes being unfilled to enable sound absorption without reflection of sound waves entering said cells; and

a coating on a face of said core comprising numerous fibers or threads in a matrix of hardenable binding or gluing substances, said fibers having a length greater than the width of said cells and positioned on the edges of said cells to form bridges between said cell edges.

10. A panel comprising:

a core of multiple cell construction, said core filled with fibers to enhance the acoustical properties of said panel; and

a coating disposed on a face of said core comprising numerous fibers or threads in a matrix of hardenable binding or gluing substances, said fibers having a length greater than the width of said cells and positioned on the edges of said cells to form bridges between said cell edges.

11. A panel comprising:

a core of multiple cell construction;

a coating on a face of said core comprising numerous fibers or threads in a matrix of hardenable binding or gluing substances, said fibers having a length greater than the width of said cells and positioned on the edges of said cells to form bridges between said cell edges; and

a layer of flexible cushioning material bonded to the outer surface of said coating.

12. A panel as defined in claim 1 wherein:

at least a portion of said resin is pigmented whereby to reduce the visibility and/or obviousness of the multicellular structure of said core.

13. A panel comprising:

a kraft paper type core formed as a sheet with multiple honeycomb-like cells, each cell extending like a tube between opposite faces of said sheet;

a coating on a face of said core comprising numerous randomly laid fibers laid on the edges of said cells forming said face of said core, said fibers bridging the gaps between said edges;

a resin disposed in the spaces between said fibers; and

a covering on the face of said core opposite said coating.

(References on following page)

References Cited by the Examiner

UNITED STATES PATENTS

2,271,929	2/42	Venzie	181—33	
2,403,872	7/46	Miller	117—72	
2,450,911	10/48	Park et al.	181—33	5
2,870,857	1/59	Goldstein	181—33	
2,931,468	4/60	Keller	181—33	
2,941,900	6/60	Schroder-Stranz	117—72	
3,025,197	3/62	Sheidley	181—33	10
3,087,574	4/63	Watters	181—33	
3,092,203	6/63	Slayter et al.	181—33	
3,113,634	12/63	Watters	181—33	

FOREIGN PATENTS

206,535	4/56	Australia.
1,054,526	10/53	France.
64,827	7/55	France
		(First addition to French Patent 1,054,526)
723,621	2/55	Great Britain.

OTHER REFERENCES

Rudin, voided British application, 501,834, printed in 1939.

LEO SMILOW, *Primary Examiner.*