Aug. 8, 1961 R. F. GREEN 2,995,198

ACOUSTICAL PANEL

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Fig. 1

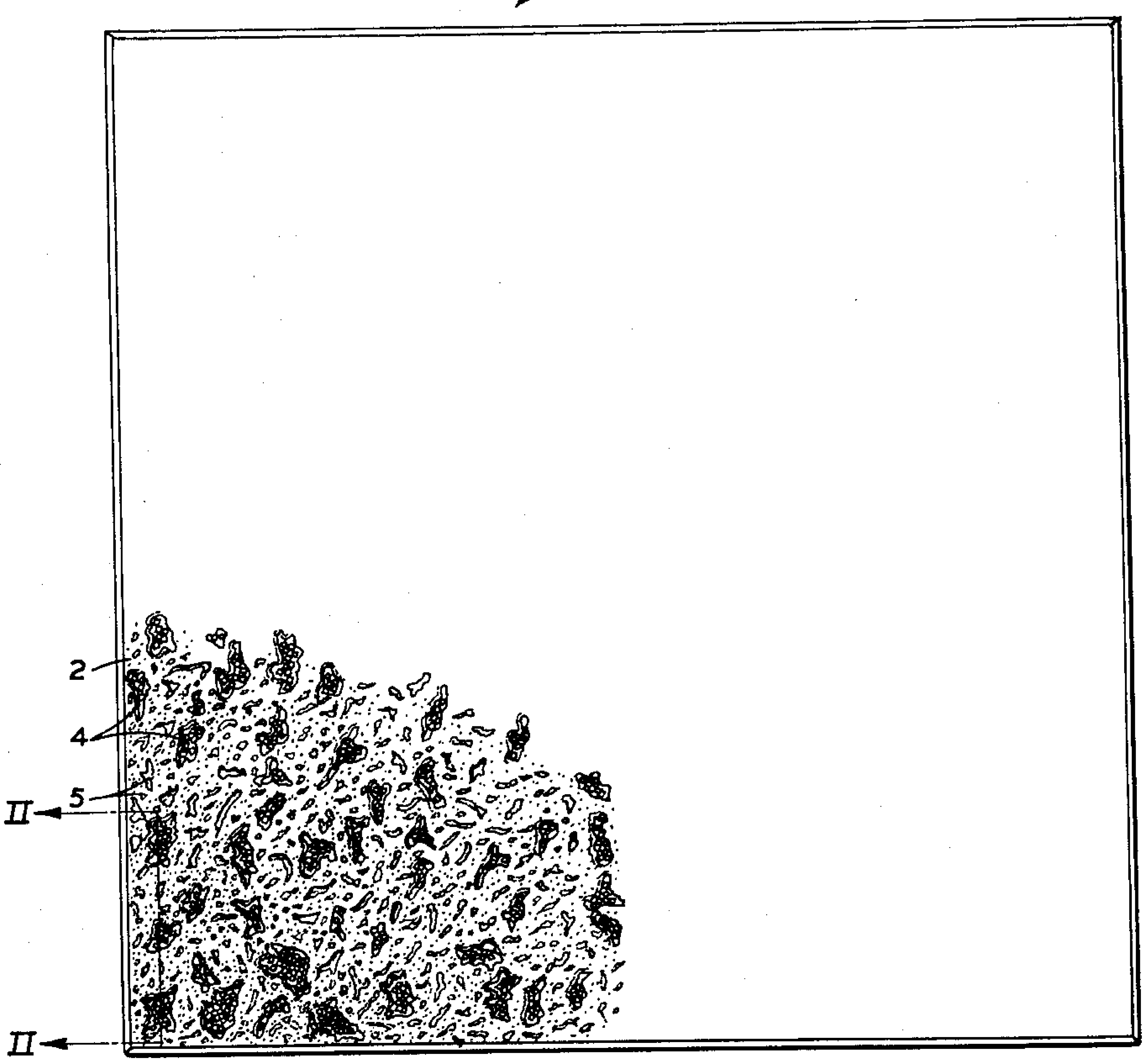
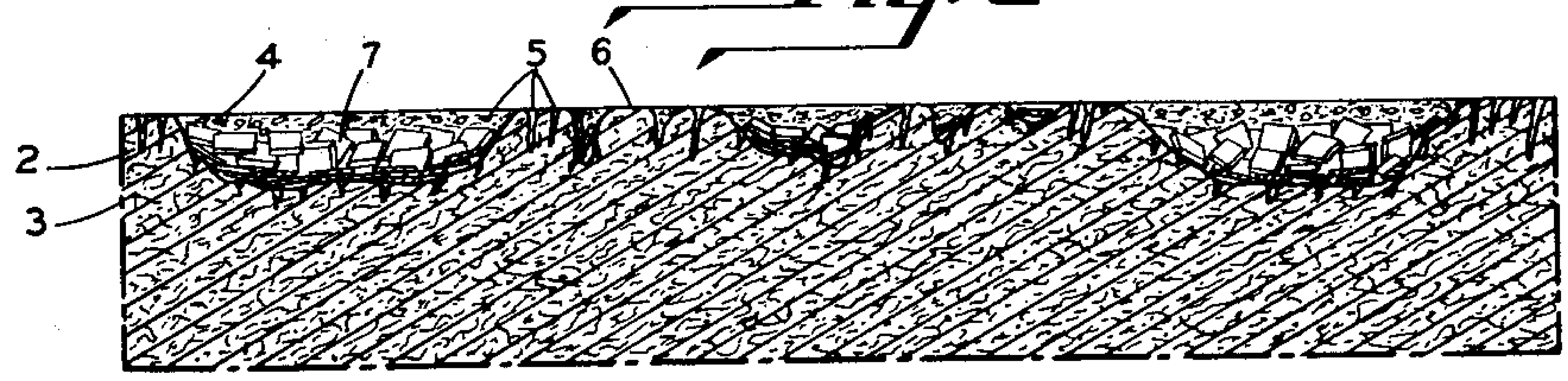



Fig. 2

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# ACOUSTICAL PANEL

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This invention relates to an acoustical panel. It is concerned more particularly with an acoustical panel possessing a combination of good sound-absorbing qualities and unique light-reflecting properties, a combination heretofore not found in acoustical materials.

Many acoustical materials, such as the wood fiberboard products, achieve sound absorption by the provision of drilled or punched openings which extend from the surface of the panel, such as the tile, into the body. The exposed surface of the board is usually painted; and the openings most frequently arranged in straight rows, but sometimese disposed in random arrangement, appear as black dots due to the play of light on the painted surface and the creation of shadows within the drilled openings. The result is a drab, mechanical appearance which is not suitable for many areas where sound-absorbing material could be used to advantage.

Mineral fiber acoustical materials frequently are provided with a fissured porous surface which impartrs more character and widens the field of usefulness of the material from a decorative standpoint. This material has a painted surface; and when the material at normal ceiling height is viewed from eye level, the fissures appear as shaded cracks and crevices in the surface.

The sound absorption material art has not kept pace with the decorative arts, and the need for a striking, light-reflecting surface in acoustical panels has not been met, although a demand has existed for such materials for use in luxury dining rooms, lounges, theatre lobbies, entrance foyers, and other areas. This failure has been due to the unusually stringent requirements which must be met in sound-absorbing materials to obtain the desired sound absorption efficiency.

An object of the invention is to provide acoustical material which possesses not only good sound-absorbing qualities but also a unique light-reflecting decorative surface.

Another object of the invention is to obtain a unique decorative effect in a fissured, porous acoustical material without substantially impairing its sound-absorbing qualities.

According to the invention, the base material consists of a body of sound-absorbing material having fissures or other depressions, referred to hereafter as fissures, which extend from a face of the material into the body. Preferably the body is formed of mineral fibers, although cellulosic fibrous materials, porous ceramic materials, and other sound-absorbing materials may be substituted. The interior of the body is porous, with interconnecting pores some of which extend into the fissured areas and into the areas between the fissures. These pore openings provide passageways for the entrance of sound waves into the body below the face. The face preferably is coated with an opaque paint which is disposed over the entire surface, including the fissures, but does not close all of the pore openings at the face. Generally, there are thousands of these openings in each square foot of surface area of the face of the material. These openings vary in size from microscopic to supramicroscopic, i.e. those which are visible to the eye. If there are insufficient pores naturally present in the face of the material, additional pores may be provided by punching the product before or after it is painted. Generally, however, an open porous mineral fiber material made especially for



sound absorption uses will have adequate pore openings at the face. These will be irregular in size and shape, and many of them will be less than 1/32″ in maximum dimension. Fiberboard acoustical material on the other hand usually will require the addition of artificially formed pores because of the nature of the cellulose fibers used in formation of the product and the fact that the modified paper-making equipment used in making the board orients the fibers into a sheet with many very fine pores but few, if any, larger pores. Flakes of specular light-reflecting material are disposed in heterogeneous arrangement in the fissures below the general surface plane of the face of the material. Preferably the flakes are hard and non-porous and are bonded to the surface and to each other with an extremely thin film of transparent adhesive and provide a network through which sound waves may pass between the flakes. Sound waves may also pass through the flakes by vibration of them. The flakes provide a multiplicity of randomly arranged planes of light reflectance in each fissured area of the face so that at substantially all angles of incidence of light striking upon the face there are a multiplicity of light-reflecting surfaces presented to the observer. The light-reflecting flakes are larger than the small pore openings in the face and are substantially all disposed within the fissured areas, although a few random flakes may be disposed in the larger of the pore openings to enhance the decorative effect. Sufficient sound-absorbing openings at the face are free and open to the penetration of sound waves into the body of acoustical material to provide the desired sound absorption. Surprisingly, by employing thin flakes arranged in reticulate fashion, substantially all of the fissures may have their walls covered with the flakes without substantial diminution of the sound-absorbing qualities of the product.

In order that the invention may be readily understood, an embodiment of it will be described in conjunction with the attached drawing, in which:

FIGURE 1 is a top plan view of a piece of fibrous acoustical material in tile form embodying the invention, and

FIGURE 2 is a sectional view to an enlarged scale taken along line II—II of FIGURE 1 showing a section of the tile of FIGURE 1 in fissured areas and in areas intervening the fissures.

The body of the tile may be made from mineral wool fibers joined into an open porous product by a binder such as starch and including a mineral filler. A typical formula is as follows, all parts being given by weight on a dry solids basis:

| | Parts by weight |
|---|---|
| Nodulated mineral fiber | 960.0 |
| Amylaceous binder material, e.g. pearl starch and beater flour | 165.0 |
| Virgin kraft pulp | 7.0 |
| Wax size | 13.0 |
| Finely divided filler material | 480.0 |

In the preparation of the material, the pearl starch may be mixed with water and heated to about 190° F. to gel the starch. The finely divided filler material, the beater flour, and the wax size then may be formed into a slurry and added to the gelled pearl starch mixture. The hydrated virgin kraft pulp diluted to the desired extent for convenient handling then may be incorporated with the other components and sufficient water added to provide a total batch of 960 gallons. To this batch is added 960 pounds of nodulated mineral wool or other nodulated mineral fiber material, such as nodulated glass wool or a mixture of both mineral wool and glass wool. This slurry is agitated to coat the fibers making up the nodules, and the product is then delivered to a forming machine, such as the conventional paper-forming wire to produce a mat of the desired thickness for subsequent fabrication into a product of the desired dimensions, e.g. 12" x 12" x 13/16". While the preferred binder consists essentially of amylaceous material, other binder ingredients may be employed. The finely divided filler material preferably is clay and the finely divided residue resulting from sawing, sanding, and other fabrication operations on the finished product of previous runs. The kraft pulp is preferably hydrated to a freeness of 10 or less and has a permanganate number of 24 or less.

Drying of the board is accomplished by passing it as delivered from the forming machine through a heated oven. The mat is heated to about 190° F. in a humid atmosphere to convert the binder and is then heated to remove water and finally activate the binder. A temperature of 220° to 230° F. in the board is a good maximum to observe, it being recognized, of course, that the oven itself will be heated to a temperature well in excess of this in a portion of the heating zone.

The product may be provided with fissures by a process such as the one disclosed in Alexander Patent 2,717,538. The finished product after drying is quite open and porous and contains a multitude of interconnecting pores which extend between and among the fibers and terminate as openings at the surface of the board. With a product formed from mineral wool, many of these openings are of microscopic size and not visible; others are much larger, depending upon the nature of the fibers, irregular entanglement of the fibers into clumps of varying size, etc.

The product of the above example after drying and sanding of the face is open and porous; and, since it is made of nodulated mineral fibers, there are a great many irregularly shaped pores of varying sizes which open into the face. Openings such as these are essential to provide good sound-absorbing properties. A fissured nonporous product would be very low in sound absorption. The fissures preferably are of irregular width and depth and are generally longer than they are wide. For best results, it is preferred to have the fissures a maximum of about .125" deep. With fissures formed in the wet sheet by the Alexander process, the walls are irregular and present a jagged surface. This is ideal for the random arrangement of the light-reflecting flakes with their faces disposed in a multiplicity of planes, as mentioned above. Similar surface characteristics can be imparted to mineral fiber and other porous acoustical materials by a punch pressing operation in which a fissuring die having projections thereon is pressed into the face of the board and forms the fissures.

In the drawing, the body has been indicated generally at **2**. The fibers have been diagrammatically illustrated at **3**; the fissures have been shown at **4**; and the visible pores have been numbered **5**. It will be noted in FIGURE 2 that the pores extend to the face **6** of the panel in the fissured areas and also in the areas between the fissures.

The specular light-reflecting flakes which are used may be of various materials and of different sizes and shapes. As an illustration, a gold-colored reflective material may be used. Flakes about 1/32" square and about .0008" thick formed from sheet aluminum having a thin coating of transparent gold lacquer on both of the flat surfaces may be used. The flakes may be combined with a powdered binder, such as a dried polyvinyl acetate emulsion. The mass comprising the metallic flakes and the powdered binder is deposited onto the face of the acoustical panel to be treated. A flexible doctor blade serves to remove most of the flakes and binder from the surface of the tile between the fissures. If desired, a rotary brush may be used to remove additional flakes and binder from within the fissures and to remove most all of the flakes and binder from the surface between the fissures. Thereafter, the face of the tile is sprayed with water to activate the polyvinyl acetate binder, and the tile is then dried in a cabinet or in any conventional drying apparatus. The process described above is disclosed more fully in the copending application of Arthur D. Park, Serial No. 757,606, filed August 27, 1958, now United States Patent No. 2,931,736, and entitled "Method of Making an Acoustical Panel," to which reference is made for a more complete disclosure of a suitable method of fabricating the article of the present invention.

It is preferred to use metallic flakes because of their high specular reflectivity and the possibility of obtaining many unique color effects. However, artificial pearl flakes, flakes of bead type reflective material, naturally occurring materials such as mica or vermiculite, and other light-reflecting materials may be used. Mixtures of different kinds of flakes may be used. Clear lacquer coated aluminum flakes mixed with artificial pearl flakes provide a very attractive effect.

Preferably the flakes are relatively thin and quite small. On the average, they should be of such size that the surface area of the exposed face of each of substantially all of the flakes is greater than the area at the surface defined by each of substantially all (95%) of the pore openings in the face of the product. Flakes about 1/32" square are ideal for most mineral fiber acoustical materials. Flakes as large 1/8" square may be use. The size of the flakes used depends to some extent upon the size of the fissures.

As a general rule, the surface defined by a majority of the fissures should be at least ten times greater than the average face area of said flakes, e.g. a 1/32" x 1/32" flake would have a face area (one flat face) of 1/1024 square inch and a majority of the fissures may have an area of 1/8 square inch or more.

For best results, the flakes should be large enough to prevent them from entering most of the pore openings, although a minor portion of the flakes may be disposed in the larger of the pore openings and will provide an over-all glitter to the product. Generally, it is preferred to have at least 95% of the flakes disposed in the fissures. Thus, the flakes will not be disposed in such manner as to seal off the pore openings.

As mentioned above, the flakes should be disposed in reticulated form to provide the desired random orientation of the flakes for light reflectance and also to effect bridging of the flakes over the pore openings to permit sound waves to enter into the body of the board through pore openings which exist in the fissures.

In FIGURE 2, the random orientation of the flakes **7** has been diagrammatically illustrated, and the reticulated character of the mass of flakes has been shown.

By reference to FIGURE 2, it will be clear that the surface **6** of the tile or other shaped panel may be repainted as occasion may require, using a nonbridging paint and applying it with a roller or other device which will limit the application of paint to the surface portions in the plane **6** of the face of the tile and not extending into the pore openings or fissures. It is inevitable that in repainting any acoustical material, some of the pores will be closed, especially the smaller ones; and, consequently, there is always some loss of sound absorption efficiency after repainting. With the present invention, however, the light-reflecting particles **7** in the fissures being smooth-surfaced and protected by a coating of lacquer or other protective coating will not soil readily, and thus an application of paint to the areas between fissures will be all that is necessary to refurbish the material, and its decorative effect will continue undiminished so long as the flakes retain their light-reflecting properties. The application of the coating to the faces of the flakes and the coating of polyvinyl acetate which serves as a binder combine to prevent rapid tarnishing of the flakes. The surface of the material also may be washed without affecting the flakes which are disposed below the plane of the surface of the material.

A sound-absorbing material made as disclosed above was found to have a noise reduction coefficient of 64. A substantially identical tile made from the same batch of material but without the light-reflecting flakes was found to have a noise reduction coefficient of about 66. From this it will be clear that the presence of the flakes surprisingly does not substantially affect the sound absorption properties of the material.

The term panel has been used in its broad sense to include tiles, planks, and pieces of other shapes.

I claim:

1. An acoustical panel comprising a body of sound-absorbing material, said body having surface depressions which extend from a face of said panel into said body, said body also having interconnecting pores which extend from said face into said body to provide openings for the entrance of sound waves into said body below said face, and flakes of specular light-reflecting material generally larger than said pore openings at the face and disposed in heterogeneous arrangement in said surface depressions below the general surface plane of said face.

2. An acoustical panel comprising a body of fibrous sound-absorbing material, said body having surface depressions which extend from a face of said panel into said body, said body having an internal interconnecting porous network with pore openings at the face of said panel which provide passageways for the entrance of sound waves into said body below said face, a coating of paint disposed over said face with said pore openings extending therefrom, and flakes of specular light-reflecting material generally larger than said pore openings at the face and substantially smaller than said depressions disposed in heterogeneous arrangement in a multiplicity of randomly arranged planes of light reflectance in said surface depressions below the general surface plane of said face, the general surface plane of said face being constituted essentially entirely of said coating of paint.

3. An acoustical panel comprising a body of sound-absorbing material, said body having fissures which extend from a face of said panel into said body, said body also having interconnecting pores which extend from said face into said body in the fissured areas and in the areas between fissures to provide openings for the entrance of sound waves into said body below said face, said pores varying in size from microscopic to supramicroscopic, and flakes of hard nonporous specular light-reflecting material disposed in heterogeneous arrangement in said fissures below the general surface plane of said face, substantially all of said pores at said face being free to the penetration of sound waves into said body.

4. An acoustical panel comprising a body of sound-absorbing material, said body having irregularly shaped fissures which extend from a face of said panel to an



irregular depth within said body, said body also having interconnecting pores within said body which open into said fissures and into said face in the areas between fissures and provide openings for the entrance of sound waves into said body below said face, said openings varying in size from microscopic to supramicroscopic, and flakes of nonporous specular light-reflecting material disposed in heterogeneous arrangement in said fissures below the general surface plane of said face with the exposed faces of said flakes disposed in a multiplicity of randomly arranged planes of light reflectance, substantially all of said openings at said face being free to the penetration of said waves into said body.

5. An acoustical panel in accordance with claim 4 in which the surface area of the exposed face of each of substantially all of said flakes is greater than the area at the surface defined by each of substantially all of said pore openings, said flakes which lie within said fissures bridging over the pore openings which extend from said fissures into said body.

6. An acoustical panel in accordance with claim 5 in which the area at the surface defined by each of substantially all of said fissures is greater than the surface area of the exposed face of each of substantially all of said flakes.

7. An acoustical panel in accordance with claim 6 in which at least 95% of all of said flakes are disposed within said fissures.

8. An acoustical panel in accordance with claim 6 in which the area at the surface defined by a majority of said fissures is at least ten times greater than the average face area of said flakes.

9. An acoustical panel comprising a body of porous sound-absorbing material, said body having surface depressions which extend from a face of said panel into said body, said body also having interconnecting pores which extend from said face into said body, and flakes of specular light-reflecting material generally larger than said pore openings at the face and disposed as a heterogeneous reticulated array of randomly arranged planes of light reflectance in a plurality of said surface depressions in said face, and an adhesive bonding said flakes to one another at their points of contact.


**References Cited** in the file of this patent

UNITED STATES PATENTS

| | | |
|---|---|---|
| 1,395,379 | Adelsperger | Nov. 1, 1921 |
| 1,830,253 | Bechtner | Nov. 3, 1931 |
| 1,832,571 | Nash | Nov. 17, 1631 |
| 1,960,372 | Davey | May 29, 1934 |
| 2,738,713 | Buczowski | Mar. 20, 1956 |