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METHOD OF MAKING ACOUSTIC TILES HAVING VOIDS CONTAINING SHRUNKEN BEADS
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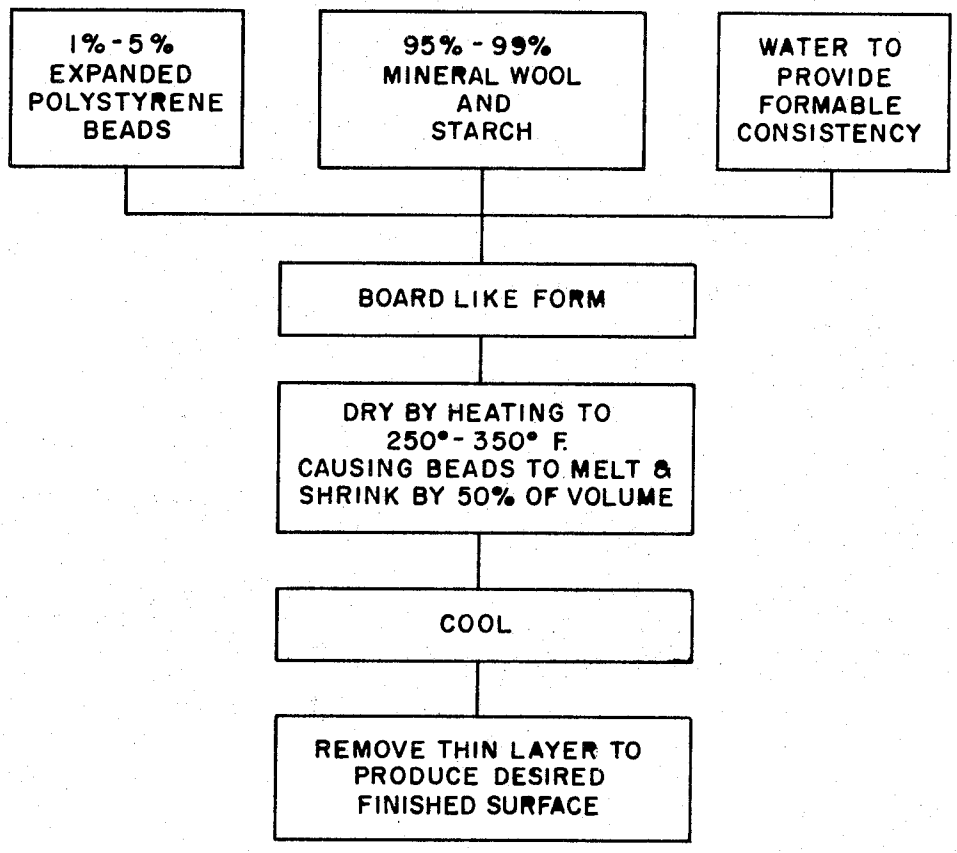


Fig.1

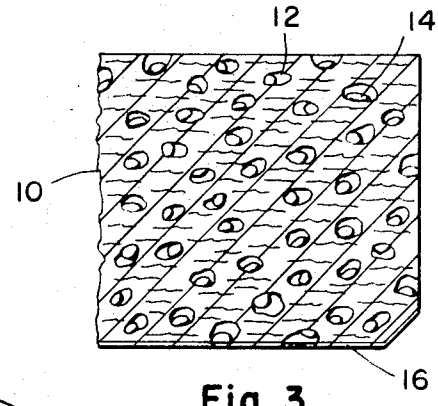


Fig. 3

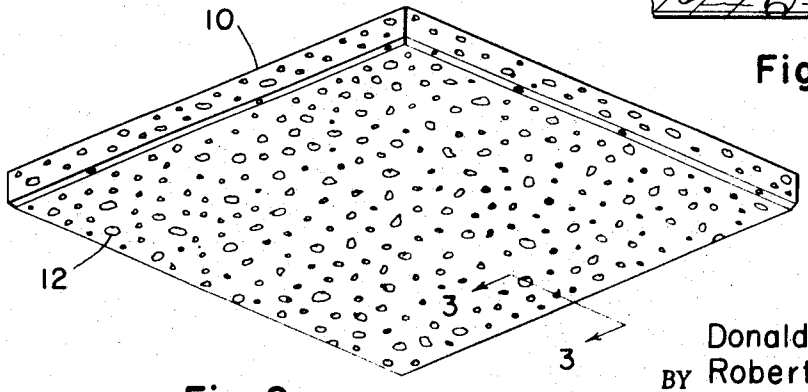


Fig. 2

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METHOD OF MAKING ACOUSTIC TILES HAVING VOIDS CONTAINING SHRUNKEN BEADS

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U.S. Cl. 264—41 3 Claims

ABSTRACT OF THE DISCLOSURE

In the production of acoustic tiles and grid panels from an aqueous slurry of board forming materials, the method of creating voids in the visible surfaces of and substantially throughout the said articles comprising the addition of preexpanded polystyrene beads to the said aqueous slurry of board forming materials, forming the said slurry of materials containing the expanded polystyrene beads into the desired article shape and thickness and heating the formed articles to a temperature and for a time period which is sufficient to remove substantially all of the water therefrom, providing conditions which are suitable to cause the polystyrene beads to melt allowing substantially all of the entrapped gases to escape whereby the said polystyrene beads shrink by at least 50% of their expanded volume thus forming the said voids.

Acoustic tiles and grid panels having attractive visible surfaces with designs therein formed by irregularly arranged voids, said irregularly arranged voids having been created in the manner described above.

BACKGROUND OF THE INVENTION

Various types of acoustic tiles and grid panels including those made essentially from wood fiber, mineral wool or the like and a binder are in common use. The faces, or visible surfaces, of these articles are perforated with holes, fissures or voids in order to impart better acoustical properties to them. In general it may be said that improved acoustical properties are achieved as the surface area exposed by the openings increases. Since these surface openings are visible when the articles are in use it is necessary to arrange the openings in such a manner as to give the articles an attractive appearance in addition to enhancnig their sound absorption characteristics. The latest trend in the industry has been to form designs with randomly arranged fissures or voids in the faces of these products in an attempt to achieve a non-directional appearance, i.e., one such that when the individual tiles or panels are incorporated into a ceiling it will give the impression to an observer of being a monolithic surface. Such designs have been formed to date by a variety of methods. Thus, it is known to use flat or arcuate metal punch plates having projections in the design of the openings desired to be formed in the finished product. The tiles or panels are contacted by the punch plates thereby acquiring the desired surface design. Another method consists of pouring the mixture of materials into casting molds having the desired design incorporated therein. The molds and material are allowed to dry and when the article is removed from the mold it has the configuration of the casting mold on its face. Such methods have not proved to be completely satisfactory for the articles produced by a particular method all have substantially identical appearances.

SUMMARY OF THE INVENTION

It is an object of the invention to provide a unique method of forming a design in the visible surfaces of acoustic tiles and panels.

It is another object to provide such a method which does not require the use of punch plates, rolls or textured molds.

It is a further object to provide a method wherein the design formed in the surface of the articles will be formed by randomly arranged voids.

It is still another object to provide a method in which the visible surfaces of tiles and panels made therewith will not necessarily have substantially identical appearances.

Briefly, the present invention consists of the addition of a small percentage, by weight, of pre-expanded polystyrene beads to the slurry of materials from which the articles are to be formed. The tiles or panels, after having been formed are then heated at a temperature which removes substantially all of the water from them and which is also sufficient to cause the expended polystyrene beads to melt and shrink to substantially their original volume. The beads are not arranged in any pre-determined pattern nor are they arranged in identical fashion in each individual tile or panel. When they are contacted by the heat and shrink, voids are created wherever the beads are located. The result, therefore, is to produce randomly arranged voids in the visible surfaces of and substantially throughout the bodies of the articles. The designs formed in the visible surfaces in this manner give the articles an attractive appearance and improve their acoustical properties. These an dother objects of this invention will be more fully understood when the following more detailed description of the invention is read in connection with the appended claims.

In the drawings:

FIG. 1 is a flow diagram of the process of the present invention.

FIG. 2 is an isometric view of ceiling tile made by the process of the invention.

FIG. 3 is an enlarged cross-section of the tile of FIG. 2 taken on line 3—3.

The present invention is applicable to the manufacture of acoustic products such as ceiling tiles **10** and grid panels made by various processes. It can be practiced with the manufacture of such articles from various materials as will be more fully described further below. Its preferred use is with a process for making acoustic ceiling tiles from mineral wool compositions and it will be described in detail with respect to such a process. A commercial method of manufacturing these tiles consists of forming an aqueous slurry of the mineral wool composition containing, inter alia a starch binder into trays lined with paper and then heating the tiles thus formed to remove substantially all of their water. The binder is prepared by adding specified amounts of starch, clay, gypsum, stucco and thickeners to water with continuous agitation to achieve a thorough dispersion of the materials in the water. Thereafter the slurry is brought to a temperature of 195° F. and maintained at that level for a period of time sufficient to cook the starch, usually not less than five minutes. The binder is then continuously slowly agitated and used as required. Specified amounts of the binder and mineral wool are then fed simultaneously and continuously to a twin screw mixer such as the type manufactured by the Sprout Waldron Company. In the practice of the present invention the pre-expanded polystyrene beads are added to the mixer along with the binder and mineral wool. The water represents between 50% and 75% of the total weight of the formulation. The twin screw mixer combines the components into a mix of dough-like consistency which is then laid onto the above described paper backing in the trays. The mix in the trays is then subjected to a conventional screeding operation while it is wet to provide a level surface.

The tiles are then placed in drying ovens to remove substantially all of their water, that is, until they contain less than 1% of their water content as described above. This can be accomplished by heating the tiles at various temperatures for lengths of time sufficient to achieve this result. The preferred method of drying the tiles is to take them at a maximum temperature of 350° F. for up to six hours after which the temperature is reduced to 300°±10° F., maintained there for four hours and then further reduced to 280°±10° F. where it is allowed to remain until the tiles are substantially dry. The temperature level used to dry the articles and the duration of the drying period will be contigent upon the type of material used in the product, the type of binder employed, the product thickness and the method of drying. For the purpose of causing the expanded polystyrene beads to melt thereby allowing the entrapped gases to escape so that the beads shrink to substantially their original volume the temperature of the tiles themselves must reach above 250° F. Thus, a temperature of over 250° F. is maintained in the drying ovens. After most of the water has been removed from the tiles, the temperature within the body of the tiles will rise to a level which will be sufficient to cause the beads to melt and shrink. The reduction in the volume of the beads will result in the formation of voids **12** wherever the beads **14** are located throughout the matrix of material.

The tiles **10** are allowed to cool and their visible surfaces sanded to remove about 1/32 inch of their thickness. They are then painted with a water base paint **16** such as a polyvinyl alcohol or polyvinyl acetate type. The finished products will have an attractive surface appearance and good acoustical properties. The voids in the surfaces of the articles will be arranged in random fashion with the design formed by the voids differing somewhat with each individual tile since the beads will not be arranged in exactly the same manner in all parts of the mixture.

Expanded polystyrene beads, due to their very low density and the fact that they do not wet out in water, tend to rise to the surface and agglomerate when introduced into water slurries. However this does not occur in the practice of this invention since the mixtures from which the acoustic articles are made are of a consistency such that the beads are firmly held throughout the matrix of material. Thus, the beads remain dispersed substantially throughout the bodies of the articles produced in this manner.

The polystyrene which is utilized in the practice of this invention is commercially available in the form of beads or pellets having diameters in the range of from about 0.0098 to about 0.0787 inch with bulk densities of from about 29 to about 40 pounds per cubic foot. These foamable thermoplastic beads contain from about 2% to about 8%, by weight, of a volatile, saturated, paraffinic hydrocarbon which has an approximate boiling point of 95° F. The hydrocarbon performs as a blowing agent and expands when contacted by heat causing the beads to foam and increase their volume. This expansion can be controlled within the limits of about two to about fifty times the volumes of the unexpanded beads by varying the temperature and duration of the heating process. The bulk densities of the expanded beads can be controlled within the range of from about 0.5 lb./ft.^{3} to about 20 lbs./ft.^{3} with commercially available equipment. Although the invention may be practiced with expanded beads having a bulk density falling anywhere in the above mentioned range, it is preferred to use beads which have been expanded to a degree such that they have a bulk density of from about 0.5 lb./ft.^{3} to about 2.5 lbs./ft.^{3}.

As the bulk density of the beads used becomes lower the finished product will itself have a lighter weight. Of course, the finished article weight will also be dependent upon the amount of polystyrene beads incorporated into

the formulation. It has been found that good results are realized with respect to surface appearance when the expanded beads represent from about 1% to about 5% by weight of the total solids content of the mixture from which the articles are formed. Since the volume occupied by the expanded beads is relatively large in relation to their weight, attempts to incorporate the beads in these articles in greater weight percentages could adversely affect the strength properties of the products to a degree such that they would not be suitable for use.

The pre-expansion of the polystyrene beads may be caried out by a number of methods. Some of these are continuous prefoaming with steam or hot air and batch prefoaming with hot air, hot water or steam. Specialized equipment is commercially available to expand the beads such as the continuous steam pre-expander which is made by the Koppers Company, Inc. Inasmuch as the beads must be expanded in an unconfined state they must be expanded before they are added to the slurry of materials from which the acoustic products are made. Attempts were made to add the beads to the formulations in their unexpanded state in order to expand them within the material. These experiments were not successful for it was found that the beads which were totally confined within the matrix of material did not expand upon the application of heat but rather merely diffused the hydrocarbon blowing agent through their walls. Only those beads which were exposed directly at the surface of the tiles exhibited some expansion.

The materials with which these polystyrene beads may be used according to the present invention are those which are commonly used to form products such as acoustic ceiling tiles, grid panels or the like. They include asbestos-cement compositions, mineral wool products, wood fiber products, lime-silica compositions and combinations thereof. The invention can be practiced as in the manner described above where the panel is formed by a single layer of the composite material or it may be applied to various other products. For example, it can be utilized in the production of an acoustic tile laminate such as that described in U.S. Pat. 3,283,849 by incorpoarting the expanded polystyrene beads in the facing layer of the product disclosed therein.

Having given a detailed description of the preferred embodiment of the invention, specific examples thereof will now be given it being understood that they are intended to be illustrative of the invention only and the scope of the invention should not be limited to the materials and amounts specified therein.

Example I

To 40 pounds of water were added 0.01 pound of Lycoid 250, a modified galactomannan base powder made by Stein Hall Company, and 0.03 pound of Polyox WSR–301, an ethylene oxide polymer made by Union Carbide Company used as thickeners for starch, with agitation until a uniform dispersion was obtained. With continued stirring, 1.50 pounds of Tex-O-Film starch, a waxy maise type which is a product of the Corn Products Company, 2.00 pounds of Allen Clay, a kaolin type available from United Clay Mines, Inc., 0.50 pound of gypsum stucco and 0.15 pound of boric acid were added in that order. The slurry was then brought to a temperature of 195° F. by saturated steam induction heating. At that point the steam was discontinued and an additional 5.5 pounds of water added. This slurry was used as the binder for the tiles.

Thirteen pounds of the binder mix and 3.4 pounds of mineral wool were then brought together in a Hobart Mixer with agitation for about four minutes after which 0.1 pounds of expanded polystyrene beads having a bulk density of about 2.5 lbs./ft.^{3} were slowly added to the slurry with continued agitation. When the addition of the beads was completed agitation was continued for about two minutes to ensure that the beads were dispersed

substantially throughout the mixture of materials. The polystyrene beads were expanded before being added to the slurry by heating them in a laboratory circulating air oven at a temperature of 220° F. for a period of about five minutes. They represented 2% of the total solids content of the mixture.

The mixture was poured into trays having a depth of one inch and the surface then screeded. The trays were dried in an oven at 280° F. for 16 hours. The tiles made in this manner exhibited attractive visible surfaces and had good acoustical properties. Table 1 shows the densities and acoustical properties of tiles made as described above with 0%, 2% and 3% of expanded polystyrene beads. The Noise Reduction Coefficient ratings were determined according to ASTM Test Method C243-69T. The results listed are the average of five determinations.

TABLE 1

	Expanded polystyrene (percent by weight)	Density, lbs./ft.^{3}	Noise reduction coefficient (sabins)
Tile:			
A	0	22.9	0.69
B	2	20.3	0.75
C	3	18.8	0.75

EXAMPLE II

An acoustical panel was made by first blending together 400 grams of portland cement, 200 grams of 120 mesh silica and 50 grams of 6D asbestos fibers, This blend of materials and 35 grams of expanded polystyrene beads having a bulk density of 2.5 lbs./ft.^{3} were then added to 600 grams of water with agitation. The resulting slurry was poured into a mold having a depth of one inch and its surface screeded. The mold was placed in a humidity chamber for 48 hours after which it was removed and autoclaved at 100 p.s.i. and 328° F. for 24 hours. The resulting panel exhibited an attractive surface appearance.

EXAMPLE III

An acoustical panel was made from the following formulation in which the amounts shown are in parts by weight:

	Parts
Mineral wool	800
4T asbestos fibers	100
Lime	200
Silica	100
Expanded polystyrene beads	25
Water	6000

These materials were combined in a container and mixed for about four minutes with a Hobart Mixer. The resulting slurry was then poured into a mold, having a depth of one inch, the surface of the materials screeded and the mold placed in an oven at 320° F. for 24 hours. The panel had an attractive surface appearance.

Having given a detailed disclosure of the preferred embodiments of our invention so that those skilled in the art may practice the same, we contemplate that variations may be made without departing from the essence of the invention or the scope of the claims.

What we claim is:

1. The method of making low density panels comprising the steps of mixing, to form a slurry of board-forming materials, about 1% to 5% of the total solids weight of expanded polystyrene beads having a bulk density of from about 0.5 to 2.5 lbs./ft.^{3}, 95% to 99% of the total solids weight of a mixture comprising fibers and binder, and sufficient water to provide a formable consistency, said fibers and binder being substantially unaffected by increases in temperature from ambient up to at least 350° F., forming said slurry of board-forming materials into a board-like form, drying said formed materials by steps including heating said formed materials to at least above 250° F. but no more than 350° F. for a time and temperature sufficient to melt said polystyrene beads, permitting escape of entrapped gases in said beads, shrinking said beads by at least 50% of their expanded volume, and retaining said shrunken beads in the randomly arranged voids formed by said shrinkage while cooling said panel.

2. The method of making low density panels comprising the steps of mixing, to form a slurry of board-forming materials, about 1% to 5% of the total solids weight of expanded polystyrene beads having a bulk density of from about 0.5 to 2.5 lbs./ft.^{3}, 95% to 99% of the total solids weight of a mixture comprising fibers and binder, and sufficient water to provide a formable consistency, said fibers and binder being substantially unaffected by increases in temperature from ambient up to at least 350° F., forming said slurry of board-forming materials into a board-like form, drying said formed materials by steps including heating said formed materials to at least above 250° F. for a time and temperature sufficient to melt said polystyrene beads, permitting escape of entrapped gases in said beads, shrinking and beads by at least 50% of their expanded volume, and retaining said shrunken beads in the randomly arranged voids formed by said shrinkage while cooling said panel, said cooled panel thence having a thin layer removed from one surface to produce the desired finished surface appearance.

3. The method of making low density panels comprising the steps of mixing, to form a slurry of board-forming materials, about 1% to 5% of the total solids weight of expanded polystyrene beads having a bulk density of from about 0.5 to 2.5 lbs./ft.^{3}, 95% to 99% of the total solids weight of a mixture comprising fibers and binder, and sufficient water to provide a formable consistency, said fibers comprising mineral wool and said binder comprising starch, forming said slurry of board-forming materials into a board-like form, drying said formed materials by steps including heating said formed materials to at least above 250° F. for a time and temperature sufficient to melt said polystyrene beads, permitting escape of entrapped gases in said beads, shrinking said beads by at least 50% of their expanded volume, and retaining said shrunken beads in the randomly arranged voids formed by said shrinkage while cooling said panel.

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PHILIP E. ANDERSON, Primary Examiner

U.S. Cl. X.R.

161—159, 168; 162—155; 181—33 GA; 260—2.5 B, 2.5 HB, 17.4 ST; 264—44, 122, 333, 342 R, DIG. 7, DIG. 19, DIG. 71

PO-1050
(5/69)

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,634,562 Dated January 11, 1972

Inventor(s) Donald R. Kole and Robert M. Johnson

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 1, line 47, "enhancnig" should be - - enhancing- - .

Column 2, line 17, "expended" should be - - expanded - -; same column, line 28, "an dother" should be - - and other - - ; same column, line 49, "alia" shoul be - - alia, - -; same column, line 52, "gypsum, stucco" should be - - gypsum stucco - - .

Column 4, line 12, "caried" should be - - carried - -; same column, line 71, "pounds" should be - - pound - -.

Column 6, line 24, "and" should be - - said - - .

In the references, the name "Schirck" should be - - Schirick - -.

Signed and sealed this 30th day of May 1972.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents