

April 12, 1966

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3,246,063

METHOD OF MAKING AN ACOUSTICAL TILE AND CEILING CONSTRUCTION

Filed Feb. 10, 1961

2 Sheets-Sheet 1

FIG. 1

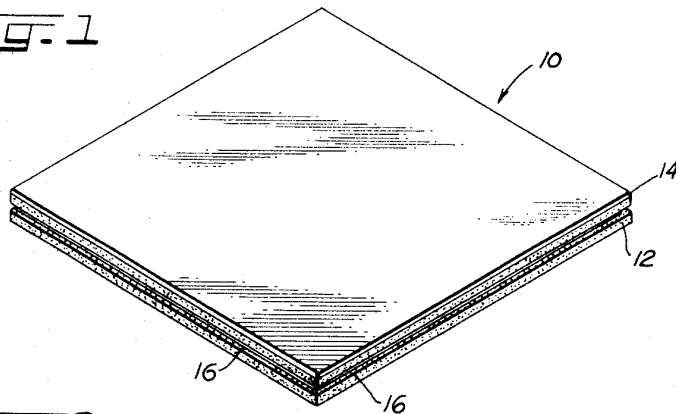
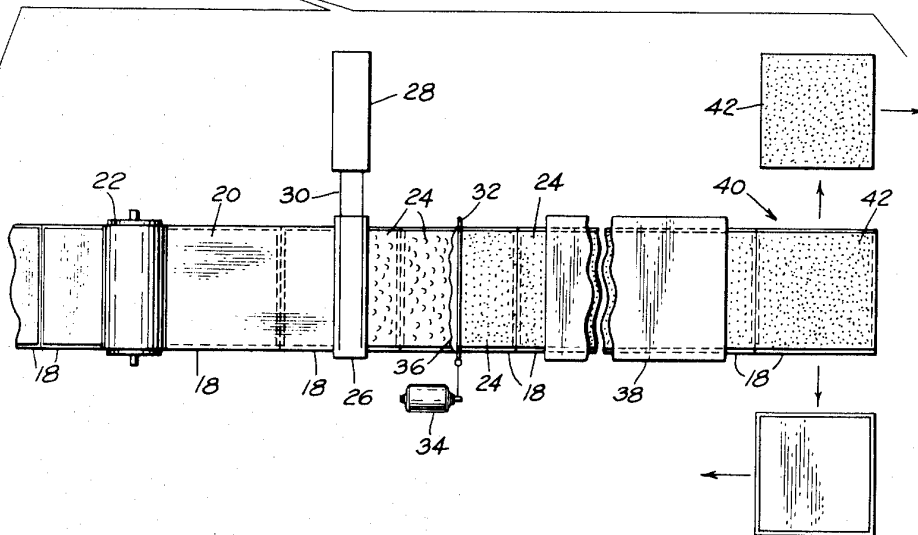


FIG. 2



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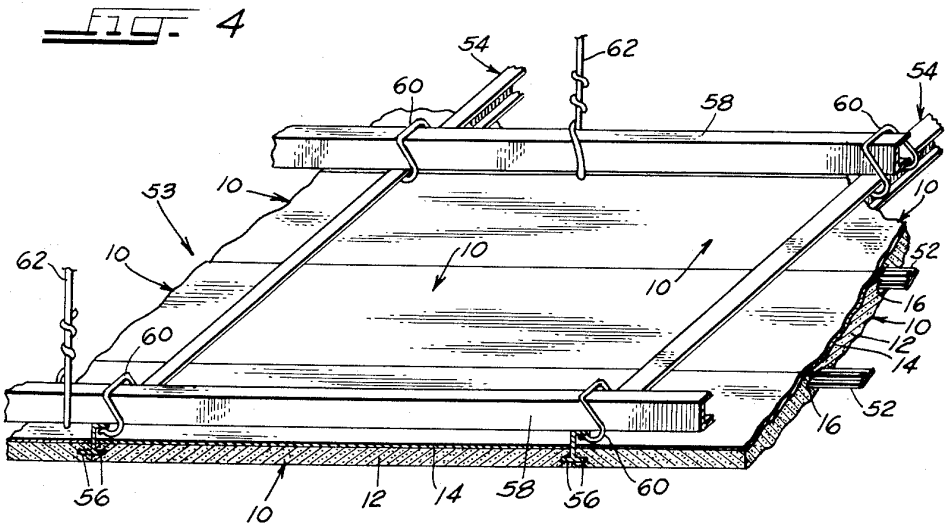
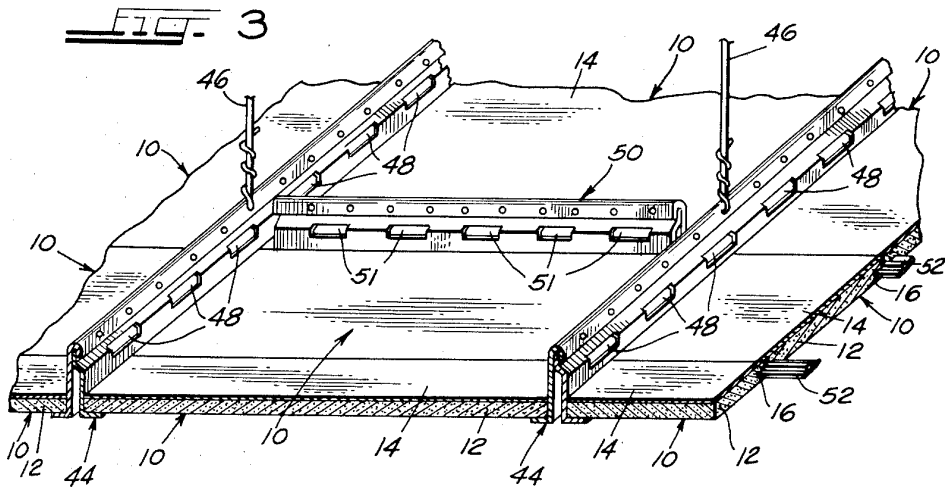
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METHOD OF MAKING AN ACOUSTICAL TILE AND CEILING CONSTRUCTION

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Filed Feb. 10, 1961, Ser. No. 88,340
4 Claims. (Cl. 264-112)

This invention relates to a method of making acoustical tile normally utilized in ceiling constructions. More particularly, this invention relates to an improved method of making acoustical tile with an impervious backing.

A popular type of acoustical tile is made following generally the procedure set forth in U.S. Patent No. 1,769,519. According to the teachings of this patent, a mixture of granulated mineral wool, fillers, certain coloring materials, if needed, and a binder, particularly one of an amylaceous nature, such as thick boiling starch, is used to form the body of the tile. Various other materials may be added to give certain properties to the tile. In preparing this acoustical tile, the composition, usually at a temperature of about 190° F., is placed upon suitable trays which have been previously covered with paper, such as newsprint, and then screeded to a suitable thickness with a reciprocating edge. A pleasing surface, including elongated fissures, resembling that of travertine stone is normally obtained. Alternatively, by screeding in a different manner the surface can be made without the fissures. The trays are then placed in an oven, and dried or cured at a temperature of between 250 to 300° F., for from about 16 to about 18 hours.

The dried sheets, called slabs, are removed from the mold, dressed on both faces to provide smooth surfaces, to obtain the desired thickness and to prevent warping, and are then cut into tiles of a desired size.

Previous to this invention it had been assumed by those skilled in this art that for maximum drying speed the moisture should leave from both the bottom and the top surfaces of the drying slab and that covering the bottom surface with an impervious lamina would increase the drying time. Accordingly, the tray bottoms were made of foraminous material and covered with thin, relatively unsized layers of paper so as to facilitate the passage of water out of the back surface of the tile through the paper. Drying the composition under these conditions resulted in migration of the starch to both the bottom and top surfaces where it strengthened the surface areas. During the dressing operation, the face surface of the slab was normally sanded off to obtain a pleasing smooth surface, thereby removing a portion of the face area of high starch-concentration. The resulting tiles were found to warp unless the corresponding back surface area of high starch content was also sanded off. Thus, the back surface of the slabs were dressed by sanding off the paper and a portion of the hardened composition to compensate for sanding of the other (face) side.

Removing the back surface of the slabs in the aforementioned process is not only a time-consuming and costly operation but also results in the loss of the paper and part of the cured composition, thereby necessitating the use and curing of extra material in initially forming the slabs.

Mineral fiber acoustical tiles, particularly the fissured type referred to above, are quite porous and thus readily transmit gases therethrough. Though high porosity is needed to give good sound absorption, a high degree of porosity presents a disadvantage when the tiles are used in certain ceiling constructions, particularly suspended acoustical ceilings with controlled ventilation systems, such for example as described in U.S. Patents No. 2,692,547, 2,782,557, 2,807,993, and 2,920,357. In such suspended ceilings the space immediately thereover serves

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as a plenum chamber for receiving and distributing air under pressure. This air then passes through the ceiling, at a controlled rate throughout the ceiling area, to the space below. When air passes through fissures or other haphazard openings in the tile, the rate of flow is not only unpredictable but also uncontrollable, thus making it difficult or impossible to obtain a uniform flow pattern, such as has been found desirable in good air conditioning practice.

In addition, the porous nature of the mineral fiber acoustical tiles referred to above permits transmission of hot gases of combustion therethrough. This results in a markedly lowered fire rating for surfaces formed of such tiles, and is especially undesirable in suspended ceiling systems where a special effort is often necessary to attain a maximum resistance to fire transmission.

It is therefore an object of this invention to set forth an improvement in the manufacture of mineral fiber acoustical tiles formed by drying a porous composition spread upon trays.

It is an object of this invention to provide a simple, economical process of manufacturing improved mineral fiber acoustical tiles.

It is another object of this invention to provide a process of manufacturing mineral fiber acoustical tiles, obviating the step of removal of the back surface of the tile.

It is a further object of this invention to provide an improvement in the drying of the aforesaid acoustical tile.

It is another object of this invention to provide an improved process for making an acoustical tile, which has good acoustical characteristics, is impervious to the extraneous infiltration of gases therethrough and which is simple and economical to manufacture.

Various other objects will readily occur to those skilled in the art to which this invention pertains from the following description.

In carrying out this invention in one form, a new and improved mineral fiber acoustical tile is produced by placing a metal foil sheet in the bottom of a slab-forming pan, depositing, screeding, drying and curing an amylaceous binder-mineral fiber composition in the pan, removing the resulting slab, dressing only the face of the slab, and cutting the slab into tiles. The resulting tiles include a foil layer covering and bonded to their entire back face. An improved plenum chamber ceiling construction may be formed by supporting a plurality of such tiles in edge to edge substantially co-planar relation to form a suspended ceiling comprising the lower wall of a plenum chamber. This construction may be formed with controlled openings therethrough to provide controlled passage of gasses through the ceiling to the space below.

For a more complete understanding of the invention, reference should be had to the drawings wherein:

FIG. 1 is a perspective view of a tile of the type forming the subject of this invention;

FIG. 2 is a schematic diagram of equipment for carrying out a process of manufacture employing the teachings of this invention;

FIG. 3 is a perspective view of a suspended ceiling construction utilizing tiles produced in accordance with the teachings of this invention; and

FIG. 4 is a perspective view of another suspended ceiling construction utilizing tiles produced in accordance with the teachings of this invention.

FIG. 1 illustrates a novel acoustical tile 10 including a baked mineral fiber composition body 12 and a layer of foil 14, such as aluminum foil (exaggerated in thickness in the drawings), firmly bonded to the back surface of

the body. The tile 10 is provided with slots or grooves 16 for installation purposes, as will be later described.

The structure of tile 10 and certain of the advantages of providing a tile of this construction are better illustrated and understood with reference to the novel process of manufacture illustrated in FIG. 2. Trays 18 upon which the acoustical tile composition is to be spread and baked are lined with a sheet of foil 20 instead of with paper, as in the prior process outlined above. An aluminum foil of about .00035", or somewhat thicker, is preferred. The foil should be free from any compound used during rolling which would adversely affect the bond between the foil and the mineral fiber composition. Foil sheet 20 is taken from the roll 22 and spread evenly as a continuous sheet over the line of molds or trays 18. The portion of the foil sheet in each tray is then covered and the tray filled with a plastic acoustical tile composition 24. Composition 24 is normally deposited in the trays, as the trays, in abutting end to end relation, pass under feeder box 26 on a suitable conveyor, not shown. The feeder box is filled from the mixer 28 by the conveyor 30.

The composition 24 is an amylaceous binder-mineral fiber composition, but can vary appreciably in content. A typical batch is made as follows:

A starch binder is prepared from the following:

Thick boiling starch	lbs.	300
Calcium sulfate hemihydrate	lbs.	200
Water	gals.	595

The above is cooked at 180°-195° F. for 5 to 8 minutes and is then ready for use. Examples of presently available thick boiling starches are Corn Products Company's starch products 3123 and 3173 and A. E. Staley Manufacturing Company's starch product Sta-Thik.

135 gallons of the above starch binder are placed in a mixer and 250 lbs. of granulated mineral wool are mixed therewith for a total mixing time, for the entire formulation, of about 8 minutes to obtain an aqueous plastic mixture.

After the composition 24 has been placed upon the trays they pass under the reciprocating screed bar 32, driven by the motor 34, which forms the fissures on the surface. A small roll head 36 of the mix 24 collects in back of the bar. The sheet of foil is then severed between succeeding trays, as by passing a knife (not shown) between the trays, and the filled trays pass into the oven 38 where their contents are dried and cured at a temperature between 250 and 300° F., for from 14 to 18 hours.

After the composition has dried and cured in the oven 38 to form slabs, the trays reach the position 40, where the slabs 42 are removed from the trays. The foil is now firmly adhered to the body of the slab. The slabs are then dressed by passing them through a sander, not shown, to remove only the top or face surface, and then through slitters, also not shown, to form tiles of the desired size. The resulting tiles have metal foil covering and securely bonded to the entire back surfaces.

It is convenient to note at this point several new and unexpected results attributable to the novel process and novel acoustical tile construction described above.

It has been discovered that contrary to the aforementioned previously established opinion, replacement of the paper with aluminum foil does not increase the drying time of the slabs. In fact, there is some indication that the drying time is less beyond that reduction which would be due to the lesser thickness of the slab (referred to below).

In the practice of this invention, the foil prevents any significant removal of moisture through the back surface and thus prevents any significant migration of starch toward this surface. The starch migrates only to the top surface of the slab. The improved starch migration pattern results in a greater concentration at the single sand-

ing face where needed, or, if desired, permits a reduction in the amount of starch used. The resulting slab can be dressed by sanding the front face only, to obtain a desirable smooth surface and to trim the slab to the desired tile thickness, without encountering warping in the resulting tile.

The temperature of the composition placed upon the tray is about 180° F. With the use of prior back sheets the temperature of the composition dropped to about 140° F. before reaching the oven. It has been found that with the use of foil sheets, the temperature of the mix drops to only about 170° F. This favorable 30° increment represents a saving of heat rendering the process more efficient and economical.

Thus, the use of metal foil as a back sheet provides a smooth even back surface and eliminates the need for sanding off the back surface of the slab or tile. This permits the casting of thinner slabs, with a consequent saving of material, and results in quicker drying and more economical tile manufacture.

It can readily be seen from the above that a great number of unexpected advantages result from the novel use of the metal foil. The paper is replaced, the sanding of the back is dispensed with, and the amount of material needed is decreased. There is a saving of heat, the foil does not adversely affect the drying, and an improved mineral fiber acoustical tile results. In addition, the foil aids in the removal of the cured composition or slabs from the trays and reinforces the back surface of the tiles.

The suspended ceiling construction illustrated in FIG. 3 serves as one wall of a plenum chamber for controlled ventilation of the space below and incorporates tiles produced in accordance with this invention to particular advantage. In this type construction the air is uniformly distributed, through openings properly spaced throughout the ceiling area, into the room below. The openings may be formed either in the tile, as shown in U.S. Patent No. 2,807,993, or in ported hollow runners used to support adjacent rows of tile, as shown in U.S. Patent No. 2,920,357 and in FIG. 3.

As illustrated in FIG. 3, the foil backed tiles 10 are supported on the ported runners 44 and similar cross members 50, with the foil back upwardly disposed. The runners are supported by wires 46 attached to the structure, not shown, of the upper boundary of the room in which the ceiling is supported. The entire plenum chamber is not shown but normally constitutes the enclosure defined by the suspended ceiling, the upper boundary of the room, and the lateral walls of the room extending between the upper boundary and the suspended ceiling. Air is introduced into the plenum chamber and passes in a well distributed and uniform rate through ports 48 in the runners 44 and ports 51 in cross members 50. The opening in these ports may be adjustable to afford control of the airflow. The runners along with the cross members are modularly spaced such as 2 ft. on centers. The cross members are attached to the primary runner by means of clips, not shown. The tiles rest upon the ledges forming the lower portion of the runners and cross members, with the tile edges forming the joints between adjacent tiles not so supported being reinforced by spline members 52 placed into the grooves 16 of each tile. The spline members are formed from sheet metal with a slight reinforcing ridge extending down the center. It is important in this type of construction that there is a close fit between the spline members and the grooves so as to prevent any passage of air through the joint.

The ceiling construction of FIG. 3 maintains the pleasing appearance and functional advantage arising from the fissured and/or porous character of the tile. At the same time, this ceiling is impervious to the passage of fluids except through the controlled ports 48 and 51. The net results are more accurate distribution and control of the air flowing from the plenum chamber into the room

below and the allowance of higher pressures in the plenum chamber.

The ceiling 53 illustrated in FIG. 4 employs tile produced according to the teachings of this invention and is well suited for a sound correcting suspended ceiling construction having high resistance to fire. In this construction the tiles are joined together and supported by sheet metal flanges or splines at all the joints, whereby the passage of gases through the joints between adjacent tile is substantially eliminated. The foil backed mineral fiber tiles 10 are supported on flanged runners 54 by the lower flanges 56 engaging the grooves or rabbets extending along the edges of adjacent tiles. The edges of adjacent tiles not directly supported on the runners are joined by splines 52. Flanged runners 54 are attached to the channels 58 by means of clips 60. The channels are supported by wires 62 which are attached to the structure above, not shown. Ceiling 53 extends between the walls of the room in which it is suspended and no open ports are provided in this construction. The result is a substantially impervious mineral fiber tile ceiling which prevents the passage of hot gases either through or around the tile. When properly erected, this type of construction has provided high fire rating test results. The foil stops the passage of the hot gas through the body of the tile while the use of the spline members and the flange runners prevents any passage through the joints, between adjacent tile. Thus, there is a barrier to the passage of hot gases, which contributes to high fire ratings.

It has been found that the use of a foil across the entire back surface of mineral fiber acoustical tile, such as set forth above, will not adversely affect the sound absorption characteristics thereof. In fact, there is an unexpected increase in the sound attenuation factor. For instance, in structures embodying this invention, attenuation factors as high as 45 decibels have been attained as compared with about 31.5 decibels without the aluminum foil.

It will thus be seen that a new and improved method of making acoustical tile has been provided. A molded mineral fiber acoustical tile and method of providing the same are disclosed in which a layer of aluminum foil extends over and is conterminous with the back surface of the tile and is made a part thereof during its manufacture by spreading the composition forming the body of the tile upon a sheet of foil applied as a liner over the bottom of a mold. The step of sanding the back surface is eliminated with consequent saving in labor and material. There are significant improvements in drying of the tile. The resultant tile may present a porous and/or fissured lower surface to obtain good acoustical characteristics and pleasing appearance but are still impervious to passage of gases therethrough and are economical to produce. Such tile may be utilized to provide a ceiling construction which facilitates control and uniform distribution of air through a suspended ceiling of mineral fiber acoustical tile from a plenum formed by the ceiling and the structure thereabove. The tile provides a pleasing appearance and equal or improved acoustical properties while preventing any passage of air therethrough so that properly spaced openings to give the desired air distribution can be used without erratic and/or extraneous flow of air through random fissures, high porosity areas, and the like, of varying degrees of air transmission. Further, in structures without intentionally formed openings, tiles produced in accordance with this invention facilitate obtaining a high fire rating.

While particular embodiments of the invention have been shown, it will be understood, of course, that the invention is not limited thereto since modifications may be made by those skilled in the art in light of the foregoing teachings. It is, therefore, contemplated by the appended claims to cover any such modifications as fall within the true spirit and scope of the invention.

I claim:

1. A process for manufacturing non-warping acoustical tile comprising the steps of preparing an aqueous plastic composition including mineral fiber material and an amylaceous binder for forming the body of such tile, providing a mold tray, covering the bottom of said tray with sheet material impervious to passage of water vapor therethrough, depositing and spreading said aqueous plastic composition in said mold tray over said sheet material to form a body-forming layer of said composition, exposing said composition on said sheet material to a heating and drying environment whereby said composition is dried within substantially the same time as that required to dry the same composition on a pervious sheet under the same drying conditions, and thereby forming a slab comprising a layer of dried porous composition having said impervious sheet material extending over and bonded to the back side thereof, dressing only the face side of said slab, and cutting said slab to form acoustical tile having said sheet material extending over and bonded to the back side thereof.

2. A process for manufacturing non-warping acoustical tile comprising the steps of preparing an aqueous plastic composition including mineral fiber material and an amylaceous binder for forming the body of such tile, providing a mold tray, covering the bottom of said tray with sheet material comprising a sheet of aluminum foil, depositing and spreading said aqueous plastic composition in said mold tray over said foil to form a body-forming layer of said composition, exposing said composition on said foil to a heating and drying environment whereby said composition is dried within substantially the same time as that required to dry the same composition on a pervious sheet under the same drying conditions, and thereby forming a slab comprising a layer of dried porous composition having said foil extending over and bonded to the back side thereof, dressing only the face side of said slab, and cutting said slab to form acoustical tile having said foil extending over and bonded to the back side thereof.

3. A process for manufacturing non-warping acoustical tile comprising the steps of preparing a heated aqueous plastic composition including mineral fiber material and starch for forming the body of such tile, providing a mold tray, covering the bottom of said mold tray with a sheet of aluminum foil, depositing and screeding said heated aqueous plastic composition on said foil in said mold tray to form a body-forming layer of said composition having a fissured surface, placing said heated composition, on said foil, in an oven while still hot, further heating and drying said composition on said foil in said oven at an elevated temperature to form a slab comprising a layer of dried porous composition having said aluminum foil extending over and bonded to the back side thereof, dressing only the face side of said slab, and cutting said slab to form acoustical tile having said aluminum foil extending over and bonded to the back side thereof.

4. A process for manufacturing non-warping acoustical tile comprising the steps of preparing an aqueous plastic composition including mineral fiber material and an amylaceous binder for forming the body of such tile, providing a mold tray, covering the bottom of said tray with sheet material comprising a sheet of metal foil, depositing and spreading said aqueous plastic composition in said mold tray over said foil to form a body-forming layer of said composition, exposing said composition on said foil to a heating and drying environment at a temperature above about 250° F., to dry said composition, and thereby forming a slab comprising a layer of dried porous composition having said foil extending over and bonded to the back side thereof, dressing only the face side of said slab, and cutting said slab to form acoustical tile having said sheet material extending over and bonded to the back side thereof.

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