Nov. 25, 1969 A. C. AUSTIN ET AL 3,480,104

ACOUSTIC TILE LAMINATE

Filed June 15, 1967

Fig. 1.

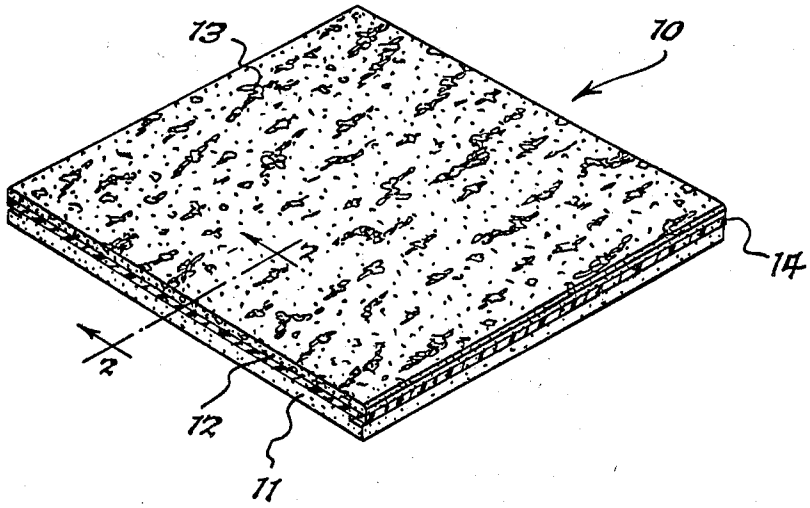
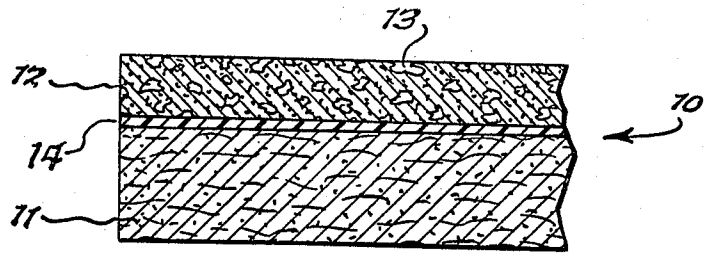


Fig. 2.



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ACOUSTIC TILE LAMINATE

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U.S. Cl. 181—33 6 Claims

ABSTRACT OF THE DISCLOSURE

An acoustic tile laminate which provides sound attenuation by virtue of having an air impervious layer of paint between two layers of sound absorbing tile, the layer of paint leaving the rear surface of the tile exposed so that both the front and rear surfaces have good sound absorbing qualities. The improved method of manufacturing the tile consists of depositing the paint on the wet backing layer of the tile and thereafter depositing the wet facing layer on the wet paint and drying all three layers simultaneously.

BACKGROUND OF THE INVENTION

The present invention relates to an improved acoustic tile of the type which performs both an attenuation function and a noise reduction function.

By way of background, acoustic tile is rated on the basis of its ability to both attenuate and to absorb sound. There are two standard tests which are utilized for the purpose of evaluating these acoustic properties. The first is a sound transmission test which measures the ability of the acoustic tile to attenuate sound, that is, its ability to stop sound from being transmitted through it. The second test is a noise reduction test, which determines how much noise is absorbed by the acoustic tile. Broadly, the ceiling sound transmission test consists of originating sounds on one side of a partition and measuring the reduction in level as the sound goes up through the ceiling on one side and down through the ceiling on the other side. The noise reduction test consists of originating a sound on one side of a tile and measuring the change in the rate of decay of the sound level in the room, thereby providing a basis to calculate the amount absorbed.

In the past, the attenuating characteristic of an acoustic tile was enhanced by securing a layer of metal foil to the rear side of the tile, that is, the side facing away from a room in which the sound originated. This layer of foil functioned as an air barrier and thus reduced sound transmission through the tile and therefore provided attenuation. However, the metal foil deleteriously affected the noise reduction characteristic of the side of the tile on which it was mounted because it did not permit the sound waves to reach the sound absorbing surface of the tile. This was undesirable because while the tile, when mounted on a ceiling, absorbed sound from the room in which it was located, it was not effective in absorbing sounds emanating outside of the room, for example, from the floor above the ceiling. Thus, the metal foil improved the attenuating characteristics of the tile; had no effect on the noise reduction characteristic of the tile face opposite to the foil; but decreased the ability of the rear face of the tile to absorb sounds emanating on the rear side. In the past, there was no way in which both sound attenuation and noise reduction could be obtained simultaneously because the use of a metal foil on the rear of a tile negated sound absorption on that side, and essentially caused sound absorption on one side of the tile and attenuation to be mutually exclusive.

In addition, the metal foil on the rear of an acoustic tile was subject to certain shortcomings. The metal foil, being thin, was subject to mutilation and destruction in handling and when this occurred, the air impervious layer which it provided was broken so as to reduce the attenuation characteristics of the tile. In addition, the application of the metal foil to one side of the tile involved the expense of the foil itself and the expense of the labor for applying it. It is with an improved acoustic tile which overcomes the above enumerated shortcomings of prior acoustic tiles that the present invention is concerned.

SUMMARY OF THE INVENTION

It is accordingly one object of the present invention to provide an improved acoustic tile which possesses good sound attenuation characteristics and also possesses good noise reduction characteristics on both sides thereof, considering that in the past the modification of a tile to improve its attenuation characteristics resulted in decreasing its noise reducing qualities on one of its sides.

Another object of the present invention is to provide an improved method of fabricating acoustic tile in which the sound attenuating layer is applied simply, easily and with relatively little expense as compared to previous ways of applying it.

Still another object of the present invention is to provide an improved acoustic tile possessing a sound attenuating layer which is so incorporated into the tile, that is, by being placed between layers of the tile so as to be protected against destruction in handling and installation. Other objects and attendant advantage of the present invention will readily be perceived hereafter.

Briefly, the present invention relates to an improved acoustic tile which is formed as a laminate including a sound absorbing backing layer, a sound absorbing facing layer, and a substantially continuous sound attenuating layer therebetween, which, in this instance, is a layer of latex paint.

The improved method of fabricating the tile is to apply a layer of latex paint to the backing layer immediately after it has been formed and while it is still in a wet condition. The facing layer in turn is laid onto the attenuating layer and all three are dried simultaneously in an oven. The water base of the central sound attenuating layer is miscible with the water of the facing and backing layers and therefore this layer will not tend to stratify in the sense of separating the facing layer from the backing layer. In fact, it acts as a bond which aids in securing the facing layer and backing layer.

Because the sound attenuating layer is shielded by both the backing layer and the facing layer, it remains intact both in handling and during application so that the qualities which it is intended to provide are not lost. In addition, this paint layer performs its sound attenuation function as well as heretofore performed by metal foil applied to the outside of the backing layer, but does not interfere with the noise absorbing qualities of the backing layer, as did the metal foil in the past, because the paint layer leaves the backing layer unshielded. The present invention will be more fully understood when the following portions of the specification are read in conjunction with the accompanying drawings wherein:

BRIEF DESCRIPTION OF THE DRAWINGS

FIGURE 1 is a perspective view of the improved acoustic tile of the present invention; and

FIGURE 2 is a fragmentary cross sectional view taken substantially along line 2—2 of FIGURE 1.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The improved acoustic tile **10** of the present invention includes a backing layer **11** consisting of felted mineral

wool in a starch binder and a facing layer **12** consisting of cast mineral wool in a starch binder, said layers being fused to each other in part by their starch contents, as will become more apparent hereafter. The face layer **12** includes fissures **13** produced by a conventional screeding process to provide a travertine stone-like appearance which is highly desirable from an aesthetic viewpoint. The composition of the foregoing portions of the acoustic tile laminate is identical in all respects to the tile disclosed and fully described in United States Patent No. 3,283,849, the contents of which are incorporated herein by reference. Only the pertinent portions of said patent will be repeated here in the interest of continuity of explanation and completeness.

The composition of the backing layer **11** by weight in the dry state has been obtained within the following ranges:

	Percent
Clay, Baker*	6–10
Pearl starch	7.1–10.2
Wax emulsion X–251–A	0.6–0.7
Boric acid	0.6–0.7
Dowicide* A	0.04–0.05
Dowicide* G	0.04–0.05
Mineral wool	75–85
Moisture, maximum	1.5

The commercial method of manufacturing the backing layer **11** of acoustic tile **10** is to form a white water having starch and Dowicide* A and G therein and all the other components listed above which are not subsequently filtered out. The mineral wool is added to the foregoing white water in a turbine-type agitator and the two are thoroughly mixed. The mixture is pumped to a storage tank, and from the storage tank the white water with the mineral wool are pumped to a "shot" separator where fresh binder is added. The resulting solution is injected into an Oliver board former and it is in the Oliver board former that the material is felted onto a rotating cylinder having a vacuum on the inside thereof and the mat so formed is laid into trays. The mineral wool used in the composition may consist of fiber lengths generally between ⅜ and ½ inch and possibly up to ¾ of an inch.

In accordance with the present invention, after the backing mat has been formed in the above described manner and while it is still wet, a layer **14** of latex-type water soluble paint is sprayed onto the mat at a rate of 20 plus or minus 2 wet grams per square foot by the use of suitable paint spraying equipment which is capable of effecting the spraying as the wet mats are transferred onto a conveyor from the Oliver board former. A commercial paint which has proved commercially satisfactory is known by the trademark Gold Bond Velvet Enamel and is a product of the National Gypsum Company. It is a semi-gloss enamel consisting essentially of latex or resin emulsion base which is water thinned and possesses approximately 50% solids, and is further identified by Specification No. 72–7–10–4, Primrose Latex Enamel. The thickness of paint layer **14** is exaggerated on the drawings for purpose of illustration. After the latex paint has been sprayed onto the wet backing, the facing is made up and laid onto the layer **14** of paint. The composition of the face layer by weight in the dry condition is within the following ranges:

	Percent
Polyox*	.23–.46
Boric acid	.9–1.0
Tex-O-Film* #4838 starch	6.34–9.5
Clay, Allen*	11–14
Stucco	3–4
Wax emulsion X–251–A	1.4–1.8
Mineral wool	70–75
Moisture, maximum	1.5

In making up the facing layer, the binder consisting of all of the elements except the mineral wool is made up by dispersing the Polyox* WRS–301 thoroughly in cold water and adding the remainder of the ingredients in the order noted above. Thereafter, the batch is brought up to 195° F. and maintained at this temperature for a sufficient time to properly cook the starch, usually not less than five minutes. The binder and mineral wool are then fed simultaneously and continuously to a twin screw-type mixer, such as manufactured by the Sprout Waldron Company. In the solution the water consists of between 50% and 75% of the total. The twin screw mixer mixes both into a dough type of mix which is laid onto the above described layer of latex paint in the trays on the wet backing. Thereafter, while the facing is still in its wet condition, it is subjected to a mechanical screeding process to provide the travertine stone-like appearance depicted in the drawings. hereafter, the laminate slabs so formed are baked at 350° F. maximum for no longer than six hours and thereafter the temperature is reduced to 300° F. plus or minus 10° F. for an additional five hours and thereafter the temperature is reduced 280° F. plus or minus 10° F. until the slabs are dry, that is, contain less than 1% of their moisture content noted above.

The composition of each of the components of both the facing layer and the backing layer are listed in detail in column 6 of Patent No. 3,283,849 but are repeated here in the interest of completeness.

The Polyox* WR–301 is a product of the Union Carbide Company and consists of ethylene oxide polymer including approximately 2% ash content by weight and approximately 4% moisture content by weight. In addition this material has a softening point of between 65–75° C. and a brittle temperature of minus 50° C. and a molecular weight of 4×10^6.

The boric acid is of 99.5% minimum purity and has a maximum of .01% chloride, .10% sulfate and .0005% iron.

The Tex-O-Film* #4838 is a product of the Corn Products Sales Company and is a milo starch having 12½% maximum moisture, .5% maximum ash content, and a pH of between 6.0 and 7.0.

The Allen Clay* is a product of United Clay Mines, Inc. and a typical analysis shows the existence consists of the following ingredients by percent: silicon dioxide 45.02, aluminum oxide 38.32, iron oxide .46, calcium oxide .06, magnesium .14, alkalies .36, titanium dioxide 1.66. In addition, the pH is 4.8 and it has a size wherein 99% passes through a 325 mesh screen. The only basic difference between Allen Clay and Baker is their color.

The Gypsum Stucco has a consistency of 49–55 ml. according to ASTM Designation C472–61, a minimum set time of 42 minutes, and a size wherein .4% is the maximum which should be retained on an United States No. 30 Sieve and 87% is the minimum which should pass through a United States No. 100 Sieve.

The Wax Emulsion X–251–A is a product of the American Cyanamid Company, the X–251–A being the grade designation. It consists of an emulsion of wax in water wherein the solids are 47 plus or minus 1% and it has a stability of six months at 75° F.

The mineral wool which forms a part of the face of the tile laminate is a granulation of zero percent plus ¾ inch screen and 5–25% plus ½ inch screen and has a diameter of 3 to 30 microns.

The mineral wool which is used in the backing is of a size wherein 30% minimum must be above a ¾ inch screen and 20% maximum must be minus a ¼ inch screen and it has a diameter of approximately 3 to 30 microns.

In addition, both of the mineral wools have a composition which is 38–42% of silicon dioxide, 36–40% of calcium oxide, 6–10% of aluminum oxide, 4–8% of magnesium oxide and less than 1% of the trace elements iron, titanium, manganese and sulfur.

The pearl starch is a white corn starch and has be-

tween 10½ and 13½% moisture and includes .10% maximum ash, .30% maximum protein, .10% maximum fiber, .10% maximum water soluble substances, .003% maximum SO_3, .10% maximum fat, 86% minimum starch by difference, and a pH of between 5.0 and 7.0.

The Dowicide* A is a product of the Dow Chemical Company and is of a flake grade having a solubility in water of .122 grams/100 grams and includes 97% minimum active ingredients comprising sodium ortho phenyl phenate and 3% maximum inert ingredients. The pH of a saturated water solution at 25° C. is between 12.0 and 13.5.

The Dowicide* G is a product of the Dow Chemical Company and is of the flake grade and includes 90% minimum of sodium salt of pentachlorophenol and 10% maximum of inerts. This material is of flake grade and has a minimum solubility of 33 grams in 100 grams of water at 25° C.

In the preceding specification, all names designated by an asterisk are trademarks.

Acoustic tiles fabricated in the above described manner were tested for sound transmission and noise reduction. Acoustic tiles having a 12" by 12" dimension and a ¾ inch thickness with a thickness of backing layer of approximately ½ inch and a thickness of facing layer of approximately ¼ inch were subjected to a Geiger and Hamme Ceiling Sound Transmission Test, which was assigned No. NG–264 FT (Continuous Construction). Acoustic tiles having the above composition but having instead a foil backing, namely, aluminum foil .00025" thick mounted on 20# kraft paper, with the kraft paper facing the tile, the tile being ¾ inch thick, were given the same Geiger and Hamme Ceiling Sound Transmission Test, which was assigned No. NG–233 FT. All of the foil-backed tile referred to in this specification possesses the above described foil backing. The above-mentioned Geiger and Hamme Test corresponds to the Acoustical Materials Association Test 1–II–1963. The following results were obtained:

TABLE A

Frequency Cycles per Second	¾" x 12" x 12" Tile Normalized Attenuation Factor in Decibels: Test NG–264 FT With Layer of Paint Between Face and Back	Test NG–233 FT With Layer of Metal Foil on Back
125	35	31
177	39	40
250	31	32
354	37	39
500	37	40
707	41	44
1000	45	45
1414	50	48
2000	59	56
2828	62	56
4000	62	52
11 Frequency Average	45.2	43.9
Sound Transmission Class	41	44

At this point it is to be noted that each of the test results for each frequency noted in the above table is an average of 10 separate tests made for each frequency on the same material undergoing tests to provide an average value. The attenuation factor is a measure of the decibel loss due to the attenuation of the tile. The foregoing tests depicted in Table A indicated that the product of the instant invention has as good sound attenuation as the foil-backed product to which it was compared.

The tile made in accordance wtih the present invention, that is, pieces ¾ by 12 by 12 inches, were assembled to provide 72 square feet of surface which was subjected to a River Bank Laboratories Test No. A66–115 and received a #7 mounting noise reduction coefficient (NRC) of .68, which falls in the (.65–.70) range, as set forth in the following table wherein the numeral given for each frequency is an average of at least 50 separate tests which were made. The NRC is an average of the middle four values. Each figure in the table represents the proportion of sound absorbed at each frequency.

TABLE B

Frequency Cycles per Second	¾" x 12" x 12" Tile: With Layer of Paint Between Face and Back	With Layer of Metal Foil on Back
125	.42	.32
250	.45	.39
500	.52	.62
1,000	.77	.86
2,000	.97	.88
4,000	.99	.71
Noise Reduction Coefficient (NRC)	.68	.69
NRC Range	.65–.70	.65–.70

The significance of the foregoing tests is that the face of both the foil-backed specimens and the specimens made in accordance with the present invention possessed the same noise reduction coefficients.

The following tests commonly called the "box" test were also made for each type of tile. The box test consists of providing a one foot by one foot by three foot oak wood box which is closed on the bottom, the two sides, and the two one by one foot ends. The top is open and contains structure for mounting three one by one foot tiles in side-by-side relationship to provide three square feet of tile surface. A microphone is placed at one end of the box and a speaker at the opposite end. Measured amounts of sound are emitted at frequencies of 256, 512, 1024 and 2048 cycles per second from the speaker, and the microphone picks up the amount of sound which is not absorbed. Two readings are taken at each frequency with the tiles in different positions at each reading. The following table shows the proportion of sound which is absorbed at each frequency. The NRC or noise reduction coefficient rating is the numerical average of the sound absorbed at each frequency.

TABLE C.—NOISE REDUCTION COEFFICIENTS (NRC)

With Layer of Metal Foil on Back		With Layer of Paint Between Face and Back	
Face	Back	Face	Back
.65–.70	.30–.35	.65–.70	.55–.60
.65–.70	.30–.35	.65–.70	.55–.60

It can readily be seen that the "box" test for the face of the material is substantially the same for both the improved interlaminate structure of the present invention and the previous acoustic tile having the foil backing. However, when this box test was performed to determine the noise reduction coefficient of the rear of the tile, it can readily be seen that less noise was absorbed by the rear of the tile having a foil backing than the rear of the tile having an interlaminate structure of the present invention. In this respect, the NRC of the back of the interlaminate structure was .55–.60 whereas the back of the foil-layered tile had an NRC of .30–.35. This shows the superiority of the tile of the instant invention in absorbing sounds emanating at the rear of the tile. As noted briefly above, the tile of the present invention, because of the improved NRC on the rear thereof can more efficiently absorb sounds emanating from the outside of a room in which the tile is installed.

By virtue of placing the paint layer between the layers of tile, any tendency which the paint has for spreading flame will effectively be negated.

While the present invention has been described with respect to a preferred type of tile composition, it will be appreciated that the principles of the present invention may be applied to any type of acoustic tile.

It can thus be seen that the improved acoustic tile laminate of the present invention is a product which can generally be manufactured at less cost than products having a metal foil backing and that by the inherent nature of the construction the sound attenuating layer is protected by both the facing and backing layer against mutilation due to handling or the like. It can also be seen that the improved tile of the present invention not only has equal attenuation characteristics with the metal foil backed tile previously used, that is, its ability to stop sound from being transmitted through it but it also has an improved noise reduction coefficient because of its capability to absorb sound both from the rear as well as from the face thereof, this being incapable of achievement by the acoustic tile having the foil backing.

What is claimed is:

1. An acoustic tile laminate as set forth in claim 2 wherein said backing layer and said facing layer include a water base and wherein said paint is a water thinned resin emulsion base paint.

2. An acoustic tile laminate comprising a sound absorbing backing layer, a sound absorbing facing layer, and a sound attenuating layer therebetween, said sound attenuating layer comprising a substantially continuous film of paint.

3. An acoustic tile laminate as set forth in claim 2 wherein said facing layer provides an NRC of at least .65–.70, and wherein said backing layer provides an NRC of at least .55–.60, and wherein said title provides an attenuation factor of at least approximately 45.

4. An acoustic tile laminate as set forth in claim 2 wherein said backing layer and said facing layer include a water base and wherein said paint is water thinned latex base paint.

5. An acoustic tile laminate as set forth in claim 4 wherein said facing layer comprises cast mineral wool in a starch binder, and wherein said backing layer comprises felted mineral wool in a starch binder.

6. A method of producing an acoustic tile having a sound attenuating characteristic and a noise reduction characteristic on both sides thereof comprising the steps of providing a sound absorbing backing layer containing water and in wet condition, applying a substantially continuous center layer of water thinned latex base paint on said wet backing layer, applying a sound absorbing facing layer containing water and in wet condition on said center layer, and drying said tile to remove said water from said facing layer, backing layer, and latex base paint.

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ROBERT S. WARD, JR., Primary Examiner

U.S. Cl. X.R.

161—160

PO-1050
(5/69)

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,480,104 Dated November 25, 1969

Inventor(s) Arthur C. Austin, Edward R. Gorka & Norbert W. Kalet

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

Column 2, line 29, change "advantage" to --advantages--.

Column 4, line 16, change "hereafter" to --Thereafter--; Line 28, change "WR" to --WSR--; line 49, after "Baker" insert --Clay--.

SIGNED AND
SEALED
FEB 24 1970

(SEAL)
Attest:

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