April 13, 1937. F. R. KANENGEISER 2,076,994

SOUND ABSORBING MATERIAL

Filed Nov. 1, 1934

Fig. 1.

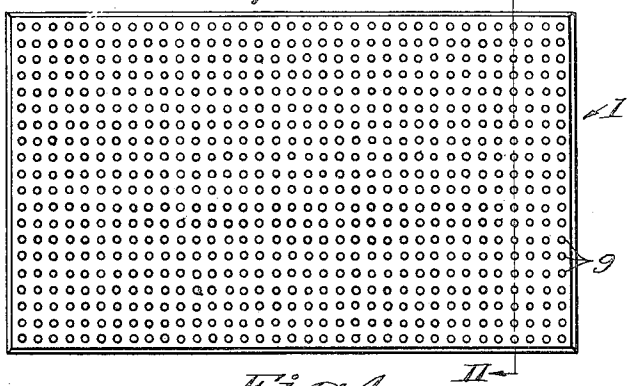


Fig. 2.

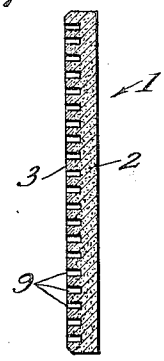


Fig. 4.

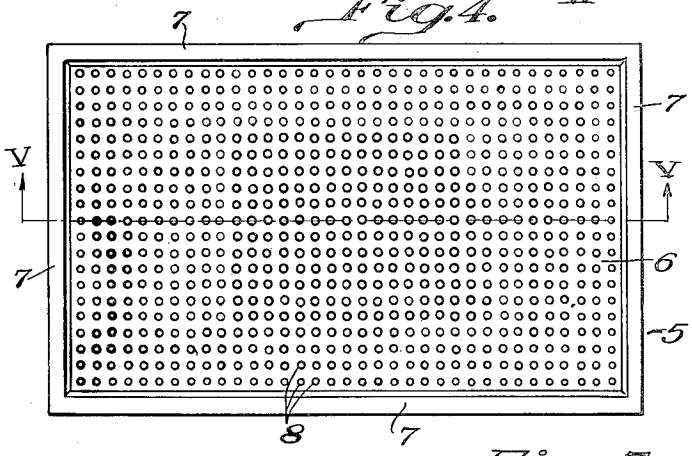


Fig. 3.

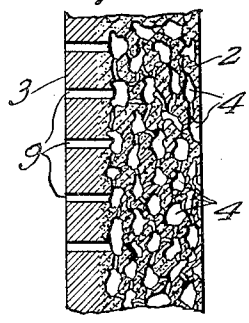


Fig. 5.

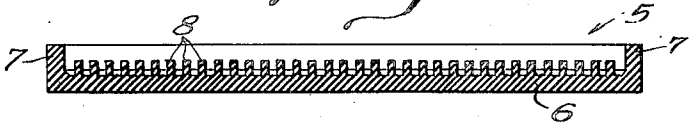


Fig. 6.

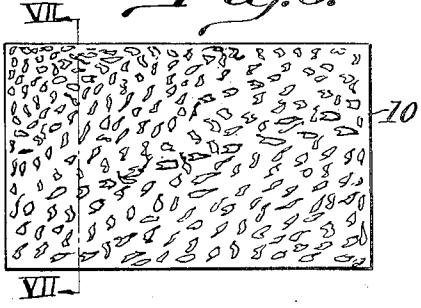
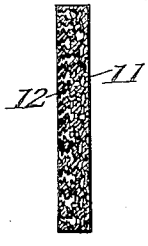


Fig. 7.



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SOUND ABSORBING MATERIAL

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Application November 1, 1934, Serial No. 751,021

3 Claims. (Cl. 72—18)

This invention relates to improvements in the construction and manufacture of sound absorbing wall-forming material of the cast or molded mineral types. Such materials are employed for the control of acoustical conditions which are present in auditoriums, halls, rooms, theaters, subways or vehicular tunnels where the minimizing of sound and its general correction to establish improved or desirable sound effects constitutes an important consideration.

To secure these and other results, porous or cellular wall-forming materials have been developed which usually comprise preformed panels or blocks composed in certain instances of heat-treated ceramic materials having rough uneven exposed surfaces with which the small internal voids or cells communicate, whereby to receive sound waves or disturbances which impinge thereon to absorb such sound and prevent its reflection as occurs with the use of wall-forming materials having smooth dense exterior surfaces. Such sound absorbing panels of a generally porous character have also been formed by suitably bonding small graded particles of a rock-like material in which a cementitious bond is used, or by the employment of blast furnace slag crushed into particles of desired size and suitably united to produce wall-forming panels. Again, minerals such as cyanite have been rendered cellular or porous through heat treatment in expanding temperatures, and the expanded particles united by a clay bonding agent.

There are also other methods of forming these sound absorbing blocks or panels which produce products varying more or less in their relative ability to absorb or control sound but in general they may be all characterized by the rough, porous and uneven texture of their exposed surfaces. This physical condition makes it very difficult, and usually impossible, to wash or clean the exposed surfaces of such materials when they are assembled in wall-forming order, and this constitutes a serious objection to their use in many cases where otherwise they would be entirely satisfactory and generally desirable.

It is, therefore, one of the outstanding objects of the present invention to provide an improved wall-forming block or panel composed of a body portion of the desired cellular or porous character formed in any of the well accepted methods of manufacturing such porous sounding material, as above described or otherwise, and wherein such body material is provided with an outer facing constituting a relative thin coating of a dense smooth surface material, but wherein is included, during its process of manufacture, a multiplicity of small closely related openings or perforations which extend to the cells, voids or interstices of the body material, so that sound waves striking the exposed surface of the facing layer will pass through these openings or perforations and are thereby absorbed or trapped in the small voids of the body forming material with practically the same efficiency as if the rough texture of the body material were directly exposed to sound contact. However, due to the presence of the relatively smooth exposed surface of the facing layer, the washing or cleaning thereof may be accomplished with ease and facility so that the wall-forming material, constructed in accordance with the present invention may be maintained in a desired state of cleanliness.

To obtain these results, very considerable difficulty was encountered in the molding of the plastic materials in their formative state. Generally, such sound absorbing materials are first formed to produce a plastic mass, which is poured into metallic molds in order to produce panels or blocks of desired configuration. It was found to be impossible, in order to produce the perforations in the facing material as above described, to provide the bottoms of such metallic molds with a plurality of upstanding pins or projections for the reason that the cementitious or ceramic materials would adhere upon setting with such pins or projections with such tenacity as to preclude the removal of the hardened panels or blocks following setting or heat treatment without injury to either the block, panel or mold.

I have discovered, however, that through the employment of a mold formed from an elastic material, such as rubber, or wherein the pins or projections of the mold used in forming the facing openings are composed of such elastic material, the hardened or molded product may without any difficulty at all be readily removed from the mold in a finished, perfected and desired state, this operation being such as to form the openings or perforations in the facing materials in an entirely satisfactory manner and at the same time avoids injury to the mold upon the withdrawal of a formed block or panel.

For a further understanding of the invention, reference is to be had to the following description and the accompanying drawing, wherein:

Fig. 1 is a plan view of a panel of sound absorbing material formed in accordance with the present invention;

Fig. 2 is a vertical sectional view taken through

the panel on the plane indicated by the line II—II of Fig. 1;

Fig. 3 is a similar view on an enlarged scale;

Fig. 4 is a plan view of a rubber mold formed in accordance with the present invention;

Fig. 5 is a vertical sectional view taken through the mold on the line V—V of Fig. 4;

Fig. 6 is a view in front elevation of a modified form of sound absorbing building block;

Fig. 7 is a transverse sectional view taken therethrough on the line VII—VII of Fig. 6.

Referring more particularly to the drawing, the numeral 1 designates a block or panel of sound absorbing material formed to comprise a body portion 2 and a facing layer 3, which may be applied to one or more surfaces of the body material. The body material is of a generally porous character and may be produced in accordance with the disclosures contained in a prior application, Serial No. 630,086 filed August 23, 1932 filed by A. H. Sexton and F. R. Kanengeiser. However, I do not limit myself to any particular method of forming or producing the body material, since it is within the scope of the invention to utilize any of the above described methods for producing a porous or cellular body through the employment of minerals which may be reduced to a moldable state and subsequently set or hardened by curing or heat treatment.

One method of forming the body 2 may consist as set forth in the aforesaid prior application, in the employment of crushed substantially uniformly graded limestone particles which are first water soaked to substantially the limit of their water absorbing capabilities, and wherein dry cement alone is added to these particles, following the removal of excess moisture, to provide a bonding medium whereby these particles of mineral matter may be united through molding in a desired homogeneous manner, but at the same time producing voids or interstitial spaces 4 between the mineral particles which are known to be effective in their ability to absorb and control sound.

In producing my improved product, I employ a mold 5 of suitable shape and dimensions which includes a bottom 6, upstanding vertical side walls 7 and an open top. The bottom of the mold is provided with a plurality of integral, relatively spaced upstanding projections or pins 8 which are of a length preferably exceeding the thickness of the facing layer 3 of the improved sound absorbing material. Preferably, the entire mold including the projections or pins 8 is formed from live rubber, possessing the ability to stretch or flex quite readily.

In the use of the mold, the materials constituting the facing layer when in a substantially fluid state, possessing substantially the consistency of a thick cream, are poured onto and over the bottom of the mold around the pins or projections 8, the depth of these forming materials being preferably less than that of the height of the projections 8 so that the upper ends of the latter will be visible after the facing layer has been poured. The materials comprising the facing layer may of course vary greatly, and I have used successfully in one form of my invention a cementitious mixture composed of approximately equal parts of a fine Ottawa sand and Portland cement, to which I add a sufficient amount of water so that the resulting mixture will possess free flowing and readily moldable properties. If desired, suitable mineral oxide coloring matter may be added to this facing layer to produce desired color effects, after the disclosures set forth in the prior application of A. H. Sexton, Serial No. 633,158 filed September 14, 1932.

Following the placing of this mixture of facing materials in the mold 5, the body forming materials may then be added to the mold to approximately the height of the side walls 7. These body materials may comprise a plastic mixture composed of crushed minerals of substantially uniformly graded particles of irregular shapes possessing the ability of absorbing water to an extent varying from 6% to 15% by weight thereof. This material ordinarily is composed of non-metallic minerals having sufficient hardness and permanency so that they will not disintegrate by elemental exposure and are carefully graded as to size within comparatively narrow limits. Thus in one form of my invention, these mineral particles may be graded between screens composed of from 6 to 12 strands to the inch, or between screens of 10 to 20 mesh, or in certain instances 20 to 30 mesh, each grading to be handled separately.

Following the grading of these relatively small, uniformly sized and crushed or shattered mineral particles, the latter are then wetted by immersion or sprinkling until they have been saturated with water. Excess water may then be drained off after the mineral particles have absorbed substantially 6% to 15% by weight of water. Dry cement, preferably Portland cement, is then added to the water-containing mineral particles and the material agitated to obtain a thorough mixing of the cement with the wetted mineral particles. After this thorough mixing, which may be done in any character of apparatus, the mixture is placed on a screen having a mesh size less than that of the particles of the aggregates. All excess material, such as unwetted dry cement, is screened out of the mass, whereby to leave only such cement adhering to the surfaces of the mineral particles which has been wetted by the moisture present therein.

This plastic material is then placed in the mold 5 on top of the facing materials and molded sufficiently to cause the cement coatings, which surround each of the mineral particles, to coalesce or bond with similar coatings on adjacent aggregate particles. The resultant material, after it has been allowed to dry and harden, comprises a porous product with a variety of interstices of different sizes communicating with one another and formed in said body between the individual cement coated particles. It is important that the material used as an aggregate should be the product of a crushing operation, so that there will be formed irregularly shaped pieces and all approximately of the same size, whereby when this mass is cemented together, the interstitial pores or passages of varying area will be produced. My invention thus provides an acoustical material of high sound absorptive value and at the same time a material which is highly fire resistant. When the molded product is removed from the mold, following the usual curing period, the facing material is integrally united with the body material so that there can be no separation therebetween. The removal of the molded product from the mold takes place easily and without the aid of machinery. This is due to the fact that the mold proper is flexible and, as stated, is formed from rubber. If there is any tendency on the part of the projections or pins 8 to ad-

here to the walls of the perforations 9 formed in the facing material, this tendency is immediately relieved by the stretching of the pins or projections, which results in decreasing their diameter so that they readily pass out of the perforations 9. Similarly, the side walls 7 of the molds may be readily disengaged from the marginal edges of the mold block or panel 1. Furthermore, there is little or no tendency of the material to cling to the rubber surfaces, and there takes place a sharp separation which leaves the mold in a cleanly condition, particularly at its corners, so that it is unnecessary to subject these molds, as is the case with metal molds, to thorough cleansing before they can be re-used.

There are numerous other advantages attending the use of the rubber mold, tray or palette in the manufacture of moldable products of the character set forth. By the use of rubber, I can obtain very intricate surface designs, also duplicate all sorts of fabric designs, wood grain or other patterns of a like nature. The use of rubber in the mold formation also permits of convenience in the casting of these intricate designs and the stripping of the molded article from the mold. Furthermore, it allows one to cast models in relief where under-cutting is necessary and gives a high degree of density and surface finish. These advantages are true whether the material is employed for uses other than as an acoustical wall material.

It will be noted that the peg-like projections 8 are extended upwardly from the bottom of the mold a sufficient distance to penetrate into the mass of the acoustical body material. The facing material, it would seem, apparently increases the total sound absorbing capacity of the material rather than to decrease it. This undoubtedly is due to the fact that once the sound wave has penetrated through the perforations 9 into the inter-communicating cells or pores of the body material, and the solid facing holds a greater percentage of the sound wave within the mass of the body material until it finally dies. By this method and construction, an improved sound absorbing material is produced both from the standpoint of its capacity to absorb sound and in addition, the improvement in appearance and cleanliness afforded the product by the outer facing. As stated, this facing may be made up in a variety of patterns or to produce different color effects, which fact materially contributes to its usefulness as a wall material.

In the form of our invention disclosed in Figs. 6 and 7, the block or panel is indicated by the numeral 10 and is formed by first producing a primary fluid-like mixture composed principally of sand, cement and water so that it may readily flow over the bottom of a pan-shaped mold, similar to that disclosed in Fig. 4 with the exception that the upstanding pegs or projections are omitted. This primary mixture is distributed over the bottom of the mold in the form of a relatively shallow layer of approximately the same depth or thickness as the facing layer 3 in the previously described form of block. We then substantially fill the balance of the mold with the porous body mixture which corresponds to that employed in the making of the body 2 with the exception that it is in a somewhat drier state so that this body material which is indicated by the numeral 11, while the primary or facing layer is indicated by the numeral 12, will absorb moisture from the facing layer at such a rate as to produce a multiplicity of relatively small irregular openings or passages in the primary layer, which extend completely through the latter in order to establish sound communication between the exterior of the block and the internal voids of the body layer. This form of block or panel, like the panel 1, also presents a smooth finished exterior surface which may be readily cleansed by being washed or otherwise renovated. So far as we are aware, a sound absorbing material having this property of being readily cleansed or renovated is generically new and the claims hereinafter made are therefore to be construed accordingly.

What is claimed is:

1. A molded wall unit for acoustical regulation comprising a porous base formed from a plastic molded composition of small uniformly sized crushed mineral particles united by a cementious binder and having formed therein a multitude of interstitial passages or voids between the mineral particles, and a facing layer having a smooth exterior surface integrally bonded on its inner side with said base, said facing layer being composed of sand and cement and having molded therein a large number of relatively spaced transversely extending openings for the transmission of extraneous sound to the sound absorbing voids and interstices of said base.

2. A molded wall unit for acoustical regulation of fixed determinable dimensions, comprising a base composed of uniformly sized mineral particles united by a cementitious binder to form a homogeneous material having disposed therein a multitude of interstitial passages or voids between said particles, and a facing layer integrally bonded on its inner side with said base, said facing layer being composed primarily of sand and cement and having molded therein a large number of relatively spaced transversely extending openings for the passage of sound energy through said facing layer.

3. A building unit of predetermined dimensions comprising a base composed of crushed substantially uniformly graded limestone particles and a cementitious binder permanently joining said particles to produce a homogeneous composition having throughout its structure a multitude of interstitial passages, cells or voids, and a facing layer having a smooth exterior surface integrally bonded at the time of manufacture of the unit with said base, said facing layer being composed primarily of sand and cement and having formed therein a large number of relatively spaced transversely extending openings for the transmission of sound to the sound absorbing interstices, cells and voids of said base.

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