

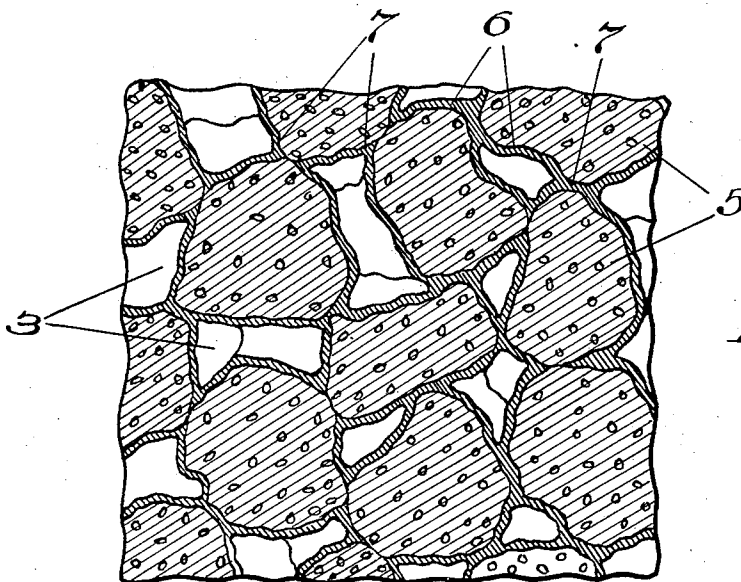
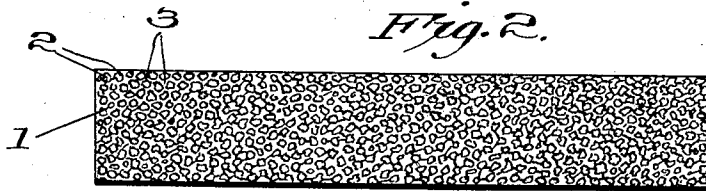
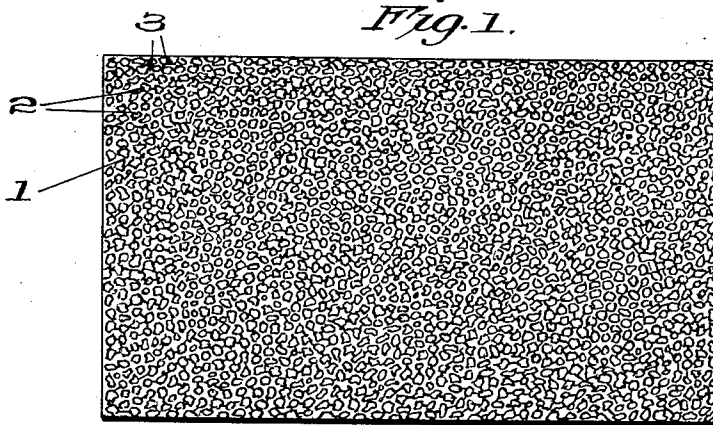
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E. T. HERMANN

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SOUND ABSORBING MATERIAL AND METHOD OF MAKING THE SAME

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INVENTOR.
Earnest T. Hermann,
BY *Arthur P. Knight and*
Alfred W. Knight
ATTORNEYS.

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SOUND ABSORBING MATERIAL AND
METHOD OF MAKING THE SAME

Earnest T. Hermann, Manhattan Beach, Calif.

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6 Claims. (Cl. 25—156)

This invention relates to sound absorbing or acoustic material, and particularly to material made in the form of tile, slabs, or blocks, adapted for covering walls and ceilings of rooms and having the property of largely absorbing sound waves striking the same, so as to minimize reflection of sound back into the room as well as transmission of sound therethrough. The invention includes not only a novel form of such material, but also a new and advantageous method of making the same.

The principal object of the invention is to produce shaped bodies of sound-absorbent material such as above described, which have a maximum sound absorption property, may be manufactured at relatively low cost, possess great mechanical strength and durability, are absolutely fireproof and not injured by heat, are unaffected by water or atmospheric conditions of any kind, and may be easily applied to the wall or ceiling to be covered thereby.

A particular object of the invention is to produce a sound-absorbing tile consisting wholly of mineral or inorganic materials and consequently non-combustible.

A further object of the invention is to produce such a sound-absorbing tile consisting wholly of mineral materials and of such nature that it is not weakened or injured in any way by the action of heat to which it may ordinarily be subjected in case of fire in the room or building in which it is placed.

A further object is to produce a sound-absorbing tile, of the type above described, provided substantially throughout with extensively intercommunicating voids opening through the surfaces thereof, or at least through the surface which is to be exposed when placed in position on the wall or ceiling.

A further object of the invention is to produce a sound-absorbing tile consisting of mineral particles of fairly uniform size, or within a certain range of sizes, bonded together by a ceramic bonding structure formed in place by the action of heat on fusible ceramic material, such ceramic bonding structure being present only in sufficient amount to coat the surfaces of the particles and secure adjacent particles together at their points of contact, while leaving the major portion of the voids between the particles free and unobstructed. The use of a ceramic bonding structure of this type provides great structural strength and protection against damage by fire, water, or atmospheric conditions, while leaving a sufficient intercommunicating porosity throughout the body of material to produce a maximum amount of sound absorption. Furthermore, a material of this type may be manufactured at low cost, both from the standpoint of cost of materials required and from the standpoint of the operations required in

the manufacture thereof. A particularly advantageous feature is that, in the heating or firing operation, only the thin glaze-like ceramic coating on the aggregate particles need be fired, so that a much less prolonged heat treatment is required than when the entire mass requires sintering throughout, as is the case with most ceramic tile or other ceramic material.

A further object of the invention is to provide a sound-absorbent tile for walls and ceilings, having advantageous properties of surface texture, color, and general appearance.

The sound-absorbing material of my invention comprises essentially a shaped body, which may be referred to as a tile, of any suitable size and shape and consisting of mineral particles, preferably of more or less uniform particle size, firmly bonded together by ceramic material of a glassy, glazed, or sintered nature confined substantially wholly to the surfaces of the particles and the junctures or points of contact therebetween, said body being provided substantially throughout with extensively intercommunicating voids or passages between the particles thus coated and bonded together.

The particles preferably consist of material of light weight and more or less porous or vesicular in itself, such as pumice, volcanic ash or bressia, or vesicular basaltic rock. The use of a material of this kind not only increases the sound-absorbent properties of the block or tile, but also minimizes the weight thereof. The invention is not necessarily restricted to these materials, but in its broader aspect includes the use of any mineral or inorganic particles having suitable strength and cohesion, and adapted to substantially retain their shape, size, strength and cohesion when heated to the temperature required for fusing or sintering the ceramic bonding material. For example, I may use crushed stone, granite, furnace slag, or any combinations of any two or more of the above mentioned mineral materials.

While I have stated that the particles are preferably of more or less uniform size, it will be understood that there is no definite limit of uniformity required. In general, the larger the particles the larger will be the voids therebetween. Furthermore, a material having relatively large particles and voids will be most efficient in absorbing sound of relatively low frequency or pitch, and a material having smaller particles and voids will be most efficient in absorbing sound of higher frequency or pitch. The most advantageous size of particle to be used in any particular case will, therefore, depend largely on the kind of sound, and particularly on the pitch of the sound, which is to be absorbed. For general use, where it is desired to absorb sounds of varying frequencies with approximately uniform efficiency, it will be found advantageous to provide some

variation in the size of the particles and consequently in the size of the voids. On the other hand, too great a variation in size is objectionable, for the reason that the smaller particles tend to fill up the voids between the larger particles and thus decrease the percentage of sound absorption. The particular sizes to be used in any case, and the breadth of range in size, should be determined by a consideration of the above factors in the order of their relative importance. In general, the use of mineral particles varying from a certain minimum size to from one and one-half to three times that size may be found satisfactory, and it will be seen, therefore, that extremely accurate screening is not required. For example, I may form a relatively fine grained tile using particles of from 16 to 40 mesh, a medium grained tile using particles of from 4 to 8 or from 6 to 12 mesh, or a relatively coarse grained tile using particles of from 2 to 4 mesh. The above figures, however, are given by way of example only and are not to be understood as limiting or defining the scope of my invention.

The ceramic bonding material, which coats the surfaces of the particles and secures the same together at their points of contact, may consist of any glassy, sintered, or glaze-like material, produced by fusion or incipient fusion of suitable glaze-forming or frit materials adapted to form a strong, coherent bonding structure. Such glaze-forming or frit materials may consist of natural silicates or other fusible earthy or mineral materials, or mixtures of any such materials, or artificial frits prepared by firing mixtures of such materials having the desired composition so as to form a frit having the proper fusion temperature.

An example of a ceramically-bonded, highly pervious, acoustic material made in accordance with my invention is illustrated in the accompanying drawing, and referring thereto:

Fig. 1 is a front elevation of an acoustic tile such as above described.

Fig. 2 is a side elevation thereof.

Fig. 3 is an enlarged cross section of a small portion of such a tile.

In Figs. 1 and 2 a sound-absorbent block or tile is indicated at 1, the surface layer of particles coated with ceramic bonding material being indicated at 2, with open voids or passages therebetween, as shown at 3. This gives a pleasing rough textured surface, which requires no further surface treatment of any kind. The appearance of the tile may be modified as to roughness of texture by selecting different sizes of particles, and may be modified as to color, either by using mineral aggregate particles which are either naturally or artificially colored, with a transparent or translucent glaze as a bonding agent, or by using a colored glaze or burned enamel as a bonding agent. The latter method is considered preferable, because of the ease of obtaining almost any desired color, with a glossy or lustrous appearance, and also because only the relatively thin coating of ceramic material need be colored in that case, thus reducing the amount of coloring material required. Furthermore, different colored glazes may be used as bonding agent on different tiles, or on different parts of the same tile, so as to give any desired mottled color effect.

The structure of the tile is better illustrated in the enlarged sectional view thereof shown in Fig. 3. The particles themselves, of pumice or other mineral aggregate, are indicated at 5. The ceramic bonding agent coats the surfaces of these

particles, as indicated at 6, and also bridges across between the particles adjacent the points of contact thereof, as at 7. Between the particles are the voids 3, which form continuous or intercommunicating passages extending through the thickness of the formed tile or body.

The method of making the above described acoustic tile comprises, in general, mixing the mineral particles or aggregate, graded to any desired size or range of sizes, with the bonding agent, consisting of a mixture of water or other suitable liquid with a suitable powdered or finely divided flux, frit, or other fusible material, and also preferably containing a small amount of temporary adhesive or binder, such as commonly used in the ceramic industry, for causing the bonding agent to stick together and to adhere to the surfaces of the particles; then molding or forming this mixture to the shape of the tile, block, or other body to be formed, and then burning or firing these formed bodies at a temperature sufficient to fuse the bonding agent, or at least bring the same to the point of incipient fusion, so as to cause the formation of a glaze or glass-like structure coating the surfaces of the particles and bonding the same together at their points of contact, without causing fusion or appreciable softening of the mineral particles themselves. By this method, therefore, the open or porous structure originally present in the body as formed or molded is maintained, while a ceramic bonding structure is produced having sufficient mechanical strength to impart the necessary strength to the finished product.

The fusible bonding agent may consist of any suitable material, or mixture of materials, adapted to fuse at a fairly high temperature but below the fusion point of the mineral aggregate particles, for example a temperature between 800 and 1200° C. The bonding agent, furthermore, should preferably have a coefficient of expansion approximately equal, or somewhat greater than, that of the aggregate material. For example, the coefficient of cubical expansion of pumice is approximately 2×10^{-5} per degree centigrade; when using this material as an aggregate, I prefer to use a bonding agent having a coefficient of cubical expansion between 2 and 4×10^{-5} . Such agent may be ground to any desired fineness and mixed with the water or other liquid and with gum tragacanth, glue, casein, or other suitable temporary binder in any suitable proportions, for example, 1 part of dry powdered bonding agent, 1 to 3 parts of water, and 1/20 to 1/10 part of adhesive or binder.

The resulting paste or wet mix containing the bonding agent is mixed with the mineral aggregate particles in any suitable proportions, for example, 1 part of actual fusible bonding agent therein to from 3 to 7 parts of mineral aggregate. In general, the proportion of bonding agent to aggregate should be sufficient to coat the surfaces of the aggregate particles and provide firm bonds therebetween, but should not exceed the amount actually required for this purpose, so as to leave the maximum amount of unobstructed, intercommunicating voids between the particles.

The temperature of firing will depend upon the bonding material used, but should be substantially, or somewhat above, the fusion temperature of such material and below the softening or fusion temperature of the aggregate particles, and the firing should be continued for a sufficient length of time to substantially completely fuse this material together as above described. I have found

that, in most cases, heating for about 10 or 15 minutes at the fusion temperature of the bonding material is sufficient, but it will be understood that the invention is not restricted to any particular time of heating. However, as above stated, the required time of heating is, in general, much less than would be the case if the entire mass of aggregate had to be fused or sintered throughout.

I will now describe two specific examples of the manufacture of ceramically bonded acoustic material according to my invention, using pumice particles as the mineral aggregate, but it will be understood that this description is by way of illustration only and that the invention is by no means restricted to the specific ingredients, proportions, temperatures, and other detailed factors given therein.

Example No. I

A raw flux was used as bonding agent, having a fusing temperature of about 1080° C. (cone 03). This flux consisted of the following ingredients:

	Percent
Feldspar	59.62
Whiting (calcium carbonate)	8.03
Zinc oxide	6.50
Kaolin	13.81
Flint	12.04

The above ingredients were mixed and ground to about 100 mesh, and the ground mixture was then mixed with water and gum tragacanth in the proportions of 100 parts of dry ingredients, 175 parts of water and 6 parts of gum tragacanth. This wet mixture was then thoroughly mixed with an aggregate consisting of pumice grains or particles graded to between 6 and 12 mesh. The proportion of the wet bonding mixture to the pumice was such as to provide one part of the dry ceramic bonding material above described by 5 parts of pumice by weight. The mixing may be effected by hand or in any suitable mixing apparatus adapted to effect uniform coating of the pumice particles by the wet bonding mixture without seriously crushing the pumice particles, and should be continued for a sufficient length of time to insure thorough and substantially uniform coating of all the pumice particles. The mixture was then placed in molds under slight pressure sufficient to cause the same to retain their shape when removed from the molds, and the shaped bodies were then removed from the molds and fired in a kiln at approximately 1080 to 1100° C. for about ten to fifteen minutes.

Example No. II

A frit was first prepared having a fusing point of 945 to 975° C. (cone 08-07). This frit was prepared from the following ingredients:

	Parts by weight
Borax	100
Soda ash	54
Potash feldspar	110
Flint	110
Salt peter	23
Fluorspar	13
Barium carbonate	25
Antimony oxide	25
Zinc oxide	25
Cryolite	25

These ingredients were mixed, ground to about

50 mesh, fused at 1200° C., broken up by dropping the same, while molten, into water, and then ground to about 100 mesh. 60 parts of this prepared and ground frit material were mixed with 10 parts of china clay, 150 parts of water and 4 parts of gum tragacanth, and the wet mixture was then mixed with 350 parts of pumice particles of from 6 to 12 mesh in size, molded as above described and burned at about 945 to 975° C. for ten or fifteen minutes.

As an example of the use of a coloring material to impart a color to the glaze or ceramic material coating the aggregate particles, a suitable coloring agent, such as cobalt oxide, may be added in any desired proportion, in making the second example above given, this particular agent imparting a bright blue color to the surface of the finished material.

I claim:

1. A sound-absorbent material comprising mineral particles bonded together by a ceramic bonding structure, said bonding structure being present only in sufficient amount to coat the surfaces of the particles and to form bonds between adjacent particles at the points of contact thereof while leaving the major portion of the voids between the particles free and unobstructed.

2. A sound-absorbing material comprising particles of vesicular mineral material bonded together by a fused bonding material coating the surfaces of the particles and providing bonds between adjacent particles at the points of contact thereof, said sound-absorbing material being provided throughout with extensively intercommunicating voids between said particles thus coated and bonded together.

3. A sound-absorbent material as set forth in claim 2, said coating of fused bonding material containing an agent imparting color thereto.

4. A sound-absorbing material comprising a shaped body consisting of mineral particles firmly bonded together by a fused bonding structure formed in place by the action of heat on fusible ceramic material and confined substantially wholly to the surfaces of the particles and the junctures therebetween, said body being provided substantially throughout with extensively intercommunicating voids between the particles thus coated and bonded together.

5. The method of making sound-absorbing material which comprises mixing a mineral aggregate with a fusible ceramic bonding material in only sufficient quantity to coat the particles of said aggregate, forming a shaped body from said mixture, and heating said body to a sufficient temperature to fuse said bonding material.

6. The method of making sound-absorbing material which comprises mixing a fusible bonding material in finely divided form with water, mixing said wet mixture with particles of mineral material, forming a shaped body from said mixture, and heating said body to a temperature sufficient to develop a ceramic bonding structure from said fusible material covering and bonding together the mineral particles, said mineral material being substantially infusible at said temperature and the bonding material being used only in sufficient proportion to provide the said bonding structure, while leaving substantially unobstructed and intercommunicating voids between the particles.

EARNEST T. HERMANN.