June 4, 1935. E. R. POWELL 2,003,309

LIGHTWEIGHT ARTICLE AND METHOD OF MANUFACTURING THE SAME

Filed Dec. 13, 1932

Fig. 1.

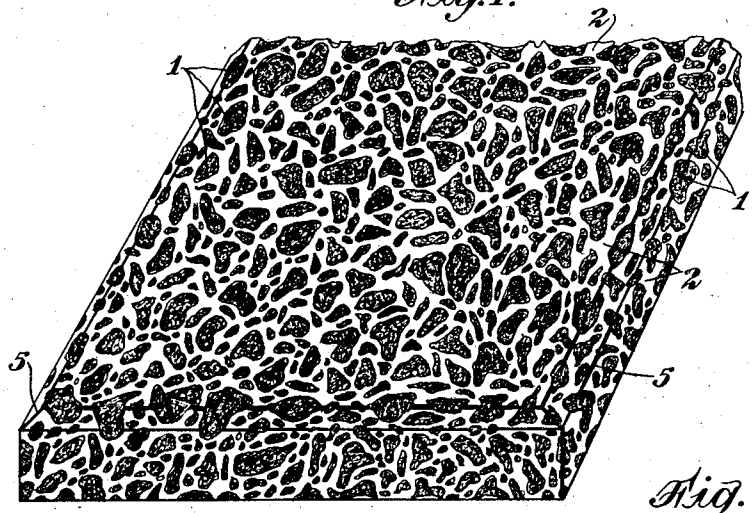


Fig. 2.

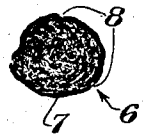


Fig. 3.

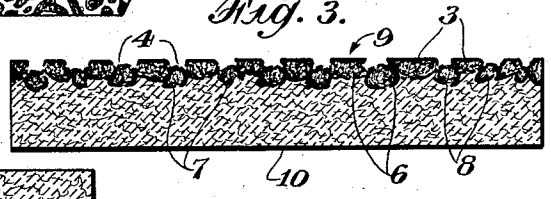


Fig. 4.

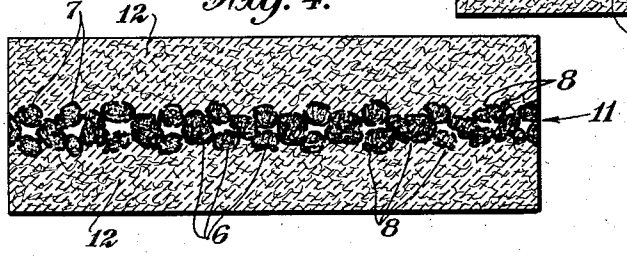
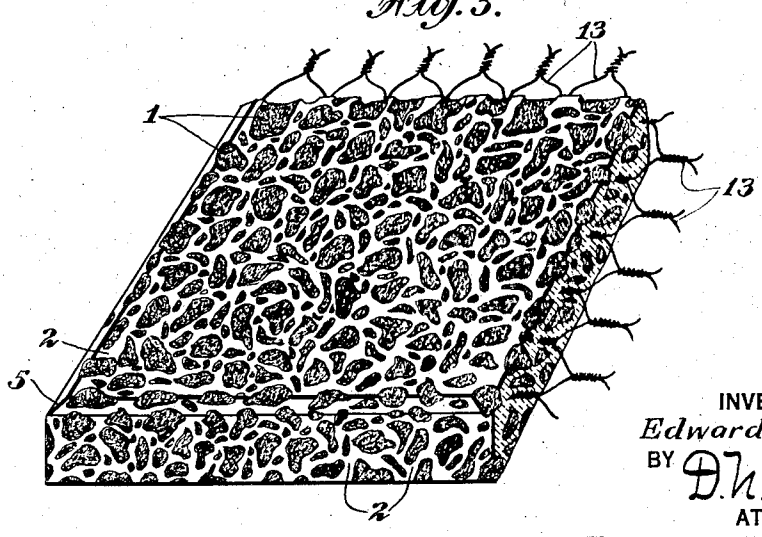


Fig. 5.



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LIGHTWEIGHT ARTICLE AND METHOD OF MANUFACTURING THE SAME

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19 Claims. (Cl. 25—156)

This invention relates to a lightweight article, particularly an acoustical and thermal insulating unit, and to the method of making the same.

The invention comprises the novel features hereinafter described or claimed and, especially, a shaped and fired article including void-containing aggregations of heat-resistant fibers, preferably well preserved, and bonding material disposed between the aggregations of fibers and adhering them into a shaped product, the binding material being one adapted initially to develop a ceramic bond on being fired to a temperature below the slagging point of the heat-resistant fibers. The invention comprises also the making of such a product by a method which includes forming nodules of heat-resistant fibers, such as rock wool, making a mixture of the nodules with an aqueous clay composition of relatively low vitrification point, as, for example, one containing clay and a small proportion of a flux or vitrification agent, shaping the mixture, and drying and firing the shaped product at a temperature adapted to cause vitrification of the clay composition but, advantageously, below the slagging point of the fibrous material used.

The invention is illustrated in the drawing in which:

Fig. 1 shows a perspective view of an article made in accordance with the present invention;

Fig. 2 shows a sectional view of a precoated nodule of heat-resistant fibers;

Fig. 3 shows a sectional view of an article of graded porosity; and

Fig. 4 shows a sectional view of an article of graded porosity which is adapted to be split in the middle, to provide an article of the type illustrated in Fig. 3.

Fig. 5 shows a perspective view, with parts broken away for clearness of illustration, of a portion of an article similar to that of Fig. 1 but provided with inner wire reenforcement.

In the various figures like reference characters denote like parts.

The articles illustrated contain heat-resistant fibers 1 and binding material 2, disposed between the fibers and adhering them into a unitary product.

The heat-resistant fibers may be mineral wool, such, for example, as rock wool or slag wool, and are preferably in the form of void-containing aggregations or clusters and well preserved in the finished products, that is, are not melted down, fused together, or slagged in the central portions of the said aggregations or clusters.

A fibrous material that has been found satisfactory is rock wool in the form of nodules. Such a material is available commercially or may be made by a conventional process, including melting and blowing an argillaceous limestone, cooling the fibers, forming them into small aggregations, as by passing a felt of the collected fibers between picker rolls, and then rolling the aggregations into more or less round shapes, by tumbling in a horizontal tumbler with screen walls. During the blowing operation a small proportion of an oil may be applied to the wool, to give a slightly oiled product.

The binder is the fired product of a composition that initially is adapted to undergo vitrification and develop a ceramic bond at a temperature below the slagging point of the fibrous material used. As a binder there has been used a composition comprising clay, suitably a clay of low vitrification temperature, such as a ball clay, a small proportion of bentonite, and/or a vitrification agent, by which is meant a flux or inorganic substance adapted to lower the vitrification temperature of clay, as, for example, borax, salt, sodium sulphate, or sodium silicate.

The product may be provided over a surface with a glaze 3. This glaze may be a conventional composition adapted initially to develop a ceramic bond within itself and also to become bonded ceramically to the body of the article at a temperature below the slagging point of the fibers. The glaze may be provided with openings 4 irregularly spaced, at close intervals, in such manner as to render the glaze readily permeable to incident sound. Thus, there has been made a glazed product in which the glaze covers approximately 75% of the face of the article, the other 25% being open and rendering the face sound-permeable.

The edges of the article may be beveled as shown at 5.

For certain purposes, as will appear hereinafter, the nodules 6 of fibrous material may be precoated with a clay composition 7. The coating may be provided with discontinuities or openings 8 adapted to admit incident sound to fibers inside the coating, say with cracks in the clay by baking.

For some purposes, it is desirable that the face of the finished product should contain nodules that are spaced relatively far apart and have a structure more open on the surface 9 than in the back portion 10. In making such an article, there may first be formed a double unit, as illustrated in Fig. 4, in which the porous portion 11, comprising the widely spaced nodules, is at the center

of the unit, and the less porous portions 12 constitute the outer portions; the double unit may then be split, as by being sawed through the center, to provide two units having each a very porous face portion.

For the purpose of reenforcing, the product may contain inwardly disposed reenforcing material 13, say chicken wire.

In general, the preferred method of manufacture comprises forming an aqueous mixture of the selected heat-resistant fibrous material with the binder composition; shaping the mixture and removing water therefrom, as by draining followed by drying at an elevated temperature; and then firing the product in such manner as to develop a ceramic bond and preserve the fibers. After being fired, the article may be finished in a usual manner, as by removing the surface portions, to shape and size the article to the desired dimensions.

This general method of manufacture is illustrated by the following specific examples.

All proportions are expressed herein as parts by weight.

Example I

Rock wool nodules are waterproofed by the application thereto of 2 parts of asphalt and petroleum wax, mixed in approximately equal proportions, for each 100 parts of the rock wool. The waterproofing composition may be applied in the form of a solution in a volatile solvent therefor and the volatile solvent then evaporated. The nodules are preferably of such size that they may be passed through a screen having 2 meshes to the linear inch, but, on the other hand, contain no substantial proportions of very fine, dust-like material.

To 60 parts of the thus waterproofed rock wool nodules there is added a fluid suspension of approximately 40 parts of clay in sufficient water to give to the mixture of the rock wool and clay suspension a consistency suitable for casting. The amount of water used may be 300 parts.

In mixing the rock wool and the clay suspension, rather gentle stirring is used, in order to avoid destroying the nodular form of the wool and also to minimize the penetration of clay particles within the nodules. The resulting mixture is shaped, say by casting into a mold with a filtering bottom and removable side and end walls. Some time is allowed for the excess water to be drained from the cast material, after which the cast and shaped article is exposed, as by removal of the side and end walls of the mold, and is subjected to further removal of water, as by drying at a temperature of approximately 200° F.

The shaped and dried article, separated from the screen bottom of the mold, is fired, in a kiln or other apparatus of suitable type, to a temperature of approximately 1500° F., say at a temperature which may vary from 1350° F. to 1600° F. The exact temperature to be selected depends, in part, upon the temperature required to develop sufficient vitrification and a satisfactory ceramic bond in the particular clay binder used, and, in part, upon the temperature above which the firing cannot be performed without slagging the rock wool fibers within the nodules. The time of firing at the selected maximum temperature may be no longer than necessary to develop the desired degree of vitrification of the clay.

By making the time of firing at the maximum temperature very short, it is possible to establish a temperature gradient throughout the article, in the final stage of the firing. Thus, the outside portion may be more thoroughly fired than the interior, whereby a relatively firm, strong exterior is produced with a relatively softer, less affected interior.

The fired article may be somewhat deformed or irregular in surface. It may be sized, and beveled by cutting wheels, in a conventional manner.

Example II

The procedure of Example I is followed, except that there is incorporated into the clay suspension 10 parts of bentonite for each 40 parts of clay. The bentonite serves to increase the plasticity of the initial binder composition and the strength after drying and to lower somewhat the vitrification temperature.

Example III

In this example the rock wool used is not especially waterproofed, but is the commercial, slightly oiled, nodulated product of size of nodules that pass a 2-mesh screen.

Of this wool 35 parts are mixed with a suspension containing 52 parts of Kentucky ball clay, 9 parts of bentonite, and 4 parts of sodium chloride (salt), in 175 parts of water. The product is shaped, dried, and fired as described above.

The resulting product has been found to weigh approximately 2 lbs. per board foot.

The salt may be substituted by other vitrification agents or fluxes, as, for example, those described.

The bentonite may be omitted if its function is not desired, in which case the binder composition as initially used would comprise clay and the vitrification agent.

An article made with such a binder composition as described in this example may be fired to a somewhat lower temperature than if the bentonite and/or vitrification agent are not present. If fired to a temperature which is sufficient to develop a satisfactory creamic bond in the absence of such vitrification agent, the present composition will give a firmer and stronger product than obtained, for instance, with the composition described in Example I.

Example IV

The procedure of any of the preceding examples is followed, with the exception that there is applied to a surface of the shaped article, a composition adapted to form a ceramic glaze and to be bonded ceramically to the said shaped article by firing. The glaze may be applied discontinuously over the surface, as by trowelling or rolling on, to leave low spots uncovered and provide areas which will provide entrance for sound incident upon the surface of the finished product. Or, the glaze may be applied over a stencil and the stencil removed, to provide spaced openings and a sound-permeable, glazed surface of the fired article. The article is fired after the glaze is applied.

Example V

The procedure of Examples I, II or III is followed, except that there is incorporated with the clay a selected proportion of comminuted diatomaceous earth, as, for example, 7 parts of high grade diatomaceous earth, in the form of a powder to 40 parts of clay.

Example VI

The procedure of Examples I, II, III or V may be followed, with the exception that the shaped article, either before or after firing, may be dipped in a solution of waterglass and subsequently dried or dried and fired to provide an outer reenforced surface comprising a substantial proportion of sodium silicate or its reaction product with other ingredients of the article.

Example VII

The article may be so made as to be initially of the type illustrated in Fig. 4, which, in turn, may be split into a product of the type illustrated in Fig. 3.

Thus, commercial nodules of rock wool, say of size to pass a 2-mesh screen, are sprayed with a thin aqueous clay slip while the nodules are being tumbled in a revolving drum with screen sides. The coated nodules are dried, finally, at a temperature above the boiling point of water, to dehydrate or bake the clay so that it will not plasticize quickly on being subsequently wetted with water. The coating on the nodules may be discontinuous and thus provided with openings adapted to admit incident sound to the interior of the nodules; the discontinuities may consist of cracks formed in the clay coating during drying, or of openings left in the original coating. There is then formed a composition comprising such precoated nodules and a limited proportion of a plastic clay and water mixture, to adhere the nodules into a very porous structure having relatively large spaces between the coated nodules.

There is formed also another composition of the type used for casting in Example I. This is cast as a layer into a mold, as described under Example I, and over this layer is spread a second layer of the first mentioned composition including the precoated nodules and plastic clay. Then another layer of the composition of type described in Example I is poured over this second layer, to form a structure in which the central portion 9 contains precoated nodules with just sufficient clay to bind the nodules together in a very porous structure and in which both the lower and the upper portions 10 contain a higher proportion of clay and a lesser proportion of pore space.

The block is then exposed and dried and is split approximately into two halves, the line of division passing through the very porous central portion. The split block is then finished.

In the finishing process, the split block may first be sprayed or otherwise lightly coated with a solution of sodium silicate containing, suitably, about 10 to 18 parts of sodium silicate, on the dry basis, to 100 parts of total solution. The silicated product is eventually fired, to give a product in which silicate serves to harden and reenforce the surface.

If it is desired to make a glazed product, the face is coated, suitably after sodium silicate is applied thereto, with a slip composition, which, when burned, will form a glaze. This glaze is preferably applied to the high spots or plateaus of the rough, highly porous surface, which, in the initial casting, constituted the central portion of the unit. When the glaze is applied over this rough surface, the glaze does not close the relatively large pore spaces between the nodules of rock wool but leaves openings therein. These openings are adapted to admit incident sound and, being irregularly spaced and of irregular shape and size, may resemble figurations of certain natural products.

In any case, the article is fired to develop a ceramic bond, as described under Example I.

Example VIII

The procedure of one of the other examples is followed except that reenforcing means are embedded in the unit at the time of the casting.

Thus, a piece of chicken wire 13 is placed in the mold to be used for the casting. The chicken wire is placed approximately parallel to the bottom of the mold and suitably spaced, as by being supported on turned down corners, about half way from the said bottom to the level in the mold that is to correspond to the top of the cast unit. The casting composition, as, for example, of type described under Example I, is then poured into the mold. The chicken wire becomes embedded therein, about midway from face to back of the cast unit. The unit is then treated and fired as described under Example I.

The reenforcing material should be strong after being subjected, in the unit, to the firing operation. Iron and nichrome netting are illustrative of suitable materials.

In the various examples, the materials specified may be substituted by other materials suitable for the purpose. Such a change may make desirable a compensating change, in some other condition, of kind that will be evident readily to one skilled in the art; thus, a somewhat smaller proportion of water may be used in the composition for casting, when the waterproofed rock wool is substituted for rock wool that is not waterproofed.

The properties of the product of the present invention have been indicated in part. They are lightweight and thermal insulating. While rigid, they are readily cut and sized, as by a cutting wheel. When the firing has been conducted carefully, at temperatures below the slagging point of the clusters of fibers used, the clusters of fibers in the finished product are well preserved, that is, fibrous and more or less soft. When, on the other hand, the firing has been conducted to a temperature above that at which the fibers are badly slagged, then the fibers may be more or less fused or bonded to other ingredients of the composition and are not well preserved in the sense in which that term is used herein. Except under the severe conditions of firing or treatment, the aggregations of fibers retain their voids in the finished product and are absorbers of sound which is incident upon the said aggregations.

The details that have been given are for the purpose of illustration, not restriction, and many variations therefrom may be made without departing from the spirit and scope of the invention.

What I claim is:

1. An article of manufacture comprising sound-permeable clusters of well preserved, heat-resistant fibers and ceramic bonding material disposed between the clusters and adhering them into a unitary product.

2. An article of manufacture comprising clusters of well preserved mineral wool fibers and ceramic bonding material, including the fired product of clay and an admixed vitrification agent, disposed between the clusters and adhering them into a unitary product.

3. A lightweight article of manufacture comprising a body portion including a ceramic bond-

ing material and heat-resistant fibers and a facing layer including a ceramic glaze integrally bonded to the body portion.

4. An article of manufacture adapted to absorb incident sound and comprising a body portion, including a ceramic bonding material and heat-resistant, fibrous clusters, and a sound-permeable, discontinuous facing layer integrally bonded to the body portion.

5. A fired article of manufacture comprising heat-resistant fibers, diatomaceous earth, and a ceramic bonding material adhering the whole into a unitary product.

6. A sound-absorbing unit comprising a body portion, including heat-resistant fibers and a ceramic material disposed between the fibers and bonding them together into a porous layer, and a facing portion ceramically bonded to the body portion and including heat-resistant fibers and a ceramic material disposed between the fibers and bonding them into a porous, sound-permeable facing layer, the proportion of bonding material being less and the degree of porosity being higher in the facing than in the body portion.

7. A sound-absorbing unit comprising a body portion, including heat-resistant fibers and a ceramic material disposed between the fibers and bonding them into a porous layer, and a facing portion ceramically bonded to the body portion and including preformed, discontinuously precoated nodules of heat-resistant fibers and ceramic material in limited quantity disposed between the nodules and bonding them into a porous, sound-permeable layer.

8. An article of manufacture comprising nodules of fibrous material and a dehydrated coating, including clay, disposed around and upon the nodules.

9. A fired article of manufacture comprising heat-resistant fibers, a ceramic bonding material disposed between the fibers and adhering them into a unit, and reenforcing means embedded within the unit.

10. In making an article comprising ceramically bonded fibers, the method which includes forming an aqueous mixture of heat-resistant fibers with a binder containing clay, shaping the mixture, removing water therefrom, and then firing the product at a temperature adapted to cause vitrification of the binder but below the temperature of slagging of the fibers.

11. In making an article comprising ceramically bonded fibers, the method which includes forming an aqueous mixture of heat-resistant fibers with a binder containing clay and an admixed vitrification agent adapted to lower the temperature of vitrification of the clay, shaping the mixture, and drying and firing the shaped product at a temperature adapted to cause vitrification of the binder but below the temperature of melting of the fibers.

12. In making an article comprising ceramically bonded fibers, the method which includes forming an aqueous mixture of heat-resistant fibers with a binder containing clay and an admixed vitrification agent adapted to lower the temperature of vitrification of the clay, shaping the mixture, removing water therefrom, and then firing the product at a temperature of approximately 1500° F.

13. In making an article comprising ceramically bonded fibers, the method which includes forming an aqueous mixture of heat-resistant fibers with a binder adapted to develop a ceramic bond on being fired, shaping, drying, and then firing the product to a selected maximum temperature, the said firing at the maximum temperature being continued for a limited period of time whereby a temperature gradient is set up in the said product in the final stage of firing and the outer portions thereof are fired to a higher temperature than the interior portion.

14. In making an article of manufacture comprising ceramically bonded nodules of rock wool fibers, the method which includes forming clay and a vitrification agent into a binder composition, forming an aqueous mixture of waterproofed nodules of rock wool and the binder composition, shaping the mixture, and drying and firing the product to develop a ceramic bond therein.

15. In making an article of manufacture comprising ceramically bonded, rock wool fibers, the method which includes forming an aqueous mixture of rock wool and a composition containing clay, shaping the mixture, applying to a face of the shaped mixture a material adapted to form a ceramic glaze on being fired, and drying and firing the thus treated product at a temperature adapted to cause vitrification of the said clay and glaze.

16. In making a glazed, lightweight article, the method which comprises forming an aqueous mixture including a binder composition adapted to be hardened by being fired and clusters of void-containing, heat-resistant fibers, shaping the mixture, applying to a face of the shaped mixture a coating of sodium silicate and then a composition adapted to form a ceramic glaze on being fired, and drying and firing the shaped and thus treated product at a temperature adapted to cause vitrification of the binder composition and the glaze.

17. In making a glazed, lightweight article, the method which comprises forming an aqueous mixture including a binder composition adapted to be hardened by being fired, and clusters of void-containing, heat-resistant fibers, shaping the mixture, applying discontinuously to a face of the shaped mixture a composition adapted to form a ceramic glaze on being fired, and drying and firing the shaped and thus treated mixture at a temperature adapted to cause vitrification of the binder composition and the glaze but below the slagging point of the fibers.

18. In making an article of manufacture comprising a ceramic binder and void-containing clusters of fibers, the method which includes forming nodules of the heat-resistant fibers, coating the nodules with a composition containing clay, drying the coated nodules at an elevated temperature to bake the coating thereon, forming a composition including the baked nodules and a limited proportion of an aqueous clay mixture, to render the outer surfaces of the nodules adherent and preserve the voids within the nodules, and drying and firing the said composition at a temperature adapted to cause vitrification of the clay but below the slagging point of the fibers.

19. The method of making coated nodules of heat-resistant fibers which includes applying to the outer surface of the nodules an aqueous, fluid composition including clay, then removing excess water from the composition, and subjecting the coated particles to an elevated temperature to dehydrate the clay.

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