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MOLDED PRODUCT AND PROCESS FOR ITS MANUFACTURE.

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The present invention relates to a porous molded material, suited to many uses and made from a mixture of a filler and a binder which puffs into a porous rigid coherent mass under the action of heat.

It is the object of the present invention to produce a molded product that shall be strong, light in weight, cheap in cost, and shall have a very high porosity, and consequently, a low thermal conductivity. In its preferred embodiment, the product disclosed herein is non-combustible, and all of the products disclosed herein are heat resisting at moderate temperatures.

Heat insulation made in accordance with the present invention may be shaped in the form of bricks, and used as linings for furnaces, or may be molded into special form for lining dental furnaces, and such gas heated furnaces as are used by tinners, or may be specially shaped to fit around steam and hot water pipes. The material can also be used with advantage in the construction of buildings, for in the form of flat slabs it can be put between the studding to serve in place of back plaster. It can also be used in sheets or blocks, to form a wall or ceiling over which a layer of plaster or hard finish may be applied. Similarly it may be used as the exposed surface of the wall, and before or after attachment to the studding may be decorated with enamel, paint, calcimine, or the like. Other uses of the material are hereinafter mentioned.

In order to obtain a product having the desired properties, we have sought for a binder, intumescent under the action of heat, to the end that the product shall be light and porous, and yet a binder, which, when incorporated with a filler, and heated shall be transformed into a rigid coherent mass. We have discovered that when a soluble silicate of proper viscosity, such as sodium silicate, is mixed in proper parts by weight with a filler and subjected to the action of heat, the mass expands or puffs up and ultimately hardens into a firm strong body. Other intumescent materials such as hide glue and corn starch may be similarly used. The expansion or puffing of the mass is preferably restricted, as in a mold, otherwise, the expansion is likely to proceed so far that the resultant product will be too light and frothy to accomplish the ends now desired by us, and take no definite form.

The density and the physical characteristics of an insulator made from such material by the application of heat in a mold will depend on several factors as for example, in part on the relative percentages of silicate and filler, in part on the size of the mold with respect to the amount of raw material put in for heat treatment, in part on the physical and chemical characteristics of the filler and the silicate, and in part on the amount of heat used. By suitable control of these factors a wide range may be obtained in the physical characteristics of the product, though all of the products embraced in the present application are relatively light in weight, are of high porosity, and of low thermal conductivity. As a filler we have had lowest apparent density in the finished product with coal ashes, and with kieselguhr, or mixtures of these. This is due in part to the light weight of either of these materials, and may be due in part to some chemical union between the silicate and the filler during the heat treatment, and the resultant liberation of water from the silicate. Good results can also be had with other mineral fillers, such as crushed limestone, blast furnace slag, or a slag of any other kind, slate, dolomite, kaolin, bauxite, asbestos, either fibrous or powdered, various clays, slag wool, or powdered silica, ochre, tripoli, volcanic ash, pumice, or mixtures of these with one another or with ashes or kieselguhr. Illustrative proportions are given below.

Instead of using a filler that is entirely of mineral origin, there may be incorporated in the mixture, before heat treatment thereof, organic materials, such as wood flour, wood pulp, cork, sawdust, charcoal or wood slivers, or shredded bark. Such organic materials may be used to alter the properties to the degree desired. For certain purposes the filler may be entirely of organic origin.

By way of illustration we give below detailed instructions for proceeding in accordance with the method of the present invention.

An alkali silicate, such as sodium silicate, having a density of about 42.5° Bé. is intimately mixed as in a mixer with a filler to

form a dough having a consistency about like that of putty. The amount of filler varies with its character, for example in using dolomite the filler constitutes about 60% of the weight of the wet mix, while in using kieselguhr or sifted coal ashes, the filler constitutes only 20% of the weight of the wet mix. The dough or mix thus formed is then introduced into the mold, the volume of which should be from about two to eight times the volume of the batch introduced. The mold may advantageously be of iron with the surface greased to prevent adhesion of the dough, though provision must be made for the escape of steam. When the batch is heated, the mold must be of such shape and so arranged that no great loss of material will occur through excessive puffing or frothing of the batch.

The next step consists in heating the mold to produce expansion of the batch. An advantageous arrangement is to have the mold walls hollow and steam tight, and to heat them with steam at a pressure of about 100 lbs. This gives a temperature of about 170° C. where the surface of the mold contacts with the batch. The application of heat of about that temperature causes the dough to puff up until it fills the entire mold. During this heating and expanding process water is driven off from the mixture, and the silicate undergoes a physical change, and there may even be a chemical reaction between the silicate and the filler. In any event, after about ten to thirty minutes, when making boards about ⅜" thick, the dough has puffed up sufficiently, and sufficient moisture has been driven off so that the dough sets in the expanded form and may be taken out of the mold. When making thicker products, such as bricks, a longer heating period would be required. In the production of insulating brick, furnace linings and similar thick materials, the mold may advantageously be heated to higher temperatures—even to a red heat to produce the desired material. A certain amount of the dough may push out through vent holes of the mold, but for the most part the batch remains within the mold and takes on a physical structure with an enormous number of small air cells or pockets distributed in substantially uniform manner throughout the molded article. In cross section the finished product is not unlike in appearance the cross section of a loaf of bread.

As explained at length in our companion application, Serial No. 720,510, filed concurrently herewith, the mold may consist of flat steam heated platens of large dimensions to produce a flat sheet of the puffed silicate mixture, and may be spaced from the mixture by sheets of paper which become attached to the batch when it expands and ultimately serve as the front and rear surfaces of the finished plates, or panels. Such panels are well adapted for use as wallboards as explained in said copending application.

A molded article made from sodium silicate and sifted coal ashes as above described weighs about 30 to 40 lbs. per cu. ft. Of its total volume about 60 to 70% is composed of air spaces or cavities. Such a molded material is especially well suited for use in furnace and building construction. As above indicated, the physical characteristics of the final product will vary with the nature of the filler. Using 2.7 parts by weight of sodium silicate of 42.5° Bé., 4.0 parts of finely ground dolomite, then mixing to a stiff dough, there may be produced, after heat treatment, a strong product weighing 45.0 lbs. per cu. ft. By increasing the proportion of dolomite a heavier product will result. Thus by adding 6.0 parts of dolomite in the mix indicated, a product weighing 62½ lbs. per cu. ft. may be made. It is not advantageous to make a denser product. Sodium silicate and dolomite alone make a strong heavy product, while sodium silicate and kieselguhr or coal ashes make a lighter but weaker product. By using a mixture of kieselguhr and dolomite as the filler a product can be made with characteristics anywhere between these limits. 50 parts of silicate and 50 parts of fire clay is suitable for the formation of bricks useful for furnace work. When bauxite is used as the filler the brick is heavier, and has the appearance of greater solidity then when ashes or kieselguhr are used. With any of the mineral mixtures as above described by way of illustration, fibrous material may be added up to 5% by weight of the batch.

When an organic material, such as wood fiber is present, care must be taken during the heating operation that the temperature does not exceed the carbonization point of the organic material. A temperature below 150° C. is safe for cellulose fibers. When fibrous asbestos is used as an addition to the batch, the puffing temperature may safely be higher.

Although we have found that a silicate solution of 42.5° Bé. gives satisfactory results, it is quite possible to use a solution of lower viscosity. In that event, however, it would be necessary to prolong the heat treatment in order to drive off sufficient water to raise the viscosity of the solution before puffing begins.

We have found that a soap, such as sodium resinate, stearate and the like, or material such as oleic acid which will be saponified by the silicate, can be advantageously added to the batch, for controlling the size and distribution of the air bubbles or cavities. For instance, with a mixture of

sodium silicate and ashes in about equal parts by weight there may be added soap to the extent of less than one-half of one percent by weight. This soap addition makes the bubbles smaller, but more numerous, and reduces the apparent density of the finished product. Presumably these holes or cavities represent spaces where steam was trapped in the mix during the puffing procedure.

We have found the following batch to give excellent results, the percentage given being parts by weight:—

39%—42.5° Bé. sodium silicate solution.
58%—powdered dolomite.
2.9%—fine. sawdust.
0.1%—sodium oleate.

Dolomite, which consists essentially of calcium and magnesium carbonates in varying proportions up to about 55% and 45% respectively, is widely distributed throughout the United States, and is available in large quantities and low cost in the State of Illinois and in neighboring States. (See Bulletin 46 of the State Geological Survey of Illinois entitled "Lime Stone Resources of Illinois.")

A molded form, as above, described, particularly in the form of blocks, plates, or sheets, can be sawed and handled much as plaster board or gypsum board is handled, and has the advantage thereover that it is lighter in weight and far more porous in structure. Nails may be driven through it, as when the sheets are nailed to the studding of the house, without destructive chipping. Not only is the material of low conductivity for heat and sound, but it has a low moisture absorption co-efficient. It can be effectively waterproofed if desired, as explained in our copending application Serial No. 720,510. When used as the exposed surface of a wall or ceiling, it can advantageously be given a coat of priming or sizing, partly to fill in the surface pores, and partly to give better adhesion for decorative coats of paint or calcimine. Pleasing surface effects may be obtained by applying an air drying enamel, or equivalent dressing, of relatively thick body.

We claim:—

1. A porous molded product comprising a mixture of intumescent binder, a filler, and a soap, puffed by heat to a rigid mass.

2. A porous molded product comprising a mixture of an intumescent binder, dolomite, and a soap, puffed by heat to a rigid mass.

3. A porous molded product comprising a mixture of alkali silicate, crushed dolomite, and a soap, puffed by heat to a highly porous rigid mass, substantially as described.

4. A porous molded product comprising a mixture of an alkali silicate, a filler, and a soap, puffed by heat to a rigid mass.

5. A porous molded product comprising a mixture of alkali silicate, a mineral filler, and sodium oleate, puffed and hardened by heat.

6. A porous sheet consisting essentially of a sodium silicate and a mineral filler, puffed by heat in a mold and having a surface dressing of enamel.

7. A porous molded product comprising a mixture of an alkali silicate and from 20% to 70% of a mineral filler based on the wet weight of the mixture, puffed by heat to a rigid mass.

8. A block consisting essentially of alkali silicate, kieselguhr, a fibrous binder and sodium oleate, puffed by heat in a mold, and having small air pockets distributed throughout the mass.

9. A porous molded product consisting essentially of alkali silicate and kieselguhr, the kieselguhr being about 20% of the weight of the wet mixture and puffed by heat to a rigid mass with air pockets distributed throughout the mass.

10. A molded product comprising a mixture in parts by weight of 39%—42.5 Bé. sodium silicate solution, 58%—powdered dolomite, 2.9%—fine sawdust, 0.1%—sodium oleate, puffed by heat to a porous body.

11. The process which comprises mixing an intumescent binder with a filler, introducing the batch so formed into a mold and there rapidly heating it until the material puffs to a porous coherent product.

12. The process which comprises mixing an alkali silicate with a filler, introducing the batch so formed into a mold and there rapidly and continuously heating it until the material puffs to a porous coherent product.

13. The process which consists in mixing an alkali silicate with a filler, introducing the batch so formed into a mold, and there rapidly heating until the material puffs to a weight less than 62½ lbs. per cu. ft.

14. The process which consists in mixing a silicate with a filler in about equal proportions, introducing the batch so formed into a mold, and there rapidly heating until the material puffs to a weight less than 62½ lbs. per cu. ft.

15. The process which consists in mixing an alkali silicate with a mineral filler, introducing the batch so formed into a mold, and there heating at about 170° C. until the material puffs and hardens to a rigid porous mass.

16. The process which consists in mixing an alkali silicate with a filler to form a batch of dough-like consistency, introducing the batch into a mold and heating at about 170° C. for about 30 minutes to puff and harden the batch.

17. The process which consists in mixing an alkali silicate with a mineral filler to form a batch of dough like consistency, in-

troducing the batch into a mold and heating at about 170° C. for about 30 minutes to puff and harden the batch.

18. The process which consists in intimately mixing an alkali silicate with a filler and a soap, introducing the batch so formed into a mold and heating to puff and harden the batch.

19. The process which consists in mixing an alkali silicate with kieselguhr and a fraction of one percent by weight of sodium oleate to form a doughy batch, introducing the batch into a mold and there heating until the batch puffs and hardens to a porous mass; substantially as described.

20. The process which consists in intimately mixing 4 parts alkali silicate with about 1 part kieselguhr by weight, adding a fraction of one percent by weight of sodium oleate, mixing the batch to a doughy consistency, introducing it into a metal mold and there heating at about 170° C. for about thirty minutes to puff and harden said dough.

21. The process which comprises intimately mixing substantially 39 parts by weight of 42.5 Bé. sodium silicate solution, 58 parts by weight powdered dolomite, 2.9 parts by weight fine sawdust and 0.1 part by weight sodium oleate, mixing the batch to doughy consistency, introducing it into a mold and there heating it at about 170° C. for about thirty minutes to puff and harden said dough.

22. The process which comprises mixing an alkali silicate with a filler, introducing the batch so formed into a metal mold having greased faces, and there heating it until the material puffs to a porous coherent product.

23. A molded product comprising a mixture of hide glue and a filler, puffed by heat to a highly porous body.

In testimony whereof we affix our signatures.

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