The present invention relates to a novel support for electric heating elements and its method of preparation; and more particularly it relates to a support for high resistance conductors comprising commercial asbestos millboard treated to improve its electrical resistance, heat resistance, flexural strength, hardness, and finish.

In electrical appliances, where heat is generated, such as for example toaster, heaters, and the like, it is necessary to support the heat-supplying current-carrying resistance elements on a material capable of supporting the same and of sufficient resistance to prevent the passage of current from the current-carrying heating elements to the non-current-carrying metal parts of the appliance. It is also necessary that the support possess sufficiently low thermal conductivity to prevent undue loss of heat from the area intended to get the full benefit of the heat. In toasters, for example, the current-carrying heating wire is wound back and forth across one face of a sheet- or board-shaped support, spaced projections on both vertical edges of the support serving to hold each 180° bend in the wire. The support in turn is secured to the body of the toaster. In such appliances, the winding support must be of sufficient strength and hardness to provide a rigid construction and to withstand bending and crushing and other abuses encountered in the manufacture and use of such appliances, and, as stated, it must also possess high electrical-resistance and low thermal conductivity.

Hitherto, supports for electrical resistance heating wires have been made of such materials as mica or ceramic-ware. However, these materials are very expensive and when the area needed to support the heating wires is large, the cost of providing supports of mica or ceramic materials becomes prohibitive. Commercial asbestos millboard has certain characteristics that would make it appear to be suitable for the purpose of supporting heating wires since it is somewhat rigid, may be cut into desired shapes, and is relatively inexpensive. It was found, however, that commercial asbestos millboard lacks the flexural strength and hardness desired for this purpose. In addition, it was found that the inherent hygroscopicity of the millboard, or, more particularly, of certain materials in the millboard, seriously reduces its electrical resistance properties in moist or humid atmospheres. In other words, moisture is absorbed by the millboard causing electrical leakage to occur from the current-carrying heating elements through the support to the non-current carrying metal parts of the appliance, resulting in the possibility of electric shocks to the user of the appliance. Although this condition exists only until the heat generated by the heating element dries out the absorbed moisture, nevertheless the danger of electric shock reappears after each period of non-use, and the electrical leakage is of such a degree that the appliances fail to pass the prescribed tests of acceptance and approval organizations, such as the Underwriter’s Laboratories.

An object of the present invention, therefore, is to provide an inexpensive material of high electrical-resistance, high flexural strength, hardness, and low thermal conductivity, even under humid atmospheric conditions, ideally suited as a support for electrical resistance heating elements.

Another object is to provide a treated commercial asbestos millboard of improved electrical- and heat-resistance properties.

Still another object is to provide a treated commercial asbestos millboard incapable of absorbing atmospheric moisture, as compared to the untreated millboard, while possessing greater flexural strength and hardness.

A further object is to provide a simple method of treating an ordinarily hygroscopic commercial asbestos millboard to convert it into a heat-stable, non-hygroscopic composition possessing high electrical- and heat-insulating properties, high flexural strength and hardness even under humid or moist atmospheric conditions, and an improved finish.

Further objects will be apparent from a consideration of the following specification and claims.

In accordance with the present invention, a commercial asbestos millboard, containing as the main binding materials sodium silicate and calcium compounds selected from the group consisting of lime and calcium carbonate, is impregnated with an aqueous solution of orthophosphoric acid capable of converting the calcium compounds in the millboard into heat-stable, non-hygroscopic calcium phosphate and of simultaneously converting the sodium silicate in the millboard into silicic acid. The porous millboard readily absorbs the solution and thus becomes thoroughly impregnated within a matter of a few seconds. The wet millboard is then dried, preferably at an elevated temperature, to remove moisture and other volatile substances. The millboard by this treatment has had the already thoroughly dispersed hydrated lime and/or calcium carbonate and sodium silicate binders, both on or near the
surfaces of the millboard and internally, converted, in situ, into non-hygroscopic compounds, namely into calcium phosphate and at least partially dehydrated silicic acid.

Referring to the asbestos millboard treated in accordance with the present invention, it is generally prepared by water-laying a suspension comprising asbestos fibers and binding materials, such as lime and sodium silicate, to form an interfelted web. This web is subsequently rolled and dried to form a rigid board, or sheet-like structure known commercially as asbestos millboard. The lime in the dried board gradually becomes converted by the carbon dioxide in the air to calcium carbonate, which then serves as part of the binding medium. In the treatment of the present invention, it is immaterial whether some or all of the lime has been converted to calcium carbonate or not, since the treatment will convert either the hydroxide or carbonate of calcium into non-hygroscopic, heat-stable calcium phosphate. Other materials such as fillers and other binders such as lignin and clays may also be present.

The important feature is, however, the presence of asbestos fibers, and of sodium silicate and calcium compounds, such as calcium carbonate and calcium hydroxide, as the main binding materials; the former to provide heat- and electrical-resistance properties, and the calcium compounds and sodium silicate for subsequent reaction with the phosphoric acid.

Such asbestos millboards generally vary in thickness over a wide range, such as from a few hundredths of an inch to several tenths of an inch in thickness or higher. For the purposes of the present invention, however, asbestos millboards in the lower range of thicknesses are most suitable such as those ranging from about 0.05" to about 0.2". Preferably, the millboard is stamped, pressed, or otherwise cut to its ultimate or final shape as a support prior to the present treatment, since then the ragged or frayed edges resulting from the cutting will become closely bound to the surface, by the treatment, and will present a smoother finish. However, the millboard as it is marketed, or in the smaller sizes, may also be treated in accordance with the present invention after which it may be cut to its ultimate form. The term “millboard” will be understood to mean, therefore, the material either in the shape ultimately to be used as a support or in any stage of cutting from the millboard as marketed to the ultimate or final shape.

As stated, the above-mentioned millboard is treated with an aqueous solution of ortho phosphoric acid capable of converting calcium compounds in the millboard, such as calcium hydroxide and calcium carbonate, into heat-stable, non-hygroscopic calcium phosphate, and of converting sodium silicate into siliceous acid. Since the acid will be in excess, tricalcium phosphate will be formed. As the phosphoric acid reacts with the lime only, or in smaller sizes, the insoluble calcium phosphate precipitates and, together with the precipitated silicic acid, fills the pores of the millboard. The flexural strength and hardness of the board when dried are thus increased; the surface finish of the board is improved; and a smooth relatively porous product is converted into one of markedly decreased permeability.

As stated, the treating acid is in the form of an aqueous solution. While solutions of any desired concentrations may be used, generally solutions containing between about 50% and 10% of the acid by weight are employed, preferably between about 35% and about 15% by weight. The acid-treating solution may be at any temperature below its boiling form, for example, between about 60 °F. and 90 °F. At these ordinary temperatures, the reaction between the acid and the calcium compounds and sodium silicate takes place upon impregnation of the solution into the board, and, therefore, while elevated temperatures may hasten the reaction somewhat, their use is not necessary.

In treating the commercial asbestos millboard, the acid solution, the solution is allowed to thoroughly impregnate the board. This may be brought about by spraying; however, dipping or immersing the millboard in the acid solution is the preferred method. The porous absorbent nature of the millboard allow it to readily take up the solution, becoming thoroughly impregnated or saturated with it in a very short time.

The acid thus contacts the thoroughly and uniformly dispersed sodium silicate and calcium hydroxide and/or calcium carbonate binding agents, reacting therewith to convert the silicate and at substantially the same time, silicic acid on the one hand and non-hygroscopic, heat-stable calcium phosphate on the other. These reaction products, being formed and precipitated in situ and substantially simultaneously from compounds already thoroughly and uniformly dispersed throughout the structure of the millboard, are themselves thoroughly and uniformly dispersed therein to form, when dried, a composition bonded with the heat-stable and non-hygroscopic compounds.

Once the millboard has become impregnated with the acid solution, it may be removed from the treating zone, drained, and dried. While the wet millboard may be dried at ordinary temperatures, at least the major portion of the drying is preferably carried out at elevated temperatures, such as 212 °F. In the preferred embodiment, the wet millboard is allowed to drain at ordinary temperature, in a draft, until liquid ceases to drip from the board. The board is then placed in a heating zone such as an oven and heated not only to quickly expel moisture and other volatiles, but also to convert the silicic acid into less hydrated forms of silica by splitting off water. The elevated temperature employed in this case is usually above the boiling point of water and may be as high as 1200 °F., and is preferably between about 400 °F. and 500 °F. The time required to dry the wet millboard depends upon the thickness and nature of the millboard as well as the temperature employed. No difficulty is encountered in adjusting the proper time-temperature conditions. For example, a saturated millboard of approximately 0.075 inch in thickness, after draining, is satisfactorily dried at about 450 °F. in about thirty minutes.

During the drying step, whether it is conducted at room or at an elevated temperature, the moisture in the treated board, and the resulting silicic acid product in the board is termed herein “at least partially dehydrated silicic acid.” Preferably, the drying step will be conducted at a temperature above 212 °F., not only to shorten the drying time, but also to convert the silicic acid into silica or a
slightly hydrated form thereof, both of which are included herein in the term "silica." In the event the drying operation does not convert the silicic acid into silica, the heat generated by the electric resistance elements during the inspection tests or initial use of the appliance is sufficient to do so.

It has been found that the wet millboard, during drying, tends to bend or warp. In many instances, it is necessary that the support present a flat or plane surface, either when positioned vertically or horizontally or otherwise. Therefore, it is desirable to secure the wet millboard in such a position, during drying, as to prevent warping or to keep warping at a minimum. Suitable supporting frames or other means of maintaining the millboard in a flat position, such as clamps, are, therefore, preferably employed during the drying of the wet millboard.

In the event the millboard has not been cut to the form or shape ultimately to be used as the winding support for electrical-resistance heating elements, previous to the treatment of the present invention, or for that matter at any time during the treatment, the dried millboard may be readily stapled, pasted, or cut into any desired shape. As stated, however, the millboard is preferably cut into its ultimate or final form as a support prior to the treatment of the present invention since the cut edges will present a smoother and more closely bound finish as compared to frayed or ragged edges of a dried millboard cut after the treatment.

The product of the present invention is thus a winding support for electrical-resistance heating elements in sheet- or board-like form cut in any desired pattern. The support comprises water-laid asbestos fibres bound in a thoroughly and uniformly dispersed mixture of non-hygroscopic, heat-stable calcium phosphate and at least partially dehydrated silicic acid. The product is light, relatively inexpensive, and possesses markedly improved hardness and flexural strength and a smoother, harder finish as compared to the untreated commercial asbestos millboard from which it is produced. Of prime importance, however, is the fact that the tendency of the treated millboard to absorb atmospheric moisture is negligible, resulting in its correspondingly high electrical-resistance and low thermal conductivity even under moist or humid atmospheric conditions. Furthermore, in the preferred embodiment of the invention, the edges are not ragged and uneven, as are those of the untreated millboard. It will, therefore, be seen that, by the relatively simple process of the present invention, a material of little value from the standpoint of suitability as a support for electrical-resistance heating elements has been converted into a material highly suited for that purpose.

The following example is given to illustrate the process of the present invention and the resulting product, and is not intended to limit the scope of the invention in any way.

**Example**

From commercial asbestos millboard, 0.075 inch in thickness were cut pieces in shapes adapted to the electrical-resistance heating wires in an automatic toaster. The pieces were immersed in a solution composed of 25% by volume of a 75% solution of orthophosphoric acid and 75% by volume of water, for 10 minutes. The pieces were then drained at atmospheric temperature in a blower draft for 10 minutes. After draining, the pieces were secured on racks and the racks were placed in an oven where the pieces were subjected to circulating air at a temperature of 400° F. for 30 minutes. The resulting dried products exhibited a smooth, hard, somewhat glossy surface. The flexural strength of the product was almost four times as great as that of the untreated millboard. The product when subjected to the same humid atmospheric conditions as the untreated asbestos millboard for a 24-hour period, exhibited an electrical resistance almost forty-two times greater than that of the untreated millboard.

**Claim:**

1. A process for producing a support for high resistance electrical conductors which comprises impregnating a commercial asbestos millboard in support form and bonded by sodium silicate and a calcium compound selected from the group consisting of calcium hydroxide and calcium carbonate, with an aqueous solution of ortho phosphoric acid to convert the sodium silicate into silicic acid and to convert the calcium compound into heat-stable, non-hygroscopic calcium phosphate, and drying the impregnated millboard at a temperature of at least 212° F.

2. The process of claim 1 wherein said impregnated millboard is secured as a flat plane during drying.

3. A process for producing a support for high resistance electrical conductors which comprises impregnating commercial asbestos millboard bonded by sodium silicate and a calcium compound selected from the group consisting of calcium hydroxide and calcium carbonate, with an aqueous solution of ortho phosphoric acid, and drying the impregnated millboard.

4. A process for producing a support for high resistance electrical conductors which comprises impregnating commercial asbestos millboard bonded by sodium silicate and a calcium compound selected from the group consisting of calcium hydroxide and calcium carbonate, with an aqueous solution of ortho phosphoric acid and drying the impregnated millboard at a temperature of at least 212° F.

5. The process of claim 4 wherein the concentration of ortho phosphoric acid in said solution is between about 10% and about 50%, by weight.

6. The process of claim 4 wherein the concentration of ortho phosphoric acid in said solution is between about 15% and about 35%, by weight.

7. A support for high resistance electrical conductors comprising commercial asbestos millboard, initially bonded by sodium silicate and a calcium compound selected from the group consisting of calcium hydroxide and calcium carbonate, treated and modified in accordance with the process of claim 1.

8. A support for high resistance electrical conductors comprising commercial asbestos millboard, initially bonded by sodium silicate and a calcium compound selected from the group consisting of calcium hydroxide and calcium carbonate, treated and modified in accordance with the process of claim 3.

9. A support for high resistance electrical conductors comprising commercial asbestos millboard, initially bonded by sodium silicate and a calcium compound selected from the group consisting of calcium hydroxide and calcium carbonate, treated and modified in accordance with the process of claim 4.

10. A support for high resistance electrical conductors comprising commercial asbestos mill-
board, initially bonded by sodium silicate and a
calcium compound selected from the group con-
sisting of calcium hydroxide and calcium carbon-
ate, treated and modified in accordance with the
process of claim 5.

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REFERENCES CITED
The following references are of record in the
file of this patent: