106-81 CROSS REFERENCE EXAMINER

Sept. 9, 1969 F. A. DONNER 3,466,354

PROCESS FOR FAST CURING ALKALI METAL SILICATE BONDED PRODUCT

Filed Jan. 16, 1967

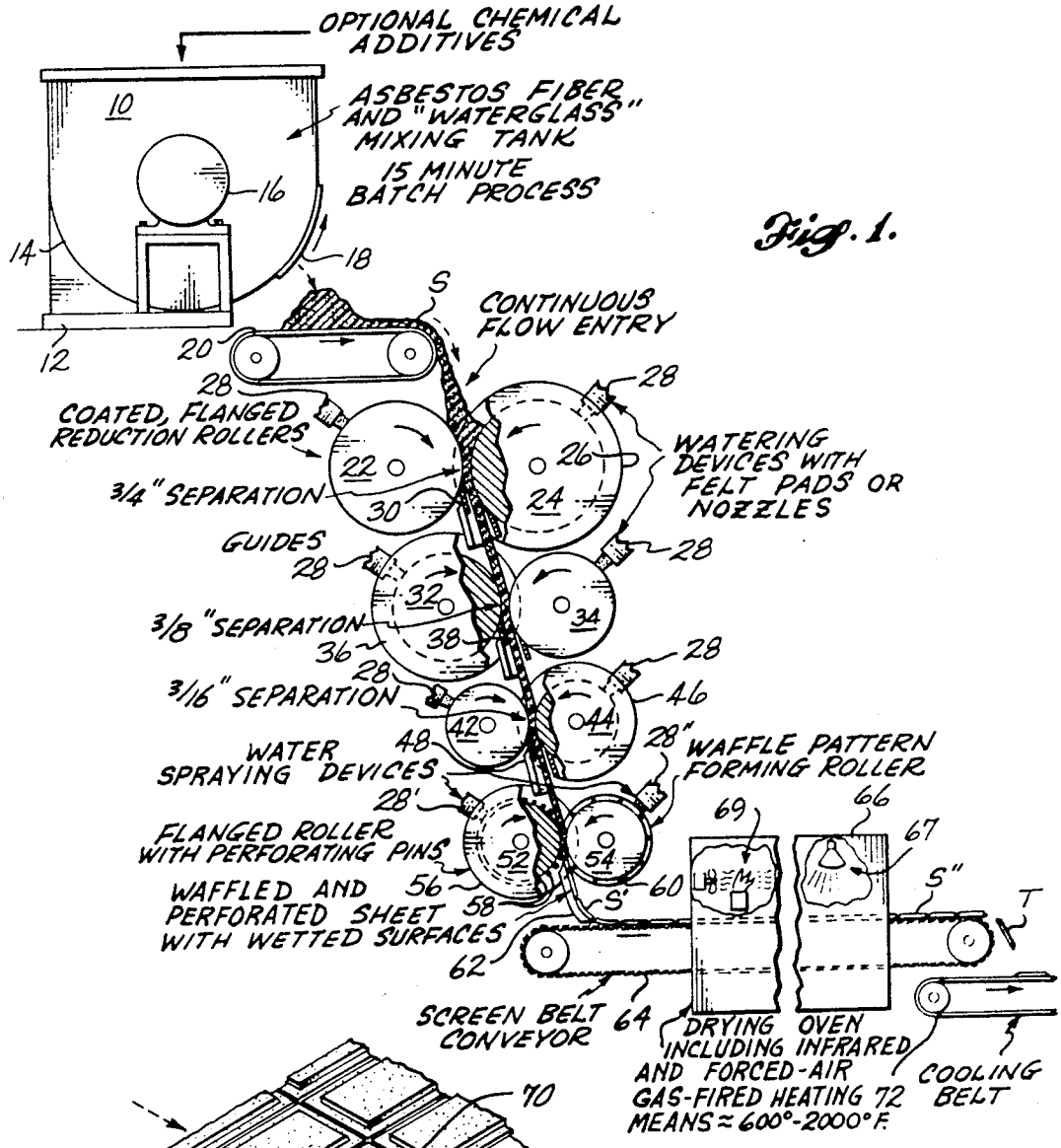


Fig. 1.

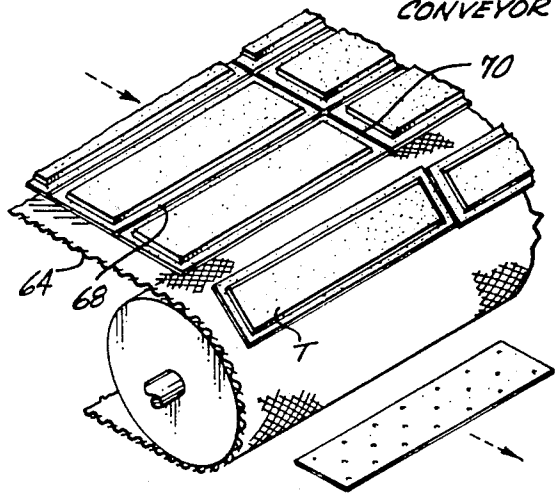


Fig. 2.

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United States Patent Office

3,466,354
Patented Sept. 9, 1969

3,466,354

PROCESS FOR FAST CURING ALKALI METAL SILICATE BONDED PRODUCT

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Filed Jan. 16, 1967, Ser. No. 609,619
Int. Cl. B28b 11/14
U.S. Cl. 264—57 17 Claims

ABSTRACT OF THE DISCLOSURE

A method of fast curing a sheet-like mass of mineral fiberous material containing an aqueous solution of an alkali metal silicate as a binder and having a minimum moisture content of 30% by simultaneously puncturing one side of the sheet to form a multitude of perforations while wetting both sides of the sheet to prevent migration of the binder to the surfaces and then exposing the sheet to a radiant heat source in an oven having an ambient temperature of 600–2000° F. so as to reduce the moisture content to less than 15% in 2–5 minutes time.

BACKGROUND AND SUMMARY OF THE INVENTION

This invention relates to improvements in the manufacture of simulated masonry products formed and colored to look like brick, stone or the like when installed, or made in tile form for floor coverings or for other purposes. While the invention is herein described in terms of a preferred form thereof, it will be recognized by those skilled in the art that various modifications may be made therein without departing from the principal features involved.

The invention involves a thin, hard product characterized by relatively compact or dense nature and high strength, yet light in weight, and capable of manufacture in different colors and surface textures.

These characteristics are achieved in an improved process which includes the very rapid removal of water under relatively high temperature conditions from a thinned sheet of a mixture of dry absorptive fibers and a high proportion, such as 50–70%, of an alkali metal silicate solution or water glass. The water glass preferably used is of low alkaline content, e.g. about 10% Na_2O, 30% SiO_2 and 60% water. Preferably 2–3% expanded vermiculite is added to impart a slightly grainy surface texture as explained herein, and a flecked appearance. Optionally about 1% of a mineral oxide may be added for color.

The ingredients are mechanically mixed and press-formed or rolled into a thin sheet which is then sectioned into wafers of the desired product size and shape while still remaining joined at the edges. The surfaces of the sheet are completely saturated with water, and one or more surfaces thereof is perforated by means forming spaced holes passing through or nearly through to the opposite surface. The sectioned, saturated sheet is then heated rapidly in an oven which preferably includes both infrared and forced air heat at a temperature of the order of 1250° to 2000° F., reducing the water content to a level of from 5% to 10% in two to five minutes time. Lower temperatures might be used, but the process then takes much longer, and insolubility of the product is generally lost if temperatures below 600° F. are used.

Similar products have been made in the past from roughly the same ingredients (but using perlite rather than vermiculite), and by methods of preparation which involve heat drying a mixture which includes sodium silicate or the like. It has been found that sodium silicate upon drying migrates to the surface, weakening the interior of the product, glassing the surface and preventing escape of the moisture. This property has been compensated for by restricting the proportion of sodium silicate and adding perlite to limit the migration and maintain a more or less uniform distribution of the silicate through the material.

Migration of the sodium silicate becomes a particularly serious problem when it is sought to speed up the production process, in which case the surface may quickly become non-porous during the drying step, preventing exit of water from the interior of the material and causing distortion of the product. Different approaches to the manufacture of products containing sodium silicate have included permitting the material to dry substantially at room temperatures prior to hardening it at higher temperatures, or heating the material very gradually. These techinques consume large amounts of time or require the use of variable temperature furnaces or a number of furnaces at progressively higher temperatures. Of course consumption of time and requirements for extensive equipment involve higher costs.

Other approaches have included the use of Portland cement or zinc or magnesium chloride in the presence of their respective oxides or other chemical additives to combine with the excess water and form a plastic mass, which is then subjected to pressure in a press prior to drying. The additional ingredients are relatively expensive, however, and such processes take longer and result in relatively weak products, often requiring a backing sheet to support them. Centrifugal force has also been used to remove excess water prior to drying.

In accordance with the present invention the result which is sought is to obtain an improved product at less cost and to dry the material very rapidly to speed production, for obvious economic reasons. The effect sought in the process is to maintain during the drying step a condition in the material for extremely rapid escape of the moisture in the mixture without introducing distortion or other ill effects. In the above described process the thinness of the material, the perforations, the high proportion of sodium silicate, the vermiculite content, and the surface saturation are the chief factors operative to achieve the desired effect.

While an exact chemical description of what takes place during the heating step is not deemed necessary for an understanding of the invention, an important aspect of the process is that the water on the sheet surfaces boils continuously during the heating step, maintaining porosity of the surface and permitting rapid escape of substantially all of the water from within the mixture itself within a very few minutes at high temperatures. Since the sheet is thin, the internal moisture does not have far to move. The perforations, preferably spaced about one inch apart, provide additional surface area and paths through which the moisture can escape. Although the high sodium silicate content might be expected to present a surface glassing problem due to migration, virtually no migration is evident.

The proportions of vermiculite and different mineral oxides may be chosen to vary the texture and color of the final product, while different surface effects may be achieved by selection of the surface texture of the means used to form the sheet into sections. In addition, the vermiculite exfoliates when the sheet is heated to about 1000° F. or more, imparting a slightly grainy texture to the surface of the material, though the percentage of this ingredient is kept low to retain the required strength.

These and other features, objects and advantages of the invention will become more apparent from the following detailed description taken in connection with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWING

FIGURE 1 is a somewhat diagrammatic representation of the process according to the invention.

FIGURE 2 is a partial isometric view showing a preferred shape of the manufactured product as it emerges from the process shown in FIGURE 1, and showing the perforations on the back side thereof.

DESCRIPTION

FIGURE 1 shows a mixing tank **10** for receiving the ingredients to be used and mixing them thoroughly prior to formation of the resulting mass into a sheet to be sectioned and heat hardened to form facing or tile product units in accordance with the invention. The mixing tank consists of an open-topped vat supported by a base **12** and having a curved bottom **14**. A motor **16** drives an internal paddle wheel (not visible) on a horizontal axis in a counterclockwise direction. The ingredients are mixed in batches at fifteen minute intervals, in the presently preferred form of the process.

First, a fiber in dry form is delivered to the tank, and an alkaline silicate solution and other optional chemical additives are introduced either manually or by any suitable conveyor or valve means (not shown). The fiber used is a suitable commercially available one, preferably asbestos or some other mineral fiber. The fibers should have an absorbent quality but preferably should not require excessive amounts of water or pulping treatment, so that they can quickly become completely coated and surrounded by the metal silicate during a relatively short mixing time.

The alkali metal silicate solution is preferably sodium silicate, or so-called water glass, a clear syrup-like substance, and that found to work best consists of about 10% sodium oxide, 30% silicon dioxide and 60% water by weight. It is added to the fiber in a ratio of roughly 70%–50% sodium silicate solution to 28–35% fiber by weight. Although the basic product can be made without the addition of expanded vermiculite, this ingredient is preferred to achieve the desired interior and surface texture. The maximum preferred percentage is 3% by weight, which is a significant amount by volume, but not great enough to weaken the final product. Up to 1% of a mineral oxide chosen for the color to be imparted to the final product is usually added during the mixing stage.

The mechanical mixing is performed without heat or pressure, and when the fibers are completely coated by and intermixed with the sodium silicate and the other chemical ingredients, the rather plastic and sticky mixture is expelled from the tank **10** through a gate **18** by means of the internal paddle wheel and falls onto a suitable conveyor **20**. This conveyor moves at such a rate that flow of the material S off the end thereof may be maintained continuous between periodic batch deliveries from the mixing tank **10**. Such continuous flow is maintained either manually or by a suitable delivery mechanism (not shown) spreading the mass of material laterally on the conveyor to be delivered to the forming rollers now to be described.

As it leaves conveyor **20** the material falls between two reduction rollers **22** and **24** which are about six feet long, twenty-four inches in diameter and have a ¾-inch separation between them. Roller **24** has flanges **26** which overlap roller **22** to confine the material therebetween as they turn in directions indicated by arrows, forming the material S into a ¾-inch sheet as wide as the rollers themselves.

In combinatiton with each reduction roller is a watering device **28** including either a nozzle or a felt pad contacting the roller and connected to a water supply (not shown) and delivering water in sufficient amounts to saturate both surfaces of the material as it passes between the rollers. Each roller is preferably coated with "Teflon" or other suitable thermoplastic nonporous, durable material to inhibit adherence of the material to it.

Suitable takeoff members or guide means **30** deliver the sheet of material from rollers **22** and **24** to the next set of reduction rollers **32** and **34**, which are about twenty inches in diameter and have a ⅜-inch separation therebetween. Roller **32** includes flanges **36** on each end overlapping roller **34** to confine the material, and additional watering devices **28** cooperate with each roller to maintain the surfaces of the sheet of material S saturated with water. Guide means **38** deliver the sheet to the next pair of reduction rollers **42** and **44**, which are about sixteen inches in diameter and have a 3/16-inch separation therebetween. Roller **44** includes flanges **46** overlapping roller **42**, and a watering device **28** cooperates with each roller, again to maintain the surfaces of the material saturated with water.

Guide means **48** deliver the sheet to the final set of rollers **52** and **54**. These rollers have a basic separation of 3/16 of an inch and are not intended to alter the thickness of the material, except to the extent that they form the sheet into sections of the shape intended for the final product. Roller **52** includes flanges **56** overlapping roller **54** to confine the material as before. Roller **52** carries perforating pins **58** spaced approximately an inch apart both laterally and circumferentially of the roller. The pins are of length equal to or nearly equal to the spacing between the rollers in order to form perforations which extend from the back surface of the sheet to the front although the holes are not readily visible on the front face. Roller **54** carries knives and ridges **60** extending longitudinally and circumferentially to form the sheet S into a waffle pattern of rectangular sections bordered by margins of reduced thickness and joined by very thin membranes of material which are easily broken after hardening to separate the sections into singular units of the product being formed. The speeds of the four sets of rollers are adjustable to achieve a sheet speed of roughly 20 to 200 inches per minute.

Watering devices **28'** and **28''** cooperable with rollers **52** and **54**, respectively, preferably comprise a plurality of spray nozzles to which water is delivered under pressure. They create a mist and keep both the rollers **52** and **54** and the surface of the material saturated. The water serves also to prevent sticking of the material to the rollers.

Pins **58** on roller **52** pull the patterned and perforated sheet S' from waffle roller **54**, and guide means **62** delivers it to a screen belt conveyor **64** moving in the direction shown. The sectioned sheet S' with all of its surfaces completely saturated with water immediately enters the drying oven **66**.

The size of the oven **66** and the speed of conveyor **64** are preferably such as to establish a transit time of two to five minutes for any point on the waffled sheet S' to pass through the oven. The oven includes both infrared heating means **67**, delivering radiant heat to interior portions of the material, and gas-fired forced-air heating means **69** for maintaining uniformity of heat within the oven chamber and rapidly removing the moisture therefrom as it boils to the surface of the material. The temperature of the material achieved within the oven is such as to reduce the moisture content to about five percent in the two- to five-minute transit time. This hardens the material and the finished sheet of joined tile units exits on conveyor **64** in the form illustrated in FIGURE 2. As previously indicated, the heavy surface saturation maintains the porosity of the surface to permit escape of water from the interior of the sheet. The punctured lower surface and the screened belt conveyor **64** also facilitate moisture removal from the material, and because of the thinness of the material the distance through which the internal moisture must travel is small.

The resulting product is hard and has a surface texture of ordinary brick or other textures, depending chiefly upon the roughness of the forming rollers **52** and **54**. The surface texture and appearance also depends upon the

proportions of vermiculite and other optional chemicals.

As the sheet reaches the end of conveyor **64** the tile sections T are broken apart along lateral and lengthwise dividing lines **68** and **70** formed by the waffle pattern roller **54** and are placed on a cooling belt conveyor **72**. The tiles may be packed almost immediately while still warm, since their temperature descends to a suitable packing temperature within a few minutes.

The total transit time of the material from the beginning of the mixing stage to the packing step as a final product is less than 30 minutes. The short heat treatment time permits a high production rate. Tile units of a size such as illustrated, about 7 inches long and 2 inches wide, can be produced at the rate of approximately 30,000 units per hour and at extremely low cost as compared with masonry and tile products produced by previously known techniques.

While the invention has been described herein in terms of a preferred form thereof it will be recognized by persons skilled in the art that certain modifications and variations may be made therein without departing from the principal features involved.

What is claimed is:

1. A method of fast curing a thin sheet-like mass of mineral fibrous material having a thermosetting binder therein consisting essentially of an aqueous solution of an alkali metal silicate, the mass containing at least 30% moisture by weight, comprising simultaneously puncturing one side of the sheet to form a multitude of perforations therein, while wetting both sides of the sheet with sufficient water to prevent substantial migration of the silicate binder to the surfaces thereof, and thereafter exposing the perforated, surface-wetted sheet to a radiant heat source in a heated oven so as to reduce the moisture content of the sheet to less than 15% by weight in two–five minutes time.

2. The method according to claim **1** wherein the sheet is perforated by drawing it between a pair of rollers having water-wetted parting surfaces and puncturing means thereon.

3. The method according to claim **2** wherein the surfaces of the rollers are wetted by spraying water mist thereon.

4. The method according to claim **2** wherein the surfaces of the rollers are coated with a resinous parting film.

5. The method according to claim **1** wherein the sheet is disposed in the oven so that the non-punctured other side thereof faces the radiant heat source.

6. The method according to claim **1** wherein the oven is also forced-air heated.

7. The method according to claim **1** wherein the ambient temperature in the oven is at least 600° F.

8. The method according to claim **1** wherein the silicate is a sodium silicate.

9. The method according to claim **1** wherein the solution is a 40% sodium silicate solution.

10. The method according to claim **1** wherein the cured sheet is subsequently subdivided.

11. The method according to claim **10** wherein the other side of the sheet is indented for the subdivision process, when the one side thereof is punctured.

12. The method according to claim **1** wherein the fibrous material is water absorbent.

13. The method according to claim **1** wherein the mineral fibrous material is asbestos.

14. The method according to claim **1** wherein the sheet is formed by mixing the fibrous material with 50–70% by weight of 40% sodium silicate solution.

15. The method according to claim **1** wherein the sheet consists essentially of fibrous material and the silicate binder therefor.

16. The method according to claim **14** wherein the sheet also comprises up to 3% by weight of expanded vermiculite.

17. The method according to claim **1** wherein the sheet is exposed to an infrared heat source.

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U.S. Cl. X.R.

106—81, 84; 264—63, 118, 126, 156