July 1, 1941. G. B. BROWN 2,247,355

METHOD OF MAKING A COMPRESSED AND DENSIFIED PRODUCT

Filed July 18, 1936

Fig. 1.

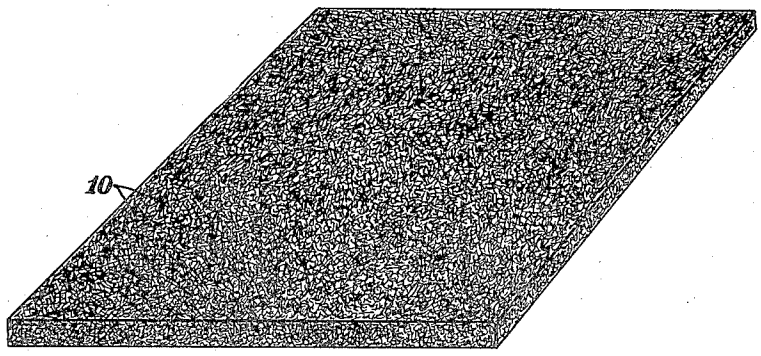


Fig. 2.

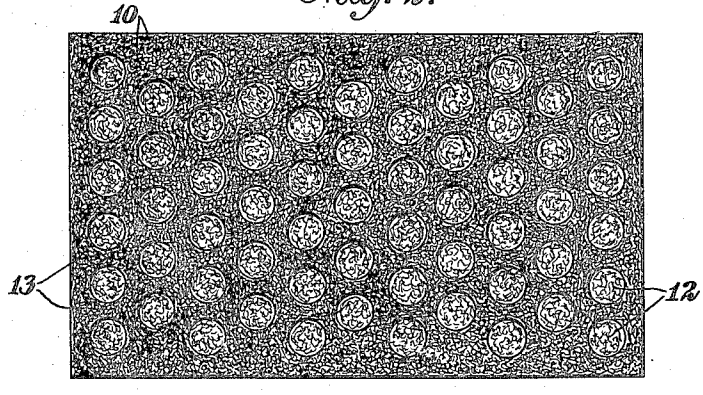
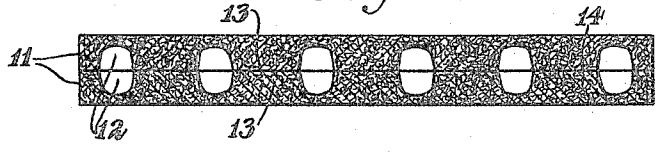


Fig. 3.



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METHOD OF MAKING A COMPRESSED AND DENSIFIED PRODUCT

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1 Claim. (Cl. 92—21)

This invention relates to a compressed and densified fibrous product and the method of making the same and, particularly, to such a product in which calcium silicate binder is formed in contact with the fibres bonded thereby and in the presence of a relatively small proportion of water.

It is an object of the invention to provide a strong, yet non-brittle sheet or block containing a large proportion of fibres and preserving in general a fibrous nature while being substantially impermeable to air. Another object is to make a fibre board that is fireproof, relatively inexpensive, strong but lightweight, and durable when exposed to the weather or to soaking in water for a substantial period. Other objects and advantages will appear from the detailed description that follows.

The invention comprises the herein described novel features of the product and the method of making it and, more particularly, a sheet in compressed and then hardened condition including a large proportion of fibres and a binder therefor including the reaction product of a wet mixture of hydrated lime and finely divided silica of very low density. The invention comprises such a sheet in which the fibres include a substantial proportion of amosite and/or wood fibres. The invention comprises, also, the method of making such a product in which there is formed an aqueous mixture of the selected fibres, hydrated lime, and finely divided silica, such as diatomaceous earth, shaping and strongly compressing the mixture against a filtering member, to remove the major portion of the water present, and then autoclaving the shaped and compressed material at an elevated temperature, to cause practically complete reaction of the lime with the silica, the silica being used preferably in amount in excess of that equivalent chemically to the lime. In one embodiment the invention includes a plurality of sheets, suitably made as described, composited with each other to define voids therebetween.

The invention is illustrated in the attached drawing and will be described for the purpose of exemplification in connection therewith.

Fig. 1 shows a perspective view of a bonded fibrous sheet of generally plane surfaces constituting the preferred embodiment of the invention.

Fig. 2 shows a plan view of a modified form of sheet suitable for being composited with a similar sheet, to form a void-containing composite.

Fig. 3 shows a cross sectional view of the finished composite of two such sheets as shown in Fig. 2.

The sheets contain fibres 10 and binder adhering the fibres into a unitary article.

The sheets 11, shown in Figs. 2 and 3, have each a face of generally plane surface and a back portion provided with depressions 12 and intervening areas 13 that are elevated with respect to the said depressions and whose top portions lie in a plane extending approximately parallel to the face of the sheet.

Two such sheets are composited, as illustrated, means, as, for example, the adhesive 14 applied over the said elevated areas securing together the abutting portions of the sheets.

The result is a lightweight sheet provided with inner voids and yet having firm portions of the composited sheets contacting at closely spaced intervals.

In making the articles of the present invention there is used a method which comprises forming an aqueous mixture of the selected fibres, hydrated lime, and finely divided silica, shaping and strongly compressing the mixture, to expel therefrom a large part of the water present and form a densified mixture. The shaped and compressed material is then subjected to an elevated temperature, while minimizing the evaporation of water, as for example, by treating the material in an autoclave with steam at superatmospheric pressure. There is thus caused substantially complete reaction between the lime and finely divided silica. Finally, the product is dried at a temperature above the boiling point of water, to remove free water.

Particularly desirable results have been obtained when the finely divided silica is diatomaceous earth. Such silica not only gives a quick reaction with the lime during the heating at an elevated temperature, but also makes possible the production of a lightweight article suitable for use as a ship panel or a thermal insulating wallboard and permits the use of the binder in such a small proportion, with respect to the weight of the fibres, as to preserve in the finished article non-brittleness and appreciable flexibility.

For the fibrous component, I have used to advantage wood fibres, chrysotile asbestos fibres, amosite, or a mixture of such fibres. An especially lightweight product has been obtained when the fibres used are wood screenings or contain a substantial proportion of well dispersed amosite. For best results, the fibre component

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is constituted largely and, preferably, entirely of amosite.

In order to obtain the desired properties in the finished bonded fibrous product, I use to advantage a large proportion of fibres at least equal approximately to the weight of the lime and silica used. For instance, I have used 50 to 70 parts by weight of wood fibres or of a mixture of short Canadian asbestos fibres to 100 parts by weight of the finished bonded article in dried condition. Also, I have used amosite fibres in the proportion of 35 to 60 parts by weight to 100 parts of the finished dried article.

The method of manufacture is illustrated in greater detail by the following more specific example:

There is formed a mixture including 50 parts by weight of fibres consisting of willowed amosite and very short Canadian (chrysotile) asbestos, the two fibres being used in about equal proportions, 16 parts of hydrated lime, 34 parts of comminuted diatomaceous earth of about the fineness of usual diatomaceous earth filter-aid, and water in amount to permit the suspension of the solid ingredients in a fluent composition, say, about 1,500 parts water.

The mixture is then agitated to form a slurry. The slurry is charged to the bed of a press having a filtering bottom, such as a firmly supported wire screen connected to a drain, so that the slurry flows over the screen and forms a layer of about the same thickness over all parts thereof. The amount of slurry used is selected to give the desired final thickness of the compressed sheet, say, 0.5 to 1.5 inches.

Strong compression is then produced, as by bringing down the ram of a hydraulic press upon the mixture on the filtering bed. The pressure on the ram may be varied within limits, that is, from about 200 to 1300 pounds to the square inch, although I have found a pressure of the order of 500 pounds to give a particularly desirable product from the standpoint of proper balance between strength and lightness of weight.

During the strong compression described, a large portion of the water of the slurry is forced therefrom and the mixture is compressed to form a densified and thoroughly consolidated mass, including a very small proportion of water, in comparison with the amount originally present. Thus, the compressed product contains ordinarily about 40 to 70 parts water to 100 parts of solids present. The reaction of the lime and the silica, in the next step to be described, occurs, therefore, in the presence of such a small proportion of water that there is formed a bond of strong calcium silicate, even though the proportion of the calcium silicate is relatively low in comparison with the proportion of such bond in articles of somewhat similar quantitative composition made heretofore.

The shaped and compressed material is removed from the press in any suitable manner and without breakage, and subjected to an elevated temperature to cause substantially complete reaction between the lime and the silica, that is, to cause the one of the reacting ingredients which is not present in excess to be combined practically entirely as calcium silicate. Since I prefer to use silica in excess of the lime and have done so in this particular example, the lime is combined with the silica and the excess of the silica remains in the finished product. The occurrence of this reaction in the presence of water results in the combination of some, at least, of the water, presumably as water of hydration and intimate association of the resulting silicate binder with the fibres and makes possible additional hardening of the binder by drying.

The reaction described is effected, conveniently and well, in an autoclave heated by live steam at superatmospheric pressure, as, for instance, at a pressure of 100 to 150 pounds to the square inch. In this autoclaving step, I allow the steam to escape slowly from an inlet, so that the pressure is not built up suddenly to the maximum desired. Thus, I have raised the pressure on the gauge from 0 to 150 pounds, at the rate of about 25 pounds an hour, to minimize splitting or swelling of the block during the steam-curing.

The steam-cured product, containing fibres bonded by means of calcium silicate extending thereover, is then subjected to thorough drying, preferably at a temperature well above the boiling point of water, to cause the removal of substantially all free water from any calcium silicate that may exist in gelatinous or other form intimately associated with a large excess of water, as distinguished from water of hydration that is expelled readily only at very high temperatures. Thus, I have dried the product at a temperature of 250° F. for about 48 hours.

After drying, the product may be shaped to exact size desired, as by band saws; one face of the sheets as made in the press is generally of practically plane surface.

A sheet so made has been found to weigh approximately 45 pounds to the cubic foot, to have a specific thermal conductance, in the engineering system of units, of only 0.55 British thermal unit, to be fireproof, flexible to an appreciable extent, strong (of modulus of rupture of the order of 1,200 pounds), and impermeable to air to such a degree that the board is adapted for use as structural panels, as, for example, for walls of buildings or bulkheads of ships.

When the steps of the example given are followed and there is used wood screenings, in place of the fibres described, there may be made a fibre board that weighs as little as 25 pounds to the cubic foot, that will not continue to burn when a gas burner flame is applied for a long time thereto and then removed, and that may be immersed in water for a substantial period without excessive softening or disintegration. Such a board has a modulus of rupture of about 800 pounds.

The hydraulic press equipment, mixers, autoclaves, and other equipment used in connection with the method described are conventional and, therefore, are not illustrated in the drawing. Thus, the hydraulic press with filtering bed and means for removing the compressed sheet from the press may be the same as used in the manufacture of asbestos-cement boards.

During the autoclaving step described, I confine the sheets to cause welding together at positions where permanent cracking would otherwise develop, as steam escapes from the sheets. In this manner the development of cracks and attendant weakening of the structure are minimized. Thus, the sheets being steam-cured may be stacked one upon another with impermeable material, as, for example, two or three sheets of asbestos-cement board of ½ inch thickness each, laid over the top of the stack. At the bottom the stack may rest upon the steel floor of a conventional hand-truck. Obviously, if the stack is very tall, intermediate spacing members may be used to permit access of the heating medium, such as

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the steam, to the interior parts of the stack. All parts of this equipment, also, are conventional and therefore not illustrated.

As another means of minimizing cracking, there may be used a small proportion of a skeletonizing agent admixed into the composition of the sheets and allowed to set or harden before the sheets are subjected to autoclaving. For this purpose there may be used a small proportion of a hydraulic cement, as, for example, ten to twenty per cent of Portland cement or a calcium aluminate cement (cement fondu), based on the weight of the finished sheets. The cement is thoroughly mixed with the other raw materials, the composition then formed into a sheet as described, the cement in the sheet allowed to set substantially fully or to a large extent, and the sheet then autoclaved in the manner described.

For some purposes an oxide of any one of the other alkaline earth metals may be substituted for the lime. When such oxide is so slightly soluble as to react not sufficiently rapidly with the silica, then there may be used a promoter to accelerate the reaction. Thus, finely divided magnesia may be substituted in equi-molecular proportion for the lime with the addition to the magnesia of about 1 mole of sodium carbonate for each 10 moles of magnesia.

In making the sheets of modified form shown in Figs. 2 and 3 there are used compositions, method and apparatus described, a departure being made in that the pressing of the mixture against the filtering member is made with a pressing member having thereon protuberances that are forced into the material, and then removed when the pressure is released. Thus, there may be used a press plate having projections thereon and corresponding on its lower surface to the negative of the pattern of the upper surface of the compressed sheet provided with depressions 12.

The sheets so embossed are steam-cured and dried as described above. The sheets are composited, as shown, the elevated portions on the embossed sides of two sheets being adhered together by an adhesive. This adhesive is preferably an inorganic cementing agent of which a silicate of sodium, calcium or zinc is an example. Thus, the adhesive may be one produced from an aqueous mixture of sodium silicate and lime or zinc oxide, applied in plastic form to the surfaces to be adhered, and then heated after the desired position of the surfaces with respect to each other has been established. For some purposes the adhesive may be a casein, resinous, or asphaltic cement or the like.

The term "asbestos" is used herein to include amosite fibres.

It will be understood that the details given are for the purpose of illustration, not restriction, and that variations within the spirit of the invention are intended to be included in the scope of the appended claim.

What I claim is:

In making a bonded product, the method which includes forming an intimate mixture of wood fibres, hydrated lime, and finely divided diatomaceous earth, shaping and strongly compressing the mixture against a filtering member, to expel a major portion of the water therefrom and produce densification, and then subjecting the compressed and shaped material to an elevated temperature while minimizing the evaporation of water therefrom, to cause reaction between the lime and finely divided diatomaceous earth with the production of a binder for the fibres.

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