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FELTED FIBROUS PRODUCTS AND METHOD OF MANUFACTURE

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This invention relates to fibrous products, and more particularly to fibrous products felted and/or pressed to shape from an aqueous pulp.

Processes are in quite common use to-day in which articles of various shapes are formed from an aqueous pulp by subjecting a mass of the pulp to relatively strong suction or pressure over a screen or foraminous mould of a shape corresponding to that of the desired article, whereby the water is drawn off or expressed from the pulp in much the same manner as an ordinary filtration procedure, thus leaving the fibres in their interlacing relation adhering to the foraminous walls of the mould, and positioned thereon parallel to the general contour of the mold or screen. After a layer of fibres of the desired thickness has been formed on the mould, the object thus formed is removed from the mould, dried and put through suitable finishing operations.

My present invention has particular relation to articles made in the foregoing manner. It has always been desired to provide for waterproofing certain articles made by these processes, since they would then find wider application under conditions of use where they might be subjected to contact with or submersion in water, and would in general afford a superior and more desirable type of article. It will be perceived by those skilled in the art, that in order to enable these suction or pressure moulding processes to be effectively carried on, it is essential that the fibers composing the stock be what is termed in the art as "short" and of such a character as to provide a very free and open stock so as to permit the ready removal of the water from the stock under the action of suction or pressure. Generally, soft fibers such as rag felt or ground wood, or hard fibres such as rope stock and the like, are used in these processes, as such fibers are about as cheap as can be had for this purpose and they meet the ordinary requirements pertaining to a free and open stock. When such fibers are moulded or otherwise formed into a compact mass, as by the suction or pressure methods, usually employed, it is a very difficult and costly procedure to waterproof the same because of the character of the fibers and the relative impenetrability of the mass. This is especially true where hard fibers have been used, and even with articles made in this way from a soft fiber stock, it is generally necessary to subject the same to a series of immersions in baths of waterproofing liquid until a certain amount of the liquid has been forced into the pores and fissures separating the fibers. Moreover, as these articles are taken from the foraminous mould upon which they are initially formed, the surface of the article which was adjacent the mould has a checkered or screen-like appearance corresponding to the design of the foraminous mould while the opposite surface takes on a rough, uneven, bark-like appearance due to the fact that the pressure or suction is not constant or evenly distributed over the surface of the mould throughout the period of formation. While this bark-like appearance of one of the surfaces may not be objectionable in certain instances, nevertheless it is undesirable in a good many cases. Attempts have been made to diminish this effect and smooth down, at least in part, the rough finish by pressing the moulded article while it is still somewhat wet and prior to the drying and saturation of the article, but where this expedient is adopted, it becomes increasingly more difficult to subsequently effect saturation of the article with waterproofing material. Furthermore, even though a certain amount of saturation may be attained, the fibers, being soft and elastic, do not admit of the article being thermomoulded in dies or presses for the purpose of supplying a smooth finished or other desirable appearance.

One of the prime objects of the invention is to provide a method whereby articles of various shapes produced by the methods above outlined may be made water repellant.

The invention has as another object the production of fibrous products of this type which, in addition to being waterproof, shall be readily susceptible to thermo-plastic moulding operations whereby the operation

of finishing an article of this type with a smooth, embossed, or any desirable appearance may be facilitated.

To this end, and with these and other objects in view, the invention consists in the incorporation of thermo-plastic waterproofing substance with the aqueous pulp from which the desired object is to be moulded. For this purpose the thermo-plastic material is first transformed into a finely divided or dispersed condition, the finely-divided particles being retained in suspension in an aqueous medium, and this aqueous dispersion is then combined with the aqueous pulp, whereupon the dispersed particles are caused to be deposited or fixed upon the fibers, so that as the article is moulded to shape, the fibers with the dispersed particles of thermo-plastic material fixed thereon, will interlace and arrange themselves in felted relation in much the same manner as though the thermo-plastic material were not present in the stock containing the fibers. After the article has been formed into the desired shape, it may then be dried so as to remove the water and cause the thermo-plastic material to fuse and coalesce whereby to produce a substantially waterproof product. By thus combining the waterproofing material with the fibers in the aqueous stock, the waterproofing of the article is made quite independent of the character of the fibers used, or the thickness of the moulded layer, inasmuch as the particles of waterproofing material are caused to be fixed on the fibers in their individualized condition in the stock, and before the interlocking and interlacing of the fibers into a unitary structure has taken place. A noteworthy advantage of this method of combining the waterproofing material with the fibers is that not only is the waterproofing thereby accomplished with ease and with substantially no waste of waterproofing material, but these results are had without in any way interfering with the freeness of the stock, so that no greater time is required to form an article of a given thickness with the waterproofing material, than is required for the formation of a similar article of the same thickness without the waterproofing material incorporated therein. As a matter of fact, it has been found that under certain conditions, the stock containing the dispersed waterproofing material is actually more "open" and "free" and can, therefore, be built up to the desired thickness on the mould either by suction or pressure, in less time than ordinarily is required.

Furthermore, the waterproofing material being in most cases of a thermoplastic nature, and coating and surroundnig as it does the fibres, acts to lubricate the fibres and permit them to move more freely one over the other so that when the dried article with the contained waterproofing material is subjected to thermo-moulding, a substantial degree of distortion may take place without subjecting the fibers to strain.

Before proceeding with a more detailed description of the invention, it may be well to point out that the dispersion of thermo-plastic waterproofing material which is combined with the aqueous pulp in carrying out the invention, is preferably an aqueous dispersion of a non-fluent bitumen such as asphalt of 100° to 200° F. melting point made in accordance with the process described in the patent to Lester Kirschbraun, No. 1,615,303, dated January 25, 1927, although my invention comprehends also the use of an aqueous dispersion of rubber produced, for example, as described in Lester Kirschbraun Patent, No. 1,498,387. It is to be understood, however, that other types of dispersions than those described in said patents may serve the purposes of the present invention, providing they are made sufficiently stable to withstand the chemical (and mechanical) treatment to which they may be subjected in carrying out the instant process.

In carrying out the invention a watery pulp of fibers such as ground wood, rag felt, rope stock, or the like, or any desired combination of these fibers, capable of forming a fairly free and open stock, is introduced into a beater engine of any suitable type.

A sufficient amount of water should be introduced into the beater to permit ready circulation of the stock therein, and the rolls of the beater are adjusted so as to secure a substantially uniform stock of the desired degree of "shortness." When this condition has been achieved, a quantity of aqueous dispersion may be led either directly from a dispersing apparatus or from a storage tank containing the same to the beater and the beating action is thereafter continued until a homogeneous mixture of the fibrous stock and dispersed material is attained.

The quantity of dispersion combined with the fibrous stock may vary over a wide range, depending upon the degree of waterproofing desired. Thus, when using a dispersion of asphalt having a melt-point of substantially 180° F. and containing 50–55% by weight of the asphalt in its dispersed condition, and 40–45% water, the quantity of dispersion used may be such that the asphaltic content of the mixture may be as low as 40% or as high as 200% by weight of the fibrous content of the stock.

It has heretofore been found, when a colloidal substance such as typified by an aqueous dispersion of asphalt, is added to a stock intended to be employed in the suction or pressure methods here contemplated for the building up of relatively thick fibrous layers upon foraminous moulds, that the

"freeness" of the stock is thereby reduced to such an extent that the formation of the article in a commercially practical manner is seriously interfered with due to the fact that the slimy nature of the resulting mixture causes the initial layer of the stock formed upon the mould to clog the pores or openings thereof thus rendering the further action of the suction or pressure ineffectual and hence preventing further accretions of fibrous stock from being formed upon the initial layer. It thus becomes impossible, from a practical standpoint, to build up the thickness usually desired in articles produced by these methods, and in that sense the process is rendered inoperative. I have found in accordance with the present invention, that the combined fibrous stock and aqueous dispersion of the waterproofing substance may be treated so as to condition the treated stock mixture whereby none of the hereinabove described objectionable action takes place to any perceptible or harmful extent.

In carrying out this feature of the invention the combined aqueous mixture of fibers and asphalt dispersion is treated with materials which are capable of reacting to form a "fixing" agent, which is adapted to cause substantially all of the particles of dispersed asphalt to become flocculated and fixed upon the individual fibers. Accordingly, after complete formation and drying out of the article, the asphalt will exist in the form of films which completely surround or enclose the fibres, while the interstices between the fibres are comparatively free of asphalt.

In order to effect this result I have found that the treating materials added to the stock containing the dispersion must be used in such relative quantities as to condition the system to a point approximating the iso-electric point of the reaction product which is to function as the "fixing" agent as above described. This point will, of course, depend upon the character of the treating materials used. Thus, where a soluble resin soap such as sodium resinate is one of the reagents, and alum is the other, the effective fixing agent in this case is in all probability aluminum resinate appearing as an exceedingly fine colloidal flocculent precipitate, and in order to realize the desirable optimum conditions above related, it is necessary that the stock be conditioned so as to bring the colloidal system composing the same to the iso-electric point of the aluminum resinate.

Likewise one may use for this purpose sodium silicate and alum, in which case it is necessary to attain in the system the iso-electric point of aluminum hydroxide, the latter being the effective fixing agent where these materials are used.

I have found that the iso-electric point of these fixing agents in a colloidal system such as represented by the aqueous mixture of the fibrous stock and the dispersion, may be achieved very rapidly and economically by means of adjusting the pH of the system. The pH value at the iso-electric point of the effective fixing agent, if not already known, may be readily predetermined within a relatively narrow range, and thereafter the reacting substances used to precipitate such agent are added to the stock in such relative quantities as to adjust the pH value of the colloidal system to substantially within the predetermined pH range. Obviously, this range will vary with the different substances functioning as the fixing agent, and hence for each substance the optimum pH value may be predetermined by suitable test measurements.

In one mode of carrying out this principle of the invention, excellent results were obtained by adding to the mixture in the beater, after the fibrous stock and desired quantities of dispersion have been thoroughly incorporated and formed into a homogeneous mixture therein, a suitable quantity of sodium silicate, representing generally about 2–5% by weight of the stock. Thereafter alum, in amounts sufficient to bring the pH of the stock to about pH 4.0 to 5.0 were added, this latter range being approximately the pH value of aluminum hydroxide at its iso-electric point.

At this range the flocculent precipitate of aluminum hydroxide causes practically all the asphalt particles to be fixed upon the fibers of the stock, thus leaving the aqueous vehicle free of asphalt and permitting a free and rapid removal of the aqueous vehicle thereby allowing the fibers with the asphalt clotted thereon to be arranged in interfelted relation in layers of any desired thickness under the continued action of the suction or pressure usually employed in the processes for making articles of this type.

In this way there is no interference by the asphalt dispersion with the freeness of the stock, and in addition, this procedure avoids loss of asphaltic or other waterproofing material from the stock due to its being drawn away with the watery vehicle under the action of the suction or pressure.

The stock as thus treated with the precipitating agents is then in condition to be transferred to the moulding apparatus and formed into articles of desired shape.

The moulding apparatus may comprise any well known type of machine adapted to effect a building up of a layer of the fibers in successive accretions from an aqueous stock containing the same. Preferably, the apparatus used for this purpose may be of the type in which a foraminous mould, shaped in accordance with the shape of the article to be produced, is submerged in a tank containing the treated stock, the mould being connected with a source of suction in such a way that a layer

of the fibers having the waterproofing substance fixed thereon is caused to adhere to one of the surfaces of the foraminous mould, the fibers and affixed waterproofing substance arranging themselves in interfelted relation in general parallelism to the contour of the mould, and the layer being continually built up during the continued application of the suction. When a layer of desired thickness has been obtained, the mould is withdrawn from the tank and the moulded article released therefrom as by the application of gas or air pressure to the surface of the mould opposite to that carrying the fibrous article.

Another type of moulding apparatus to which the present invention is particularly adaptable is that in which the treated fibrous stock is forced by pressure onto a foraminous mould of desired shape thereby expressing the water through the openings in the mould and leaving an interfelted layer of and waterproofing material adhering to one of the surfaces of the mould. In this type, the mould may be made in separable sections adapted to be connected so as to form a unitary structure during the moulding operation and after a layer of desired thickness is built up, such sections may then be disconnected so as to free the moulded article from the mould.

The moulded article by whichever of the above methods it is produced, may then be conveyed through suitable drying mechanism, As the drying and consequent removal of the water proceeds, the dispersed particles of asphalt coalesce and form continuous films about the fibers thus effectively waterproofing the fibrous mass composing the article.

One of the important advantages of incorporating the thermoplastic waterproofing material in the form of a dispersion as herein described, is that the dried moulded article lends itself very well to deformation under thermo-moulding because of the tendency of the fibers to flow.

Hence, where it is desired to remove the normal bark-like appearance on the surface of the moulded article, or where it is necessary or desirable to modify the shape thereof, the dried article may be positioned between solid male and female dies of suitable shape, and subjected to pressure and heat, or both, whereby to cause fluxing of the contained thermoplastic material while the fibers are rearranged or distorted by the pressing action whereafter the removal of the heat and pressure will permit the asphalt to set with the fibers in their respectively new or distorted positions. The article may then be surfaced or finished in any desired manner.

The present invention provides means whereby not only waterproof hollow articles such as buckets, baskets, containers of various descriptions, may be produced, but by employing suitably formed moulds, waterproof articles of flat, curved, or any other shape may be produced.

Thus, by using a foraminous mould of suitable dimensions and formed in sinuous fashion with alternating crests and valleys, I may build up on one of its surfaces a layer of the fibrous material as above described and produce a structure which may serve as a tile-shaped roofing base resembling the Spanish tiles. A roofing unit as thus produced may be made as waterproof as necessary by the incorporation of suitable quantities of a dispersion of asphalt in the fibrous stock, and after being formed, may be subjected to heat and pressure, if necessary, to effect a smoother appearance on its surface, whereupon the unit may be coated to any desired extent with weather and water-resistant material such as high melting point blow asphalt, and thereafter surfaced on one or both surfaces, and upon its edges if desired, with a layer of comminuted or granular material such as crushed slate, or the like. The finished unit when laid with others in overlapping relationship on a roof affords a very desirable ornamental appearance, closely resembling that of the well known Spanish tiles. The roofing articles produced in accordance with the invention are however, not nearly as expensive as the Spanish tiles, it is much lighter in weight, and the protection afforded thereby to a roof is equal if not superior to that of the Spanish tiles.

My process is also adapted for the production of relatively large objects either in sheet form, or of irregular form, it being necessary in such case only to provide molds of the desired size and shape and to increase the suction or pressure if necessary, in order to exert its effect substantially uniformly over the entire surface of the mold. Thus, by means of suitably shaped molds, I may produce waterproof fibrous one-piece tops for automobile bodies in a very rapid and economical manner, and after the formation and drying thereof, these tops may be subjected to thermo-molding as above described and otherwise treated so as to provide the same with any desirable type of finish.

I claim as my invention:

1. A method of producing waterproof fibrous articles which comprises forming an aqueous fibrous stock, adding a waterproofing substance in aqueous dispersed form to said stock, causing a fixation of dispersed waterproofing particles upon the fibers by means of a fixing agent formed in situ in the mixture, at the iso-electric point of said agent, and thereafter forcing the aqueous mixture of fibers and waterproofing substance against a foraminous mould.

2. A method of producing waterproof fibrous articles which comprises forming an aqueous fibrous stock, adding a bituminous water-proofing substance in aqueous dispersed

form to said stock, treating the mixture so as to bring the same to a point approximating the iso-electric point of a fixing agent contained therein, and thereafter forcing the aqueous mixture of fibers and waterproofing substance against a foraminous mould.

3. A method of producing waterproof fibrous articles which comprises forming an aqueous fibrous stock, adding a bituminous waterproofing substance in aqueous dispersed form to said stock, treating the mixture whereby to form a fixing agent therein and to adjust the pH of the system to a predetermined value approximating the pH of said fixing agent at its iso-electric point, and thereafter forcing the aqueous mixture of fibers and waterproofing substance against a foraminous mould.

4. A method of producing shaped hollow fibrous articles having waterproof material incorporated therein, which comprises forming an aqueous fibrous stock, adding a waterproofing substance in aqueous dispersed form to said stock, adjusting the pH value of the system to the iso-electric point of a fixing agent contained therein, thereafter causing water to be expressed from said mixture while in contact with a foraminous mould corresponding in shape to that of the article to be produced, whereby to form a layer of interfelted fibers and waterproofing adjacent one surface of the mould.

5. A method of producing waterproof fibrous articles which comprises forming an aqueous fibrous stock, adding a waterproofing substance in aqueous dispersed form to said stock, precipitating a fixing agent in said mixture and adjusting the pH of the system to the iso-electric point of said agent, thereafter forcing the aqueous mixture of fibers and waterproofing substance against a foraminous mould, and releasing the formed article from the mould.

6. A method of producing waterproof fibrous articles which comprises forming an aqueous fibrous stock, adding a waterproofing substance in aqueous dispersed form to said stock, adjusting the pH value of the system to the iso-electric point of a fixing agent contained therein, thereafter forcing the aqueous mixture of fibers and waterproofing substance against a foraminous mould, releasing the formed article from the mould and drying the same whereby to effect fusion and coalescence of the waterproofing material.

7. A method of producing waterproof fibrous articles which comprises forming an aqueous fibrous stock, adding a waterproofing substance in aqueous dispersed form to said stock, adjusting the pH value of the system to the iso-electric point of a fixing agent contained therein, thereafter forcing the aqueous mixture of fibers and waterproofing substance against a foraminous mould, releasing the formed article from the mould and drying the same whereby to effect fusion and coalescence of the waterproofing material, and subjecting the dried article to heat and pressure to effect thermo-moulding thereof.

8. In the manufacture of fibrous objects of curvilinear contour and of the type wherein the fibres are interlaced and interfelted with one another in directions parallel to the contour of the forming mold therefor, the improvement which consists in rendering such objects water-resistant by incorporating waterproofing material in aqueous dispersed form with the aqueous fibrous stock from which the objects are formed, and effecting intimate admixture of said waterproofing material with the stock prior to the formation of the object on its forming mould.

9. In the manufacture of fibrous objects of curvilinear contour and of the type wherein the fibers are interlaced and interfelted with one another in directions parallel to the contour of the forming mould therefor, the steps which comprise rendering such objects water-resistant by incorporating waterproofing material in the form of finely divided particles in water with the aqueous fibrous stock from which the objects are formed, and effecting intimate admixture of said waterproofing material with the stock prior to the formation of the object on its forming mould.

10. In the manufacture of fibrous objects of curvilinear contour and of the type wherein the fibers are interlaced and interfelted with one another in directions parallel to the contour of the forming mould therefor, the steps which comprise rendering such objects water-resistant by incorporating waterproofing material in the form of finely divided particles in water with the aqueous fibrous stock from which the objects are formed, effecting intimate admixture of said waterproofing material with the stock prior to the formation of the object on its forming mould, subjecting the mixture of fibrous stock and waterproofing material to suction from one side of a curvillinear forming screen whereby to cause the mass to be felted on the screen, removing the felted object from the screen and drying the same.

11. In the manufacture of fibrous objects of curvilinear contour and of the type wherein the fibers are interlaced and interfelted with one another in directions parallel to the contour of the forming mould therefor, the steps which comprise rendering such objects water-resistant by incorporating waterproofing material in the form of finely divided particles in water with the aqueous fibrous stock from which the objects are formed, effecting intimate admixture of said waterproofing material with the stock prior to the formation of the object on its forming mould, subjecting the mixture of fibrous

stock and waterproofing material to suction from one side of a curvilinear forming screen whereby to cause the mass to be felted on the screen, removing the felted object from the screen, drying the same and subjecting the dried article to heat and pressure to effect thermomoulding thereof.

12. An article of manufacture comprising a fibrous object felted on a forming screen of curvilinear contour and having the fibers thereof interlaced and arranged parallel to the general contour of the forming screen, said fibers being coated with films of coalesced waterproofing material derived from an aqueous dispersion.

13. An article of manufacture comprising a fibrous object having the characteristics of having been felted on a forming screen of curvilinear contour so that the fibers thereof are interlaced and arranged parallel to the general contour of said screen, said fibers being coated with continuous films of waterproofing material.

14. An article of manufacture comprising a fibrous object having the characteristics of having been felted on a forming screen of curvilinear contour so that the fibers thereof are interlaced and arranged parallel to the general contour of said screen, said fibers being coated with continuous films of waterproofing material, said article being susceptible to thermomoulding without strain upon the fibers.

15. An article of manufacture comprising a fibrous object felted on a forming screen of curvilinear contour, having the fibers thereof interlaced and arranged parallel to the general contour of the forming screen, said fibers being coated with films of coalesced waterproofing material derived from an aqueous dispersion, and the interstices between the fibers being comparatively free of waterproofing material.

In testimony whereof I affix my signature.

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