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TEXTILE FABRIC

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This invention relates to fabrics, pads and similar materials made of fibers, including both cloth-like sheet materials which can be used for many of the same purposes as textile fabrics while still having distinct and individual characteristics, and also thicker, more bulky fibrous bodies.

The fibrous structures above referred to are produced without using any of the common fabricating processes such as spinning, weaving, knitting, felting, or the like.

In my copending application Serial No. 30,022, filed July 5, 1935, I have described a novel fibrous product. This product comprises a body of loosely intermingled fibers through which are distributed waterproof binder fibers which serve to unite the whole into a highly porous unified structure. In the manufacture of a preferred form of this invention cotton fibers are mixed with cellulose acetate fibers, while the latter are in a dry and non-adhesive condition. Subsequently this mixture is treated with a solvent for the binder or by heat, either procedure serving to develop the normally latent adhesive properties of the fiber and thus to bond them to, or unite with, other fibers with which they are in contact to form the product of this invention. While the normally latent adhesive properties of the binder fibers are so developed the mixture may be compressed more or less, if desired, thus making a product in which each fiber is in more intimate contact with its neighbors. After the solvent has evaporated, or the mass has cooled, depending upon the method employed to develop the adhesive characteristics of the binder elements, the fibers of the resulting product are securely bonded to each other in a unified mass. In such a product the binder may or may not completely retain its fibrous form.

The fact that the binder material which unites the fibers to each other is thermoplastic and soluble in many of the common organic solvents, some of which may be used in dry cleansing operations or in surgery or in other uses for this product, necessarily restricts the field of utility of products in which the unifying material consists of a solvent or temperature-sensitive substance. Moreover, this solvent sensitivity is objectionable from the standpoint of manufacturing expense in making bleached cotton fabrics because it is well known that the basic solutions used in kier boiling and in the common bleaching operations will attack these bonding materials. It has been considered necessary, therefore, to make such fabrics from cotton fibers previously bleached. Also, for many uses the presence of plasticizers in the binder material is objectionable because of odors, light instability, toxicity effects, and the like. The product of this invention includes structures in which no plasticizers need be included if they are not desired.

This application is a product division of my copending application Serial No. 124,235. As there explained, I have made the surprising discovery that these fabrics can be kier boiled and bleached in the usual way without disintegrating, and that when so processed those products made with the preferred binders, such as cellulose acetate and other cellulose esters, are no longer sensitive either to heat or to solvents. Thus a novel product of special utility is produced. This is an astonishing result considering the nature of the bonds which unite the fibers to each other and the well known susceptibility of these binding agents to attack by the caustic solutions used in kier boiling and bleaching agents. Not only is the integrity of the structure maintained through such a treatment, but when the binders consist of cellulose acetate, or other cellulose esters, they are regenerated or deesterified into cellulose and the soluble alkaline salts of the esterifying acids, which are later removed in the kier liquid and subsequent washes, leaving the bonds in the final product neither thermoplastic water separable nor sensitive to common solvents. On the contrary, they are approximately as resistant and stable as is cotton fiber itself. Such a product thus consists of cellulose fibers unified by a coalescence of the fibers or, in other words, by cellulose bonds.

This product therefore completely eliminates all of the objectionable characteristics above described in applicant's earlier product. If the conversion or deesterification of the binder is complete, and the goods originally consisted of cotton fibers bonded together by cellulose ester fibers, then the entire fibrous body is converted into an integral chemically homogeneous structure. The degree of conversion during the kier boil is intimately related to the alkaline solution used, the temperature applied, and the length of time occupied by the process. For example, typical conditions maintained in a kier boil are to use a de-esterifying solution comprising a 1% solution of sodium hydroxide in water at a temperature of approximately 250° F. for a period of, say, ten hours. Such a treatment produces a fairly complete conversion of the cellulose acetate binder fibers to a relatively pure

cellulose form. If, however, this time is shortened, the temperature is lowered, or the alkalinity is reduced, then the degree of conversion will be lessened. When raw cotton fibers are included, this treatment also scours the cotton fibers, removing the normal waxes and oils from them, and reduces them to an approximately pure cellulose form except for such colored impurities as may later be removed by bleaching. In my preferred products the binder material, as well as the fibrous material, is preferably easily wettable by water, and the binder material will be rendered highly wettable by water at the preferred degree of de-esterification.

It follows from this fact and what has been said above that the preferred products, taken as a whole, are highly porous and highly absorbent bodies. The bleaching operation effects a further purification of the cotton fibers, improves their color, and slightly increases their absorbency. Any of the common commercial bleaching agents which are used with cellulosic textiles and which will give adequate whiteness without substantial destruction of the cellulose, may be used. Generally, such a bleaching solution is an alkaline oxidizing agent. A common form of bleach is a solution of sodium hypochlorite. While it is preferable to de-esterify the cellulose ester by kier boiling or bleaching, or both, since this treatment produces highly desirable changes in the fibers, such de-esterification can, if desired, be produced by treatment with other aqueous alkaline solutions when kier boiling or bleaching is not desirable.

The binder generally used in making my preferred product is ordinary commercial acetone-soluble cellulose acetate. It is thermo-softening. Similarly, I may use allied cellulose esters, such as the acetate propionate and the acetate butyrate, so long as they exhibit comparable solubility and thermo-softening properties and are capable of being de-esterified by the processes herein described. As above indicated, the total removal of ester groups attached to the cellulosic binder is not necessary, although this may occur. For most purposes a satisfactory product is obtained when the binder has lost its solubility in the organic solvents and its thermo-sensitive properties, as herein defined, whether or not all ester groups have been removed. In this connection it may also be pointed out that commercial cellulose acetate fibers are not completely esterified for the reason that fibers having more desirable properties are produced if the esterification is partial rather than if it resulted in pure triacetate binder fibers. Also, that in the mixed fiber product prior to de-esterification, the binder fibers are soluble in a range of solvents to which the cotton fibers are highly resistant, whereas after de-esterification both kinds of fibers are about equally resistant to the latter solvents and solvents for one are also solvents for the other.

It should be observed that in this process the binder performs an essential structural function in the production of the initial fibrous body, and that its subsequent treatment, in accordance with my invention, produces a profound chemical change in the nature of the binder without any visible physical degradation or destruction of the binding power exerted by it whereby, as a result, a unique and highly useful new structure is formed. Thus, in my preferred product, as distinguished from the product disclosed in Serial No. 30,022, the binder and the product as a whole are neither sensitive to organic solvents nor to softening by heat. At the same time the union of the fibers, both as to functional characteristics and as to strength, is substantially like that which existed before the treatment herein described. So far as I am aware, such a product has never been produced heretofore.

For convenience the bond, union, or similar relationship of the fibers to each other produced in the manner above described, and which is relied upon to give the fibrous body its strength and stability, is frequently herein designated as a "coalescence," or by some similar term, whether or not such terms are used in their strict or technically accurate sense.

In manufacturing the product of application Serial No. 30,022, it is a common practice to incorporate a plasticizer in the cellulose ester binders, and it is desirable to remove these constituents because they are normally complex organic compounds which are often toxic. I have discovered that the kier boiling operation will produce desirable products which are entirely or substantially free of plasticizers that may have been included in the original structure before the treatment above described. For example, a preferred plasticized acetate composition may contain as much as 50% of a plasticizer known as para toluene ethyl sulphonamide. This plasticizer is readily removed in the manner above described, and notwithstanding the fact that it originally constituted a high proportion of the mass of the fiber, the removal of part or all of it leaves the fibers securely bonded to each other. Residual solvents and other impurities also are removed by this process.

An important advantage of the product of this invention lies in the fact that it permits the initial preparation of the fibrous structure from raw cotton, which is far more satisfactory material to handle in such machines as pickers, garnets, and the like, than is bleached cotton. The natural wax lubricant of the raw cotton facilitates these mechanical operations and reduces the waste and fly created in working the fibers. In fact, some grades of cotton which can be carded in the raw are practically impossible to card after kier boiling and bleaching. Moreover, the unified body produced by the method above described can be kier boiled and bleached exactly as in the case of any cotton fabric. This also permits the economical handling of the fabrics by those methods commonly used with woven, felted, knitted, and like products, as against the far more expensive and cumbersome method of bleaching the cotton fiber in bulk prior to making up the fabric structure. In addition, a web made from raw cotton which is subsequently kier boiled and bleached has a more attractive appearance than one made from cotton which has been kier boiled and bleached with the cotton fiber in bulk. Usually the web consists of a series of carded webs superposed one on another.

In a product of this invention made by processes described in the earlier application Serial No. 30,022, above referred to, the development of the coalescing properties of the binder fibers during the unifying step may, if desired, be carried to such a point that the fiber form of the binder will be destroyed and this constituent of the mixture will be left distributed throughout the product in the form of small individual droplets or irregularly shaped bodies adhering to the cot-

ton fibers in such a manner as to bind them together into a coherent mass. If such a product is subjected to the de-esterifying treatment above described, these droplets or other binder elements will be converted into cellulose, as in the case of the product in which the binder is left in a fiber form. The conversion treatment neither changes the position nor substantially changes the shape of the binder elements.

In referring to de-esterification of the cellulose ester binder material in the specification and claims hereof, it is to be understood that I mean conversion of the binder material into one of lower acetyl, or even of no acetyl content, while maintaining its solid form, so that the binder material is no longer thermoplastic nor soluble in the common organic solvents for cellulose esters, such as acetone; and in referring to de-esterified cellulose ester binding material, I mean the product of the de-esterifying action just referred to.

It should be observed that since this is a textile fiber product, and because only a very small percentage of textile fibers in a carded web are less than ½" in length, and most of them considerably longer, the nature of this product differs materially from short-fibered products, such as paper, in such qualities as pliability, porosity, and the like. It is also to be observed that these differences can be utilized in controlling and predetermining the characteristics of the product to be made. For example, many of the goods covered by this invention contain only a small percentage, say, in the neighborhood of 3–5%, of binder fibers, although products containing higher percentages of binder fibers are also useful. With such small proportions and even higher percentages of binder fibers, the spacing of the points of coalescence or welding of the fibers to each other may be made relatively great so that there are comparatively long lengths of fibers which are free from attachment to, or bonding with, other fibers, and these free lengths of fiber are important characteristics of these highly porous and very flexible products. Also, this product is substantially free from the degraded forms of cellulose always found in paper and which there serve as binding materials, smeared over the fibers and embedding them in a matrix of degraded cellulose binder. In my product, the number of points at which a given fiber is coalesced with another fiber is variable. Several separate points of union of a given fiber with other fibers may occur, or a relatively few fibers may not be actually fused at all to other fibers. Within the limitations of the mechanical process of distribution of the binder and non-binder fibers, as above described, I have, however, a true statistical distribution of bonds in all directions in an unlaminated fabric. In a laminated fabric I may vary the average distribution from face to face by varying the composition of the individual laminae, while still maintaining random distribution in the laminae themselves.

While the product of this invention is probably of greatest practical utility in those forms which include cotton or those in which cotton forms a predominating constituent, nevertheless, equally useful products include other textile fibers, such as wool, silk, and particularly those of a cellulose nature such as rayon of the type known as viscose.

In this connection it may also be pointed out that a purified product, particularly one from which plasticizers and similar objectionable constituents of the binder have been eliminated, is of advantage regardless of any other effect on the binder. Plasticizers are primarily used to lower the thermo-softening range of the binder or to change its characteristics in some manner adapted to facilitate the subsequent step of developing the normally latent adhesive properties of the binder and unifying the product. After this step has been performed, the presence of the plasticizer is a disadvantage, both for the reasons above pointed out and also because it makes the binder more sensitive to the action of heat, solvents, and the like. Consequently, the mere fact of eliminating these constituents improves the product since it converts the binder into a more stable form in which it is less likely to be destroyed or adversely affected.

In connection with the foregoing it may be pointed out that by "heat sensitivity" I mean a softening range whereby the material may be heated, softened and manipulated in accordance with the teaching of this patent application. The absence of such a softening range I define, for my purposes as "heat stable."

By the term "solvent sensitivity" I mean, for the purposes of this patent application, solubility at atmospheric temperatures in one or more of the following, e. g., alcohol, ether, chloroform, and acetone. For the purposes of designating substances which are not sensitive to this class of solvents, I call them "solvent stable."

It is to be understood that the products of this invention comprise various fibrous products, including different kinds of fiber and different binders, variations or modifications of the structure being necessary to suit the requirements of their particular use.

It will be evident from the foregoing that this invention provides a product which may take a considerable variety of forms, including both sheeted articles and also thicker and more bulky bodies such as pads, surgical sponges, and the like. The fact that these products can be made economically by methods such that they contain no foreign material, but consist of approximately pure cellulose, and further that they can be made of a highly porous and extremely absorbent nature makes them very useful as base materials in the production of such articles as surgical dressings or other articles where a pure, or substantially pure, cellulose product is desired.

This application is a division of my copending application Serial No. 124,235, filed February 5, 1937 (since issued as Patent No. 2,269,479), the claims on the method being presented in the parent case while those of the instant application are limited to the product.

Having thus described my invention, what I desire to claim as new is:

1. A fibrous structure of the character described, composed essentially of intermingled, unorganized, textile fibers united by discrete de-esterified cellulose ester bonds and secured thereby in relatively fixed relationship to each other.

2. A fibrous structure of the character described, composed essentially of intermingled, unorganized, dry-assembled bleached cotton fibers united permanently by de-esterified cellulose ester fibers into a highly porous absorbent structure, the two kinds of fibers being coalesced at intersecting points spaced apart by appreciable distances.

3. A fibrous structure of the character described, composed essentially of a mixture of cotton textile fibers and de-esterified cellulose ester

textile fibers intimately intermingled in an unorganized relationship and united at intersecting points by the coalescence of the fibers themselves.

4. A fibrous structure of the character described, composed essentially of an unorganized mixture of cotton textile fibers and de-esterified cellulose ester fibers intimately intermingled and united at intersecting points by coalescence of the fibers themselves, the points of coalescence being so spaced and distributed as to leave relatively long lengths of fibers free from attachment to each other.

5. A fibrous structure of the character described, composed essentially of textile fibers and de-esterified cellulose ester fibers intimately intermingled with each other and coalesced at spaced intersecting points, thereby uniting the entire body of fibers into an integrated structure, said fibers and the points of coalescence of the fibers with each other being solvent stable.

6. A fibrous structure of the character described, composed essentially of a mixture of heterogeneously intermingled bleached cotton fibers and de-esterified cellulose ester fibers united at intersecting points by discrete bonds forming parts of said de-esterified cellulose ester fibers, said bonds and the latter fibers being de-esterified to such a degree as to give them solvent stable and heat stable characteristics approximating those of the bleached cotton fibers, said bonds being so spaced as to provide relatively long lengths of fibers free from attachment to other fibers.

7. A sheeted product of the character described, comprising a plurality of superposed carded webs composed essentially of bleached cotton fibers and de-esterified cellulose ester fibers heterogeneously intermingled, with the latter fibers distributed in random fashion throughout the cotton fibers, both kinds of fibers being united by coalescence at spaced points of contact with each other and both kinds of fibers being highly resistant to the action of the common solvents for cellulose esters, said points of coalescence securing said fibers in a relatively fixed relationship to each other but being so spaced as to leave relatively long lengths of a high proportion of the fibers free from attachment to other fibers.

8. A sheeted fibrous structure of the character described, comprising a plurality of superposed carded webs composed essentially of cellulose textile fibers and de-esterified cellulose ester fibers intimately intermingled with each other and united at intersecting points by the coalescence of the fibers with each other, said points of coalescence being so spaced and distributed as to leave relatively long lengths of fibers free from attachment to each other and the entire product being substantially free from plasticizers.

9. A fibrous structure of the character described, composed essentially of de-esterified cellulose ester fibers and other textile fibers heterogeneously intermingled with each other and united into a unitary structure by coalescence of the fibers themselves at spaced points.

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