

UNITED STATES PATENT OFFICE

2,306,781

PRODUCT CONTAINING SILICEOUS FIBERS
AND METHOD OF MAKING THE SAMECarleton S. Francis, Jr., Chestnut Hill, Pa., as-
signor to Sylvania Industrial Corporation,
Fredericksburg, Va., a corporation of VirginiaNo Drawing. Application July 17, 1941,
Serial No. 402,811

17 Claims. (Cl. 57—140)

This invention relates in general to fibrous products made from siliceous fibers and in particular to textiles including yarns, fabrics and felts comprising siliceous fibers and to correlated improvements designed to enhance the quality, structure and properties of the products so produced. This application is a continuation-in-part of my co-pending applications Serial No. 157,018 filed August 2, 1937; Serial No. 300,876 filed October 23, 1939; and Serial No. 381,292 filed March 1, 1941.

Textiles, including felts made from siliceous fibers, for example, glass fibers, asbestos fibers, rock wool and the like, are characterized by many valuable technical properties, but these products have also certain inherent qualities which detract from the quality, structure and properties of the products made therefrom and limit their field of use.

Siliceous fibers as a class are characterized by being smooth of surface, straight and relatively brittle. Staple fibers of siliceous material, in particular, glass fibers and rock wool, do not show any substantial tendency to cling to one another and, therefore, these fibers cannot be felted or spun as readily as curly or irregular fibers such as wool and the like. Yarns of siliceous fibers tend to untwist because the fibers cannot be maintained permanently in any substantial degree of distortion. Yarns made from siliceous staple fibers are deficient in strength because the smooth straight fibers freely slip upon one another. Another disadvantage of yarns and felts made from siliceous staple fibers is the fact that such products have a very substantial nap, the ends of the fibers which protrude in many cases break off and there is also a substantial loss of short fibers from the product, all of which properties impart a very low resistance to abrasion. Yarns made of continuous glass filaments are so smooth that they slip upon one another in fabrics formed therefrom.

It is a general object of the present invention to provide fibrous products comprising siliceous fibers which are substantially free from the above mentioned disadvantages.

It is another general object of the invention to provide yarns and fabrics of siliceous fibers, in particular, staple fibers, which products will be characterized by an increased tensile strength, a stabilized yarn twist, a decreased tendency to unravel at the ends and an increased abrasion resistance.

Another object of the invention is to provide felts of siliceous fibers which will be character-

ized by greater tear resistance, increased flexibility and an increased resistance to abrasion and, if desired, a greater compactness and stiffness.

5 Other objects of the invention will in part be obvious and will in part appear hereinafter.

According to the present invention fibrous products such as textiles including yarns, fabrics and felts of improved characteristics are produced from siliceous fibers, in particular, staple fibers, by associating the siliceous fibers with potentially adhesive fibers, preferably thermoplastic fibers, forming the fibers into a textile or felt and thereafter activating the potentially adhesive fibers to bind the siliceous fibers in the product.

10 In one embodiment, the invention contemplates the production of improved textile fabrics formed in whole or in part of yarns, for example, singles yarns made by mixing together, prior to the completion of spinning, siliceous staple fibers and a minor proportion of potentially adhesive fibers preferably thermoplastic fibers, forming the mixture of fibers into a yarn, or composite yarns made by twisting or doubling the potentially adhesive strand with another strand or yarn into thread or cord, and, if desired, weaving or knitting such yarns into textile fabrics. The textile is treated to activate the potentially adhesive fibers to bind the siliceous fibers in the product.

15 In another embodiment of the invention felts, either flat or molded in any desired shape, are formed by mixing together siliceous fibers and potentially adhesive fibers during the formation of the bat and, if desired, pressing the bat of fibers into a pressed felt, and activating the potentially adhesive fibers to bind the siliceous fibers in the product.

20 The invention is applicable for making fibrous products of all kinds from siliceous fibers as a class. Therefore, there may be used in the invention siliceous fibers of all types such for example as glass fibers, asbestos fibers (which may be either amphibole asbestos or serpentine type asbestos) and mineral fibers as a class, such as rock wool, mineral wool, slag wool and the like. The siliceous fibers and/or the potentially adhesive fibers may be continuous filaments or short fibers of any length. The artificial siliceous fibers such as glass, rock or slag fibers may be produced in any suitable manner as is well known in the art. A conventional process for the production of such fibers is to melt the siliceous material (glass, rock or slag) and disperse

a stream of the molten material by means of an air blast so as to produce fibers which harden upon cooling. In certain embodiments of the invention the siliceous fibers may be employed in the form of continuous filaments, but in most embodiments of the textile, yarns and fabric and in all the embodiments of the felted products herein contemplated, the fibers are understood to be discontinuous short fibers.

The potentially adhesive fiber preferably comprises any fibrous material which has an inherent tackiness upon heating, but which is non-tacky at room temperature, preferably a thermoplastic synthetic resinous material or a thermoplastic cellulose derivative, capable of being formed into fibers. The potentially adhesive fiber may comprise a resin formed by the polymerization of various organic compounds such as cumarone, indene hydrocarbons, vinyl, styrene, sterol aldehyde, furfural ketone, urea, thiourea, and condensation products such for example as urea-aldehyde resins, phenol-aldehyde resins, amine-aldehyde resins, sulfonamide-aldehyde resins, polyhydric alcohol-polybasic acid resins, drying oil-modified alkyd resins, resins formed from acrylic acid, and methylmethacrylate, sulfur-olefine resins, resins formed from dicarboxylic acids and diamines (Nylon type); fibers formed from synthetic or artificial rubber such, for example, as polymerized butadiene, olefine-polysulfides, e. g., "Thiokol," isobutylene polymers, e. g., "Vistanex," chloroprene polymers, e. g., "Duprene" and plasticized polyvinyl-halides, e. g., "Koroseal," chlorinated rubber e. g., "Pliolite," also fibers formed from the co-polymers of two or more resins-forming compounds such, for example, as co-polymers of vinyl halide and vinyl acetate, co-polymers of vinyl halide and acrylic acid, co-polymers of vinyl compound and styrol compound; and also fibers formed from a mixture of resins, such for example as a mixture of vinyl resins and acrylic acid resins or methacrylate resins, a mixture of polyolefine resins and phenol aldehyde resins, or a mixture of two or more resins from the different classes just named.

The thermoplastic resins above-mentioned may be classified as:

(a) Heat non-convertible resins such for example as glycol polybasic acid resins, vinyl resins and the acid type phenol-aldehyde resins, and the like.

(b) Heat-convertible thermosetting resins such for example as a glycerol polybasic acid resin, polyolefine resins, phenol-aldehyde resins and the like.

(c) An element-convertible resin (which becomes infusible through the action of certain elements, such as oxygen and sulfur) such for example as glycerol-polybasic acid-drying oils, resin and olefine sulfur resins.

In addition to the thermoplastic synthetic resins, there may be employed for the potentially adhesive fiber, a fiber formed from a thermoplastic cellulose derivative, such for example as a cellulose ester, a cellulose ether, a mixed cellulose ester-ether, or a mixed cellulose ether. For example, the thermoplastic cellulose derivative fiber may be a fiber of cellulose acetate, cellulose nitrate or an organic soluble cellulose ethyl ether, and the like. The potentially adhesive fibers may be formed from a thermoplastic mixture of cellulose derivatives and resins, such for example as a mixture of cellulose nitrate and an oil soluble phenol-aldehyde resin, or a cellulose

acetate and a methylmethacrylate resin, or an organic solvent soluble cellulose ether and a vinyl resin.

For the thermoplastic fiber, it is preferred to employ a resin fiber because such fibers, as compared to the cellulose derivative fibers, are tougher and harder, become tacky at lower temperatures and cool to form tougher and more pliable products. Moreover, the resin fibers used are preferably those which are inert to acids, alkalies and dry-cleaning fluids, and are not water-swelling, such for example as the polyvinyl resins, acrylate resins and the linear polyamides. Use of such resins prevents distortion of the adhesive bond under changing atmospheric conditions or in the presence of salts, acids and alkalies, so that the wet and dry tensile strength of the adhesive bond will be substantially the same. Finally, the resin fibers exhibit, particularly when plasticized, a high tensile and a high elasticity almost as great as that of natural silk.

The potentially adhesive fibers may comprise cellulose derivatives such as cellulose ethers and esters which are soluble in organic solvents or a cellulose ether which is soluble in alkali; or gelatine, casein, zein, chitin and like protein materials which may be rendered insoluble by conventional methods. The potentially adhesive fibers may be used in the unstretched or pre-stretched condition.

The association of the siliceous fibers with the potentially adhesive fibers may be carried out in any manner appropriate to the type of fiber and the product to be produced. For example in the fabrication of textiles, yarns and fabrics, the two types of fibers may be mixed or blended by carding, combing, drafting or other operation prior to the completion of spinning, or by means of twisting or doubling of the strands or yarns. For example, the two types of fibers may be mixed together in a picker and the mixture carded, or they may be fed together into a carding machine; or slivers made separately from each type of fiber may be combined by feeding the slivers of the different types together between the rolls of a drafting machine and the mixed sliver spun into yarn. Alternatively, a strand or yarn formed of siliceous fibers either continuous filaments or staple fibers, may be twisted about a strand or yarn formed of potentially adhesive fibers either continuous filaments or staple fibers, so that in the finished yarn the potentially adhesive fibers constitute the core of the yarn; or a strand or yarn of the potentially adhesive fibers of either type may be twisted about a strand or yarn formed of the siliceous fibers of either type so that in the final product the siliceous fibers constitute the core of the yarn. In another embodiment one or more yarns formed in whole or in part of siliceous fibers, either continuous filaments or staple fibers, are twisted or doubled with one or more yarns formed in whole or in part of potentially adhesive fibers to make a plied yarn which may be a thread or cord.

In another embodiment of the invention the siliceous fibers and the potentially adhesive fibers may be mixed together by forming a gaseous dispersion of each type of fibers and causing the fibers to intermingle and deposit together. For example, the siliceous fibers and/or the potentially adhesive fibers may be formed by a spraying operation and admixed together as disclosed in my

co-pending application Serial No. 381,292 filed March 1, 1941.

The relative proportions of the siliceous fibers and of the potentially adhesive fibers may be varied in accordance with their properties; the nature of the activating treatment, the intended use of the finished product, and of the characteristics desired therein. In the now preferred embodiment, the potentially adhesive fibers constitute the minor proportion of the fibrous product. For most fibrous products, the potentially adhesive fibers may comprise from 2 to 20 per cent by volume of the mixture without limiting the invention to this range. The fiber mixture may be fabricated into felts, yarns and fabrics of all kinds.

The fibrous product containing the mixture of fibers is treated to activate the potentially adhesive fibers, that is, to render them sufficiently tacky and adhesive that they will adhere to each other, or preferably will adhere to the siliceous fibers. The expression "activating" as used in the following specification and claims is intended to designate any treatment by which the potentially adhesive fibers are rendered adhesive and with or without retention of the fiber form. The extent of the activating treatment will depend, inter alia, upon the nature of the potentially adhesive fibers, upon their proportion in the product and upon the properties and characteristics desired in the product.

The activation may be in predetermined areas or uniformly throughout, depending upon the effect desired; also, the textile may be subjected to two or more activating treatments either in sequence or separated by other treatments and textile operations. Activation, in general, may be carried out at any time after the association of the fibers. Among the methods which may be used for activation are the following, taken singly or together in appropriate combinations:

(1) When the potentially adhesive fibers are thermoplastic, they may be activated by heat with or without solvents or pressure.

(2) By applying to the textile a solvent or swelling agent or mixtures thereof with diluents, under such conditions of concentration and temperature as to render the potentially adhesive fibers tacky or to convert them into an adhesive mass. For example, alkali soluble cellulose ethers may be activated by the use of aqueous solution of caustic alkali, or quaternary ammonium bases; fibers of regenerated cellulose can be rendered adhesive by solutions of cupraammonium, zinc chloride, alkali-metal perchlorates, and the like. Organic cellulose derivatives, such as cellulose esters, may be rendered adhesive by solvents, such as acetone, ethyl acetate, butyl acetate and the like.

(3) A latent activating agent may be combined with the potentially adhesive fibers by impregnating them with such an agent prior to their association with the siliceous fibers. Such agent may be rendered active by a subsequent treatment, such as by heat, thus producing a simultaneous activation of the fibers. For example, cellulose derivative or resin fibers may be impregnated with a liquid which, at room temperature, is a non-solvent therefor but which, at a higher or lower temperature, is a solvent sufficiently active to render the fibers adhesive.

While the fibers are in an adhesive condition, the fibers may be subjected to a compacting treatment to promote a partial or complete adhesion and/or fusion of the associated fibers at their points of contact. For example, mechani-

cally applied pressure or centrifugal force may be exerted on the activated fibrous structure during and/or after activation, or deactivation, and/or during calendering, embossing, printing, drying and other finishing operations. Compacting may be accomplished by twisting the yarns, threads, cords and the like with or without application of additional external pressure and/or tension. Alternatively, an activated yarn or fabric may be subjected to tension, warpwise and/or weftwise, to cause the fibers and yarn to make more intimate contact with each other. The step of compacting is optional, depending upon the properties and finish desired in the product.

The spinning, twisting and doubling of the yarn may be carried out during activation while the fibers are in an adhesive condition, thus improving the adherence and bonding of the fibers and/or of the yarns to one another.

Simultaneous with or subsequent to compacting, the textile may be treated to deactivate the adhesive, that is, to render the adhesive non-tacky so as to fix the new relationship of the fibers. The nature and extent of the deactivation treatment will depend, inter alia, upon the nature and extent of the activating treatment and upon the proportion and kind of potentially adhesive fibers used. If activation has been accomplished by heat, deactivation may be accomplished by heating to a higher temperature (for thermosetting resins) or by cooling (for thermoplastic materials), if by solvents, deactivation may involve evaporation, extraction, neutralization or coagulation of the solvent. The removal of the activating agent depends upon whether its presence in the product is desirable or objectionable.

The activating, compacting and deactivating treatments herein described may be carried out independently of, or simultaneously with, various treatments common to the fabrication and finishing of textiles.

Further, the textiles and felts of the invention may be embossed, calendered, molded or otherwise shaped to deform the surface while the adhesive fibers are still tacky and then subsequently deactivated to set them with a desired form or surface condition. Such molding and deformation may take place before, during or after activation, compaction and/or deactivation. Such deformation may be produced in predetermined areas or over the entire surface by pressure rollers, friction calenders, embossing rollers, and the like, which may be used hot or cold and with or without the aid of agents which soften, swell, plasticize or otherwise modify the fibrous product acted on.

To facilitate the handle and fabrication of the siliceous fibers these fibers may be lubricated with a suitable wax, oil, plasticizer or the like. To increase compactness of the fibrous product, the siliceous fibers and/or the fibrous product may be sized with a composition comprising starch, casein, a cellulose derivative, a resin, viscose, rubber, latex, with or without fillers, pigments, dyes and textile assistants. The external sizing may be chemically similar or dissimilar to the potentially adhesive fibers and the external sizing may be applied before, during or after activating the potentially adhesive fibers; the sizing composition may comprise a substance such as an alkali or an organic solvent which will serve to activate the potentially adhesive fibers.

By way of illustration, but not by way of limiting the invention, there will be given the fol-

lowing examples of fibrous products which can be made according to the present invention.

From the mixture of glass fibers and potentially adhesive fibers there may be made yarns, fabrics and felts in general and in particular such articles as battery separators, filter cloths, fire-proof curtains, shields and garments, neckties, sewing thread, wearing apparel for those handling acids or corrosive liquids, tire cords, insulating covers and sleeves for electric cables, and the like. From the mixture of asbestos fibers and potentially adhesive fibers there may be made yarns, textiles and felts in general and in particular wearing apparel for fire fighting, fire curtains and screens, stage curtains, ironing pads, covers for ironing rollers, gloves, boots, hats, pads and felts for burners and heating equipment, insulating layers for heat and sound proofing, shingles, wall board, and the like. From mixtures of rock wool or mineral wool and potentially adhesive fibers there may be made yarns, textiles and felts in general and in particular insulation against sound, heat and vibration, fire shields, fire screens and curtains, plant mulches, packing material for containers of acid and other corrosive liquids.

By way of illustration, but not by way of limiting the invention, there will be given the following specific examples of methods of making some of the articles above mentioned:

Example 1

A mixture of 93% glass staple fibers and 7% polyvinyl acetate staple fibers are mixed prior to completion of the spinning as by carding the fibers together and spun into a yarn which is fabricated into an insulating fabric. The fabric is heated to a temperature sufficient to cause the resin fibers to soften and coalesce with each other and with the glass fibers at their points of contact. Upon cooling there is formed a strong, non-inflammable fabric having a relatively high flexibility.

Example 2

A mass of glass fibers or mineral wool fibers which normally contain a substantial weight of small beads or pellets of glass or mineral is first carded, by which operation the beads are effectively removed, and, before or after such carding operation, the siliceous fibers are admixed with a minor proportion of thermoplastic cellulose derivative fibers by any suitable means and the mixture is formed into a bat. This bat is subjected to heat sufficient to render the thermoplastic cellulose derivative fibers adhesive to bind fibers in the bat. If no pressure is employed the bat will be soft and of loose porous character suitable for use as an insulator blanket in the construction of refrigerators or for pipe covers. If pressure is employed in combination with the heating step, the pressed felt thus produced will be more compact, although relatively flexible, and thus suitable for electrical insulation, filters and battery separators.

The felts made according to the present invention are characterized by having, in comparison with felts the fibers of which consist of siliceous fibers, higher tensile strengths, a greater resistance to the loss of fibers and a higher abrasion resistance; also the ability to be molded, formed or embossed in any desired configuration and to remain permanently in such configuration. In prior felts containing a binder, the siliceous fibers are substantially coated with the binder whereas

in the present felt, the fibers are not coated and accordingly there is no substantial loss of porosity and there is a gain in flexibility.

Example 3

Rock wool or glass wool mats intended for use in covering pipes to insulate them against temperature changes are normally molded or spirally wound to conform to the shape of the pipe. These mats are formed by depositing the fibers on the surface of a belt moving through the bottom of a chamber, with the fibers laid longitudinally to the direction of the belt, sprayed with a binder and compressed by means of a cold roller. These mats should show substantial cohesion and tensile strength, and must be capable of bending and flexing. However, since the glass fibers are laid parallel by the process described, such prior mats show a tendency to separate into layers, and exhibit little tensile strength transverse to the length of the fibers, and frequently break when bent. These disadvantages may be overcome by use of the present invention, for example, by blowing into the chamber in which the rock wool or glass wool fibers are being deposited, a minor proportion by volume for example 15% of thermoplastic fibers, for example, polyvinyl resin fibers of suitable length which may be preformed fibers or fibers formed by spraying concurrently with the deposition of the glass fibers, compressing the mat of mixed fibers as by means of rollers heated to a temperature of 150° C. whereupon the vinyl resin fibers are rendered adhesive and bind the glass fibers together. Since the resin fibers are uniformly distributed and are in random arrangement in the felt, there is thus produced a porous insulating mat which has a high tensile strength transverse of the length of the glass fibers, a high mass integrity and which can be flexed or bent without cracking or separating.

Example 4

The present example will illustrate the production of non-porous sheet materials comprising glass fibers, adapted for use as electrical insulators. By carding or air-deposition there is formed a mixture of glass fibers and from 10% to 30% by volume of fibers formed of a thermosetting resin, for example a phenol-formaldehyde resin, a urea-formaldehyde resin, a melamine-formaldehyde resin, and the fiber mixture compressed into a sheet by the application of high pressure and sufficient heat to cause the resin fibers not only to melt, but also to flow so that the fibrous sheet is permeated by the resin and rendered solid and non-porous. The sheet thus formed may be surfaced by coating it with a film of resin, cellulose derivative or rubber, or by laminating it to a sheet of material having a high dielectric, for example, regenerated cellulose, such sheet being coated preferably on both sides with a film of the thermosetting resin and laminated to the non-porous layer of fibers by heat and pressure. The plain or surfaced layer of fibers is characterized by being of high dielectric value, resilient, impervious to moisture and resistant to vibration, shock and abrasion. This sheet is then cut into segments and the segments interposed between the metal segments of a commutator or other electrical device in place of the brittle mica sheets heretofore used for such purpose. When such commutators are assembled they are usually coated with varnish and baked, during which treatment the

thermosetting resin is converted to the infusible hard form so that the copper segments and the insulating segments are united into an integral piece.

Example 5

There will be shown the application of the present invention to the production of hollow porous tubes for use as storage battery electrodes. These tubes have heretofore comprised an inner layer of fine glass fibers and an outer layer of coarser glass fibers, the outer layer being impregnated with a binder such as vulcanized rubber to give strength and rigidity, but such binder must be confined to the external layers of the tube because it is corroded by contact with the paste within the tube. By the present invention such binders can be dispensed with by forming both layers or preferably the outer layer of the tube from a mixture comprising a major portion of glass fibers and a minor portion, for example 20% by volume of polyvinyl resin fibers and activating the resin fibers by heat to cause the resin fibers to bind the glass fibers, thus obtaining the requisite strength and rigidity and preventing the loss of fibers while retaining the desired porosity of the tube for the battery fluid.

Example 6

In the manufacture of plied yarns by twisting or doubling a plurality of singles yarns composed of siliceous fibers, it has been found that the plies tend to separate after the twisting or doubling operation, this separation being termed "blooming." According to the present invention such "blooming" is prevented by using as one of the singles yarns which are to be twisted together or doubled from a yarn comprising a mixture of siliceous fibers and potentially adhesive fibers, which yarn can be formed by twisting the potentially adhesive fibers around a strand of the siliceous fibers or by drafting a roving of the potentially adhesive fibers with rovings of siliceous fibers and twisting the composite roving in such a way as to cause the potentially adhesive fibers to be substantially on the surface of the yarn. Such a singles yarn is then twisted or doubled with yarns of siliceous fibers and heated during the twisting operation sufficiently to render the potentially adhesive fibers tacky, thus causing the plies in the yarn to be bound together, or, alternatively, the plied yarn is wound under tension upon a spool and the yarn package heated to activate the potentially adhesive fibers.

Various changes may be made in the present process and in the article without transcending the scope of the invention. In addition to containing siliceous fibers and potentially adhesive fibers, the yarns may comprise other fibers which are not potentially adhesive, such as fibers of wool, cotton, silk and strands of metal. The potentially adhesive fiber and/or any organic fibers which may be present may be dyed or pigmented to impart identifying or decorative effects to the finished products. By causing the potentially adhesive fibers to be substantially on the surface of the yarns the activation may be such as to provide the siliceous fiber yarn with a substantially continuous coating of the material resulting from the activation of the potentially adhesive fibers. This will be advantageous, in the manufacture of plied yarns where adhesion between the plies is desirable in preventing yarn slippage in fabrics and also beneficial when it is

desired to impart a uniform color to the yarns, in which case the color is carried by the potentially adhesive material. When the potentially adhesive fibers are substantially only in the center of the yarn, the external appearance of the yarn is not altered although the core of potentially adhesive fibers strengthens the yarn.

The textiles of the present invention are characterized, when they are in the form of yarns, threads and cords, by having higher tensile strength for a given amount of yarn twist, less nap, less tendency to shed fibers, a more stabilized yarn twist and substantial freedom from unravelling. In the particular case of plied yarns, the proportion of the potentially adhesive fibers and the degree of activation may be so correlated as to bind the plies together so as to prevent blooming or separation of the plies during handling or treatment of the plied yarn. When the textiles are in the form of fabrics, they are characterized by having higher tensile strength, decreased slippage of the yarns one upon another, less nap, a smoother finished surface and higher abrasion resistance. Due to the bonding of the asbestos fibers to each other through the medium of the adhesive resulting from the activation of the potentially adhesive fibers, it is possible to prepare yarns having the same tensile strength with less twist than prior yarns of the same kind, or to make yarns having higher tensile strength when using the same twist as prior yarns of the same kind. It is possible by the present invention to make a more compact yarn of siliceous fibers which has a decided advantage when the yarn is used for braiding electric cables or for winding electric wires which are to be used in heating units because it is thus possible to increase the diameter of the wire or to increase the number of wires per unit area. Other advantages of the invention will be obvious from the above detailed description.

I claim:

1. In a process of making a fibrous product, the steps comprising associating siliceous fibers with organic fibers which are potentially adhesive, forming the associated fibers into a fibrous product, and activating the potentially adhesive fibers to render them adhesive to bind fibers in the product.

2. A process of making a textile, which comprises commingling, prior to the completion of spinning, siliceous fibers with organic fibers which are potentially adhesive, forming said commingled fibers into a textile, and activating the potentially adhesive fibers to render them adhesive to bind fibers in the product.

3. A process of making a yarn, which comprises mixing together, prior to the completion of spinning, siliceous fibers and potentially adhesive organic fibers having an inherent tackiness on heating, spinning said mixture of fibers into a yarn, and subsequently rendering said potentially adhesive fibers tacky by heat to effect a strong and substantially permanent adhesion between fibers in the product.

4. In a process of making a felt from normally non-felting fibers, the steps comprising forming a fiber mixture comprising siliceous fibers and potentially adhesive organic fibers, and treating said potentially adhesive fibers in said mixture to render them tacky and effect bonding of fibers in said product.

5. In a process of making a textile, the steps

comprising associating potentially adhesive organic fibers, concurrently with their formation, with siliceous fibers and activating the potentially adhesive fibers to bind fibers in said product.

6. In a process of making a composite yarn, the steps comprising twisting a strand comprising potentially adhesive organic fibers with a strand comprising siliceous fibers to form a yarn, and activating said potentially adhesive fibers to bind fibers in said yarn.

7. A fibrous product comprising siliceous fibers associated with potentially adhesive organic fibers, fibers in said product being bound together as the result of activation of said potentially adhesive fibers, the binding of the fibers stabilizing the structure of said product.

8. As an article of manufacture, a textile comprising yarns formed from a mixture of siliceous fibers and potentially adhesive organic fibers, fibers in said textile exhibiting a strong and substantially permanent adhesion due to the activation of said potentially adhesive fibers, the binding of the fibers stabilizing the structure of said textile.

9. As an article of manufacture, a yarn comprising siliceous fibers and potentially adhesive organic fibers and having an inherent tendency to untwist, fibers in said yarn exhibiting a strong and substantially permanent adhesion due to the activation of said potentially adhesive fibers, whereby the twist of said yarn is stabilized.

10. As an article of manufacture, a felt comprising siliceous fibers and potentially adhesive organic fibers, which fibers have an inherent tendency to slip upon each other, fibers in said felt exhibiting a strong and substantially permanent adhesion due to the activation of said potentially adhesive fibers, whereby the structure of said felt is stabilized.

11. A fibrous product as claimed in claim 7, in which the potentially adhesive fiber is a thermoplastic fiber.

12. A fibrous product as claimed in claim 7, in which the potentially adhesive fiber is formed from a thermosetting material.

13. A fibrous product as claimed in claim 7, in which the potentially adhesive fiber is a cellulose derivative fiber.

14. A fibrous product as claimed in claim 7, in which the potentially adhesive fiber is a thermoplastic synthetic resin fiber.

15. A textile as claimed in claim 8 in which the potentially adhesive fiber is a thermoplastic synthetic resin fiber.

16. A yarn as claimed in claim 9 in which the potentially adhesive fiber is a thermoplastic synthetic resin fiber.

17. A felt as claimed in claim 10 in which the potentially adhesive fiber is a thermoplastic synthetic resin fiber.

CARLETON S. FRANCIS, JR.