July 19, 1949. C. A. CASTELLAN 2,476,283

TEXTILE PRODUCTS AND METHODS OF PRODUCING THEM

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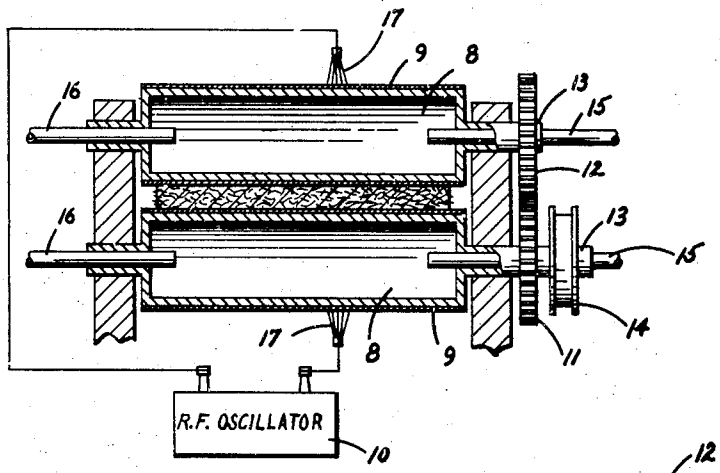


FIG. 2

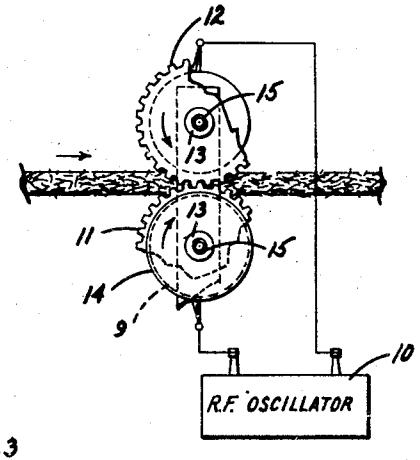


FIG. 3

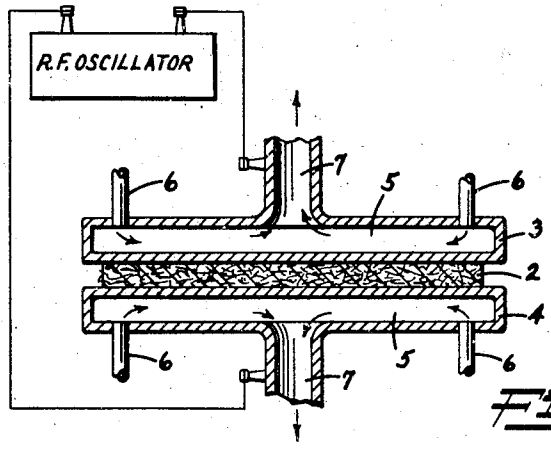


FIG. 1

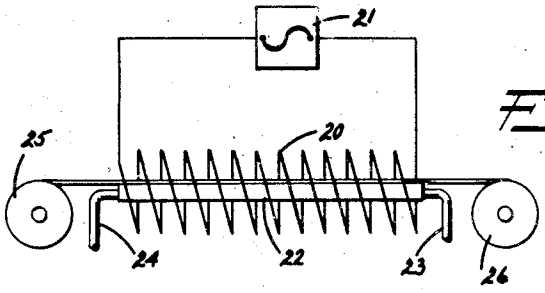


FIG. 4

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TEXTILE PRODUCTS AND METHODS OF PRODUCING THEM

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This invention relates to improved textile products, and methods and apparatus for producing them, of the type which consist of or comprise potentially adhesive fibers, some of which are bonded to adjacent fibers by virtue of coalescence induced by heating.

It has heretofore been suggested to mix non-adhesive fibers with thermoplastic fibers, to fabricate the mixture into a textile, such as a knotted, woven, braided, netted, or knitted fabric, spun or continuous filament yarn, felts or papers, and the like, and either during or after fabrication of the mixed fibers, to set the structure of the fabric by heating. In utilizing the conventional arrangements for heating such products, difficulties arise in obtaining uniform activation of the thermoplastic fibers within the mass, particularly when the fabric is heavy and thick, such as pile fabrics, coarse woven fabrics, thick felts and heavy papers, such as cardboard. When applying heated surfaces to the surfaces of the textile product, the activation of the inner portions of the product is retarded by the resistance to heat transfer afforded by the portions of the fabric intervening between the central portion and the heating surfaces. In addition, the exposed potentially adhesive fibers at the surface of the product which contact with the heating surfaces tend to stick to such surfaces and when the product after activation is removed, it is frequently torn and disrupted adjacent the points of sticking. Even when applying internal heat by means of high frequency induction, the exposed thermoplastic fibers have the opportunity of sticking to whatever surfaces upon which the product may rest, or between which it may be held during such activation.

In accordance with the present invention, the textile product is supported in contact with one or more cooled surfaces, while it is being heated internally by high frequency induction, either inductively or capacitatively coupled therewith. By thus applying the heat, thorough activation of the interior of the product is obtained, while at the same time, the thermoplastic fibers in the surfaces of the product are prevented in one or both surfaces from attaining their fusion point. The resulting product has a bound-fiber structure, giving increased strength and setting it against shrinkage, creasing, wrinkling and the like, while the exposed surfaces of the fabric retain a soft pleasing handle and are as porous as the unactivated product.

The textile product may consist entirely of the thermoplastic potentially adhesive fibers which

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are activatable by heat, or it may comprise such fibers with non-adhesive fibers. Again, it may comprise a mixture of two types of thermoplastic fibers, one of which has a lower tacking point than the other type.

Examples of potentially adhesive fibers are those of cellulose acetate or other cellulose esters and ethers or mixed esters, such as cellulose acetate propionate or cellulose acetate butyrate, in plasticized condition; also, resins, either permanently thermoplastic or thermosetting but in the thermoplastic state, formed by the polymerization or condensation of various organic compounds such as coumarone, indene or related hydrocarbons, polyethylene, vinyl compounds, styrene, sterols, phenol-aldehyde, resins either unmodified or modified with oils, urea-aldehyde resins, sulfonamide-aldehyde resins, polyhydric alcohol-polybasic acid resins, drying oil-modified alkyd resins, resins formed from acrylic acid, its homologues and their derivatives, sulfur-olefine resins, resins formed from dicarboxylic acids and diamines (nylon type); synthetic rubbers and rubber substitutes, herein called "resins," such for example as polymerized butadiene, olefine polysulfides, iso-butylene polymers, chloroprene polymers; and fibers formed from a resin comprising the product of co-polymerizing two or more resins, such as copolymers of vinyl halide and vinyl acetate, co-polymers of vinyl halide and an acrylic acid derivative, and also a mixture of resins, such as a mixture of vinyl resins and acrylic acid resins or methacrylic acid resins, a mixture of polyolefine resins and phenol-aldehyde resins, or a mixture of two or more resins from the different classes just named. There may be employed also fibers made from rubber latex, crepe rubber, gutta percha, balata, and the like.

Further, the potentially adhesive fibers may be mixtures of the cellulose derivatives with resins or rubber, such for example, as a mixture of cellulose nitrate and an acrylic acid resin, or a mixture of benzyl cellulose and a vinyl resin, or a mixture of ethyl cellulose and shellac.

A preferred class of vinyl resins from which the filaments may be formed are the copolymers of vinyl chloride with vinyl acetate or vinyl cyanide and after-chlorinated copolymers of vinyl chloride and vinyl acetate.

The resins above mentioned may be classified as:

(a) Heat-non-convertible resins such for example as glycol polybasic acid resins, vinyl resins (particularly those of the preferred class

above) and the acid type phenolaldehyde resins, and the like.

(b) Heat-convertible or thermosetting resins such for example as glycerol-polybasic acid resins, 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 oil resins and olefine-sulfur resins.

Among the non-adhesive filaments which may be used are wood pulp fibers, cotton, flax, jute, kapok, silk, and the like, or synthetic filaments of cellulosic compositions, such as a cellulose or regenerated cellulose, cellulose derivatives, such as cellulose esters, mixed cellulose esters, cellulose ethers, mixed cellulose ester-ethers, mixed cellulose ethers, cellulose hydroxy-ethers, cellulose carboxy-ethers, cellulose ether-xanthates, cellulose xanthofatty acids, cellulose thiourethanes; natural and synthetic rubber and derivatives thereof; alginic acid, gelatine, casein; mineral filaments such as spun glass, asbestos, mineral wool and the like; filaments made of natural and synthetic resins which should be of such type that they are not rendered tacky when the potentially adhesive filaments are rendered tacky by heating; and the filaments made by slitting, cutting or shredding non-fibrous films, such as waste cellophane.

The drawing illustrates various arrangements of apparatus for accomplishing the invention.

Figure 1 is a transverse cross-section in elevation of one embodiment,

Figure 2 is a cross-section in elevation partly in cross-section of a modification,

Figure 3 is a side elevation of the embodiment of Figure 2, and

Figure 4 is a side elevation of the third embodiment.

Figure 1 illustrates a batch method with the electrodes in cross section. The textile product 2, whether a fabric, felt-like, or paper-like, is supported between two opposed flat-surfaced electrodes 3 and 4 at a predetermined pressure of compaction. One pole of the radio frequency oscillator is connected to the electrode 3 and the other pole is connected to electrode 4. The electrodes are hollow and the cavities 5 receive a cooling fluid introduced by pipes 6 and discharged through pipes 7. As a cooling medium, a gas, such as air, oxygen or nitrogen at any desired low temperature may be used. Alternatively, liquefied air or liquefied gases may be used. If desired, water, alcohol, hydrocarbons in liquid form and the like may be used. Preferably the liquid that is used is one which does not tend to ionize and has a minimum polarization under the influence of the electric field to be used.

Figures 2 and 3 show front and side elevations respectively of a modification, in which hollow drums 8 of insulating material are each provided with an external conductive cover 9 and are connected to opposite poles of a radio frequency oscillator 10 to serve as electrodes. Gears 11 and 12 provided on projecting trunnions 13 of the drums are adapted to be driven by means of a pulley 14. Inlet pipes 15 and outlet pipes 16 extending through opposite trunnions of the drums serve to introduce and discharge the cooling medium. In this embodiment, the connection between the electrodes and the leads from the poles of the oscillator may be accomplished by brushes 17. This arrangement provides for

the continuous travel and activation of a product of indefinite length.

Figure 4 shows a modification utilizing an electromagnetic field, the induction coil 20 being connected to the opposite poles of an alternator 21 and a hollow narrow platform 22 being disposed approximately with its upper surface centrally of the coil. Cooling medium is introduced through the connection 23 and removed from the hollow platform by the pipe connection 24. A yarn or narrow strip of fabric, felt-like or paper-like material is carried from the supply reel 25 over the top surface of the supporting platform 22 on to the take-up reel 26. The internal diameter of the coil 20 may be varied widely to accommodate strips of textile product of various widths.

The fabricating procedure may be of various types depending upon the particular product desired. Depending upon the particular type of product, it may be desired to apply the high frequency electric or electromagnetic field at different stages in the fabricating procedure and in some cases at a plurality of distinct stages in any one particular fabricating procedure. Thus, in the preparation of a woven or knitted fabric from a mixture of the potentially adhesive filaments with non-adhesive filaments, the two types of filaments may be mixed upon a picker or card and may then be subjected to drafting and spinning for producing a yarn. Such yarn may be subjected to the heating effect of the high frequency electric or electromagnetic field prior to fabrication into the final fabric. Alternatively, the heat-activation may be deferred until weaving, knitting, braiding or other fabricating operation has been completed so that the heat-activation serves not only to more or less stabilize the structure of the yarns within the fabric but also to stabilize the structure of the fabric as a whole by adhesion of the filaments at points of intercrossing of the weft and warp or of the loops in the knitted fabric. Another alternative procedure is to activate the yarns prior to fabrication and to activate after fabrication. Such a procedure would be of special advantage where it is desired to impart an increased stiffness to the yarns within a fabric without a proportional increase in the adhesion between yarns forming the structure of the fabric. Such activation may be accompanied by a compacting pressure by cooled surfaces, if desired, and where the fabric being subjected to the electric field is positioned between opposed substantially parallel plates used as electrodes having suitable insulating coatings bearing against the fabric, the pressure may be exerted against the fabric by the electrodes themselves, the electrodes being cooled.

The invention is applicable also to fabrics in which alternating yarns may consist entirely of non-adhesive filaments and the other yarns therein may comprise or may consist entirely of potentially adhesive filaments activatable by heat. Besides mixing filaments of relatively short lengths such as staple fibers in the manner contemplated by the descriptions hereinabove, the yarns may be formed of continuous filaments some or all of which are activatable by heat and such activatable yarns may be fabricated by knitting, weaving, braiding, netting, or knotting in the same manner as a staple fiber yarn. Here, again, the activation may be effected upon the yarn prior to fabrication; activation may be performed after fabrication; or activation may be performed both after and before fabrication to textile products. The mixing of the continuous filaments of nonadhesive nature with those

which are heat-activatable may be performed at the initial stage of filament formation where it is a matter of artificially producing the filaments. Alternatively, natural or artificial continuous filaments of non-adhesive nature may be combined with natural or artificial continuous filaments of heat-activatable nature by withdrawing untwisted filaments of the two types from suitable packages thereof and winding and twisting them simultaneously upon a third common suitable package.

Pile fabrics may be produced from yarns composed of or comprising as a part thereof heat-activatable filaments either of continuous or short length nature and, as in other fabric constructions, the weft, warp and pile yarns may be of identical or entirely distinct composition and, as in the case of other fabrics, the yarns may be activated prior to the fabrication or the pile fabrics may be formed of un-activated yarns or activated yarns and subsequently subjected to effect activation thereof.

For the production of felt-type fabrics, such as textile felts, papers, paper and pulp products, such as cardboards, the mixtures of the two types of filaments may be effected by carding or by beating the two types of filaments together in a suitable liquid suspension. Alternatively, the filaments may be blown together in a vessel and allow to deposit by gravity upon a travelling conveyor such as a belt and, in this procedure, the filaments thus thrown into the vessel may be produced in situ at that time by spraying or electrostatic methods. The felt-like sheet thus produced may be subjected to an electrostatic field between cooled insulated electrodes which may be pressed together against the sheet with any desired amount of pressure, as in Figure 1.

The filamentous product being subjected to the electric field may be passed continuously between insulated electrodes as in Figures 2 and 3, or it may be passed over a cooling support (as 22 of Figure 4) or between two such cooling supports as it passes through an electromagnetic field, or it may be held stationary during such treatment. Alternatively, the yarn, cord, fabric, and the like may be cut into pieces and formed into a pile which is subjected to the electric or electromagnetic field. Again, the yarns or fabrics may be wound upon themselves into a package in which forms treatment may be effected.

Prior to subjection to the high frequency electric or electromagnetic field, the products to be treated may be impregnated or coated with any desired agent for the purpose of imparting a desired finish, hand, pliability or appearance to the final product.

Any suitable high frequency oscillator may be employed for the purposes of the invention and the voltage at which it is operated may be varied widely within the limit determined by the development of a corona discharge between the electrodes. A frequency of from ten to thirty megacycles per second is entirely satisfactory, the particular frequency employed in any particular case depending upon the allowable voltage and the amount of power desired.

As stated hereinabove, pressure may be applied to the filamentous product while it is being subjected to the high frequency electric field and such pressure may advantageously be applied through the medium of the electrodes themselves, such electrodes being insulated in such case, or it may be applied by the cooling

supporting surfaces. While the application of pressure is by no means necessary, it generally serves to more reliably and effectively control the extent of adherence between the adhesive and non-adhesive filaments in the product. Whereas the application of the activation heat by means of the ordinary procedures of radiation, convection and conduction has tended to give rise to glazed surfaces and non-uniform heating throughout the body of the mass, the use of the high frequency electric field for generating heat within the body of the individual filaments of dielectric losses therein completely eliminates this difficulty.

During the stage of activation, the fabric may be manipulated in such a way as to modify its dimensions and to reduce residual shrinkages in the products. For example, a fabric comprising yarns, all of which contain a major proportion of filaments composed of a copolymer of vinyl chloride and vinyl acetate which has been produced with a stretch may be subjected to a high frequency electric field and brought to such a condition whereby as to cause the yarns to tend to shrink strongly by release of internal molecular forces. During such activation, the size of the fabric may be altered by allowing such shrinkage to occur to a controlled extent to obtain the predetermined dimensions.

After activation, the fibers may be de-activated by cooling. This may be accomplished merely by interrupting the supply of radio frequency power to the electrodes in the case of the electrostatic arrangements of Figures 1 to 3, or by interrupting the alternating current in the arrangement of Figure 4. Alternatively, the textile structure may be removed from between the electrodes or from within the high frequency coil and cooled outside their influence.

Textile fabrics, whether knitted or woven, braided or piled, can thus be produced which are substantially free of any tendency of the component yarns and filaments therein to slip with respect to the others thereby causing the fabric to stretch undesirably. This is particularly important in knitted fabrics, which are thus made free of any tendency to run or "ladder" upon the breakage of one of the loops therein. It is possible to control slippage and laddering to any predetermined extent by adjusting the extent of activation. Fabrics thus stabilized by activation of the yarns thereof may be characterized by the same high porosity and fullness of hand as such fabrics before such stabilization.

Depending upon the particular desideratum in the final fabric to be produced, the percentage of activatable filaments therein may be varied widely. For simple stabilization of the fabric, a range of activatable fibers between 5 to 25% of the entire weight of the fabric is generally adequate, the balance being non-activatable. When considerable stiffening of the fabric is also desired, higher percentages up to 100% of activatable fiber may be present in the fabric.

By the invention, it is possible to activate the interior portions of the textile products to effect stabilization thereof by the bonding of fibers therein without at the same time bonding fibers in the faces of the fabric. In this manner, by controlling the cooling effect of the surfaces in contact with the product in relation to the heating effect thereupon, a preferred handle and porosity may be present in the surface layers, regardless of the proportion of potentially adhesive

fibers in the product, while at the same time any degree of activation of the fibers within the interior of the structure can be accomplished to stabilize the structure either by merely bonding the fibers without loss of fiber identity, or to render an interior layer of the fabric substantially impermeable by causing the fibers therein to flow freely and thereby form a film through which the non-adhesive fibers extend. Stabilization of the interior of the structure may be accomplished by heating only sufficiently to soften the thermoplastic fibers enough to cause them to shrink and to become deformed about the non-adhesive fibers without actually becoming adhesively bonded thereto. Again any degree of activation between the extremes stated can be accomplished to obtain various properties in the product.

The present invention may be applied in the production of braids, felts, threads, or cords, for use as packing material and gasket material for sealing relatively moving or stationary parts of machinery of any kind, or in similar form as wicks for transmitting liquids to elements or surfaces to be lubricated or otherwise coated. The invention may also be applied for the production of felt-type products for making hats or other textile products or for use as battery separators, heat-insulation material, sound-insulation material, cushioning, padding, or as filtering materials either for gaseous or liquid suspensions, etc.

The description herein is intended to be illustrative only and it is to be understood that changes and variations may be made without departing from the spirit and scope of the invention as defined by the appended claims.

I claim:

1. A method of making fibrous products comprising the steps of fabricating a mass of fibers comprising potentially adhesive heat-activatable fibers into a product having the activatable fibers distributed generally throughout the product, continuously passing the product through a path between the nip of a pair of cooled rotors and inducing internal heating of such product as it passes between the rotors by a high frequency current passed therethrough to render the activatable fibers adhesive to bind fibers in the body of the product while cooling the surfaces of the product to prevent the development of adhesiveness in the fibers which lie in, and in close proximity to, the surfaces.

2. A method in accordance with claim 1 in which a mixture of non-adhesive fibers and potentially adhesive fibers are fabricated into a felt-like mass.

3. As an article of manufacture, a felt-like product formed from a mat comprising a mixture of non-adhesive and potentially adhesive heat-activatable fibers distributed generally throughout the product, the activatable fibers being generally homogeneously distributed throughout the thickness of the mat at least some of said fibers in the body of the product exhibiting a strong and substantially permanent adhesion due to the thermal tackiness after heating thereof, and those portions of said fibers which lie in, and in close proximity to, the surfaces of the product being unadhered.

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