

# UNITED STATES PATENT OFFICE

2,126,755

## METHOD OF MAKING A COMPOSITE FABRIC

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No Drawing. Application September 13, 1934,  
Serial No. 743,835

9 Claims. (Cl. 154—2)

This invention relates to the preparation of stiffened fabrics and also to wearing apparel or other technical or commercial articles formed in whole or in part of such stiffened fabrics.

5 An object of my invention is to prepare fabrics of any desired degree of increased stiffness and in a simple and expeditious manner. A further object of my invention is to prepare wearing apparel and other technical or industrial articles consisting of or containing such stiffened fabric. Other objects of the invention will appear from the following detailed description.

10 In the making of stiffened fabrics by causing cellulose acetate or other organic derivative of cellulose to melt or coalesce by operations involving the application of heat and pressure, it has previously been considered necessary to have present during this operation acetone or other volatile organic solvent for the derivative of cellulose. The use of such volatile organic liquids is generally objectionable since these operations are normally conducted in rather small factories where no apparatus for the recovery or even the removal of the vapors of the organic liquid is provided. As a result, the operation entails the added cost of the organic liquid and even hazards to the health of the operators engaged therein.

15 I have found that if plasticizers for the cellulose acetate are present in the assembly of cellulose acetate and fabric of nonthermoplastic fibres, good stiffening effects and firm adhesion may be obtained by the application of heat and pressure if water or moisture is present during the pressing. That water may replace organic solvents for the cellulose acetate for this purpose is quite surprising in view of the fact that little, if any, adhesion is obtained under certain circumstances if no water is present during the hot pressing.

20 The products formed by this invention may be used for any purpose where a stiffened and/or relatively impermeable fabric is desired. An important application of such products is wearing apparel which may be formed in whole or in part of fabrics made or prepared in accordance with this invention. Thus collars or cuffs may be formed entirely of the product of this invention. Alternatively shirts may be made wherein the attached collars, neckbands, cuffs, fronts or bosoms are made of such products. Hats or parts of hats may likewise be formed of such material, as may also be the inner or sweat bands of hats, visors for caps, cuffs of gauntlets, inner linings for cravats, stiffening material used in the inner portions of garments such as coats to help retain

the shape thereof, etc. The fabrics of this invention may be used for a variety of other purposes, and indeed may be used for any industrial or technical purpose where fabric of increased stiffness and/or impermeability is required.

5 In order that the desired degree of stiffening and adhesion be attained upon the hot pressing in the presence of water, it is of importance that there also be present in the assembly being treated a plasticizer or relatively high boiling or non-volatile solvent for the cellulose acetate. This plasticizer may be caused to be present in any manner. Thus it may be incorporated with the cellulose acetate in whatever form it may be present, either by way of the dope or spinning solution from which it is formed or by spraying, dipping or otherwise treating the cellulose acetate with a solution of the plasticizer in a volatile solvent such as benzol and permitting the solvent to evaporate. Alternatively, the plasticizer may be applied to or incorporated with the non-thermoplastic fibres in which case the plasticizer may or may not be present in the cellulose acetate material.

25 Any suitable plasticizer may be employed, which plasticizer may or may not be soluble in water. Examples of suitable plasticizers for cellulose acetate are dimethyl phthalate, diethyl phthalate, diethyl tartrate, dibutyl tartrate, diacetin, triacetin, etc. The amount of plasticizer present is preferably large, and is on the order of from less than 40% to 150% or more of the weight of the cellulose acetate present.

30 In one form of this invention the assembly of fabrics with an intermediate layer comprising cellulose acetate employed as starting material may first be cut, sewn or otherwise shaped. After the desired articles, such as collars, cuffs or other wearing apparel or parts thereof are formed and plasticizer being present therein, they may then be treated with water and then subjected to heat and pressure to impart the desired stiffness and/or impermeability. In this manner the sewing of stiff material is avoided.

35 Products of this invention have any desired degree of stiffness, which is relatively permanent, so that they may be subjected to repeated laundering without substantially losing their stiffness. In this manner the use of starch or other extraneous stiffening materials during laundering may be avoided.

40 This invention may be carried out in a large number of ways, particularly as to the nature of the fabric or number of fabrics employed, provided that cellulose acetate in any form, such as

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powder, film or yarns or filaments is present in the fabric if a single fabric is used, or in or near at least one of the fabrics if a plurality of fabrics are used.

5 If the cellulose acetate is present in the form of yarns or filaments, there should be present in the product treated at least one layer of fabric, which either consists wholly of cellulose acetate yarn or  
10 which is a mixed fabric containing yarn of cellulose acetate alternating either in the warp or in the weft or both, in any desired degree of alternation, with yarns of other non-thermoplastic fibres such as cotton, regenerated cellulose, linen, wool or natural silk. This alternation may be for instance  
15 1, 2, 3 or more cellulose acetate yarns with 1, 2, 3 or more yarns of cotton or other non-thermoplastic fibres. For convenience the warp may be made with such alternation of cellulose acetate yarn and yarn of other fibres, while the weft may consist wholly of such cellulose acetate yarn or  
20 wholly of yarn of other fibres. However the weft may consist of an alternation of such cellulose acetate yarns and non-thermoplastic yarns of other fibres, in which case, if the fabric is made in ordinary looms, the alternations will be preferably  
25 in two's or multiples of two's. If desired a fabric may be used in which either the warp or the weft consists wholly of cellulose acetate yarn while the other component consists of non-thermoplastic yarn.  
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Instead of employing a woven fabric, a knitted or netted fabric may be employed. Also a fabric containing mixed yarn containing both filaments of cellulose acetate and fibres of cotton or other  
35 non-thermoplastic material may be employed.

Only a single layer of fabric consisting wholly of cellulose acetate yarn or a single layer of any of the fabrics above described containing both cellulose acetate yarn or filaments and non-thermoplastic  
40 fibers may be treated by this invention, whereby relatively thin fabric having the desired degree of stiffness or impermeability throughout or only locally may be produced. Alternatively 2, 3, 4 or more of such fabrics may be treated with  
45 water, and in the presence of a plasticizer, heat and pressure applied to the whole surface to form a composite fabric that is united throughout, or only in local areas by application of heat and pressure only at the desired local areas.

50 In another, and in some cases preferred method of carrying out the invention, one or more fabrics consisting wholly of non-thermoplastic yarns, such as cotton, linen, reconstituted cellulose, wool or silk, is assembled with one or more fabrics consisting  
55 wholly of cellulose acetate yarn or of a mixture of cellulose acetate yarn and filaments and yarn of non-thermoplastic fibres, as above described, may be treated by this invention, whereby a composite fabric made up of a plurality  
60 of layers may be made. If a product is to be produced wherein all the layers thereof are united, it is of importance where two or more layers of fabric consisting wholly of non-thermoplastic material are used, that at least one layer of fabric consisting of or containing cellulose acetate yarn  
65 be interposed between two layers of such fabric.

Instead of employing the cellulose acetate in the form of yarns or filaments, it may be present in  
70 other forms. Thus it may be in the form of sheet-like material such as foil having a thickness of 0.0005 to 0.003" or more which may be prepared by casting or flowing a solution of cellulose acetate in a volatile solvent, which solution may or  
75 may not contain plasticizers, onto polished sur-

faces of bands, drums, film wheels, etc. and permitting the volatile solvent to evaporate.

Alternatively, fabrics of any desired construction and made of yarns of cotton, reconstituted  
5 cellulose, linen, natural silk, wool or other non-thermoplastic fibres may be impregnated with or coated with a solution of cellulose acetate.

The layer of cellulose acetate that is interposed between the fabrics may be in the form of finely  
10 divided powder with which a plasticizer may or may not be in intimate admixture. This powder may be blown or sprayed onto one or more layers of the fabrics to be laminated and, if desired, gums or other appropriate binders may be employed  
15 to cause such powder to adhere to the fabrics.

In still another form of this invention a fabric made of or containing non-thermoplastic fibres may be coated or impregnated with an intimate  
20 mixture of finely divided cellulose acetate with or without plasticizers, and binders or agglutinants such as methyl cellulose that swells in water, gum tragacanth, gum arabic, and this fabric is then interposed between two or more layers of fabric  
25 which consist wholly of non-thermoplastic fibres, such as cotton, linen regenerated cellulose, wool, or natural silk.

In the case of cellulose acetate yarns, foils, fabrics impregnated with solutions of cellulose acetate, powder and the like above described,  
30 wherein plasticizers are not incorporated during manufacture, such plasticizer may be added to such cellulose acetate products after they are formed or to the fabric of non-thermoplastic yarns with which they are laminated.  
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In order to increase the opacity of the final product or to impart special color effects thereto, finely divided white pigments such as titanium dioxide or antimony trioxide or colored pigments  
40 such as lamp black may be incorporated with the cellulose acetate.

As instances of the manner that the various fabrics may be assembled, the following are given. In the case of collars, cuffs, etc. where  
45 an exterior of cotton or linen is desired, a layer of fabric consisting wholly of or containing cellulose acetate yarn, as above described, and to which plasticizer has been applied, may be interposed between two layers of fabric consisting of  
50 cotton, linen or other non-thermoplastic fibres. An assembly that is also useful for such purposes comprises three layers of fabric consisting wholly of such non-thermoplastic yarns, with one layer of fabric consisting of or containing cellulose acetate yarn between two layers of such fabrics.  
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To obtain good adhesion, water should be present during the application of heat and pressure in accordance with this invention. The liquid  
60 may be applied to the assembly of fabrics having an intermediate layer containing cellulose acetate in any suitable manner, such as by dipping, spraying or brushing. A convenient manner of wetting the assembly is by padding the same with  
65 the water. If an assembly of two or more fabrics is treated, both sides of the assembly should be wetted with the water, as it is desirable that all of the layers of the fabric present be wetted therewith when heat and pressure is applied.

The so wetted fabric or assembly of fabrics is  
70 then subjected to heat and pressure. This may be done by any suitable device, for instance by hot ironing or by passing between pressure rolls, one or both of which are heated, or between a heated roller and a heated or cold plate or sur-  
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face, or between a heated pressing iron or plate and a cold board or surface. The heating device may be heated to the desired temperatures for instance 80 to 180° C. or more and the pressure applied may be any desired pressures, for instance from 10 to 600 pounds per square inch.

If heated devices that have desired designs, such as stripes, dots, rectangles or other geometric, floral or other designs, embossed thereon are employed, novel effects are obtained, since only those portions that come in contact with the embossed portions of the heated device become united, while the other portions retain the properties of the original fabrics. This local application of heat and pressure may be done by manually operated means if desired. By locally applying or having present the plasticizer only in those places which are to be united, the union of other portions upon subsequent laundering is avoided.

In order further to illustrate my invention but without being limited thereto the following specific example is given.

#### Example

A fabric consisting wholly of acetone soluble cellulose acetate has applied thereto by spraying, dipping or padding, a solution of dimethyl phthalate or other plasticizer in benzol, and the benzol permitted to evaporate. The concentration and amount of solution employed are such that the amount of plasticizer added is 75% of the weight of the cellulose acetate fabric.

For making fabrics to be used for making a desired article, there is employed an assembly of two layers of cotton or linen fabric with an interposed layer of the fabric consisting wholly of acetone-soluble cellulose acetate filaments containing the plasticizer. Instead of employing as the intermediate layer a fabric consisting wholly of cellulose acetate yarn, there may be employed a fabric containing both cellulose acetate yarn and cotton yarn in any of the desired constructions as has been described.

The assembly is then wetted on both sides with water. Thereupon the assembly is pressed with a hot iron or calendar to form a stiffened material in which the fabrics are united. Preferably the heating and pressing is done on both sides of the assembly. By controlling the degree of heat and pressure and/or selection of the type of fabrics employed and the amount of cellulose acetate present, and/or the amount of plasticizer present the degree of stiffness may be controlled. Generally a semi-stiff fabric is formed, which retains its stiffness after repeated laundering so that the use of starch or like material is not required.

If collars or cuffs or bosoms or other articles which are to be sewn onto shirts or other articles of apparel are to be formed, it is advantageous to cut the assembly of fabrics to the desired shape or form and sew it to the shirt or other article prior to the application of the water and the heat and pressure so that the assembly is stiffened and united by wetting with water and application of heat and pressure only after the shirt or other article is completed.

The fabrics and articles obtained by this invention may be made more or less stiff as desired by controlling the amount of cellulose acetate present in the layer in the assembly of fabrics being treated; the more cellulose acetate present, the stiffer the resultant products. Likewise the softeners may be controlled by the amount of plasti-

cizer present, the greater the amount of plasticizer the softer the product.

While this invention has been described particularly in connection with cellulose acetate, such cellulose acetate may be replaced in whole or in part by other derivatives of cellulose such as cellulose nitrate, or cellulose formate, cellulose propionate, cellulose butyrate, or other organic esters of cellulose, or methyl cellulose, ethyl cellulose and benzyl cellulose or other cellulose ethers. In each case a suitable plasticizer for the particular derivative of cellulose will be chosen.

It is to be understood that the foregoing detailed description is given merely by way of illustration and many variations may be made therein without departing from the spirit of my invention.

Having described my invention, what I desire to secure by Letters Patent is:

1. Process for the production of collars, cuffs and like parts of wearing apparel, which comprises uniting by the action of heat and pressure the components of an assembly comprising a layer of non-thermoplastic fabric and a second layer of fabric containing a thermoplastic derivative of cellulose and plasticizer for said derivative of cellulose, the union being effected in the presence of water as the sole assisting liquid.

2. Process for the production of collars, cuffs and like parts of wearing apparel, which comprises uniting by the action of heat and pressure the components of an assembly comprising a layer of non-thermoplastic fabric and a second layer of fabric containing cellulose acetate and plasticizer for said cellulose acetate, the union being effected in the presence of water as the sole assisting liquid.

3. Process for the production of collars, cuffs and like parts of wearing apparel, which comprises uniting by the action of heat and pressure the components of an assembly comprising a layer of non-thermoplastic fabric and a second layer of fabric containing a thermoplastic derivative of cellulose and water-insoluble plasticizer for said derivative of cellulose, the union being effected in the presence of water as the sole assisting liquid.

4. Process for the production of collars, cuffs and like parts of wearing apparel, which comprises uniting by the action of heat and pressure the components of an assembly comprising a layer of non-thermoplastic fabric and a second layer of fabric containing cellulose acetate and water-insoluble plasticizer for said cellulose acetate, the union being effected in the presence of water as the sole assisting liquid.

5. Process for the production of collars, cuffs and like parts of wearing apparel, which comprises uniting by the action of heat and pressure the components of an assembly comprising a layer of non-thermoplastic fabric and a second layer of fabric containing a thermoplastic derivative of cellulose and a plasticizer for said derivative of cellulose in an amount exceeding 40% of the weight of the derivative of cellulose present, the union being effected in the presence of water as the sole assisting liquid.

6. Process for the production of collars, cuffs and like parts of wearing apparel, which comprises uniting by the action of heat and pressure the components of an assembly comprising a layer of non-thermoplastic fabric and a second layer of fabric containing cellulose acetate and plasticizer for said cellulose acetate in an amount exceeding 40% of the weight of the cellulose acetate

present, the union being effected in the presence of water as the sole assisting liquid.

5 7. Process for the production of collars, cuffs and like parts of wearing apparel, which comprises uniting two layers of fabric composed of non-thermoplastic cellulosic materials to an intermediate layer containing yarns of a thermo-  
10 plastic organic derivative of cellulose and a plasticizer for the cellulose derivative, union being effected by the application of heat and pressure in the presence of water as the sole assisting liquid.

15 8. Process for the production of collars, cuffs and like parts of wearing apparel, which comprises uniting two layers of fabric composed of non-thermoplastic cellulosic materials to an in-

intermediate layer containing yarns of cellulose acetate and a plasticizer for the cellulose acetate, union being effected by the application of heat and pressure in the presence of water as the sole assisting liquid.

5 9. Process for the production of collars, cuffs and like parts of wearing apparel, which comprises uniting two layers of fabric composed of non-thermoplastic cellulosic materials to an intermediate layer containing yarns of cellulose  
10 acetate and a plasticizer for the cellulose acetate in an amount exceeding 40% of the weight of the cellulose acetate present, union being effected by the application of heat and pressure in the presence of water as the sole assisting liquid. 15

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