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C. S. FRANCIS, JR

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APPARATUS FOR PRODUCING COATED FABRICS

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Fig. 1.

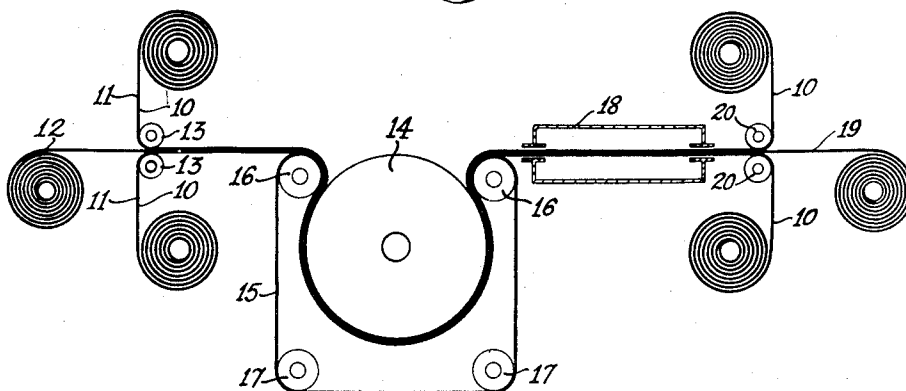


Fig. 2.

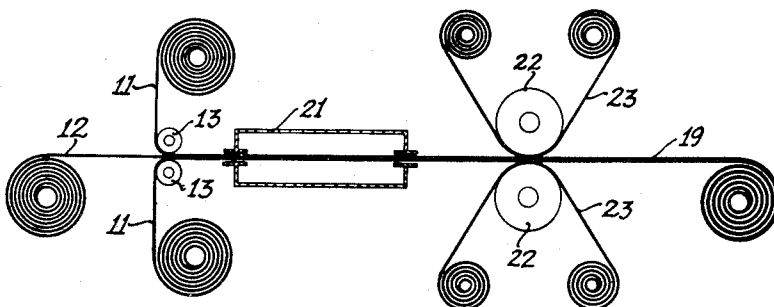


Fig. 3.

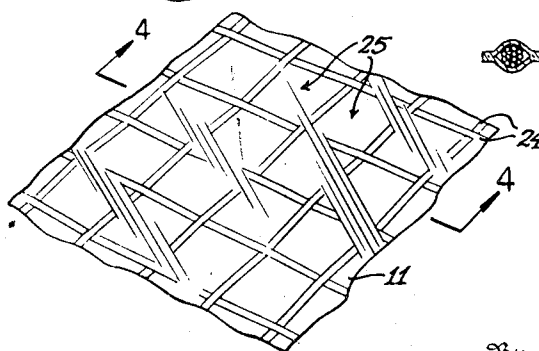
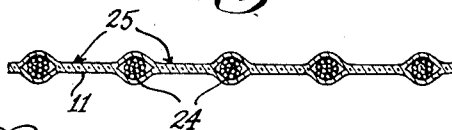


Fig. 4.



Inventor
CARLETON S. FRANCES, JR.

By *John Robert James*
Attorney

UNITED STATES PATENT OFFICE

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APPARATUS FOR PRODUCING COATED FABRICS

Carleton S. Francis, Jr., West Harwich, Mass.,
 assignor, by mesne assignments, to American
 Viscose Corporation, Wilmington, Del., a cor-
 poration of Delaware

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2 Claims. (Cl. 154—37)

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This invention relates in general to coating waterproof fabrics and in particular to a process and apparatus for producing such fabrics by use of thermoplastic transfers and includes correlated improvements designed to enhance the appearance, improve the strength and extend the use of coated fabrics.

In the production of mountain tents, ponchos, rain coats, and light-weight tarpaulins, particularly for use by aircraft personnel and paratroops, it is essential that both the total weight and the thickness of such sheet materials be maintained at an absolute minimum. However, such coated materials must meet the following stringent specifications:

(a) They must be extremely light in weight;
 (b) They must be waterproof and water-repellent;

(c) They must not become tacky when folded and stored under pressure, even in the tropics at temperatures up to 125° F.;

(d) They must not become brittle or inflexible at the lowest temperatures experienced in the arctic regions;

(e) They must be impermeable and proof against the effects of both water vapor and gases.

It has been found that conventional methods of coating fabrics will not meet all of the above stringent requirements. In particular, it has been found that the tear resistance, tensile strength and stretch of the fabric are all important factors. When an attempt is made to increase these factors by increasing the yarn count of the fabric, it has been found that after a certain yarn count, further increases in the yarn count actually cause a decrease in the tear resistance and also produce a very marked decrease in the stretch. These decreases in tear resistance and stretch are further augmented when the fabrics are coated by conventional processes involving the application of flowable compositions to the fabric because such prior processes invariably result in impregnation of the yarns to a substantial extent. It has been found that when the yarns are impregnated, they are stiffened and they are thus unable to adjust themselves to stretching forces, and if distorted by tension, such impregnated yarns do not recover to any material extent but remain stretched. It is obvious that increasing the yarn count and impregnating the yarns with the coating composition both tend to increase the total weight of the coated fabric.

Accordingly, it is a general object of the present invention to overcome present disadvantages residing in prior coated fabrics while providing

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coated fabrics with a thin continuous impervious coating.

Another general object of the invention is to provide a light weight fabric which will have high tear resistance, high tensile strength and a substantial stretch while exhibiting a material recovery after being stretched.

A specific object of the present invention is to provide a method of coating fabrics without impregnating the yarns thereof.

A further specific object is to provide an open mesh textile fabric with a thin continuous non-selfsupporting impervious coating.

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

According to the present invention, an open mesh textile fabric is coated without impregnating the yarns thereof by applying to each side of the fabric a thin continuous nonselfsupporting impervious film of an organic thermoplastic material supported on a temporary backing to which the film exhibits no permanent adhesion, applying heat and pressure to the assembled sheet material to cause the films to adhere to the surfaces of opposite outer sides of the yarns and to fuse to each other in the spaces between the yarns, the films and inner sides of the yarns thereby defining spaces between them, and preferably after cooling the article, stripping the temporary backing sheets from the coated fabric. The coated fabric thereby produced is characterized by superior tear-resistance and tensile strength.

The expression "open mesh fabric" as used in the specification and in the appended claims is used in its conventional meaning in the textile art, that is, a fabric having discrete and substantial spaces between the yarns in such a fabric.

For a more complete understanding of the nature and objects of the present invention, reference should be had to the accompanying drawing in which:

Figure 1 is a diagrammatical representation in side elevation of means for carrying out one embodiment of the process of the invention;

Figure 2 is a diagrammatical representation in side elevation of a second embodiment of means for carrying out the process of the invention;

Figure 3 is a perspective view of one embodiment of the fabric of the invention;

Figure 4 is a cross-section of the fabric illustrated in Figure 3.

The invention is applicable to the coating of open mesh fabrics as a class regardless of the method of their manufacture. Thus, the open

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mesh fabrics may be formed by weaving, knitting, netting, crocheting, and the like.

Some common varieties of open mesh fabrics are, for example, scrim, cheesecloth, bobinet, and crinoline. It is to be understood that the fabrics may be formed of natural or artificial textile fibres and mixtures thereof. Improved anchorage of the coating to the yarns can be obtained if the yarns comprise organic thermoplastic fibres which are rendered tacky at the temperature at which the coating is applied. Suitable thermoplastic fibres may be formed from thermoplastic cellulose derivatives, thermoplastic synthetic resins, and compatible mixtures of these materials in accordance with the invention disclosed in my U. S. Patent No. 2,253,000.

The backing sheet

The backing may be a flexible self-supporting film formed of any film-forming organic material which is solid at room temperature but which has a softening point preferably above about 160° C. but, in general, between about 100° C. and about 300° C., provided its thermal softening point is above the thermal tacking point of the transfer film employed.

The backing sheet should have a smooth, non-fibrous surface to which the transfer film exhibits no permanent adhesion. Thus, the choice of the backing sheet depends on the transfer film used.

Backing sheets which are operative in this invention include the following classes of materials:

(a) Sheets formed in whole or surfaced with a nonfibrous hydrophilic film-forming material such, for example as regenerated cellulose, alkali-soluble water-insoluble cellulose ethers, gelatine, casein, denitrated nitrocellulose deacetylated chitin, zein, and the like. Thus, the backing sheet may comprise a homogeneous film formed of one of such materials or a layer of fibrous material such as paper, felt, or fabric coated with such hydrophilic materials. All such backing sheets should have a smooth, nonfibrous and nonthermoplastic surface which exhibits no permanent adhesion to the transfer film.

(b) Sheets formed in whole or surfaced with a hydrophobic thermoplastic or thermosetting composition, which has a thermal softening point higher than the thermal tacking point of the transfer film. This embodiment of the backing sheet comprises preferably a sheet of paper or fabric coated with a thermosetting resin in the infusible nonthermoplastic state. For such resins there may be used the thermosetting resins as a class, such as the resins employed in the transfer film. It is essential that the transfer film show no permanent adhesion to the backing sheet or the coating thereon and whether it be formed of a thermoplastic or thermosetting material that it may be readily stripped therefrom after transfer to the surface being coated.

(c) Sheets, films, or endless bands, or a drum of polished metal, or metal foil which is smooth, nonfibrous and nonthermoplastic under the conditions of temperature and pressure may be used in the transfer operation. The composition used for the production of the thermoplastic transfer film may, for example, be applied to a moving metallic band at one point and the solvent evaporated or the composition hardened by cooling. The film thus formed is preferably preheated and then transferred from the metal support to the

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article to be coated at a point spaced from the point of application of the composition to the band.

The transfer film

For the thermoplastic transfer film which is temporarily applied to the backing sheet, there may be used any thermoplastic film-forming material, including thermoplastic cellulose derivatives as a class, thermoplastic synthetic resins as a class and thermosetting resins as a class while in a thermoplastic incompletely polymerized state.

Thermoplastic resins

Polyvinyl chloride
Polyvinylidene chloride
Polystyrene
Copolymers of vinyl chloride and vinyl acetate
Copolymers of methyl methacrylate and vinyl chloride
Polyvinyl butyral
Polyvinyl acetal
Polymethyl methacrylate
Polymethyl acrylate
Polyethylene
Polyamides
Coumarone-indene with rubber
Oil-modified and unmodified alkyd resins (prepared from dihydroxy alcohols and dicarboxylic acids)
Phenol-formaldehyde resins (prepared from phenols having only two reactive positions)
Polytetrafluoroethylene
Polyvinyl alcohol

Thermoplastic cellulose compounds

Cellulose acetate
Cellulose acetate butyrate
Cellulose acetate propionate
Cellulose propionate
Benzyl cellulose
Ethyl cellulose
Butyl cellulose
Hydroxy ethyl cellulose

Thermosetting resins in a thermoplastic stage

Urea-formaldehyde
Melamine-formaldehyde
Aniline-formaldehyde
Phenol-formaldehyde (phenols having three reactive positions)
Phenol-furfural
Unsaturated polyesters
Polyallyl alcohol and derivatives
Protein-formaldehyde resins: casein-formaldehyde shellac-formaldehyde
Alkyd resins (prepared from polyhydric alcohols and polycarboxylic acids)
Urea alcohol ether formaldehyde

Mixtures of thermoplastic and thermosetting resins

Polyvinyl chloride and urea-formaldehyde-butanol ether
Polyvinyl chloride and phenol-formaldehyde
Polymethylmethacrylate and urea-formaldehyde
Polystyrene and alkyd
Coumarone-indene and alkyd polyvinyl acetal and melamine-formaldehyde
Polyvinyl butyral and urea-formaldehyde

Liquid resin-forming ingredients

Allyl alcohol
 Allyl bromide
 Furfuryl alcohol
 Vinyl alcohol
 Liquid unsaturated hydrocarbons
 Octylenes
 Coumarone
 Allyl chloride
 Furfural
 Acrylic acid esters
 Indene
 Ethylenic hydrocarbons
 Heptylenes
 Higher dienes
 Methylol urea
 Dicarboxylic acid esters of allyl alcohol

The transfer film may also contain suitable plasticizers, moistureproofing agents, water-proofing agents, fireproofing agents, pigments, dyestuffs, and other materials as desired. The plasticizer may be either volatile or nonvolatile.

The transfer film may be applied to the backing film by any suitable means. The transfer film composition, if liquid, may be coated upon the backing sheet and then polymerized by heating to form a tacky thermoplastic film. If solid, it may be dissolved in a volatile solvent which is a nonsolvent for the backing film, or the coating thereon, if any, applied to the backing and dried at a temperature below the softening point of the backing film. The transfer film material when solid may also be melted and applied in a molten condition to the backing film whenever the softening of the backing film is higher than the melting point of the transfer film material. Finally, the transfer film material may be softened by heating or by admixture with a solvent to form a plastic mass which may then be calendered on to the surface of the plastic backing film, after which the calendered film is cooled or the residual solvent evaporated.

Regardless of the method selected, it is apparent that the transfer film must not permanently adhere to the backing sheet.

Of the various thermoplastic or thermosetting materials which may be employed for the transfer film, the synthetic elastomers as a class are preferred over all other materials. Thin films formed of the synthetic elastomer have the property of stretching and recovering after stretch. This permits the finished product to be subjected to substantial stress and strain without permanent distortion or without permanent change in dimension, since after the stress is removed the synthetic elastomer film causes the fabric to return to its original structure and shape. Further, the synthetic elastomers are superior to the other film-forming materials in their resistance to oils, greases, water vapor, and also exhibit a superior resistance to abrasion. The fact that the yarns of the fabric are not impregnated with the film permits the yarns also to recover their original shape after stress.

It is preferred to employ non-self-supporting films which are normally less than one mil thick, since these films provide substantially the same degree of imperviousness and protection as a self-supporting film while possessing the advantages of lighter weight and lower cost. Moreover, mats and webs having a non-self-supporting film adhered to one surface have better drape and are more flexible.

The coating operation

In producing the coated fabric of the invention, the transfer film supported upon the temporary backing sheet is adhered to the fabric to be coated by pressure.

The transfer film will preferably be in a tacky state at the time pressure is applied when contacting the fabric. This may be accomplished by (1) preheating the transfer film where the film is formed of a solid resin or cellulose derivative, or (2) where the film has been formed of a liquid resin arresting the polymerization while the resin is still in a tacky state, or, (3) contacting the surface of the film briefly with a solvent by passing it over a kissing roll or brush. By procedures (2) and (3) the use of heat during lamination is made unnecessary.

Where heat is employed to render the transfer film tacky, the exact temperature will, of course, depend upon the thermal tacking point of the transfer film. It will, however, be between the thermal tacking temperature and within about 50° C. higher than that temperature. In any event, it must not be so high that the film becomes fluid and flowable; likewise, the film must not have a viscosity so low that impregnation of the fibers to a substantial extent occurs. Generally, the temperature will be between 70° C. and 200° C., the above conditions being met.

The pressure employed during lamination should be between about 25 and 300 pounds per square inch, preferably between 50 and 150 pounds per square inch. It must be regulated carefully and preferably should be as low as possible so as to prevent forcing the surface fibers of the fabric through the film. In the preferred finished product, the film should be substantially as thick where it contacts the fibers as where it spans the fibers.

There is shown in Fig. 1 one embodiment of suitable means for carrying out the invention in which backing sheets 10 carrying a transfer film 11 on one surface are fed between the assembly rolls 13 so as to enclose a web 12 of open mesh fabric supplied from the roll 9. The assembled sheets are then passed around the heated drum 14, being pressed against the drum by means of the blanket 15 which travels about the pressure rolls 16 and the tension rolls 17. Heat and pressure applied by the drum 14 and blanket 15 cause the transfer film to adhere to the yarns and fuse together between the yarns in the meshes. The stripping of the backing sheets from the product is facilitated if the composite sheet material is cooled prior to stripping, for example, by passing the composite sheet material through the cooling chamber 18. The backing sheets are stripped from the coated fabric by passing around the stripping rolls 20. The backing sheets 19 and the coated fabric 19 may be wound up separately.

In Fig. 2 there is shown a second embodiment of means for carrying out the process when it is desired to use self-supporting unbacked thermoplastic film. In this case the fabric 12 is led through the guide rolls 13 between two self-supporting thermoplastic films 11 and the assembled sheets preheated in the chamber 21 after which they pass through the nip of the heated calendar rolls 22 whereupon the thermoplastic films are adhered to the yarns and fused together in the meshes. To prevent the unbacked thermoplastic films from adhering to the surface of the calendar rolls 22, these rolls may be covered with a sheet of smooth hydrophilic material to which the thermoplastic films show no tendency for

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permanent adhesion such, for example, as webs 23 of cellophane, gelatine, casein, alkali-soluble water-insoluble cellulose ethers, and the like.

One embodiment of the product produced by this process is illustrated in Figs. 3 and 4 in which it is noted that the yarns 24 of the fabric are enclosed between the two transfer films 11 although the yarns are not impregnated by the material of the transfer film. It should also be noted that the two transfer films are fused together in the spaces 25 or meshes between the yarns 24. The two coating films are adhered to the opposite outer surfaces of the yarns, the films and inner sides of the yarns thereby defining spaces 26 between them. Accordingly, the fibres in the individual yarns are relatively free to move upon each other. On the other hand, the fusion of the films between the yarns permits the fabric to be stretched and distorted but also promotes the prompt recovery of the fabric and stabilize its dimensions.

It is to be understood that many variations and alternatives are possible in the article and process of the invention. If desired, the transfer film which is applied to the one side may be dissimilar in chemical composition, color, thickness and other characteristics from the transfer film which is applied to the other side. For example, for military ponchos and tents to be used in the arctic, the film on one side is preferably pigmented or colored white while the film on the other side may be colored or pigmented olive drab. Also, the transfer film on one side may comprise an acid-curing thermosetting resin and a latent acid catalyst so that after the fabric is coated, the fabric may be subjected to curing conditions to convert the resin to the heat-hardened infusible state, while the thermoplastic coating on the other side remains uncured, thus retaining substantial flexibility in the coated fabric. It is also possible, if desired, to apply a thermoplastic cellulose derivative film on one side of the fabric and a thermoplastic or thermosetting resin film on the other side.

By way of illustration but not by way of limiting the invention, there will be given the following specific examples:

EXAMPLE I

A cotton scrim having 16 yarns to the inch is coated on both sides with a film of a thermoplastic cellulose acetate butyrate plasticized with dibutyl phthalate. Each of the transfer films has a thickness of from 0.0005 to 0.001 inch. The coated fabric thus produced has an overall thickness much less than coated scrim produced by prior processes, has a tear resistance and tensile strength substantially greater than prior cotton scrim of the same yarn count, and the present product also exhibits a recovery from stretching and dimensional stability much greater than the same fabric coated by prior methods.

EXAMPLE II

A cotton scrim having a leno weave and comprising 8 yarns to the inch is coated on both sides with a preformed film comprising a thermoplastic copolymer of vinyl chloride and vinyl acetate plasticized with a mixture of 50% methyl cellosolve acetyl ricinoleate and 50% tricresyl phosphate. The two films are fused together in the meshes by subjecting the composite fabric to a temperature of 130° C. at 200 lbs. pressure per square inch for 10 seconds.

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EXAMPLE III

To a nylon marquisette fabric there is applied on each side a film having a thickness of .001", the film comprising 70% of an acetone-soluble fusible phenol-formaldehyde resin, 20% of polyvinyl butyral resin and 10% of dibutyl sebacate as a plasticizer. The films are first formed on a sheet of cellophane as a temporary backing, both films being applied to the fabric simultaneously at a temperature of 150° C. and 200 lbs. pressure to cause the films to fuse together in the meshes between the yarns; however, the film is continuous over the yarns and does not substantially penetrate the yarns. The fabric will have extremely light weight, high tensile strength and a remarkable ability to recover its shape and dimensions after distortion. The fabric is ideal for raincoats or ponchos.

EXAMPLE IV

The process of Example III is repeated but to the composition of the thermoplastic film there is added ½% of chloracetic acid as a curing catalyst for the thermosetting phenol resin and, after transfer, the composite fabric is heated to 100° C. for one-half hour to cure the thermosetting resin and render the film non-thermoplastic. The fabric can be used for making containers for water or gasoline.

EXAMPLE V

A tear resistant waterproof fabric is produced as follows: A solution is prepared containing 260 parts of vinyl acetate polymer, 30 parts methylmethacrylate resin, and 9 parts dibutyl phthalate in a suitable solvent. Films having a thickness of .005" are formed on a temporary backing sheet comprising paper coated with thermosetting urea-formaldehyde resin in the heat-hardened condition, and such films are transferred at a temperature of 125° C. and 300 lbs. pressure to enclose a single thickness of nylon marquisette fabric, the films being continuous over the yarns but fused together in the meshes. The film is extremely flexible and elastic and capable of following the expansion and contraction of the fabric without rupture of the film.

EXAMPLE VI

The process of Example V is repeated except that the fabric is enclosed between two films of Neoprene having a thickness of .001", the films being bonded together by heat and pressure in the meshes. This fabric will have a superior elasticity, a more complete regain of shape and dimension and a higher abrasion resistance than the fabrics produced according to the other examples. The fabric is suitable for use in making flexible, collapsible containers for gasoline.

EXAMPLE VII

A composition comprising a mixture of polyvinyl butyral, a phenol-formaldehyde resin in a thermoplastic state and olive drab pigments was formed into a transfer film upon a backing sheet of smooth infusible urea-formaldehyde resin-coated paper. This transfer film was adhered to an open mesh cotton marquisette fabric at a temperature of 100° C. and a pressure of 35 lbs. per square inch. The weight of coating per square yard of coated fabric was found to be 3.22 ounces.

Another section of the same cotton marquisette fabric was coated by the doctor blade method using the same coating composition, dissolved in

an organic solvent. It was necessary to give the marquisette seven coats before an impervious coating was obtained. The same degree of imperviousness was obtained in one operation employing the transfer coating process of the present invention. The two coated samples of material were then compared with the uncoated marquisette fabric in a series of tests. The results of the tests were as follows:

	Fabric Coated with the Doctor Blade Method	Fabric Coated with a Transfer Film	Uncoated Fabric
Hydrostatic Pressure Tests.....	The sample showed a waterproofing in tests. The material held a water column at a height of 50 cms. for 1 hour without leakage.	Leakage at a height of 35 cms.	-----
Tear Resistance: (Strip Tear Method Federal Specification CCC-T-191a)-----			
Warp Across Filling.....lbs..	2.5-----	3.5-----	3.16
Filling Across Warp.....lbs..	2.5-----	4.5-----	4.16
Average Tensile Strength: (CCC-T-191a Grab Method)-----			
Warp (Length).....lbs..	65.0-----	61.5-----	42.3
Filling (Width).....lbs..	70.0-----	73.5-----	48.3
Bursting Strength: (Mul- len Tester).....lbs..	142.5-----	138.5-----	142.3
Weight Per Square Yard.....ozs..	10.38-----	4.20-----	0.98

The fabric was conditioned for four hours in an atmosphere of 65% relative humidity at 70 degrees Fahrenheit temperature before testing.

Thus, the coated fabric of the invention, despite the smaller weight of coating material employed, was found to have superior tear resistance while the tensile and bursting strength was also excellent. The degree of imperviousness compared with the weight of the coating employed was quite good, nearly the same degree of imperviousness being obtained with approximately $\frac{1}{3}$ the weight of coating.

These improved properties are believed the result of the freedom of the yarns to move upon each other in the coated fabric. In a fabric coated by the doctor blade method the individual yarns of the coated fabric are held together by the coating composition. In the fabric of the present invention the yarns are confined in pockets, the sides of the yarns being free of coating film, thus materially increasing the amount of movement possible by each yarn.

Many variations can be made in the process and apparatus without transcending the scope of the invention. For example, instead of applying the two thermoplastic films simultaneously to the single thickness of fabric, these films may be applied in sequence. The apparatus of Fig. 1 may be modified so that one of the films 11, supported on the backing sheet 13, is applied to the fabric 14 and before stripping off the backing sheet, a second film supported on another backing sheet is applied to the other side of the fabric by interposing heated calender rolls between the drum 14 and the cooling chamber 18, thereafter both backing sheets may be stripped from the films.

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

1. Means for applying thin films of coating material to both sides of a fabric layer comprising means for directing and concurrently positioning a fibrous layer between and in contact with two films of thermoplastic coating material temporarily supported on backing sheets, means for uniformly subjecting the assembled films and fibrous layer to heat and pressure throughout their area to adhere the films to the

fibrous layer, means for concurrently cooling the films and both sides of the fibrous layer, and means for concurrently drawing the backing sheets in substantially opposite directions away from the films, concurrently stripping both backing sheets from the films and winding the backing sheets in rolls while supporting the assembled films and fibrous layer from both sides in a region adjacent the region in which the

backing sheets are stripped comprising a pair of stripping rolls engaging both of the backing sheets.

2. Means for applying thin films of coating material to both sides of a fabric layer comprising means for concurrently positioning thin films of thermoplastic coating material temporarily supported on backing sheets, on both sides of a fabric layer, means for uniformly subjecting the assembled films and fibrous layer to heat and pressure throughout their area to adhere the films to the fibrous layer, means for cooling the assembled films and fibrous layer, and means for concurrently drawing the backing sheets in substantially opposite directions away from the films, concurrently stripping both backing sheets from the films, and winding the backing sheets in rolls comprising a pair of stripping rolls engaging both of the backing sheets.

CARLETON S. FRANCIS, JR.

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