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METHOD OF MAKING AIRPLANE FABRIC

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This invention relates to coated fabrics, and more particularly to those designed for use in covering air frames of airplanes.

In the construction of aircraft, the practice has been to tailor an uncoated fabric to the air frame of an airplane and subsequently by brushing or spraying, or combination of both methods, to apply a solution of cellulose derivative coating in sufficient quantity to tauten and protect the fabric. The uncoated fabric is sewn in the form of a "sock" and after turning it "inside out" it is stretched over the air frame and the open end is then closed. The "sock" is deliberately prepared under-size in order to make it fit more tightly. The application of a cellulose derivative solution to the fabric-covered air frame protects the fabric and effects shrinking of the fabric to produce the necessary tautness. Another reason for coating the fabric is to eliminate its porosity and to prevent the air from flowing through the fabric. In general, the practice is to apply the base coat cellulose nitrate of dope by hand brushing to force the dope down into the interstices and also thoroughly permeate each individual thread, the subsequent coats being ordinarily applied by spray application. The hand brushing and spray coating of the fabric is a bottleneck in the mass production of airplanes due to the fact that this is a long tedious step and each coat must dry before the subsequent coats are applied. Even the so-called "all metal" airplanes employ the fabric covered air frames for the ailerons, elevators and other control surfaces.

The coating dope employed for protecting and tautening the fabric covered air frame must contain a very low ratio of plasticizer to film forming material in order to obtain satisfactory tautening. Compositions containing a high ratio of plasticizer to film former when applied to a fabric tailored to an air frame do not result in sufficient tautening of the fabric upon drying.

The prior art methods of applying the coating after the fabric has been tailored to the air frame is very time-consuming, since it is necessary to apply at least six coats of dope with drying of the volatile solvents of the coating composition between each successive coat. Sanding of the surface two or three times during the building up of the coating on the fabric is necessary to obtain smoothness which decreases the resistance to the flow of air over the coated surface when the plane is in flight.

Heretofore there have been many attempts to apply the coating dope to the fabric by machine operation before it is attached to the air frame. It has also been proposed to apply only a portion of the dope to the fabric by machine coating and then apply to the predoped fabric after it is attached to the air frame, the balance of the required coating by hand brushing or spraying. In the prior art attempts, in order that the partially coated fabric would shrink after it was attached to the air frame and subsequently wetted with additional spray coats, it was necessary to use very little or no plasticizer in the pre-doping composition. The unplasticized or slightly plasticized coating rendered the fabric too stiff for satisfactory tailoring to the air frame. When sufficient plasticizer was added to the coating to render the coated fabric sufficiently supple for satisfactory tailoring to the air frame, the coating would not shrink after it was attached to the air frame and treated with additional coats of the coating composition.

A primary object of this invention is to provide predoped fabric suitable for covering air frames which eliminates a large portion of the time and labor consumed in doping and finishing the fabric by hand after it has been applied to the air frame.

A further object is to provide a predoped fabric which is sufficiently supple to permit satisfactory tailoring and application to an air frame and which is so formulated that it shrinks upon application and drying of additional dope.

A still further object is to provide a predoped fabric which overcomes the disadvantages and eliminates a large portion of the bottleneck of the prior art methods of doping airplane fabric in mass production. Other important objects will be readily apparent to those skilled in the art as the description of the invention proceeds.

The foregoing objects are accomplished by coating a water wet fabric with a cellulose derivative coating composition having a very low ratio of softener to film-forming material. The coating dope is made up, applied, and dried in such a manner that the dry coating is deposited in the interstices in a porous condition and capable of penetration by solvents therefor when additional coats of a cellulose derivative coating composition are superposed over the dry coating. The predoped fabric should preferably have a potential shrinkage of 5 to 15 per cent of the width of the fabric before coating. After the removal of the volatile ingredients of the coating composition, the predoped fabric is next tailored to the air frames and the balance of the necessary amount of coating is applied by either spray or hand brushing applications.

The following specific examples are given by the way of illustration and not limitation:

Example I

Grade A Flightex mercerized cotton sheeting, 36" wide, having a thread count between 80 and 84 in both the warp and filler direction and weighing approximately 4.0 ozs. per square yard is thoroughly wetted with water. The dry fabric absorbs approximately its own weight of water.

While the fabric is in the wet condition the width shrinks to approximately 32 inches or about eleven per cent of the original width. The fabric is rolled up in the wet condition and transferred to a coating machine where it is coated by means of a doctor knife. A suitable coating apparatus for this purpose is disclosed by W. T. Anderson in U. S. Patent 2,107,276. The predoping composition is as follows:

	Per cent by weight
Cellulose nitrate	17.5
Dibutyl phthalate	1.8
Castor oil	1.8
Methyl ethyl ketone	78.9

On a non-volatile basis there is 82.94 per cent cellulose nitrate and 8.53 per cent each of dibutyl phthalate and castor oil.

Sufficient dope is applied to the wet fabric by means of the doctor knife application to deposit .5 to 1.5 ounces of non-volatile ingredients of the coating composition per square yard of fabric. The coating dope is forced into the interstices of the web fabric and the water in the threads prevents any appreciable penetration of the coating dope into the individual threads. The coated material is then passed through a drying chamber, such as described by Anderson et al. in U. S. Patent 2,107,275 where the methyl ethyl ketone is volatilized first and the water present in the fabric precipitates the cellulose nitrate at the point of contact with the wet threads. The film is deposited in a porous condition and is readily re-dissolved when contacted with subsequent coats of a nitrocellulose solution. The precipitation of nitrocellulose at the point of contact with the wet threads is an important part of the present invention in that it allows the fabric interstices to be completely filled with the coating composition without appreciably penetrating the individual threads. A composition containing a low ratio of softener to film forming material as in the above composition would result in stiffening the fabric if applied in the prior art manner and could not be satisfactorily tailored to an air frame. It is also an important part of this invention that the fabric be dried under sufficient tension to pull the fabric back to its original 36" width. Tenter frame drying equipment is employed to restore the coated fabric to its original width during the drying of the coating composition. After the material has been coated and dried as described above, it is subjected to a calendering operation by passing it between heated polished rolls under pressure. The predoped fabric may be stored in roll form indefinitely or may be immediately tailored and applied to an air frame.

After the predoped fabric is properly attached to the air frame it is then given additional spray or brush coats of the following composition:

	Per cent
Cellulose nitrate	6.5
Dibutyl phthalate	1.5
Castor oil	1.5
Butyl acetate	10.5
Butyl alcohol	20.5
Pigment	4.0
Ethyl acetate	24.0
Ethyl alcohol	3.5
Aromatic petroleum naphtha	28.0

Sufficient coats of the above composition are applied to bring the total weight of the dry cellulose derivative coating composition up to 4.0 ounces per square yard. The volatile solvents are allowed to evaporate after each successive spray coat. The spray coats which are applied after the predoped fabric is attached to the air frame effect solution of the coating previously deposited and upon redrying the coated fabric shrinks and produces the desired tautness. Upon the re-solution of the porous coating in the interstices, the threads become permeated with the solution and when re-dried the coated fabric shrinks and becomes taut. Subsequent spray coats, upon drying, continue the tautening procedure until satisfactory degrees of tautness and weight of coating have been reached. In general, the predoped fabric should have a potential shrinkage of 5% to 15% of the original width of the fabric before predoping when the coating is wetted and re-dissolved by active solvents for the coating and allowed to shrink without tension. This method of doping the fabric results in a very smooth surface without the necessity of sanding the coated surface which is a time-consuming operation. Further, the time and labor required for applying the spray coats to the predoped fabric is approximately 30 to 50 per cent less than that required in former practice.

Example II

A predoped fabric is also prepared in the same manner as described in Example I except that the predoping composition is formulated as follows:

	Percent by weight
Cellulose aceto butyrate	15.75
Triphenyl phosphate	1.75
Methyl ethyl ketone	82.50

Example III

The following composition is satisfactory for predoping the fabric:

	Per cent by weight
Cellulose nitrate	16.80
Dibutyl phthalate	3.90
Castor oil	3.90
Pigment	10.30
Methyl ethyl ketone	65.10

The material may be stored after coating or may be immediately tailored and applied to an air frame, and finished in the regular manner. The additional coating applied by spray coats readily re-dissolves the ruptured porous coating which permeates the individual threads and upon re-drying the fabric shrinks and becomes taut.

It is noted that in all of the above examples, it is essential to have the base fabric wet with water or other precipitating agent. It is important that the cellulose derivative film forming material be deposited in the interstices of the fabric upon drying in a porous condition in order that it will be readily re-dissolved when contacted with additional coats of the finishing composition.

It is noted that the fabric shrinks in the wet condition before coating from 36" width to 32" width or 11% of the original width. If the fabric was coated and dried at 32" width without any further treatment, there would be no appreciable shrinkage of the fabric after tailoring and application to an air frame when subsequent coats of the cellulose derivative composition were applied. For this reason it is important that the fabric be pulled back to its original width simul-

taneously with the drying operation or after the coating has been completely dried.

In the examples of the predoping composition cellulose nitrate and cellulose acetobutyrate are disclosed. Cellulose acetopropionate may be used in place of cellulose acetobutyrate with equally satisfactory results. Cellulose acetate and ethyl cellulose can be used but is not preferred for airplanes due to their poor tautness retention.

It will be noted in the formulae of the predoping composition the ratio of plasticizer component to the film forming material varies between 31.6 parts of plasticizer to 68.4 parts film forming material and 10.0 parts of plasticizer to 90 parts of film forming material. It has been found that compositions containing a ratio of plasticizer to nitrocellulose higher than 40 parts of plasticizer to 60 parts of film former, i. e., more than two-thirds as much plasticizer as film-forming cellulose derivative, do not shrink sufficiently when re-dissolved and dried on a fabric base. If compositions containing very low ratios of plasticizer to cellulose derivative film forming materials are deposited on the fabric, the interstices are filled and the threads permeated with such a composition rendering the fabric too stiff for tailoring and fitting to an air frame. However, by employing compositions with the low ratio of plasticizer to film forming material and following the coating procedure as outlined in the above example, the permeation of the individual threads by the predoping composition is prevented and a supple and readily tailored pre-coated fabric is obtained which will shrink when the coating is re-dissolved on the fabric and allowed to dry under tension.

The coated fabric herein described is designed primarily for use in covering the air frames of airplanes and particularly the control elements such as ailerons, elevators, and rudders of the so-called "all metal" planes. The predoped fabric is also used in the form of a tape to cover seams, rib stitching, and for other finishing purposes. In practice the tape is applied immediately after the application of a brush coat of dope to the area to be reinforced. The predoped fabric can also be used where coated fabrics are attached to frames and tautness is desired, such as large moving picture screens, including the translucent type of screen. It can also be used for drum heads, etc.

The primary advantage of the invention is the elimination of a large portion of the time and labor consumed in finishing and doping airplane fabrics according to the prior art methods.

A further advantage is that the method herein described results in a supple predoped fabric which may be easily and readily tailored to an air frame with no more difficulty than an uncoated fabric.

A still further advantage is the elimination of the sanding operation employed in the prior art methods of finishing and doping of airplane fabrics.

It is apparent that many widely different embodiments of this invention may be made without departing from the spirit and scope thereof, and therefore, it is not intended to be limited except as indicated in the appended claims.

I claim:

1. The process of manufacturing predoped airplane fabric of improved pliability and suppleness which comprises wetting the fabric with water, applying thereto a water-insoluble cellulose derivative coating composition containing a volatile solvent for the cellulose derivative, and evaporating said solvent at a rate greater than the evaporation of the water in the said fabric to precipitate the cellulose derivative and render the coating discontinuous.

2. In the process of preparing a predoped airplane fabric and the like having a potential shrinkage of 5% to 15% of its original width before applying the dope, the improvement which comprises thoroughly wetting the fabric with water and while wet allowing the fabric to shrink 5% to 15% of its original width before wetting, filling the interstices of the wet coated fabric with a cellulose derivative composition containing a volatile solvent for the cellulose derivative, stretching the wet coated fabric in a drying chamber back to its original width before wetting while simultaneously removing the volatile portion of the cellulose derivative composition before the water to minutely fracture the dried coating and render it readily penetrable by solvents for said cellulose derivative.

3. The process of claim 2 in which the cellulose derivative composition contains a plasticizer in amount less than two-thirds of the cellulose derivative in the said composition.

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