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FABRICS FOR AEROPLANE CONSTRUCTION AND PROCESS
AND COMPOSITION FOR MAKING SAME
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Fig. 1

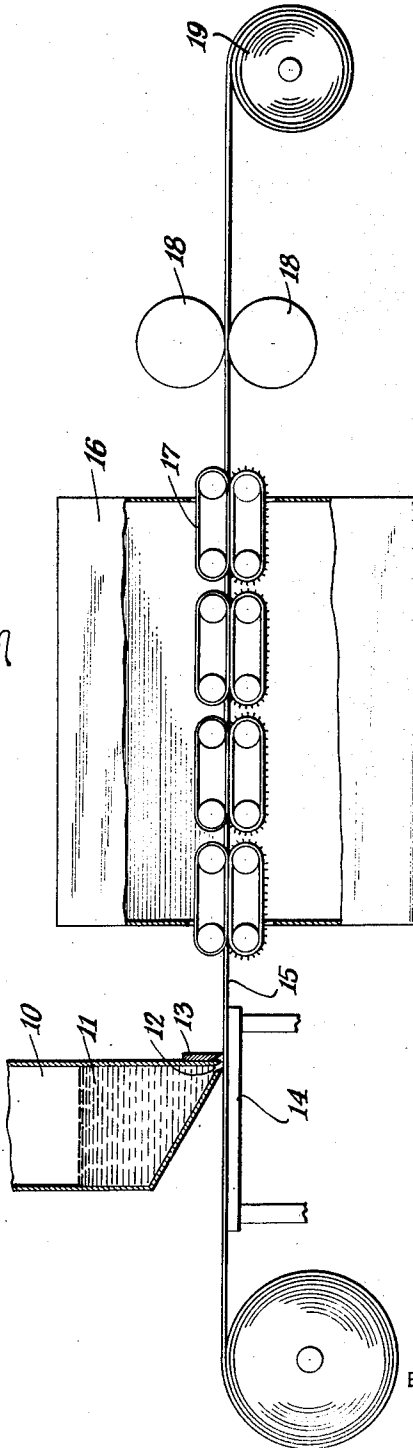
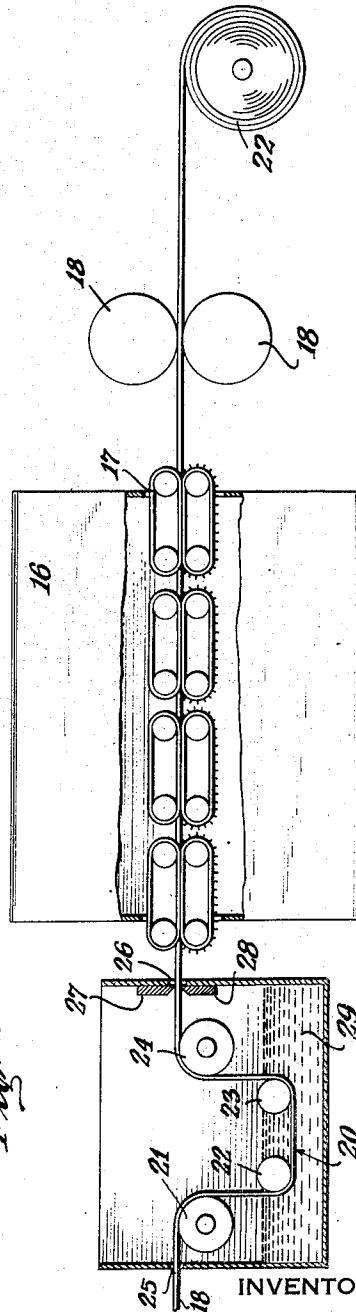


Fig. 2



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FABRICS FOR AEROPLANE CONSTRUCTION
AND PROCESS AND COMPOSITION FOR
MAKING SAME

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5 Claims. (Cl. 91—68)

This invention pertains generally to cellulosic plastics, and particularly to cellulosic plastics adapted for use as coating compositions. The invention pertains more particularly to textile and metal fabrics coated or impregnated with cellulosic plastics and intended for special uses such, for instance, as for constructing aeroplanes or lighter than air craft.

The invention, therefore, will be described in connection with a fabric adapted for use in constructing aeroplane wings. However, it is to be understood that the invention has many other uses.

According to the present practice in aeroplane wing construction the fabric is first applied to the wing framework, is drawn as tightly as possible, and is then coated or impregnated with a cellulosic plastic coating composition which functions, among other things, to shrink the fabric and draw the fabric exceedingly taut. The tautness of the fabric of a finished wing may be compared with that of a drumhead. A tautness of this character is required in aeroplane wing construction for, if there were any looseness at any point, there would be a tendency for the fabric to flap at high speeds with the result that the fabric and consequently the wing structure would fail.

After the fabric has been applied it is customary to cover all seams, joints, etc. with strips of fabric tape. This tape is generally impregnated at the time of its application in order that it may be held in place and may strengthen and assist in drawing the fabric taut across the seam.

Should there be a tear or rupture of the finished fabric at any time, particularly after the aeroplane has been in use, it is customary to repair such torn or cut portions by applying strips impregnated at the time of their application, which by their shrinkage tend to pull the fabric tight across the separated portions.

After the fabric has been applied to the wing framework, as above set forth, a cellulosic plastic coating composition is applied by means of brushing or spraying. The fabric upon drying becomes taut. The surface is then sanded in order to make it smooth for the following coats which generally comprise an intermediate and a final coat but may be as high as seven or eight. In some instances the sanding operation may be repeated after each one or more coats.

It is quite evident that even though extreme care is exercised the applied coats will be non-uniform in character. This is particularly true of the first coat inasmuch as it is applied directly

to the fabric which not only has a rough surface but also soaks up the coating composition so that it is not always evident how much of the coating composition has been applied at any one place. The tendency is to apply too much coating composition or dope. In extreme cases as much as 16 ounces of dope per square yard of surface have been applied, considering dope as dry material. It is not unusual to find that from six to eight ounces of dope, considered as dry, per square yard have been applied. Bearing in mind that the average total area requires about 360 square yards of fabric, it can be seen that anything but the most rigid care in the application of dope might result in considerable excessive dead weight.

When tape is applied either to the seams or in patching, as above set forth, it is necessary to work the edges of the impregnated tape with the fingers in order to keep the edges from curling to eliminate wrinkles and to draw the tape tight. This is a laborious and time consuming operation and, in view of the fact that the fingers become covered with sticky dope, it is one that has not met with general approval by workmen.

In all of the foregoing instances it is necessary to allow the first coat to dry before the second can be applied, the second coat to dry before the third can be applied, etc. A day is generally required for the drying of each coat. It can therefore be seen that considerable time is consumed not only in preparing the wing in the first instance but in making repairs, regardless of how trivial the repair might be.

Furthermore the sanding operations above referred to not only result in non-uniformity in the amount of dope per square yard but, unless carried out with the utmost care, will carry away portions of the fabric, thus causing weak spots.

According to my invention the first coat of cellulosic plastic dope is applied to the fabric before the fabric is applied to the wing framework. In order to preserve the shrinkability of the fabric, the fabric is stretched or held to its customary width during the drying of the dope. The material is then passed through calender rolls or similar means in order to impart to the surface or surfaces of the fabric a smooth finish. The material is then ready for application to the wing framework.

The drying of the dope with the fabric held to its normal width results in a coated product of normal width, the dried dope apparently holding the fibers in place. This product, however, is

still shrinkable and, after its application to the wing framework in the normal way, it is merely necessary to wet the same such as by applying an intermediate or finish coat of dope in order to cause the normal shrinkage of the fabric, thus drawing the same to drumhead tightness.

A coated fabric of this character must, of course, have a certain degree of softness and pliability approaching that of the cloth uncoated, in order that it can be readily sewed and handled and cut into patterns. My product not only meets these specifications but can actually be cut into patterns more readily than uncoated cloth.

I find that, whereas according to the prior practice six to eight ounces of dope, considered as dry, per square yard is applied as an average and in extreme cases as high as sixteen ounces of dope per square yard, according to my invention I apply only from about one to two and one-half ounces of dry material per square yard for the first coat and, in view of its unusual evenness and smoothness, do not exceed a total of approximately five ounces of dry material per square yard of fabric area in a finished wing.

Tape for covering seams and for repairing is made by cutting the fabric into strips, which strips may be wound into rolls. The tape having more body than the uncoated fabric and having its normal shrinkability, may be applied with the greatest of ease by merely moistening the surface with a solvent or cement and unrolling the roll of tape along the seam. The tape is thus cemented in place and there are no wrinkles or curling of the edges. The normal shrinkage, however, takes place with the normal drawing and re-enforcement of the material across the seam.

The tape when used for patching has sufficient body to remain flat, does not bag, and therefore not only smoothes out the material at the point under repair but because of the shrinkage of the tape that occurs, draws the edges of the separated fabric together. It does not fray.

Among the advantages of my invention are uniformity of coating; economy in coating material; time and labor saving in covering, recovering and repairing; normal pliability and flexibility; adaptability to shrinkage after application to the framework; ease of pattern cutting; normal characteristics in stitching and tailoring operations; reduction in skin friction; non-inflammability; low final cost; etc.

The dope may be applied to one or both surfaces of the fabric or alternately on one and then on the other, or a greater number of coats may be applied to one side than to the other as desired.

While the application of the first coat, the drying operation and the calendering or smoothing may be carried out by any suitable means as long as the shrinkability of the fabric is substantially completely or at least in large part preserved. I have illustrated diagrammatically in the drawing merely for the purpose of illustration means by which the invention may be carried out. Like reference characters are appended to like parts in the various figures.

Figure 1 is a diagrammatic illustration of means for applying dope to one side of a length of fabric of normal width.

Figure 2 is a diagrammatic illustration of means for applying dope to both sides of a length of fabric of normal width.

Referring to Figure 1, at 10 is shown a hopper

containing dope 11. At the bottom of the hopper is slit 12 adjacent to which is a doctor knife 13 adjustably secured to the hopper 10. The doctor knife is adjustable to and from the fabric and performs its usual function of removing excess material. A table 14 is shown below the hopper for steadying the fabric. The fabric is shown at 15.

At 16 a dryer is shown which may be accompanied by a solvent recovering system if desired. Drying takes place with the fabric under tension and held to normal or substantially normal width. Means for holding the fabric under tension is shown generally at 17 and may comprise any suitable means for this purpose. For instance a plurality of pairs of opposed endless belts, one belt of each pair provided with projecting pins or clips, may be arranged at each edge of the fabric, the fabric passing between each pair. These belts may be diverging, if desired or if necessary. This particular construction is known in the art, and need not be described in detail.

After the fabric leaves the dryer the surface or surfaces are preferably smoothed such as by calender rolls shown at 18. The material may then be collected in any manner such as on a roll 19.

This particular description as to apparatus is merely for the purpose of illustration and it is to be strictly understood that the invention is in no way limited thereto inasmuch as any other apparatus may be employed.

Referring now to Figure 2 wherein I illustrate means for applying dope to both sides of the fabric, at 20 is shown a container having a plurality of rolls 21, 22, 23 and 24, an inlet opening 25, an outlet opening 26, and doctor knives 27 and 28. Dope 29 is shown in the bottom of container 20. Roll 21 is shown opposite the inlet opening 25 and roll 24 is shown opposite the outlet opening 26. Rolls 22 and 23 are so positioned that when the fabric is passed over roll 21, underneath rolls 22 and 23, and over roll 24, it will pass beneath the surface of dope 29 so as to become impregnated therewith. Doctor knives 26 and 27 are so adjusted as to remove excess dope. The fabric then passes through dryer 16, is held under tension as to width by the mechanism shown generally at 17, the surfaces are smoothed by smoothing means such as the calender rolls shown at 18, and the material is collected such as on roll 22.

This particular description is also merely for the purpose of illustration and the invention is in no way limited thereto.

Although the dope may have any suitable composition and consistency, I have found that a very suitable dope for the initial application may be made as follows:

A cellulose derivative 100 parts, plasticizer 75 to 125 parts, volatile solvent sufficient to give the dope a proper body for application.

The total amount of plasticizer may exceed 125 parts and may in fact go as high as 200 parts. The upper limit of plasticizer is governed to a great extent by the amount of shrinkage necessary after the initially coated fabric has been applied to the wing framework. The lesser the amount of necessary immediate shrinkage the higher may be the proportion of plasticizer. Likewise the proportion of plasticizer may fall below 75. The lower limit of the plasticizer is governed to a great extent by the amount of softness and pliability desired in the fabric. The

softness and pliability will decrease with decrease in plasticizer. In fact the proportion of plasticizer might in some instances go as low as 50 or perhaps less, depending upon the softening qualities of the particular plasticizer or combination of plasticizers employed.

The initial coat may be made up of one application of the dope above set forth or a second application may be made of a dope with considerably less plasticizer, say for instance with a dope having between 25 to 50 parts of plasticizer to 100 parts of cellulose derivative. This second application might be followed by a third application with a dope known in the art as 'hard clear' having up to 10 parts of plasticizer to 100 parts of cellulose derivative. If desired the 'hard clear' application may be applied directly to the first application.

The function of the plurality of applications is as follows: The first application imparts the softness and pliability to the treated fabric. The high proportion of plasticizer appears to aid in holding the fabric to its original width.

The second application imparts a slightly firmer body underneath the surface, and the third application imparts a dry, non-sticky surface.

It is of course understood that any number of applications may comprise the predoping or first coat depending upon the physical properties desired. This also applies to the subsequent coats. The term 'coat' is a general one and is used somewhat loosely in the art.

After the initially treated fabric is applied to the wing framework and a second coat applied, which moistens the first coat, the second and/or third application of the first coat appear to absorb some of the plasticizer from the first application of the first coat. The removing of plasticizer from the first application of the first coat seems to assist in the shrinking of the fabric and this tendency to shrink by virtue of absorbing plasticizer from the initial application of the first coat may take place throughout the life of the fabric, thus always keeping it taut.

It is to be understood, however, that the primary shrinkage takes place due to the moistening of the first coat, the fabric then taking a normal shrinkage such as it would have done in the first instance.

As a general rule two coats of clear dope and a final coat of dope carrying some color will be applied to the fabric after it has been made up into a wing structure. If all of the shrinkage has not occurred due to the application of the second coat, such shrinkage will be assisted by the succeeding coats.

Due to the highly smooth surface of the one coat, the succeeding coats may be applied without any sanding operations and without using excess dope.

Another suitable dope for many types of uses may comprise a cellulose derivative and a volatile solvent without a plasticizer or with quantities between zero and the smaller quantities given above. The first coat may comprise only this type of material or various combinations may be made.

Pyroxylin is very suitable as a cellulose derivative and may be either of the regular or of the reduced viscosity variety. I find castor oil and tricresylphosphate to be excellent plasticizers, either singly or mixed, for the pyroxylin. Any other plasticizer might be substituted in whole or in part particularly if such plasticizer had the essential properties of the foregoing plasticizers.

Among these are the ability to diffuse into the second and/or third applications of the first coat and/or into the succeeding coats as above set forth. However, small portions of other plasticizers not having this property of diffusion might be mixed with those having this property.

Cellulose acetate also makes an excellent cellulose derivative. Suitable plasticizers with cellulose acetate are tricresylphosphate and dibutyl tartrate, either singly or mixed, and small amounts of dibutyl phthalate might be used. Substitutions of plasticizers might also be made when using cellulose acetate. Although cellulose acetate is somewhat more expensive than pyroxylin, it has the advantage of being somewhat less inflammable.

Other cellulose derivatives might be used such as follows:

Cellulose formate	
Cellulose butyrate	20
Cellulose propionate	
Cellulose phthalate	
Ethyl cellulose	
Methyl cellulose	
Benzyl cellulose	25

Mixtures of cellulose derivatives might also be used.

Other plasticizers of which desired amounts might be used according to their properties are triphenylphosphate, monochloronaphthalene, paraethyltoluolsulfonamid, camphor, etc.

Any of the well known solvents or combinations of solvents may be employed. The use of solvents with cellulose derivatives has been extensively described in publications. However, I find a very suitable solvent to be as follows, although the invention is in no way limited thereto:

	Per cent
Ethyl acetate.....	40
Ethyl alcohol.....	40
Butyl acetate.....	15
Toluol.....	5

In the choice of solvents the usual consideration will be given to the prevention of blushing and precipitation of lacquer solids, etc., all of which is known to persons skilled in the art.

Pigments, dyes and/or lakes may be added to the dope if desired. Ordinarily color will be added to the dope for the final coat only. By regulation of the amount of coloring matter the final total dried cellulosic plastic film may be made sufficiently diaphanous to permit inspection of the fabric when in use and if the fabric is sufficiently reticular, such as wire fabrics, the inner part of the wing may also be inspected.

By treating the fabric with solutions of fireproofing agents such as ammonium carbonate, a substantially fire-proof, impregnated fabric may be manufactured.

The higher concentration of plasticizer in the dope for the first application of the first coat and a much lower concentration of plasticizer in the succeeding applications of the first coat, as well as in the succeeding coats, is the general rule, although it is subject to variation.

While the first coat only would generally be applied before the material is attached to the wing structure, more than one coat might be applied prior to this time without departing from the spirit of the invention. For instance the material used for patching might have its final coat applied prior to use. It will then be merely necessary to apply a solvent or cement and then roll

on or otherwise apply the material. A repair job may thus be finished within a very short time, sometimes not over a few minutes. On the other hand, patching with untreated tape very often takes days because the same time is required in finishing a patch of untreated fabric as is required in finishing a whole new wing in view of the drying time required between coats.

The invention is, of course, applicable to any type of fabric. Fabrics generally used in aeroplane construction at the present time are known commercially as grade A fabric, grade HH fabric, and grade BB fabric.

Coated fabrics made in accordance with my invention are characterized by all of the advantages herein set forth.

Having described my invention it is obvious that many modifications may be made in the same within the scope of the claims without departing from the spirit thereof.

The term "penetration" as used in the specification and claims is not limited to complete penetration but includes any penetration sufficient to bring about at least a partial shrinking of the predoped fabric.

Although the invention for the purpose of illustration has been described in connection with aeroplane wings, it is equally applicable to all other aeroplane parts, such as the fuselage, control surfaces, etc. as well as to lighter than air craft. The predoped fabric will obviously find many other uses in other arts. The invention therefore is not to be considered as limited to aircraft purposes.

However, when my predoped fabric is used for aeroplane purposes the rate of shrinking is such that an unusual uniformity thereof results so that the stresses of shrinking are evenly transmitted to the framework. This is in contrast to the use of untreated fabric which shrinks so rapidly and so non-uniformly as to cause very undesirable local stresses on the framework during the application of dope.

I claim:

1. The process of preparing a material adapted for use for aircraft covering purposes which comprises applying a dope coating containing a cellulose derivative and a plasticizer in the relative proportions of 100 parts of the derivative to from 75 to 125 parts of the plasticizer, to a fabric, and drying said fabric while holding the same to substantially its normal width and length, then applying another dope coating containing a cellulose derivative and a plasticizer in the relative proportions of 100 parts of cellulose derivative to from 25 to 50 parts of plasticizer, to said fabric, and drying while holding the fabric to substantially its normal width and length.

2. The process of preparing a material adapted

for use for aircraft covering purposes which comprises applying successive coatings of a cellulose derivative and a plasticizer in which there are decreasing amounts of plasticizer to a fabric while holding said fabric substantially to its normal width and length and drying said fabric immediately after each application of said coating.

3. The process of forming a covering on an aircraft member which comprises applying successive coatings containing a cellulose derivative, a plasticizer and a solvent to a fabric, said coatings having successively decreasing proportions of plasticizer, drying said fabric after each application of coating while holding said fabric substantially to its normal width and length, thereafter applying said fabric to the aircraft framework, and thereafter applying a further coating of cellulose derivative containing a substance adapted to penetrate and soften the preceding coatings and thereby cause migration of the plasticizer constituent of said preceding coatings and shrinking of the fabric to take place.

4. The process of forming a covering on an aircraft member which comprises applying to a fabric a dope coating containing a cellulose derivative and a plasticizer in the relative proportions of 100 parts of the derivative to from about 75 to 125 parts of the plasticizer, then applying to said fabric another dope coating containing a cellulose derivative and a plasticizer in the relative proportions of 100 parts of cellulose derivative to from about 25 to 50 parts of plasticizer, and immediately after each coating step drying said fabric while holding the same to substantially its normal surface dimensions; thereafter applying said fabric to the aircraft framework; and thereafter applying a further coating of cellulose derivative containing not exceeding 10 parts of plasticizer to 100 parts of cellulose derivative and also containing a substance adapted to penetrate and soften the preceding coatings and thereby cause migration of the plasticizer constituent of the said preceding coatings and shrinking of the fabric to take place.

5. A material adapted for use for aircraft covering purposes comprising a fabric coated with a dope composition containing a cellulose derivative and a plasticizer, said composition being disposed thereon in successive layers, the lowermost containing a relatively high proportion of plasticizer to cellulose derivative, and the successive layers containing progressively decreasing proportions of plasticizer, said coating material being further characterized by having substantially its normal uncoated surface dimensions and the property of shrinking when said dope composition is softened by a solvent.

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