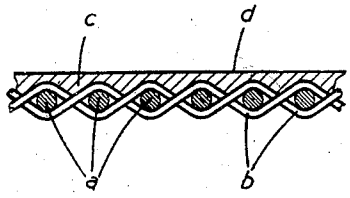
Sept. 11, 1945. A. RYAN 2,384,771

COVERING MATERIAL FOR AIRCRAFT FRAME STRUCTURES AND THE LIKE AND METHOD OF PRODUCING THE SAME

Filed Oct. 2, 1943



INVENTOR
ALFRED RYAN.
BY Haseltine, Lake & Co.
ATTORNEY

Patented Sept. 11, 1945 2,384,771

UNITED STATES PATENT OFFICE

2,384,771

COVERING MATERIAL FOR AIRCRAFT FRAME STRUCTURES AND THE LIKE AND METHOD OF PRODUCING THE SAME

Alfred Ryan, Glasgow, Scotland, assignor to The Ioco Rubber and Waterproofing Company Limited, Glasgow, Scotland, a British company

Application October 2, 1943, Serial No. 504,712
In Great Britain August 6, 1942

11 Claims. (Cl. 28—74)

This invention relates to covering materials for aircraft frame structures and the like.

It is known that in the early development of the covering of such structures to secure curved surfaces, textile materials were used which were coated with rubber and cellulose compounds prior to fixing on the framework.

It is also known that in order that the curved surface shall be regular and even and take the correct form between the ribs of the structure, the covering was applied by hand methods in such manner that the greatest degree of tension was applied in the direction of least curvature.

The object of this procedure was to avoid excessive dips or flats in the covering material, thus securing a more even airflow over the aerofoils than would be the case if such flats or dips occurred to an excessive degree. This procedure, however, was not fully satisfactory or controllable and it was not possible to secure the necessary tautness.

Owing to the difficulties arising in the earlier methods, it became usual to apply fabrics in the so-called "biassed" condition, that is with the threads composing the fabric at approximately 45° to the two principal directions of curvature. This facilitated the tensioning of the fabric in position on the surfaces and the fabric was subsequently tautened by the application of so-called "dope," which has the property of shrinking the material to the desired condition. This method, although useful in securing a smooth taut surface, accentuated the "flats" over the surface between the frame members.

It is among the objects of this invention to produce a material that can be used to bridge the gaps between the frame members in such manners as to give a true surface of the desired shape and which can be tensioned to the correct degree by controllable mechanical means. It is also an object of the invention to ensure that this tension can be practically permanent and not affected to any appreciable degree by changes in conditions.

According to the invention, a covering material for aircraft frame structures and the like comprises as a base, a fabric which consists of non-corrosive metal wires woven in one direction in such manner as to remain straight in the fabric and textile threads woven in the other direction.

It is essential that the material be woven so that the wires remain straight in the fabric, that is, free from the crimping usually experienced in the threads or wires of woven fabrics, in order to ensure that the wires shall "set" to an even tensioned and permanent length when the material is stretched in position. In this way, the full strength of the individual wires is utilized in the material, each wire taking up a proportionate share of the tension applied to the material.

The covering material is applied to the structure in such manner that the wires run in the direction of maximum tension and it is therefore desirable that said wires should have a high ratio of tensile strength to weight so as to provide a low degree of extensibility but high elasticity in that direction. The textile threads will run in the other direction where a low degree of tension and a greater degree of extensibility coupled with flexibility and elastic properties are desirable.

In referring to the wires as non-corrosive, I mean that the wires are either non-corrosive per se, for example, of high tensile stainless steel, or are rendered non-corrosive, for example, by tinning or lacquering.

The textile threads may consist of cotton, flax, silk, rayon, nylon, Vinyon or any known textile yarn depending upon the particular requirements. It will, of course, be understood that there must be a suitable relationship between the wires and the textile threads and the latter must not be so thick and strong as to cause crimping of the metal wires.

The metal wires are preferably woven as warp and the textile threads as weft.

According to a further feature of the invention the metal wires are evenly tensioned before being fed to the weaving position on the loom.

The finished material is required to be serviceable and retain its form and properties over the wide range of temperatures and weather conditions encountered between the ground and high altitudes. Another property required is that the surface of the finished material shall be perfectly smooth so that in addition to reducing air resistance by maintaining its form and avoiding flats, it also offers a small degree of skin resistance. Another desirable feature is that the material shall be capable of being deformed in its own surface by distorting the angle between the textile threads and the metal wires where necessary.

According to a further feature of the invention therefore and in order to produce the finished material from the base described, the combined wire and textile woven fabric is first coated or covered with a substance that will unite the points of contact between the textile threads and metal

wires sufficiently to prevent relative displacement at the points of contact but without preventing a small angular movement between said threads and wires. An outer covering or coating is then applied which will leave the finished material with a smooth, continuous outer surface. The first coating is therefore of a flexible, resinous, glutinous or rubber-like character, whilst the outer covering or coating is composed of a rubber, rubber-like or "plastic" compounded material which is applied by dipping, spraying, printing, calendering or the like.

Either during or after the application of the outer covering or coating a smoothing operation is carried out by means of hot pressing or calendering so that with the heat applied during the process or by additional heating the compound may be "set," vulcanised, polymerized or cured to the correct degree.

The final coating may be applied by pressing a film of the rubber-like or plastic compound on to the prepared base fabric by pressing between heated platens or other means.

According to yet another feature of the invention, the textile threads which are woven with the wires are non-inflammable whereby the fabric is rendered comparatively fireproof. This is of particular importance in the application of the material to aircraft frames.

Thus, the textile threads may consist of a non-inflammable material per se, such as glass fibre yarn or a substance such as polyvinyl chloride or a co-polymer of vinyl chloride and vinyl acetate which has been plasticised with tricresyl phosphate or other fire-resisting plasticiser. Alternatively, the textile threads are not non-inflammable per se, but are rendered so as by coating with a non-inflammable flexible material such as polyvinyl chloride plasticised with tricresyl phosphate or other fire-resisting plasticiser. In the latter case, the fabric may be pressed under heat and pressure before coating to give the fabric a smooth surface by flattening the textile threads and spreading them over the wires. This pressing operation may be carried out in addition to any other cloth finishing process employed. After being pressed, the fabric may be provided with a further non-inflammable coating as hereinbefore described.

The invention will now be described with reference to the following example.

A base fabric was woven from high tensile stainless steel wires as warp, with 40 wires of .006" diameter per inch width, and high-grade cotton yarn of 40 s count as weft, with 100 picks per inch. The tensile strength of the wires was at least 120 tons per sq. in. A creel was fitted up with individual bobbins of single wire sufficient for the full width of the cloth to be woven and each bobbin was fitted with a braking device to ensure that a small tension was necessary to unwind the wires. The wires were led over guides and a carrier weight of staple-like form was hung, if necessary, upon each wire prior to passing over the first guide. The wires were then taken to the loom and threaded through a reed after which they were passed under and over rollers in parallel juxtaposition to the weaving position. Two or more of these rollers were pressed together by a weighted lever attachment, or, if preferred, one of the heavier rollers may "float" on the full width of the wires by being free to oscillate in its bearings, thus acting as a compensation weight on the tensions of the various wires. The necessary even tension on the individual wires across the full width was thus provided for. A suitable temple, or width-maintaining mechanism, was fitted to the loom to hold the cloth to full width after the shuttle and weaving operation had placed the weft in position. A textile selvedge was woven on each side of the wire-textile cloth between the textile weft and a number of textile warp threads provided on each side of the width of the wires. At the same time, the temple or width-maintaining mechanism caused a loop of the weft threads to be produced on the extreme edges of the finished fabric. A tape was fed into this loop formation on each side to facilitate handling the material in the first coating or fixing operation.

Lengths of the finished fabric were in turn fitted on to two lines of pins or clips which were spaced apart a distance such that the fabric was stretched to the full width by attaching the tapes or selvedge to each row of pins or clips. Heating devices, for example, steam-heated platens, were arranged beneath the fabric to dry off the moisture or solvent used in the first coating operation. The lengths of complete fabric are then coated with a casein solution and dried in position on this apparatus. In the condition of the fabric as it leaves the loom, the weft slips readily along the wires owing to the wires being free from crimp and the nature of the weave. After this first treatment, however, the textile weft adheres to the wires in the required manner and the fabric can be handled readily for subsequent coating and finishing operation.

The final coating was applied by either of two methods. According to the first method, a film of plasticized polyvinyl chloride or co-polymer was first prepared and subsequently pressed on to the fabric surface by heat and pressure in a multiple platen press. The platens of this press can be heated or cooled as necessary. On one side of the fabric a sheet of polished stainless steel was fitted in order to produce the smooth surface required on the side of the fabric exposed to air resistance. On the other side of the fabric a resilient pad of rubber, or rubber-coated cloth, was arranged so that when the pressure was applied any damage to the textile weft that might have been caused by pressing on the wire was prevented. The platens were cooled as desired in order to remove the material which is liable to adhere to the steel plate or pad after processing if left hot. In the second method, the material was coated on a spreading machine of the ordinary roller and doctor-knife type which applied the plasticized polyvinyl chloride or co-polymer in paste form across the surface of the fabric. The material was then passed to the press and the pressure applied in the same manner as in the previous method.

As an alternative to the pressing method used to secure smoothness and evenness of the coating and also the required adhesion, the material may be passed between a hot roller and a continuous belt. The hot roller in this case has a smooth, polished surface to provide a smooth surface to the material and the continuous belt is coated with a resilient material such as rubber to act as a pad and press the material against the roller. With the paste method of spreading and using this apparatus for finishing, the material may be produced in continuous form and it has been found that the material leaves the surface of the roller satisfactorily when cooling without special arrangements.

A cross-section through a material according

to the present invention is illustrated in the accompanying diagrammatic drawing.

a represents the straight wires, *b* the textile threads, *c* the outer coating and *d* the smooth outer surface of said outer coating. The textile threads *b* are impregnated with the preliminary coating so as to prevent their slipping with respect to the metal wires *a*.

What I claim and desire to secure by Letters Patent of the United States is:

1. A covering material for aircraft frame structures and the like comprising as a base, a fabric which consists of non-corrosive metal wires woven in one direction in such manner as to remain straight in the fabric, and textile threads woven in the other direction, a first coating derived from a solution of casein which unites the points of contact between the textile threads and metal wires sufficiently to prevent relative displacement at the points of contact but without preventing a small angular movement between said threads and wires, and an outer coating of material selected from the class of rubber, rubber-like and plastic compounded materials, which forms a smooth outer surface.

2. A covering material for aircraft frame structures and the like comprising as a base, a fabric which consists of non-corrosive metal wires woven in one direction in such manner as to remain straight in the fabric, and textile threads woven in the other direction, a first coating of a flexible material selected from the class of resinous, glutinous and rubber-like materials, which unites the points of contact between the textile threads and metal wires sufficiently to prevent relative displacement at the points of contact but without preventing a small angular movement between the threads and wires, and an outer coating of polyvinyl chloride which forms a smooth, continuous outer surface.

3. A covering material for aircraft frame structures and the like comprising as a base, a fabric which consists of non-corrosive metal wires woven in one direction in such manner as to remain straight in the fabric, and textile threads woven in the other direction, a first coating of a flexible material selected from the class of resinous, glutinous and rubber-like materials which unites the points of contact between the textile threads and metal wires sufficiently to prevent relative displacement at the points of contact but without preventing a small angular movement between said threads and wires, and an outer coating of a co-polymer of vinyl chloride and vinyl acetate, which forms a smooth continuous outer surface.

4. A covering material for aircraft frame structures and the like comprising as a base, a fabric which consists of non-corrosive metal wires woven in one direction in such manner as to remain straight in fabric, and non-inflammable textile threads woven in the other direction whereby the fabric is rendered comparatively fireproof, a first coating of a flexible material selected from the class of resinous, glutinous and rubber-like materials which unites the points of contact between the textile threads and metal wires sufficiently to prevent relative displacement at the points of contact but without preventing a small angular movement between said threads and wires, and an outer coating of material selected from the class of rubber, rubber-like and plastic compounded materials which forms a smooth, continuous outer surface.

5. A covering material for aircraft frame structures and the like comprising as a base, a fabric which consists of non-corrosive metal wires woven in one direction in such manner as to remain straight in the fabric, and textile threads woven in the other direction and selected from the class comprising polyvinyl chloride and copolymers of vinyl chloride and vinyl acetate which have been plasticised with a fire-resisting plasticiser, a first coating of a flexible material selected from the class of resinous, glutinous and rubber-like materials which unites the points of contact between the textile threads and metal wires sufficiently to prevent relative displacement at the points of contact but without preventing a small angular movement between said threads and wires, and an outer coating of material selected from the class of rubber, rubber-like and plastic compounded materials which forms a smooth continuous outer surface.

6. A covering material for aircraft frame structures and the like comprising as a base, a fabric which consists of non-corrosive metal wires woven in one direction in such manner as to remain straight in the fabric, and textile threads woven in the other direction and which are not non-inflammable per se but are rendered so by coating with a non-inflammable flexible material such as polyvinyl chloride, plasticized with a fire-resisting plasticiser, a first coating of a flexible material selected from the class of resinous, glutinous and rubber-like materials which unites the points of contact between the textile threads and the metal wires sufficiently to prevent relative displacement at the points of contact but without preventing a small angular movement between said threads and wires, and an outer coating of material selected from the class of rubber, rubber-like and plastic compounded materials which forms a smooth continuous outer surface.

7. A method of producing a covering material for aircraft frame structures and the like which consists in weaving a fabric from metal wires and textile threads in such manner that the metal wires are straight in the fabric, the crimp of weaving being taken entirely by the textile threads, coating said fabric with a solution of casein which will unite the points of contact between the threads and wires sufficiently to prevent relative displacement at the points of contact but without preventing angular movement between the threads and wires, and providing the fabric with a smooth continuous outer covering of material selected from the class of rubber, rubber-like and plastic compounded materials.

8. A method of producing a covering material for aircraft frame structures and the like which consists in weaving a fabric from metal wires and textile threads in such manner that the metal wires are straight in the fabric, the crimp of weaving being taken entirely by the textile threads, coating said fabric with a material which will unite the points of contact between the threads and wires sufficiently to prevent relative displacement at the points of contact but without preventing angular movement between the threads and wires, and providing the fabric with a smooth continuous outer covering of polyvinyl chloride.

9. A method of producing a covering material for aircraft frame structures and the like which consists in weaving a fabric from metal wires and textile threads in such manner that the metal wires are straight in the fabric, the crimp of weaving being taken entirely by the textile threads, coating said fabric with a material which

will unite the points of contact between the threads and wires sufficiently to prevent relative displacement at the points of contact but without preventing angular movement between the threads and wires, and providing the fabric with a smooth continuous outer covering of a co-polymer of vinyl chloride and vinyl acetate.

10. A method of producing a covering material for aircraft frame structures and the like which consists in weaving a fabric from metal wires and textile threads in such manner that the metal wires are straight in the fabric, the crimp of weaving being taken entirely by the textile threads, coating said fabric with a material which will unite the points of contact between the threads and wires sufficiently to prevent relative displacement at the points of contact but without preventing angular movement between the threads and wires, providing the fabric with an outer covering of material selected from the class of rubber, rubber-like and plastic compounded materials, and pressing the material between a heated plate on one side and a pad of resilient or yielding material on the other.

11. A method of producing a covering material for aircraft structures or the like which consists in weaving a fabric from metal wires and textile threads in such manner that the metal wires are straight in the fabric, the crimp of weaving being taken entirey by the textile threads, passing said fabric along an endless band, coating said fabric while passing along said band with a material which will unite the points of contact between the threads and wires sufficiently to prevent relative displacement at the points of contact but without preventing angular movement between the threads and wires, providing the fabric with an outer covering of material selected from the class of rubber, rubber-like and plastic compounded materials, and passing the material to a pressing position where said material is pressed between a suitably heated metal plate or roller on one side and a continuous belt having a resilient or yielding surface on the other.

A. RYAN.