May 14, 1940. E. F. FIELD 2,200,838

APPARATUS FOR PROTECTING SURFACES FROM ICE FORMATION

Filed Nov. 13, 1937 2 Sheets-Sheet 1

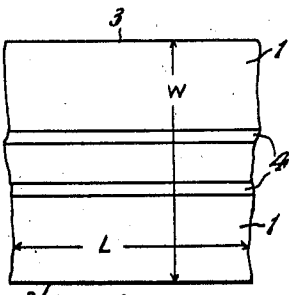


Fig. 1.

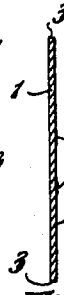


Fig. 2.

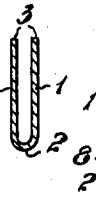


Fig. 3.

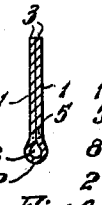


Fig. 4.

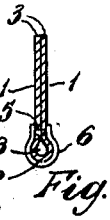


Fig. 5.

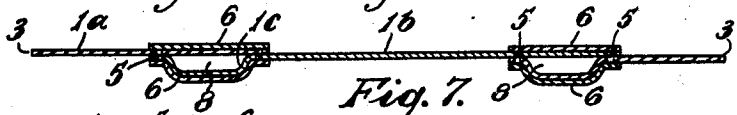


Fig. 7.

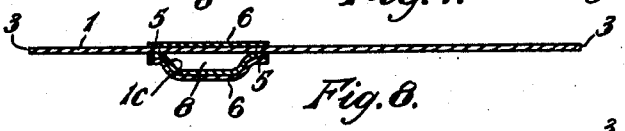


Fig. 8.

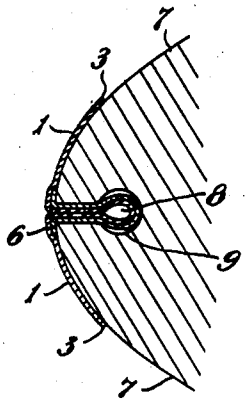


Fig. 6.

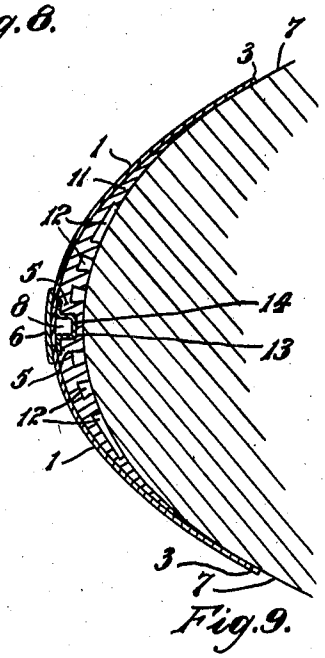


Fig. 9.

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May 14, 1940. E. F. FIELD 2,200,838

APPARATUS FOR PROTECTING SURFACES FROM ICE FORMATION

Filed Nov. 13, 1937 2 Sheets-Sheet 2

Fig. 13.

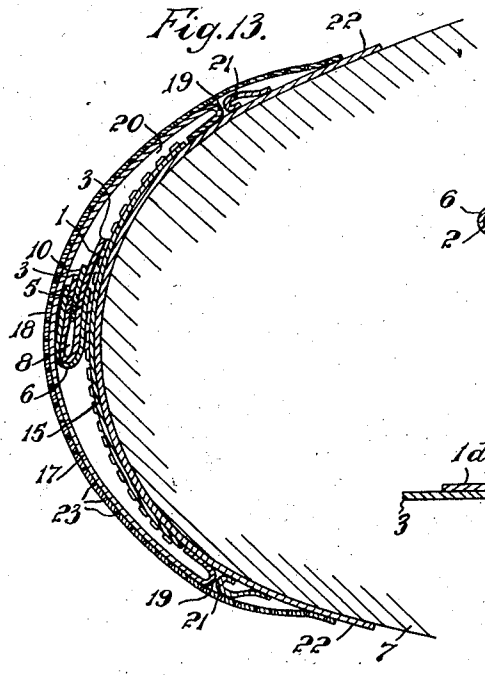


Fig. 10.

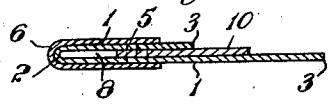


Fig. 11.

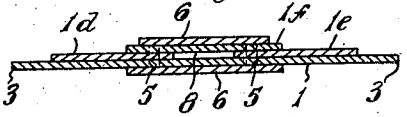
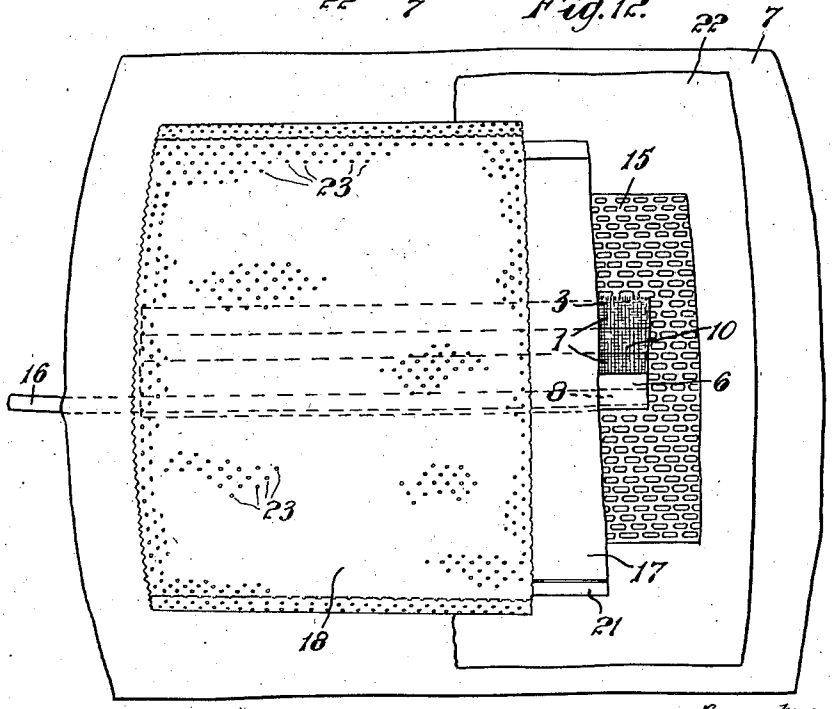


Fig. 12.



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UNITED STATES PATENT OFFICE

2,200,838

APPARATUS FOR PROTECTING SURFACES FROM ICE FORMATION

Edgar Fuller Field, Sutton Coldfield, England, assignor to Dunlop Rubber Company, Limited, London, England, a British company

Application November 13, 1937, Serial No. 174,301
In Great Britain November 24, 1936

12 Claims. (Cl. 244—134)

This invention concerns improved means for protecting surfaces from ice formation and in particular concerns improved means for preventing the formation of ice upon the surfaces of aircraft.

Permeable coverings for such surfaces have already been proposed, such coverings being fed on the under side by contact with apertures or wicks in a supply tube or channel fed with a liquid capable of lowering the freezing point of water.

The rapidity and uniformity with which such permeable coverings can be saturated throughout the area to be protected is of great importance if adequate protection is to be secured in a period sufficiently short to prevent or minimize loss of altitude due to decreased lifting capacity.

My invention provides in apparatus of this type a more rapid initial saturation of the surface to be protected, and a rapid and uniform replenishment of the ice preventing liquid which is carried away by the air during flight.

This rapid saturation is readily attained by the present invention, in view of the intimate initial contact and penetration of the liquid, not only into the actual material of which the supply channels conducting the liquid are constructed, but also into the remainder of the covering fed by the channels.

In my invention, the ice preventing liquid is rapidly absorbed by the whole length of the wall of each channel, and the liquid percolates out simultaneously therefrom to the area to be protected through a very large number of adjacent and individually conductive paths.

This improved capacity for intensive absorption and percolation per unit length of channel permits the use of a comparatively low feed pressure for initial saturation, and a still lower pressure to maintain saturation during flight.

It will be evident that the nature of the material lends itself readily to economy and to uniformity of manufacture and replacement and in its preferred form can be assembled upon the leading edge of an existing wing without any alteration to the wing or its aerodynamical properties.

According to my invention, means for protecting aircraft from ice formation of the kind in which a permeable covering is positioned on the surface of the structure to be protected through which ice preventing liquid is diffused to the outer surface of the covering comprises a strip or strips of absorbent textile fabric positioned beneath the said covering and forming one or more channels extending across portions of the threads of the said strip or strips which channels and the threads extending therefrom serve to conduct and to distribute liquid to the said covering.

Preferably, portions of the thread which form the supply channels extend integrally also to or towards the edges of the strip in an upward or downward direction while the channels extend substantially horizontally along the leading edge of the wing or strut.

The various features of my invention are illustrated by way of example in the accompanying drawings, in which—

Fig. 1 is a plan view of a portion of a channel forming strip prior to the formation of a channel embodying my invention; Fig. 2 is a sectional elevation of the strip of Fig. 1; Figs. 3, 4 and 5 are side elevations of the strip folded to form a channel; Figs. 6 and 9 are cross-sections showing two embodiments of the leading edge of the wing of an aircraft to which folded strips are secured; Figs. 7, 8 and Figs. 10 and 11 are part sectional views of strips incorporating alternative forms of supply channels; Fig. 12 is a front elevation of a section of an assembly embodying a preferred form of the invention; Fig. 13 is a vertical section of the assembly of Fig. 12.

As shown in Fig. 1, a strip 1 of absorbent fabric, such as bleached duck of a suitable width W, is folded at 2, Figs. 3 to 5, and the contacting faces of the folds 2 coated with a suitable adhesive along narrow width lines 4 are secured together by stiches 5, thereby forming a supply channel 8, the walls of which are integral with the free edge portions 3.

A part or parts of the channel portion 8 are preferably coated with a narrow impermeable band or bands of rubber or rubber coated fabric 6 which may be subsequently vulcanized thereto for the purpose of confining the outward diffusion of the liquid substantially to the vicinity of the junction formed by the adhesive and/or stitches 5.

As shown in Fig. 6, the supply channel 8 is seated in a groove 9 formed in the surface of the leading edge 7 and the free edges 3 when pulled apart from the position shown in Figs. 4 and 5, are secured to the surface of the leading edge on either side of the channel 8 by suitable adhesive.

The surface of the leading edge itself may be protected by a foundation layer of unvulcanized rubberized fabric impervious to the ice preventing liquid which may be ethylene glycol, such a layer being shown at 22, Figs. 12, 13.

Several such tubular supply channels may be formed parallel to one another from a plurality of parallel folds or at suitably converging angles and the supply channels may be graduated in length or section to vary the supply of liquid in accordance with the taper of the wing from its root adjacent the fuselage to its outer end or tip.

In the modifications shown in Figs. 7, 8, 10 and 11, a plurality of component fabric strips are employed, the edges of which overlap one another to form the supply channels. For example, each one of the supply channels shown in Figs. 7 and 8 is formed by a pair of component fabric strips in which the free edge of one strip *1a* is overlapped when lying flat to a depth of about one and a half to two inches by a portion of another strip *1b* adjacent to it. The overlapping portion of the adjacent strip *1b* is not laid flat upon the first strip *1a* but is formed of greater width at *1c* so that, when the overlapping edges are secured together by stitches and/or adhesive, a broad tube or channel of flattened section is produced when the composite strip is lightly stretched in position on the wing structure.

As shown in Figs. 7 and 8, portions of the threads of each one of the strips *1a* and *1b* from an integral part of one supply channel **8**, and extend integrally away from it on one side, and the threads of the other strip also form a part of the same channel and extend away from it to form part of an adjacent channel, if desired.

The modification shown in Fig. 9 permits the device to be assembled upon the leading edge of the wing of an aircraft without the necessity for providing grooves in the surface of the leading edge.

As shown in Fig. 9, a base member **11** is secured to the leading edge **7**, the under surface of the member **11** being preferably formed with a plurality of grooves **12** serving to reduce the weight of the member and to promote sufficient flexibility to make it adaptable to the profile of the leading edge.

The base member **11** may be made or moulded from any suitable lightweight material, for example, cork, and of such a cross-section that the streamline profile is unimpaired.

A groove **13** is formed or moulded in the outer surface of the base **11** and is reinforced with a fabric strip **14**, which may be rubberized.

A fabric strip **1** extending across the surface to be protected is secured to the base member **11** by stitches **5** and/or adhesive, and the portion of the strip forming the outer surface of the supply channel **8** is covered by an impermeable band **6** promoting the flow of liquid laterally through the threads towards the edges **3**.

When the strip and its integral supply channel **8** is positioned, as shown in Fig. 6 or 9, the fabric constituting the rear portion of the channel seated in each groove is comparatively free from tension and subsequently permits an unrestricted flow of liquid.

In the modification shown in Fig. 10, the free edges **3** extending away from the folded portion **2** of the strip **1** are not coterminous with one another, but are superposed and separated from one another by an interposed strip **10** of narrower width.

In Fig. 11, a modification is shown in which a single broad strip **1** constitutes the base of the supply channel **8** and extends from the free edge **3** on one side to the free edge **3** on the other side, and upon the broad strip **1** are positioned two strips *1d* and *1e*, the adjacent edges of which are spaced apart to constitute the supply channel **8**, which is completed by a further strip *1f* partly overlapping the adjacent edges of the strips *1d* and *1e* and by nonpermeable bands **6** above and below the channel **8**.

The construction shown in Fig. 11 is particularly advantageous by reason of its conforming as nearly as possible to a streamline form.

If desired, the strips may be composed of bias cut fabric, so that the threads extend at an angle from the walls of the channels.

In the preferred assembly, as shown in Figs. 12 and 13, a foundation layer **22** is secured to the surface of the leading edge **7** and upon this is positioned a vulcanized rubber sheet **15**, the surface of which is embossed, or formed with other minor projections and indentations, which serve to spread the flow of ice-preventing liquid.

Adjacent the centre line of the leading edge is positioned the folded strip or strips **1** formed with the supply channel **8**, into which liquid is fed from a feed pipe **16**.

Positioned upon the fabric strip or strips **1** incorporating the supply channel **8** is a covering **17** of permeable material, such as leather serving as an additional spreading and diffusing member.

As shown in section in Fig. 13, the marginal portions of the permeable leather covering **17** are turned inwards at **19** and secured in contact with the impermeable foundation layer **22**, so that the edges of the said marginal portions abut the edges of the embossed rubber sheet **15** and form therewith a shallow curvilinear space **20** supplied with liquid from the supply channel **8**.

The yielding surface of the permeable leather covering **17** is maintained in streamline contour and is protected from abrasion due to the air stream by an outer permeable covering **18**, which consists of a rubber sheet vulcanized to an inextensible backing, both sheet and backing being perforated with a plurality of fine apertures **23**.

Fairing elements also of leather may be positioned at **21** to ensure the preservation of the streamline contour of the marginal portion of the outer permeable covering **18**.

It is to be particularly understood that Fig. 13 is diagrammatic insofar as the various parts, for clearness, are shown more widely spaced and of greater thickness than obtains in the final assembly.

For example, the overall thickness of the supply channel **8** is of the order of one sixteenth of an inch between the outer surfaces of the impermeable bands **6**.

In consequence, when the coverings **17** and **18** are tensioned in position, the inner face of the leather covering **17** contacts with the embossed surface of the embossed rubber sheet **15**, whereby the streamline profile is preserved, as mentioned previously.

In operating the liquid, which may be fed into the supply channel **8** through the feed pipe **16** by a suitable pump immediately saturates all the threads of the strip or strips of fabric in which the channel or channels **8** are incorporated and saturates that portion of the permeable leather covering in contact with the channel or channels, any excess liquid filling the space **20** and diffusing rapidly through the remainder of the permeable leather covering and through the apertures in the outer permeable covering **18**.

Having now particularly described my invention, I claim—

1. Means for protecting aircraft from ice formation which comprises a permeable covering positioned on the surface of the structure to be protected through which ice preventing liquid is diffused to the outer surface of the covering, a conduit extending beneath said covering and having a wall comprising a strip of absorbent textile fabric, the threads of said strip extending outwardly from said conduit, which conduit and the threads extending therefrom serve to conduct and to distribute liquid to the said covering.

2. Apparatus for protecting aircraft surfaces from formation of ice which comprises a flexible base of streamlined section having a groove, a conduit in said groove, said conduit having walls comprising a strip of fabric having threads extending from said channel outwardly over said base and a covering on said conduit and base to distribute the fluid therefrom.

3. Apparatus for protecting the leading edge of an air-plane wing against accumulations of ice which comprises a distributing sheet permeable to an ice preventing liquid secured to the leading edge of said wing to form a narrow space therebetween, a conduit extending lengthwise of said leading edge comprising a strip of fabric coated with an impermeable material and permitting liquid to pass from said conduit lengthwise of said fabric, an embossed flexible base on said leading edge and supporting said conduit.

4. Means for protecting aircraft from ice formation which comprises a permeable covering positioned on the surface of the structure to be protected through which ice preventing liquid is diffused to the outer surface of the covering, a conduit positioned beneath said covering and having a wall comprising a strip of absorbent textile fabric the threads of said strip extending outwardly from said conduit, said conduit and the threads extending therefrom serving to conduct and to distribute liquid to said covering, and a protective covering on said permeable covering and having a plurality of apertures therein.

5. Means for protecting aircraft from ice formation which comprises a permeable covering positioned on the surface of the structure to be protected through which ice preventing liquid is diffused to the outer surface of the covering, a conduit positioned beneath said covering and having a wall comprising a strip of absorbent textile fabric the threads of said strip extending outwardly from said conduit, said conduit and the threads extending therefrom serving to conduct and distribute liquid to said covering and a channel of impermeable material partly encasing said strips.

6. Means for protecting aircraft from ice formation which comprises a permeable covering positioned on the surface of the structure to be protected through which ice preventing liquid is diffused to the outer surface of the covering, a conduit formed by overlapping edges of adjacent strips of absorbent fabric positioned beneath said covering, the threads of said strips extending outwardly from said conduit, said conduit and threads serving to conduct and distribute liquid to said covering.

7. Means for protecting aircraft from ice formation which comprises a permeable covering positioned on the surface of the structure to be protected through which ice preventing liquid is diffused to the outer surface of the covering, a conduit formed by the overlapping edges of adjacent strips of absorbent fabric in which one side of the conduit formed by the said overlapping edges is of greater width than that side of the same conduit formed in the other strip with threads of said strip extending outwardly from said conduit, said conduit and the threads extending therefrom serving to conduct and distribute liquid to said covering.

8. Means for protecting aircraft from ice formation which comprises a permeable covering positioned on the surface of the structure to be protected through which ice preventing liquid is diffused to the outer surface of the covering, a conduit positioned beneath said covering and having a wall comprising a strip of absorbent textile fabric having threads extending at a substantial angle to said conduit and outwardly from said conduit, said conduit and threads extending therefrom serving to conduct and to distribute liquid to said covering.

9. A conduit for conveying and distributing an ice preventing fluid which comprises a conduit which is formed of a permeable fabric folded double and stitched parallel to the edge of the fold thus formed and at a short distance therefrom to form part of a conduit and having threads permeable to said fluid and extending away from said conduit whereby fluid may penetrate from said conduit through said threads and serve to conduct and to distribute liquid to said covering.

10. A conduit for conveying and distributing an ice preventing fluid which comprises a pair of overlapping fabrics stitched on parallel lines to form a part of a conduit and having threads permeable to said fluid and extending away from said conduit whereby fluid may penetrate through said threads and an impermeable material covering said overlapping fabrics to permit seepage of fluid only through said stitched parts.

11. A conduit for conveying and distributing an ice preventing fluid which comprises a base fabric, a strip of fabric stitched in spaced parallel lines to said base fabric to form a conduit and having threads permeable to said fluid extending away from said conduit whereby fluid may penetrate from said conduit to said threads, the walls of said conduit being exteriorly coated with an impermeable material whereby liquid may seep therefrom only through the stitched portions of said fabric.

12. Apparatus for protecting aircraft surfaces from formation of ice which comprises a conduit for conveying and distributing an ice preventing fluid and having a longitudinally extending slot, a fabric forming a part of the conduit and permeable to said fluid and extending through said slot outwardly beyond the outer surface of said conduit whereby fluid may penetrate from said conduit through said outwardly extending part of said fabric.

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