Patented Apr. 17, 1945 2,373,727

UNITED STATES PATENT OFFICE

2,373,727

COMPOSITIONS FOR THE PREVENTION OF THE FORMATION OR ACCRETION OF ICE ON EXPOSED SURFACES

Harry Longhurst West and Alexander Robert Ogston, London, England, assignors to Intava Ltd., Westminster, London, a British company

No Drawing. Application March 20, 1942, Serial No. 435,552. In Great Britain April 10, 1941

10 Claims. (Cl. 106—13)

This invention relates to compounds for application to aerofoils and like surfaces subjected to high relative speed air currents and ice forming conditions to prevent or reduce the formation and/or accretion of ice thereon.

It is known that certain parts of aircraft flying in certain weather conditions tend to become coated with formations of ice of different types depending upon the particular conditions and that often these formations of ice build up or accrete and form substantial coatings of ice over the parts in question which add considerably to the gross weight of the machine and may cause this to rise over the safe load. Furthermore, such accretions of ice on the various parts of the aircraft alter considerably the aerodynamic properties of certain parts which interferes more or less seriously with the operation of the aircraft and in some cases the accretions of ice may be such as to prevent the movement of some parts in which movement is necessary for the control and manoeuvrability of the aircraft and such accretions will therefore interfere seriously with the safe and efficient operation of the said aircraft. It is therefore extremely desirable that means should be provided either to prevent or reduce the formation of such coatings of ice, or to enable such coatings of ice which may be built up on the parts to be easily detached and removed.

Several methods of attacking this problem have already been suggested and various devices and compounds have been proposed for application to the parts most liable to become coated with such coatings of ice, either to prevent the occurrence of ice or to remove the same as soon as it is formed. Among such methods are methods for maintaining over the surfaces affected, a film of liquid between the ice and the solid surface to prevent the adhesion of the ice to the said solid surface so that it may be swept away by air currents flowing over the surface. These methods include methods for flowing over the said surface a film of liquid which is immiscible with ice and so maintain a liquid film between the ice and the surface, and also methods in which the surface is coated with a liquid or solid cryoscopic substance which reacts with the ice to melt the same when in contact with it and maintain a film of melted ice water between the ice and the surface and such methods have included means for causing a film of liquid to flow continuously over the surface, e. g. by pumping the liquid through a suitable spreading device.

The arrangements for maintaining a film of immiscible liquid or for flowing a cryoscopic liquid over the surface of the parts in question have the disadvantage that they entail the use of mechanical devices which again add to the weight of the aircraft and reduce its useful loading capacity besides utilising considerable power. Such mechanical devices also require considerable maintenance and have a liability to fail at the time when they are most needed and often occupy areas which are required for other more important equipment. It has also been suggested to coat the parts likely to be affected with a compound containing a cryoscopic substance capable of lowering the freezing point of ice coming into contact with it and maintaining a liquid film between the solid surface and the ice so that the ice does not adhere to the surface and may be swept away by the air currents passing over the said parts. One such compound comprises a jelly of a gelatinous material and glycerol or glycol or mixtures thereof.

Such mixtures have been found to be not entirely satisfactory in that the ice is not very readily detached from the surfaces coated with the material, and under such conditions more ice rapidly builds up on that already formed and may give rise to dangerous conditions more quickly than an uncoated surface.

It has now been found that these disadvantages can be largely overcome by incorporating in such a mixture of gelatine and glycol and/or glycerol a proportion of a suitable liquid which is immiscible with the aqueous solution produced by the melting ice.

The present invention accordingly comprises a composition for application to parts of aircraft and the like to prevent or inhibit the formation and/or accretion of ice on such parts comprising a jelly base consisting of gelatinous material and glycol or glycerol or homologues thereof or polyglycols or polyglycerols, e. g., diethylene glycol or tri-ethylene glycol or mixtures thereof containing a proportion from 5–20% by weight of a liquid which is immiscible with ice or water and remains liquid at temperatures down to 10° F.

In addition to the glycol or glycerol compounds above referred to, the composition may also comprise a proportion of a water soluble monohydric alcohol such as ethyl alcohol.

Examples of liquids immiscible with water which may be incorporated in the jelly base are mineral, vegetable and animal oils including essential oils, such as petroleum lubricating oils, castor oil and pine oils, synthetic oils, the water

immiscible alcohols and in general any liquid which is immiscible with water and remains liquid at temperatures below 10° F.

It is found that the incorporation of such liquids in the gelatine-glycol base is not always simple, and it has been found necessary to add to the mixture a small proportion of a dispersing agent to assist in dispersing the oil through the jelly base. Examples of such dispersing agents are soaps, for example, alkali metal or organic base soaps of fatty acids such as stearic acid or oleic acid, naphthenates, sulphonic acid salts including those obtained from the residues from the treatment of mineral oils with strong sulphuric acid, commercial soaps and monohydric alcohols. In the case of soaps, the amounts added may be considerably in excess of that required to disperse the oil in the jelly base. The jelly base employed according to the invention may be prepared from any suitable material such as gelatine, glue, soap or gum, such as gum tragacanth, which forms a heat reversible jelly-like mass with the glycol and/or glycerol.

The compositions are prepared in a simple manner by dissolving the gelatinous material in the glycol or glycerol with the aid of gentle heat and stirring the water immiscible liquid and the dispersing agent together into the mass. In certain cases the oil and dispersing agent may be mixed or combined together to form a homogeneous composition before addition to the gelatine mixture.

Examples of compositions prepared according to this invention are:

1. 15% Isopropyl alcohol
   72% Glycol
   8% Gelatine
   5% Oil

2. 23.5% of a mixture of glycerol, containing 3% sodium stearate
   67.5% of a mixture of ethylene glycol, containing 10% gelatine
   9.0% Mineral oil

3. 81% Ethylene glycol
   9% Gelatine
   5% Soap } previously mixed to form a
   5% Mineral oil } homogeneous composition

4. 81% Glycol
   9% Gelatine
   1% Tri-ethanolamine oleate
   9% Oil

5. 58.7% Glycol
   11.2% Gelatine
   0.5% Gum tragacanth
   19.6% Water
   1.0% Soap
   9.0% Oil

6. 63.0% Glycol
   7.0% Gelatine
   19.0% Water
   2.0% Soap
   9.0% Oil

The above compounds when tested by the following method in the laboratory all showed useful results. The experiments were carried out in a small wind tunnel installed in a refrigerated chamber and practical icing conditions were simulated by placing model aerofoils in the tunnel through which currents of air at low temperature are driven, and spraying water on to the leading edge of the aerofoil with respect to the wind current.

By varying the conditions of experiment, all types of icing from the hard glassy ice to soft crystalline rime can be produced on the aerofoil.

Samples of the de-icing media described above, when tested under these conditions showed that as the ice tends to form, the oily or immiscible liquid content in the medium forms an oily interface having a very low adhesion for the ice which can thereore be readily removed by the air currents. Under very severe conditions the coating of the medium may become entirely covered with ice but this is held very loosely and would, in all probability, become dislodged and removed under practical flying conditions.

In a particular test, an aerofoil treated with a compound according to formula 6 above, was tested under severe icing conditions at a temperature of 28° F. in a wind current of 70 miles per hour and at the end of five minutes, it was found that hardly any ice had formed on the treated surface, whereas in a control aerofoil alongside untreated with the compound, a coating of clear glassy ice ⅜ inch thick had been formed. With continued exposure to still more severe icing conditions, an ice layer up to ¼ inch thick was formed on the treated aerofoil, whereas that on the untreated aerofoil was about ¾ inch thick.

Further, in a comparative test between this type of compound and one which has already wide use on aircraft, in a period of 30 mins. the latter was coated with an irregular formation over 1 inch thick, whilst the former had only a thin ice cap $\frac{1}{16}$ of an inch in thickness.

It was found in general on comparing the compounds prepared as above containing the immiscible liquid or oil with similar compounds not containing oil, about 30% to 50% improvement was obtained.

These compositions are easily applied to the parts in question by melting the jelly to a viscous liquid and then spraying or brushing the same on to the parts to be treated. They form stable coatings which are not removed rapidly by the friction of the air currents or slip stream over the parts in question and will retain their ice preventative properties for a considerable time in non-icing conditions, although, of course, under conditions of icing or heavy rain, the effective life of the coating will vary with the severity of the conditions and the amount of cryoscopic liquid which is used up in melting and dissolved out by the water present.

The composition can frequently be applied with advantage over many of the preparations and mechanical devices previously disclosed for this purpose and gives a coating which has a greater efficiency than any of the coatings or methods previously described, for example, it may be applied to the flexible shoes fitted to the leading edges of aircraft and intended to be flexed periodically to split off ice formed thereon, or it may be applied as an upper or an under coating in combination with any of the coating compositions previously described for this purpose.

What we claim is:

1. A composition for application to surfaces exposed to the deposition of ice to prevent the formation or accretion of ice thereon, comprising a jelly base composed of from about 7 to 17 percent by weight of a gelatinous material and from about 83 to 93 percent by weight of an antifreeze material of the class consisting of glycol, glycerol, polyglycols, polyglycerols and their mixtures, having incorporated therein from about 5

to 20 percent by weight of an organic liquid which is immiscible with ice and water and which remains liquid at temperatures below plus 10° F.

2. A composition according to claim 1 in which the immiscible liquid is a mineral lubricating oil.

3. A composition according to claim 1 in which the immiscible liquid is a vegetable oil.

4. A composition according to claim 1 in which the immiscible liquid is an animal oil.

5. A composition according to claim 1 containing as a dispersing agent a soap of the class consisting of an alkali metal soap of a higher fatty acid and an organic base soap.

6. A composition according to claim 1 containing as a dispersing agent a low molecular weight alkyl monohydric alcohol.

7. A composition comprising 23.5% of a mixture of glycerol and 3% of its weight of sodium stearate, 67.5% of a mixture of ethylene glycol and 10% of its weight of gelatin and 9% by weight of mineral oil.

8. A composition for application to surfaces exposed to the deposition of ice to reduce the formation and accretion of ice thereon comprising 81% by weight of a mixture of ethylene glycol and 9% of its weight of gelatin and a mixture of 5% by weight of mineral oil and 5% by weight of soap.

9. A composition for application to surfaces exposed to the deposition of ice to reduce the formation and accretion of ice thereon comprising 72% of ethylene glycol, 15% of iso-propyl-alcohol, 8% of gelatin and 5% mineral oil.

10. A composition for application to surfaces exposed to the deposition of ice to reduce the formation and accretion of ice thereon comprising a combination of 58.7% of ethylene glycol, 11.2% of gelatin, 0.5% by weight of gum tragacanth, 19.6% by weight of water, 1% by weight of soap and 9% by weight of mineral oil.

HARRY LONGHURST WEST.
ALEXANDER ROBERT OGSTON.