H. F. CROOKE

ELECTRICAL DE-ICING EQUIPMENT

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Fig. 1

Fig. 2

Inventor

HAROLD F. CROOKE

By Watson Cole,bridge

ATTORNEYS
This invention relates to electrically heated surface de-icing or anti-freezing equipment, which will herein be referred to for convenience as de-icing equipment, as used for example in aircraft, and of the kind comprising an electrical resistance element in the film of a thin conducting layer on the surface to be freed of ice, and at least two terminals which lead through the surface and are connected to the resistance element to supply electrical heating current thereto.

It has now been found that “cold spots” tend to occur on the external surface of the equipment adjacent such terminals, due partly to the drain of heat through the terminals themselves which inherently tend to have greater thermal conductivity than the surface to which the equipment is applied, and due also partly in some cases to the form of the pattern in which the resistance element is applied, which may leave a relatively large area of unheated surface adjacent a terminal.

It is an object of the invention to provide improved de-icing equipment of the type referred to, which will reduce this tendency to the formation of “cold spots.”

According to the present invention therefore, in electrical surface de-icing equipment of the kind referred to, at least one of the terminals is arranged beneath a part of the resistance element and spaced therefrom by an electrical insulating substance, so as to assist in maintaining the required surface temperature adjacent such terminal.

For convenience in the following specification and claims the surface is referred to as lying in a horizontal attitude with the exposed surface uppermost, but it will be understood that the invention is equally applicable to surfaces in any other attitude.

The invention is thus particularly applicable to the type of de-icing equipment which comprises a layer of insulating material on the surface to be freed of ice, an electrical resistance element in the form of a thin layer of conducting material applied (preferably in a pattern) on the insulating layer, and a second insulating layer of material applied overall, terminals being connected to spaced points on the resistance element for the supply of heating current thereto.

In one form of the invention the main part of the resistance element is in the form of a layer making contact with the tip of the terminal, and the equipment includes an auxiliary heater element in the form of a subsidiary layer lying above the level of the main layer where it makes contact with the tip of the terminal, and spaced therefrom by a layer of insulating material.

In any case the part of the resistance element which lies above a terminal is preferably connected electrically in series or in parallel with at least part of the main portion of the resistance element.

The invention may be performed in various different ways and one specific embodiment will now be described by way of example, as applied to de-icing apparatus on the leading edge of an aircraft wing or other surface exposed to the atmosphere, with reference to the accompanying drawings, in which:

Figure 1 is a fragmentary plan view of one form of heater element.

Figure 2 is a sectional side elevation on an enlarged scale through a terminal on the line II—II of Figure 1.

In the form of de-icing apparatus illustrated in Figures 1 and 2, the surface of the wing 10, which may be of thin sheet metal, is first coated with a layer 11 of a synthetic plastic electrical insulating adhesive substance, for example the insulating thermostetting resin material sold by Ciba Company, Inc., of 627 Greenwich Street, New York 14, N. Y., under the registered trademark Arimidite, an electrical resistance pattern in the form of a thin layer 12 of aluminium is then applied as by spraying through a stencil on to the plastic layer, the resistance pattern is then covered with a second layer of plastic 13, and the plastic is finally cured. De-icing apparatus of this kind is described and claimed in copending United States application Serial No. 304,964, now U. S. Patent 2,791,606, granted May 7, 1957.

Two or more points in each resistance pattern are connected to terminal conducting pillars (one of which 14 is illustrated), which extend through the wing surface 10 and are insulated therefrom electrically as by means of a block 15 and sleeve 16 of insulating material, the “outer” ends of these terminal pillars being in electrical contact with the resistance pattern 12 while their “inner” ends are connected to an electrical supply lead 17.

In this example a subsidiary resistance element 20, which may also be applied by spraying metal through a stencil, is applied to the plastic coating 13 covering the first resistance element 12, above or adjacent to each terminal pillar 14. A further layer of plastic material 21 is then applied over the subsidiary resistance element 20, and cured in situ. The subsidiary resistance 20 is preferably supplied with heater current through the same terminal pillars 14 and is connected in series or in parallel with at least part of the main resistance element 12. In such case the electrical connection between the main and subsidiary resistance elements 12 and 20 may be formed by laying bare two spaced points on the main resistance element 12 which is otherwise coated by the top layer 13 of plastic insulating material and applying the subsidiary resistance element 20 so as to make contact with the main element at these points.

What I claim as my invention and desire to secure by Letters Patent is:

1. Electrical surface de-icing equipment comprising an electrical resistance element in the form of a thin conducting layer on the surface to be freed of ice and an electric terminal leading through the said surface in a direction normal to the plane of the surface, the resistance element including a lower part which is electrically connected to the tip of the terminal where it projects through the said surface and extends laterally therefrom, and an upper part which is connected electrically to the lower part of the resistance element and to the terminal and which extends over the tip of the terminal, but is spaced therefrom by a layer of thermal insulating substance, whereby said upper part overlies and is out of heat conductive relation with said terminal.

2. Electrical surface de-icing equipment comprising a main electrical resistance element in the form of a thin main conducting layer on the surface to be freed of ice, and at least two terminals leading through the said surface in a direction normal to the plane of the surface at each point and connected to the main resistance element to supply electrical current thereto, in which the main resistance element is in the form of a layer making contact with the tip of one said terminal, and including an auxiliary heater element in the form of a subsidiary
layer lying above the level of the main layer and overlapping said main layer where it makes contact with the said tip of the terminal, and spaced therefrom by a layer of insulating material.

3. Electrical surface de-icing equipment as claimed in claim 2 in which the subsidiary resistance element is electrically connected in the same electrical circuit with at least part of the main resistance element, and is supplied with current through the same terminals.

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