

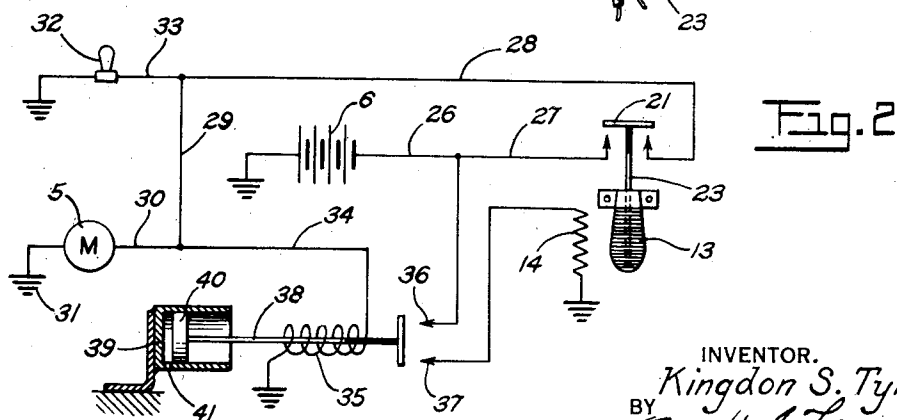
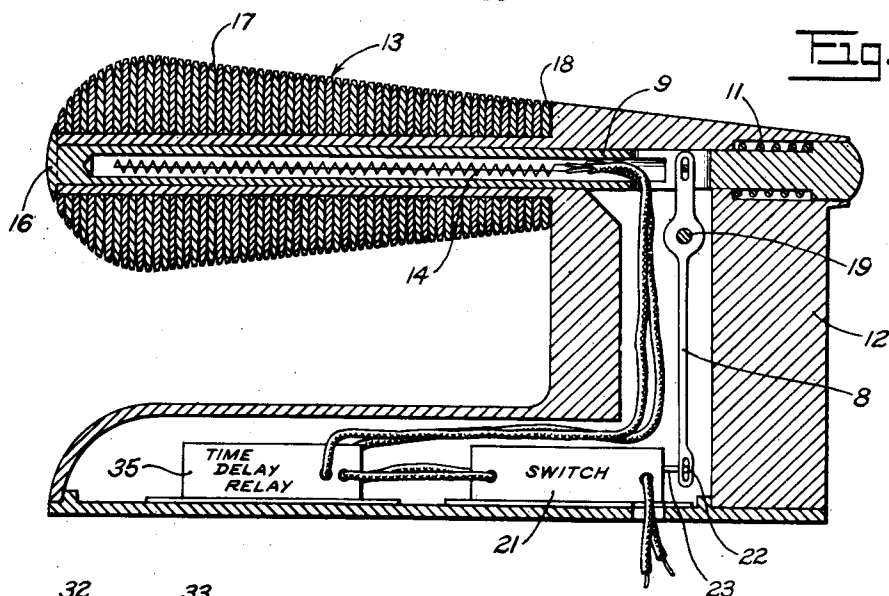
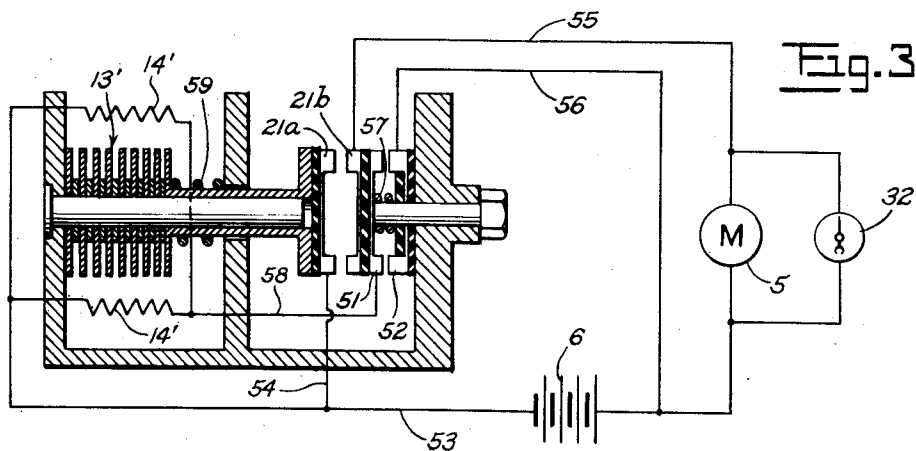
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AUTOMATIC ICE REMOVAL

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AUTOMATIC ICE REMOVAL

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This invention relates to aircraft, and more particularly to a means for preventing the accumulation of ice on aircraft surfaces, such as the wing and tail structures, the propeller blades, and other exposed surfaces.

It is well known that under certain conditions of temperature and relative humidity, ice will form on the structural parts of an airplane. This formation is cumulative and at times seriously interferes with the control and operation of aircraft. The more common locations for the ice formation are the leading edges of the wings and tail structure.

In Patent No. 1,998,809 granted to G. C. Geer on April 23, 1935 there is illustrated a type of flexible and expansible "overshoe" provided upon such leading edges of the wings and tail structures and adapted to expand and contract periodically in response to the operation of pneumatic energizing means.

An object of the present invention is to provide for the automatic control of the operation of such "overshoes", or other suitable type of ice removing means, so as to relieve the operator of the craft of the necessity of maintaining vigilance to determine the proper moment for bringing such mechanism into operation.

Other objects of the invention will become apparent upon examination of the following description which is to be read in connection with the accompanying drawing illustrating two embodiments of the invention.

In said drawing:—

Fig. 1 is a view in transverse section of an aerofoil structure and associated parts embodying the invention;

Fig. 2 is a diagram of the electrical connections for the system of Fig. 1; and

Fig. 3 shows a second embodiment.

Referring to the drawing, reference character 5 designates an electric device for controlling the energization of the "overshoe" actuating means, or any equivalent ice dislodging mechanism, and reference character 6 indicates a source of current for supplying the unit 5 with the operating energy required.

Reference character 21 designates a switch adapted to be operated by a linkage 8, 9, the linkage being normally held in open circuit position by suitable means such as the coiled compression spring 11 located in a recess in the wall 12 forming a part of, or an extension of, the aerofoil section 13 which in turn may be an integral part of the wing surface of the craft or other aerofoil surface from which it is intended

to remove ice, or the said elements 12 and 13 may be mounted in proximity to the surface from which ice is to be removed, in which case element 13 will preferably include ice removing means of its own which may take the form of an electrical resistance unit 14 adapted to generate sufficient heat for the purpose upon the flow of current therethrough, the circuit to the said heating coil 14 being indicated in Fig. 2.

At the end of the rod or link 8 opposite to that which is acted upon by the spring 11, there is provided a formation 16 adapted to move outwardly and hence operate the rod in a circuit closing direction, in response to changes in the over-all length of the aerofoil assembly 13. As shown, the unit 13 is composed of a plurality of juxtaposed plates or laminae 17 adapted to be displaced laterally by the pressure resulting from the freezing of water on the surfaces thereof, it being well-known that freezing water produces a volumetric increase or expansion which in the case of a structure as indicated in Fig. 1 would result in an increase in the over-all length of the assembly, beginning at the fixed point 18, so that such increased length will produce a corresponding shifting of the rod 9 to the left as viewed in Fig. 2 and hence a swinging of the link or lever 8 in a counter-clockwise direction about its fulcrum 19. This counter-clockwise swinging of the lever 8 will produce a closure of the switch mounted in the housing 21, by reason of the connection 22 between the lever 8 and the switch actuating rod 23. Closure of the switch 21 results in a flow of current to the ice removing control unit 5, the circuit being from the source 6 by way of conductors 26 and 27, switch 21, and conductors 28, 29 and 30; the current returning to the source by way of the "ground" connection 31. There is preferably an index element 32 located in the branch 33 of the circuit just traced, so that the operator will have knowledge of the proper functioning of the system. There is also a second branch 34 leading to an electromagnetic device 35 which, upon energization, creates a force tending to bridge the switch contacts 36 and 37 and thus supply current to the heater coil 14 heretofore described, and constituting the ice removing or "de-frosting" means for the control unit 13. In order to allow a predetermined time delay between the beginning of operation of the ice removing control motor 5 and the actual energization of the de-frosting unit 14, there is provided a means for retarding the switch closing action of the electromagnetic plunger 38. This retarding means may take any

desired form, but is shown as embodied in a dashpot cylinder and piston, 39 and 40 respectively, the retarding effect of which may be controlled by varying the size of the suction controlling orifice 41.

In the embodiment shown in Fig. 3 the time delay relay of Figs. 1 and 2 is replaced by a pair of cooperating switch elements 51 and 52 which are adapted to close upon a predetermined amount of movement of the switch element 21a corresponding to the switch 21 of the first embodiment. As shown, the expansion of the assembly 13' which is produced by the formation of ice thereon causes a movement of the switch element 21a toward the cooperating switch element 21b which, as shown, is integral with the switch contacts 51 just described. When the expansion is sufficient, a circuit will be closed to the ice removing control unit 5 and the indicator 32, the circuit passing from source 6 by way of conductors 53 and 54, switch elements 21a and 21b, and conductor 55. Upon a further predetermined amount of movement of the switch elements 21a and 21b in unison, under the continuing expansion of the assembly 13', a second circuit will be closed to energize the de-frosting coils 14', this second circuit passing from the source 6 by way of conductor 56, switch elements 52 and 51 (normally held apart by resilient means indicated at 57) and thence to the coils 14' by way of conductor 58. When sufficient ice has been removed the resulting contraction of the assembly 13' under the pressure exerted by the compression spring 59 (corresponding to the spring 11 of Fig. 1) will cause a return of the parts to the position indicated in Fig. 3 and a resulting cessation of operation of the ice removing control motor 5. Should the craft be still in a region of ice formation, the cycle of events above described will be repeated as often as is necessary to prevent undue accumulation of ice.

Where manual operation of the ice removing means is considered sufficient, the connections to the automatic unit 5 will of course be eliminated, but the mechanism will still function to give an indication, through signal 32, whenever ice begins to form, and the de-frosting circuit may likewise continue to function, if desired.

What is claimed is:

1. The combination, with an aerofoil surface and an auxiliary unit associated therewith, of means for removing ice therefrom, means operated by ice formed on said auxiliary unit to control energization of said ice removing means, means for de-frosting said auxiliary unit, and

means for operating said de-frosting means in pre-determined time relation to the operation of said ice removing means.

2. The combination, with an aerofoil surface and an auxiliary unit associated therewith, of means for removing ice therefrom, means operated by ice formed on said auxiliary unit to control energization of said removing means, said last-named means including a circuit controlling switch, means shiftable by the expansion of the freezing ice to operate said switch, means for de-frosting said auxiliary unit, and means for operating said de-frosting means in predetermined time relation to the operation of said switch.

3. The combination, with an aerofoil surface and an auxiliary unit associated therewith, of means for removing ice therefrom, means operated by ice formed on said auxiliary unit to control energization of said removing means, said last-named means including a circuit controlling switch, means shiftable by the expansion of the freezing ice to operate said switch, means for de-frosting said auxiliary unit, means for operating said de-frosting means in predetermined time relation to the operation of said switch, said last-named means including a second switch closeable upon further movement of said first-named switch.

4. The combination, with an aerofoil surface and an auxiliary unit associated therewith, of means for removing ice therefrom, means operated by ice formed on said auxiliary unit to control energization of said removing means, said last-named means including a circuit controlling switch, means shiftable by the expansion of the freezing ice to operate said switch, means for de-frosting said auxiliary unit, means for operating said de-frosting means in predetermined time relation to the operation of said switch, said last-named means including a second switch closeable in response to the passage of current through the circuit controlled by said first-named switch.

5. The combination, with an aerofoil surface and an auxiliary unit associated therewith, of means for removing ice therefrom, means operated by ice formed on said auxiliary unit to indicate the formation of such ice, said last-named means including a circuit controlling switch, means shiftable by the expansion of the freezing ice to operate said switch, means for de-frosting said auxiliary unit, and means for operating said de-frosting means in predetermined time relation to the operation of said switch.

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