March 26, 1957 A. C. VELDHUIS 2,786,927

AUTOMATIC DE-ICING SYSTEM

Filed Sept. 29, 1953

Fig. 2.

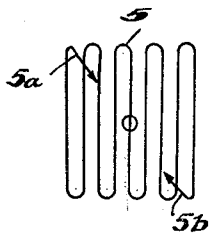


Fig. 1.

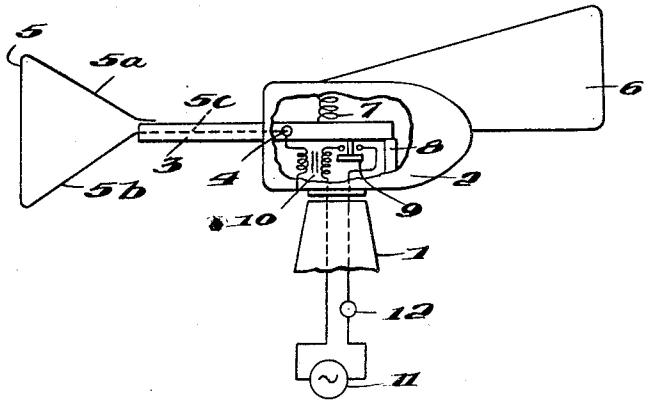


Fig. 3.

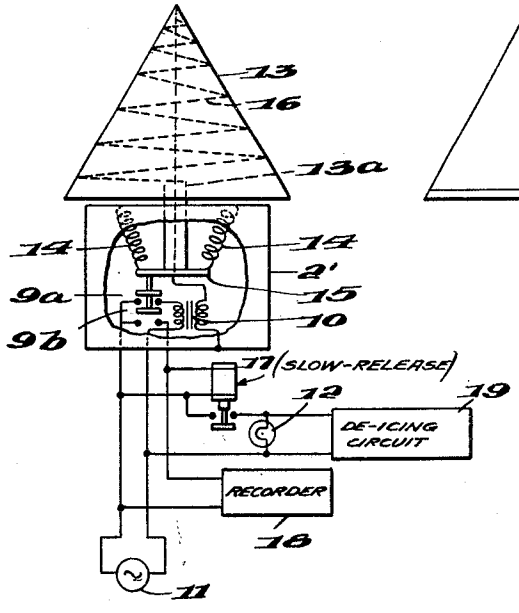
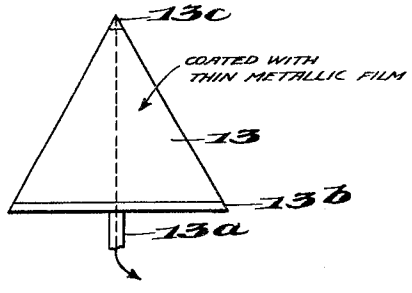


Fig. 4.



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AUTOMATIC DE-ICING SYSTEM

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Application September 29, 1953, Serial No. 383,112

3 Claims. (Cl. 219—19)

This invention relates to a system which responds automatically to ice forming conditions and applies power to a de-icing circuit so long as the ice forming conditions continue.

My invention is also concerned with a novel form of indicator for detecting ice forming conditions.

The icing condition detector of my invention may be employed for the sole purpose of indicating ice forming conditions, or it may be employed to control an automatic de-icing system to prevent the formation of ice on outdoor structures, such as wind power plants, radio antenna installations, power transmission lines, towers in general, and bridges.

My invention is illustrated in the accompanying drawing in which

Figure 1 is a diagrammatic representation of one form of icing condition detector and indicator employing a counterbalanced wire grid as the ice collector;

Figure 2 is a front view of the wire grid of Figure 1;

Figure 3 is a diagrammatic view of the complete de-icing system and showing a different form of icing condition detector from that shown in Figures 1 and 2; and

Figure 4 shows another form of ice collector suitable for use in Figure 3.

Referring to Figure 1, 1 indicates the top portion of a suitable tower for supporting the ice formation detector. Certain parts of the detector are enclosed within a suitably streamlined casing 2 mounted upon the tower 1 for turning about a vertical axis. A balance beam or bar 3 is arranged so that one end thereof extends into the casing 2 from the front of the casing and is suitably mounted for pivotal swinging about horizontal axis 4. The balance bar 3 may be formed of a hollow tube. The front end of casing 2 is sealed around bar 3 by suitable means, such as a flexible diaphragm, to prevent the entry of moisture into the casing. An ice collector in the form of a metal wire grid 5 is mounted at the front end of the bar 3, the plane of the grid being arranged at right angles to the axis of the bar 3, and one end of the grid being connected to the bar by wire section 5*a* and the other end of the grid being connected by wire section 5*b* to an insulating conductor passing through the arm 3 and into the casing 2. A suitable tail or wind-vane 6 is attached to the casing 2 and extends rearwardly therefrom for the purpose of keeping the grid 5 facing into the wind.

Within the casing 2 suitable biasing means represented by the spring 7 is provided to normally hold the bar 3 against a fixed stop represented at 8. The biasing force is sufficient only to counterbalance the weight of the bar 3 and the collector 5 when these elements are free of ice, but formation of ice on these elements causes the bar 3 to tilt in an anti-clockwise direction about the axis 4 against the action of the biasing spring 7. An electric switch 9 enclosed in the housing 2 is arranged to be controlled by the bar 3 so that with the bar in its normal position and resting against the stop 8 the switch is opened and is moved to closed position when the bar

tilts under the weight of ice formed on the grid 5. The switch 9 is connected to control the primary circuit of a step-down transformer 10 arranged in the casing 2, the secondary winding of which is connected to supply heating current through the metal wire grid 5 by way of insulated conductor 5*c*. Transformer 10 is energized from a suitable source of alternating current represented at 11, and this source may be a commercial power circuit, or it may be supplied from a local source such as a wind driven generator. The switch 9 also controls the energization of a suitable indicator, and in the example shown in Figure 1 the indicator assumes the form of an electric lamp 12 connected in the energizing circuit of the transformer 10, but a separate energizing circuit for the lamp 12 may be provided if desired. It will be understood that the lamp 12 will usually be located at some place remote from the tower 1.

The operation of Figure 1 is as follows:

So long as the weather conditions are dry and above freezing temperature, the exposed part of the bar 3 and the grid 5 will be free of ice, and the switch 9 will be held in open position. As soon as ice forms on the grid 5 sufficient to cause closing of the switch 9, heating current will be supplied to the grid 5 through the transformer 10, and as soon as the ice is melted from the grid the bar 3 will return to its normal position, thereby opening switch 9. So long as icing conditions continue, the arrangement will operate in repeated cycles according to that described above. While the indicator lamp 12 is energized intermittently, that is, during the intervals when ice depresses the grid 5, it is possible, by the arrangement shown in Figure 3, to produce continuous energization of the lamp 12 so long as icing conditions exist.

In the arrangement shown in Figure 3, a different form of ice collector is employed which permits considerable simplification in the arrangement. The preferred form of casing in this arrangement is cylindrical in shape as shown at 2′ and is mounted in fixed position at the top of any suitable support, not shown. The ice collector in this arrangement is in the form of a conical member 13 mounted above the casing 2′, and preferably in axial alignment with the casing. The cone 13 is supported upon a tubular stem 13*a* which extends downwardly into the casing 2′ and is supported in suitable bearings, not shown, for limited vertical movement. The weight of the cone 13 and of the parts moving therewith is normally counterbalanced by suitable biasing means, such as the springs 14 arranged within the casing 2′ and connected between an upper part of the casing 2′ and a cross-member 15 secured to the lower end of the stem 13*a*. An electric switch having two contacts 9*a* and 9*b* is arranged within the housing 2′ and is controlled by the member 15 so that the contacts are normally open when the collector 13 is free of ice and is held in its upper position, but the contacts are moved to the closed position when the collector 13 is depressed under the weight of ice formed thereon.

A heater wire 16 is carried by conical member 13, preferably in the form of a conical spiral, the lower end of the spiral being connected to the vertical tube or stem 13*a* and thence through various conducting parts to the metallic casing 2′. The upper end of the heater spiral 16 is connected to an insulating conductor passing through the stem 13*a* and being connected to one terminal of the secondary winding of transformer 10, the other terminal of the secondary winding being grounded to the casing 2′. Wire 16 may be secured to the outer surface of cone 13, but it is preferred to embed the wire in the wall of the cone. Switch contact 9*a* controls the energizing circuit of transformer 10 in the manner indicated above for Figure 1. Switch contact 9*b* controls a sep-

arate circuit which energizes a relay **17** and a suitable recording device **18** for making a record of the operation of the icing conditions. Relay **17** controls a circuit which energizes a signal lamp **12** and suitable de-icing circuit **19**. Relay **17** is of the type which closes instantly but is slow to release. This relay is designed so that its contacts remain closed after each operation for a period of time greater than the time which the contact *9b* of the ice detector switch is open during its normal cycle of operation. With this arrangement, so long as icing conditions exist, the icing detector will function in repeated cycles to open and close the switch *9b*, but the relay **17** will remain closed, and the indicator lamp **12** and the de-icing circuit **19** will be energized continuously so long as icing conditions exist. As soon as the icing conditions disappear and the contact *9b* remains open for a time longer than the release time for relay **17**, the lamp **12** and the de-icing circuit **19** will be de-energized.

It will be understood that the de-icing circuit **19** will be arranged to apply heat to any desired structure or location, such as those mentioned in the first part of this specification.

In Figure 4 I have illustrated a modified form of ice collector which may be used in the arrangement shown in Figure 3. In this arrangement the collector **13** is in the form of a conical element as in Figure 3, but instead of using a spiral wire heater on the collector, the heating element is formed of a thin metallic film applied to the conical surface of collector **13** and connected at the lower edge with a ring *13b* of low resistance and the upper part of the film is connected to a cap *13c* of low resistance. One terminal of the secondary winding of transformer **10** would be connected to the cap member *13c* by an insulating conductor passing through the stem *13a*, and the other terminal of the secondary winding would be connected through various conducting parts to the ring *13b*. The heater film may form the outer surface of the cone **13**, but it is preferred to cover the metallic film with a protective layer of varnish.

Certain subject matter disclosed herein is being claimed in divisional application Serial No. 550,991, filed December 5, 1955.

I claim:

1. A system for indicating icing conditions comprising a movable ice collector element normally biased to an upper position and being movable to a lower position under the weight of ice collected thereon, said ice collector comprising a metallic wire formed into an open-mesh grid, means for heating said collector element to melt ice therefrom comprising a circuit for passing electric current through said wire forming said open-mesh grid, a source of electric power for energizing said circuit, and switch means controlled by the movement of said collector element for connecting said circuit to said source of power when said collector element is in said lower position, whereby said collector element is operated periodically between said upper and lower positions in response to continued icing conditions.

2. A system for indicating icing conditions comprising a movable ice collector element normally biased to an upper position nad being movable to a lower position under the weight of ice collected thereon, said ice collector element comprising a metallic wire formed into an open-mesh grid, means for heating said collector element to melt ice therefrom comprising a circuit for passing electric current through said grid, a source of electric power for energizing said circuit, switch means controlled by the movement of said collector element for connecting said circuit to said source of power when said collector element is in its lower position, whereby said collector element is operated periodically between said upper and lower positions in response to continued icing conditions, means mounting said grid for turning about a vertical axis, and a wind-vane connected with said grid for causing said grid to face into the wind.

3. An ice collector comprising a length of metallic wire formed into a flat open-mesh grid structure, means mounting said grid for movement vertically under the weight of ice collected thereon, an electric switch, means for operating said switch to closed position by the downward movement of said mounting means, means mounting said grid for turning about a vertical axis, and a wind-vane connected with said grid for causing said grid to face into the wind.

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