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REFRIGERATING APPARATUS

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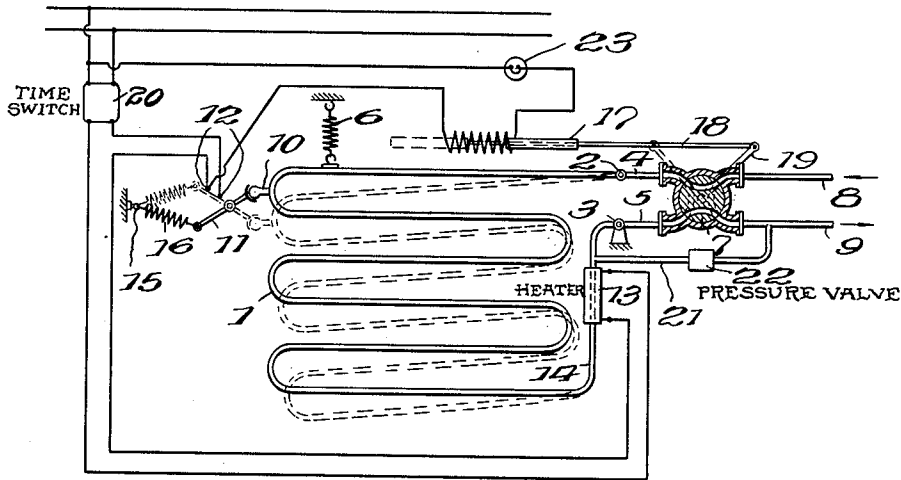


Fig. 1

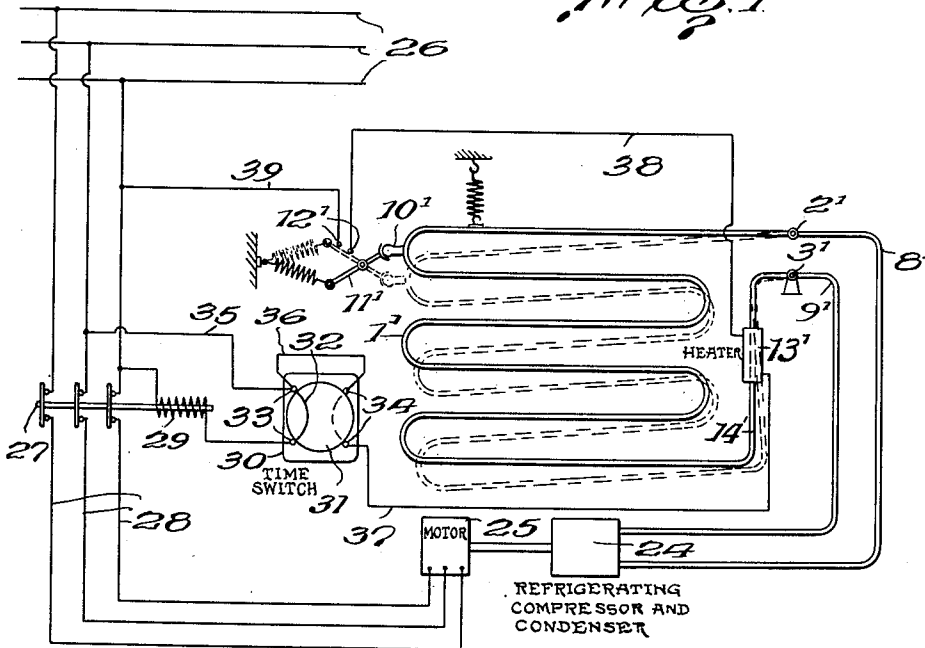


Fig. 2

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REFRIGERATING APPARATUS

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This invention relates to refrigerating apparatus of the kind in which the cooling element or elements are intended to be positioned in an atmosphere containing moisture, and in which, as an incident to the cooling of the atmosphere, moisture therein condenses and freezes upon the cooling element.

In my Patent No. 2,025,456, granted December 24, 1935, I have shown and claimed a refrigerating apparatus in which the cooling element is so mounted that it is free to move when the formation of ice or frost thereon varies the gravitational force exerted by the element. Such movement of the cooling element is utilized to actuate means for applying heat to the cooling element to cause a de-icing or defrosting thereof, or to render the cooling element ineffective, or both.

The present invention is an improvement on the form of apparatus shown in my aforesaid patent, in that dual means are provided for controlling the action of the means for applying heat to cause the de-icing or defrosting of the cooling element, and the means for rendering the cooling element ineffective.

When the means for applying heat to the cooling element to de-ice or defrost the same, or the means for rendering the cooling element ineffective, is controlled solely by an increase in the gravitational force exerted by the cooling element, due to the accumulation of ice or frost thereon, it frequently happens that the de-icing or defrosting of the cooling element, or the rendering of it ineffective, takes place at a time when interruption of the cooling action should be avoided, either because of the refrigeration requirements or because of a greater cost of the heating medium at those times.

The above disadvantages of having the cooling action interrupted, except at definite, predetermined periods, are avoided by the present invention, in that the heating means or the means for rendering the cooling element ineffective is further controlled by a time switch which will temporarily prevent interruption of the cooling action, if the accumulation of ice or frost on the cooling element otherwise should be sufficient to cause the actuation of the heating means or the means for rendering the cooling element ineffective. Such a time switch may be set or adjusted so that the interruption of the cooling action will occur only at the most advantageous periods, either with respect to refrigeration requirements or to the cost of the heating medium, or both.

The invention will be further described in connection with the accompanying drawing, but it

is to be understood that such further illustration is merely by way of exemplification, and that the invention is not limited thereby, except as may be specifically set forth in the subjoined claims.

Fig. 1 is a diagrammatic view of a refrigeration apparatus embodying the present invention, and

Fig. 2 is a diagrammatic view of a modified form of refrigeration apparatus embodying the invention.

Referring now to the drawing, a cooling element 1 here shown as a pipe coil through which brine or cooling medium may be caused to flow and adapted for use as an air cooler, has its ends pivotally connected at 2 and 3 to fixed supply and discharge pipes 4 and 5, respectively, whereby the coil is movably mounted and free to move downwardly as its effective weight increases, due to the accumulation of ice or frost thereon. A tension spring 6 supports the free end of the coil. However, the tension of the spring 6 is such as to permit the coil to descend by gravity when a predetermined weight of ice or frost has accumulated on the coil.

The supply of brine or other cooling medium to the coil 1 is controlled, at least in part, by a rotary valve 7, having a pair of passages there-through. The rotary valve 7 may be turned to the full line position shown in Fig. 1, in which the passages therein connect inlet and outlet pipes 8 and 9, with the fixed pipes 4 and 5, respectively, or which may be turned approximately 90° to the dotted line position in which the passages connect the fixed supply and discharge pipes 4 and 5, and the inlet and outlet pipes 8 and 9, respectively, so that the supply of cooling medium to the coil 1 is cut off, and the cooling medium in the coil is free to circulate therein.

The free end of the coil carries a projection or finger 10 which engages one end of a switch arm 11. The other end of the switch arm is movable to bridge a pair of contacts 12, to complete an electric circuit through an electric heater 13, surrounding an upwardly-extending part 14 of the coil 1. The end of the switch arm 11 remote from the finger is connected to a fixed point 15 by spring 16, so that the opening and closing of the switch is accomplished by a snap action in a well-known manner.

In addition to controlling the supply of electric current to the electric heater 13, the switch arm 11 also controls the operation of a solenoid 17, operatively connected by rod 18 to an operating handle 19 of the rotary valve 7.

As so far described, when the ice or frost on the coil 1 has accumulated to a predetermined weight, the coil, due to its increased gravitational force, will move downwardly to an extent sufficient to move the switch arm to the dotted line position in Fig. 1, in which it bridges the contacts 12 to close the electric circuit through the heater 13. Simultaneously, the solenoid 17 is energized and the armature thereof is drawn into the coil and causes the rotary valve 17 to be moved into the position shown in dotted lines so that the cooling medium which normally would enter the coil 1 through the inlet pipe 8 and the fixed supply pipe 4 is bypassed to the outlet pipe 9, and the fixed discharge pipe 5 is placed in communication with the fixed inlet pipe 4, so that the cooling medium in the coil is free to circulate therein. The closing of the circuit through the electric heater 13 causes the cooling medium in the upwardly-extending part 14 of the coil to be heated and a thermo-circulation of the cooling medium set up in the coil. The heated medium circulating in the coil melts the ice or frost on the coil until the gravitational force exerted thereby no longer is sufficient to overcome the force of the spring 6. The spring then reasserts itself and moves the coil upwardly until the finger 10 operates the switch arm 11 to open the circuits, including the electric heater 13 and the solenoid 17. The armature of the solenoid then returns to the full line position and restores the valve 7 to the position in which cooling medium from the inlet pipe 8 again may flow through the fixed supply pipe 4 and coil 1.

In order that the cooling action of the coil 1 may not be interrupted except at those times when interruption is most advantageous, a time switch 20 is connected in series with the electric heater and solenoid 17. The time switch 20 may be of any well-known type and will be set to permit the circuits through the electric heater 13 and solenoid 17, to be closed at such times as the refrigeration requirements are at a minimum or the cost of electric current for the heater 13 is the lowest, or both.

If the accumulation of ice or frost on the coil 1 should become sufficient to increase its effective weight sufficiently to cause it to descend and move switch arm 11 into the position in which it bridges the contacts 12 at a time other than that at which the time switch is set to permit electric current to pass, no current can flow through the electric heater 13 and solenoid 17, and the refrigerating action will continue until a time is reached when it is desired that the de-icing or defrosting shall take place. The time switch 20 will then move into a position to permit current to flow therethrough, and as the contacts 12 have remained bridged by the switch arm 11, the solenoid 17 and heater 13 will be energized to discontinue the supply of the cooling medium and to supply heat to de-ice or defrost the coil 1. Such postponing of the de-icing or defrosting of the coil for a few hours will have no appreciable disadvantageous effect, as the de-icing or defrosting of the coil is necessary only every eight or ten days, and the exact time at which the de-icing or defrosting takes place is not critical.

To allow for expansion of the cooling medium within the coil 1 when heat is applied thereto, and the supply and discharge pipes 4 and 5 are connected through the valve 7, a pipe 21 having a pressure-operated valve 22 connects the coil 1 with the outlet pipe 9 so that when the pressure

in the coil exceeds a predetermined maximum, the valve 22 will open sufficiently to permit a part of the cooling medium in the coil to be discharged into the outlet pipe 9.

An indicating device here shown as an electric lamp 23 is inserted in the circuit including the solenoid in order to indicate when no refrigerating action is being obtained from the coil 1.

In Fig. 2 I have shown a modified form of the invention in which the means for rendering the cooling element ineffective and de-icing or defrosting the same is embodied into an apparatus having a time switch for controlling the driving motor of the refrigerating compressor, whereby temporary low-current rates may be utilized. In this form of the invention the cooling coil 1' has its ends pivoted at 2' and 3' so that it is movably mounted, the same as the coil 1 of Fig. 1. The ends of the coil communicate with supply and discharge pipes 8' and 9', which lead from and to a compressor 24 of the refrigerating mechanism. The compressor is driven by a motor 25 which receives electric current from the main supply lines 26 when a switch 27 in the lines 28 leading to the motor is closed.

The free end of the coil 1', like the coil of Fig. 1, carries a projection or finger 10', which engages a switch arm 11' and which, when the coil 1' descends because of an increased effective weight, due to the formation of ice or frost thereon, bridges a pair of contacts 12' to complete an electric circuit through an electric heater 13' surrounding an upwardly-extending part 14' of the coil 1'.

In order to utilize temporary low current rates, the switch 27 controlling the supply of electric current to the motor 25 has the operating part thereof formed as the armature of a solenoid 29, which is under the control of a time switch 30. The time switch 30 comprises a rotor 31 driven in any suitable manner, and under the control of a timing device. The rotor 31 has a contact piece 32 which is adapted to register either with a pair of contacts 33 or a pair of contacts 34. When in the position shown in full lines, the contact piece 32 registers with contacts 33 and completes an electric circuit through the solenoid 29, which moves the armature to the right to close the switch 27 as shown in Fig. 2, whereby electric current is supplied to the motor 25 to drive the compressor 24. When coil 1' has descended and moved the switch arm 11' so that it bridges the contacts 12' and the rotor 31 has been rotated through an arc of approximately 180°, the contact piece 32 will be in the dotted line position, with the supply of electric current to the motor 25 interrupted, and an electric circuit completed from the supply lines through lines 35 and 36, contact piece 32, line 37, electric heater 13', line 38, contact arm 11', and line 39, whereby heat will be supplied to the cooling medium in the coil 1' to de-ice or defrost the same as previously described in connection with the form of the invention shown in Fig. 1.

With the arrangement just described, the time switch 30 operates to permit the electric circuit through the heater 13' to be completed only at such times as the motor current is cut out, that is, when the refrigerating mechanism is stopped, and to cut out the electric heater as soon as the motor current is cut in.

I claim:

1. In refrigerating apparatus, a movably mounted cooling element, means for cooling said element, whereby, in the presence of moisture, 75

a coating of ice or frost will form on said element and increase the gravitational force exerted thereby, means operable by gravitational movement of said element for causing heat to be applied to said element to cause a de-icing or defrosting thereof, and means independent of the position of the means operable by gravitational movement of said element for preventing the application of heat to said element except at predetermined times.

2. In refrigerating apparatus, a movably mounted cooling coil, means for supplying cooling medium internally to said coil to cool the same, whereby, in the presence of moisture, a coating of ice or frost will form on said coil and increase the gravitational force exerted thereby, means operable by gravitational movement of said coil for causing heat to be applied to said coil to cause a defrosting or de-icing thereof, and means independent of the means operable by gravitational movement of the position of said coil for preventing the application of heat to said coil except at predetermined times.

3. In refrigerating apparatus, a movably mounted cooling element, means for supplying a cooling medium internally to said element to cool the same, whereby, in the presence of moisture, a coating of ice or frost will form on said element and increase the gravitational force exerted by said element, means for supplying heat to said element to cause a de-icing or defrosting thereof, and dual means for controlling the application of heat to said element, one of said dual means being operated in accordance with the position of said element, and the other of said dual means being time-controlled and independent of the other controlling means.

4. In a refrigerating apparatus, a movably mounted cooling coil, means for supplying a cooling medium internally to said coil to cool the same, whereby, in the presence of moisture, a coating of ice or frost will form on said coil and increase the gravitational force exerted thereby, an electric heater adjacent a part of said coil for supplying heat thereto, an electric circuit for said heater, a switch in said circuit, an operative connection between said coil and said switch, such that gravitational movement of said coil actuates said switch, and a time-controlled switch in said circuit, whereby electric current may flow to said heater only when the coil has moved gravitationally to close said first-mentioned switch, and at such time as the time-controlled switch is in closed position.

5. In a refrigerating apparatus, a movably mounted cooling coil, means for supplying a cooling medium internally to said coil to cool the same, whereby, in the presence of moisture, a coating of ice or frost will form on said coil and increase the gravitational force exerted thereby, an electric heater adjacent a part of said coil for supplying heat thereto, an electric circuit for said heater, a switch in said circuit, an operative connection between said coil and said switch, such that gravitational movement of said coil actuates said switch, a time-controlled switch in said circuit, whereby electric current may flow to said heater only when the coil has moved gravitationally to close said first-mentioned switch, and at such time as the time-controlled switch is in closed position, and means for discontinuing the supply of cooling medium to said coil when electric current is being supplied to said heater.

6. In a refrigerating apparatus, a movably

mounted cooling coil, means for supplying a cooling medium internally to said coil to cool the same, whereby, in the presence of moisture, a coating of ice or frost will form on said coil and increase the gravitational force exerted thereby, an electric heater adjacent a part of said coil for supplying heat thereto, an electric circuit for said heater, a switch in said circuit, an operative connection between said coil and said switch, such that gravitational movement of said coil actuates said switch, a time-controlled switch in said circuit, whereby electric current may flow to said heater only when the coil has moved gravitationally to close said first-mentioned switch, and at such time as the time-controlled switch is in closed position, and means for discontinuing the supply of cooling medium to said coil and permitting cyclic thermo-circulation of the medium therein when electric current is being supplied to said heater.

7. In a refrigerating apparatus, a movably mounted cooling coil, a compressor for supplying cooling medium to said coil to cool the same, whereby, in the presence of moisture, a coating of ice or frost will form on said coil and increase the gravitational force exerted thereby, a motor for driving said compressor, a time-controlled switch for preventing operation of said motor, except at predetermined times, an electric heater adjacent a part of said coil for supplying heat to said coil, an electric circuit for said heater, including said time-controlled switch and a second switch, and means operated by gravitational movement of said cooling coil for closing said second-mentioned switch, whereby electric current may flow to said heater only when the coil has moved gravitationally to close said second-mentioned switch, and at such time as the time-controlled switch is in closed position.

8. In a refrigerating apparatus, a movably mounted cooling coil, a compressor for supplying cooling medium to said coil to cool the same, whereby, in the presence of moisture, a coating of ice or frost will form on said coil and increase the gravitational force exerted thereby, a motor for driving said compressor, a time-controlled switch for preventing operation of said motor, except at predetermined times, an electric heater adjacent a part of said coil for supplying heat to said coil, an electric circuit for said heater, including said time-controlled switch and a second switch, and means operated by gravitational movement of said cooling coil for closing said second-mentioned switch, whereby electric current may flow to said heater only when the coil has moved gravitationally to close said second-mentioned switch, and at such time as the time controlled switch is in closed position, said time-controlled switch causing an interruption of the flow of electric current to said motor when it is in position to establish flow of electric current to the electric heater.

9. In a refrigerating apparatus, a movably mounted cooling coil, a compressor for supplying cooling medium to said coil to cool the same, whereby, in the presence of moisture, a coating of ice or frost will form on said coil and increase the gravitational force exerted thereby, a motor for driving said compressor, a circuit for said motor, including switch, a solenoid for operating said switch, a time-controlled switch for energizing said solenoid, to cause the same to operate said switch at predetermined times, an electric heater adjacent a part of said coil for supplying heat to said coil, an electric circuit for said

heater, including said time-controlled switch and a second switch, and means operated by gravitational movement of said cooling coil for closing said second-mentioned switch, whereby electric
5 current may flow to said heater only when the coil has moved gravitationally to close said second-mentioned switch, and at such time as the solenoid-controlled switch is in open position and the flow of electric current to the motor is inter-
10 rupted.

10. In a refrigerating apparatus, a movably mounted cooling coil, a compressor for supplying cooling medium to said coil to cool the same, whereby, in the presence of moisture, a coating
15 of ice or frost will form on said coil and increase the gravitational force exerted thereby, a motor for driving said compressor, a circuit for said motor, including switch, a solenoid for operating said switch, a time-controlled switch for energizing

said solenoid, to cause the same to operate said switch at predetermined times, an electric heater adjacent a part of said coil for supplying heat to said coil, an electric circuit for said heater, including said time-controlled switch and a second switch, and means operated by gravitational
5 movement of said cooling coil for closing said second-mentioned switch, whereby electric current may flow to said heater only when the coil has moved gravitationally to close said second-men-
10 tioned switch, and at such time as the solenoid-controlled switch is in open position, said time-controlled switch causing the solenoid to be de-energized and the motor switch moved to open
15 position when the time-controlled switch is in position to establish flow of electric current to the electric heater.

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