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MEANS FOR DE-FROSTING REFRIGERATING APPARATUS

Filed Dec. 22, 1959

3 Sheets-Sheet 1

FIG. 1.

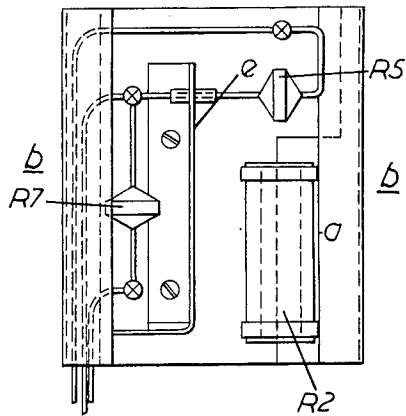
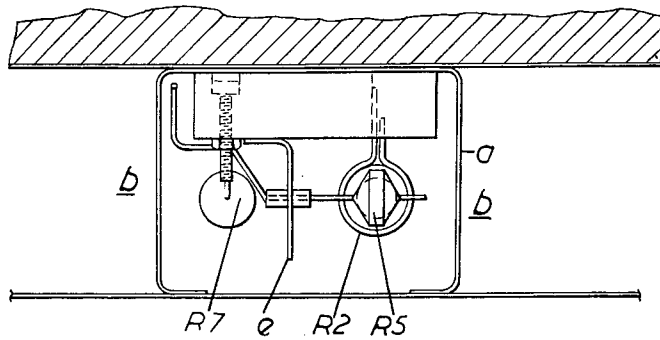


FIG. 2.



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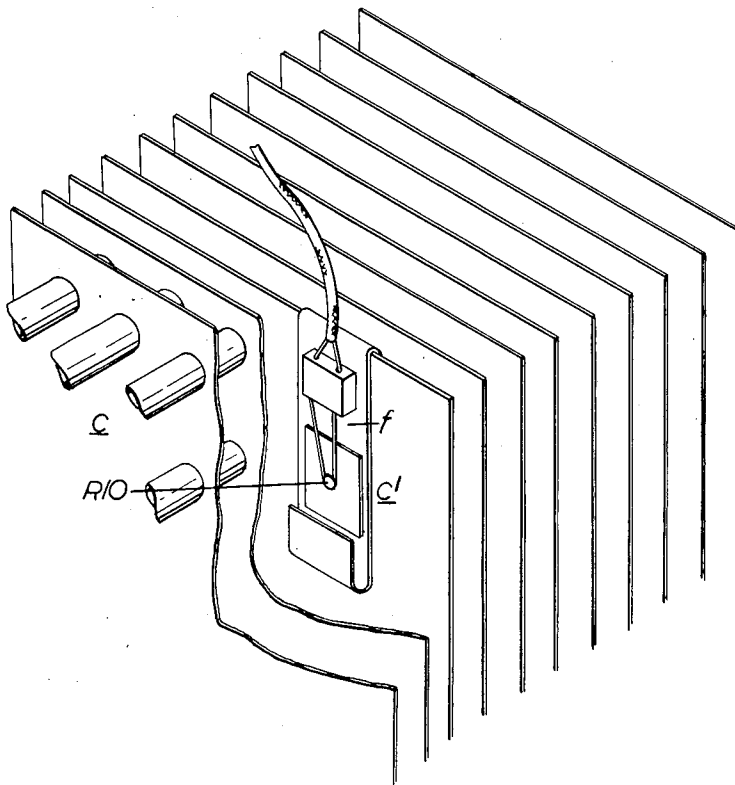
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FIG. 3.



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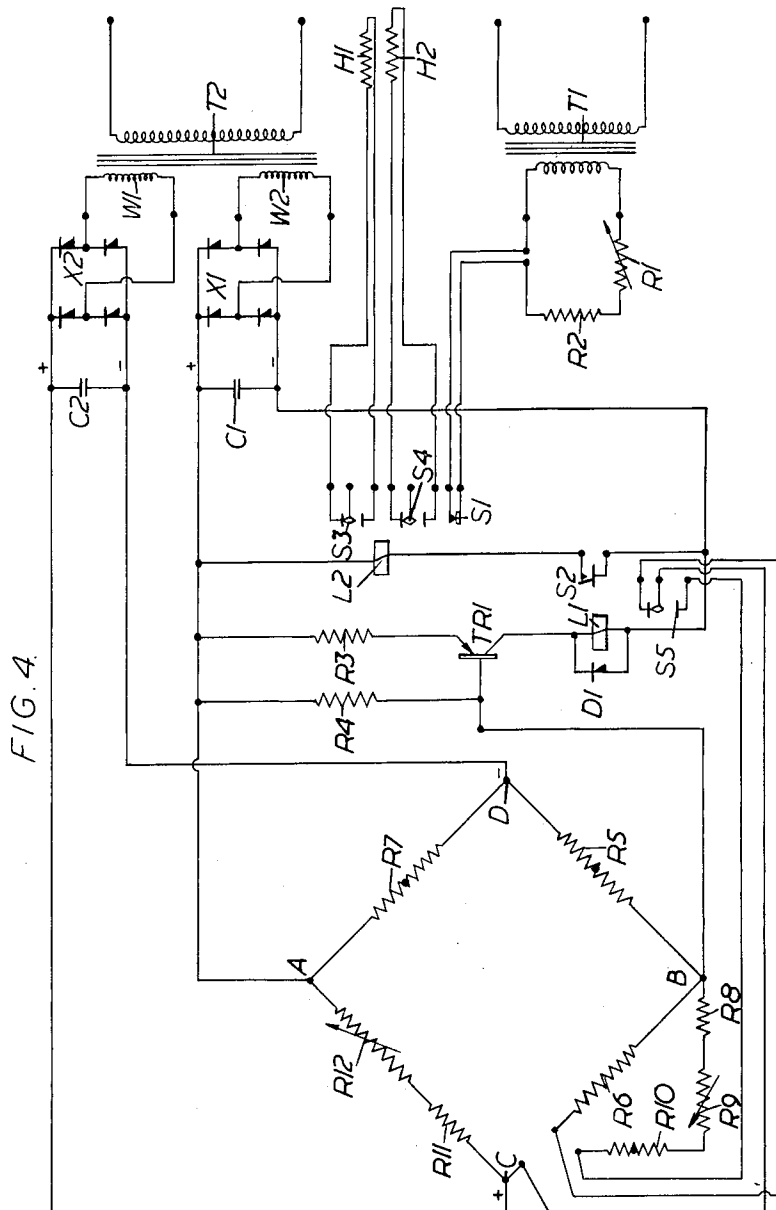
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MEANS FOR DE-FROSTING REFRIGERATING APPARATUS

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3 Sheets-Sheet 3



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3,039,278

MEANS FOR DE-FROSTING REFRIGERATING APPARATUS

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4 Claims. (Cl. 62-140)

This invention has reference to improved means for de-frosting the evaporator unit of refrigerating apparatus employed for cooling the air present within for example a food display cabinet.

It has heretofore been the practice to interrupt the normal refrigerating function and to initiate the defrosting of the evaporator unit of the refrigerating apparatus automatically at predetermined time intervals say by means of a time switch. Such an arrangement does not however provide a good mode of control since the rate of deposit of ice on the evaporator unit varies within wide limits according to inter alia the relative humidity and the ambient temperature of the air being circulated over the evaporator with the result that the de-frosting cycle is often initiated insufficiently or too frequently according to the prevailing conditions.

The present invention has for its object to provide improved means for de-frosting the evaporator unit the operation whereof is controlled according to the amount of ice present on the evaporator.

The invention consists of the incorporation in refrigerating apparatus including an evaporator unit and means for circulating air over the evaporator unit, of de-frosting means comprising a heater associated with said evaporator unit and control means responsive to the amount of ice present on the evaporator unit so as to energise said heater means to de-frost the evaporator unit when a given amount of ice is present on the evaporator unit.

The invention further resides in the incorporation in refrigerating apparatus including an evaporator unit and means for circulating air over the evaporator unit of de-frosting means comprising a heater associated with said evaporator unit, and control means responsive to variation of the volume of air flowing over the evaporator unit and thus to the amount of ice present on the evaporator unit for energising said heater means to de-frost the evaporator unit when a given amount of ice is present on the evaporator unit.

Preferred means for carrying the invention into practice will now be described, by way of example, only, with reference to the accompanying drawings wherein:

FIGURE 1 is a sectional side elevation of the detecting head hereinafter described,

FIGURE 2 is a plan view of the detecting head of FIGURE 1,

FIGURE 3 is a perspective view of temperature responsive means associated with an evaporator unit as hereinafter described, and

FIGURE 4 is a circuit diagram of de-frosting control means according to the invention.

In the illustrated embodiment the de-frosting control system comprises a detecting head including an open-ended housing *a* having mounted therein a pair of temperature sensitive resistors, otherwise known as thermistors, R5 and R7, with the thermistor R5 thermally isolated from the thermistor R7 by means of a screen *e*. The housing *a* is located in an air duct *b* leading cooled air from the evaporator unit *c* of the refrigerating apparatus incorporated in a food display cabinet so that a part of the airstream is admitted through the open ends of the housing *a*.

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The evaporator unit *c* is disposed within a casing (not shown) in or forming part of the refrigerator cabinet, and the size of the casing is such that it imposes a substantial restriction upon the air-flow over the plates of the evaporator unit which is induced by a circulating fan in known manner.

The detector head also includes a heating resistor R2 located upstream of the thermistor R5 which resistor can be energised by a transformer T1 to heat that part of the air flowing from the evaporator *c* through the duct *b* which passes through the section of the housing containing the thermistor R5. Thus the thermistor R5 will respond to variation in the temperature of the air flowing through the housing *a* which is heated by the resistor R2, whereas the air flow over the thermistor R7 is thermally isolated from that heated by the resistor R2 and is therefore responsive only to the standing temperature of the air passing through the duct *b*.

As seen in FIGURE 4 the thermistors R5 and R7 are incorporated in two arms of a Wheatstone bridge including a third arm embodying a reference resistor R11 and a bridge sensitivity adjusting variable resistance R12, and a fourth arm embodying either a reference resistor R6 or alternatively a resistor R10 in series with two resistors R8 and R9 according to the setting of the contacts of a relay L1.

The resistor R10 consists of a thermistor which is secured to a clip *f* mounted on a plate *c*¹ of the evaporator unit with good thermal contact between these parts so that the variation of the resistance of the thermistor R10 is indicative of the temperature rise of the evaporator plates which follows the completion of the melting of ice on the evaporator.

The terminals C and D of the Wheatstone bridge are fed by a D.C. voltage derived from the secondary windings W1 of a transformer R2 through rectifier bridges X2 and a smoothing condenser C2.

The output of the bridge circuit between the terminals A and B is applied to a transistor TR1 associated with a biasing resistor R4 and a stabilising resistor R3. The transistor TR1 controls the energising coil of a relay L1 incorporating contacts S2 and S5. A diode D1 is connected in parallel with the relay L1 to protect the transistor from any reverse voltage surges which may be induced by the relay winding. The contacts S2 of the relay L1 control the energisation of a relay L2 incorporating contacts S3, S4 and S1. The contacts S3 and S4 control the energisation from the mains of a pair of resistance heaters H1, H2 embodied in known manner in the evaporator unit *c* for effecting the de-frosting operation, and the contacts S1 control the energisation of the heating resistor R2 through the adjustable resistance R1.

The transistor TR1 is powered by the D.C. output derived from the secondary windings W2 of the transformer T2 through the rectifier bridge X1 and smoothing condenser C1.

The operation of the system is as follows:

During the normal refrigerating function within a food display cabinet the volume of air flowing from the evaporator through the housing *a* varies according to the restriction which is imposed on the air flow through the casing about the evaporator unit by reason of the thickness of ice present on the plates of the evaporator unit, and as the amount of ice on the evaporator unit increases the air volume flowing through the evaporator will decrease with the result that the temperature of the air flow from the resistor R2 to the thermistor R5 increases and the temperature of thermistor R5 rises with respect to that of the thermistor R7. By this means an out-of-balance potential difference is produced between the points A and B of the Wheatstone bridge circuit in proportion to the build-up of ice on the evaporator, and this voltage is ap-

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plied across the biasing resistor R4. As the point B becomes progressively more negative with respect to point A the conductance of the transistor TR1 increases to the point where the relay L1 is operated, contacts S2 and S5 are actuated, and relay L2 is energised thereby to substitute for the resistor R6 the resistor chain R8, R9 and R10.

Prior to a de-frosting operation the resistance of the thermistor R10 is high since the thermistor is at a low temperature due to the presence of ice on the evaporator. In this condition the total resistance of the chain R8, R9 and R10 is arranged to be greater than the value of the resistor R6 so that the introduction of the resistor chain R8, R9 and R10 has the effect of driving the point B further negative with respect to A whereby the transistor is biased to maximum conductance to lock the relay L1 to its de-frost contact condition.

The operation of the relay L2 which follows the closure of the contacts S2 of relay L1 energises through the contacts S3 and S4 the heaters H1 and H2 which are built into the evaporator units thereby to melt the ice present on the evaporators, and by opening contacts S1 de-energises the heater R2 thereby to equalise the temperatures of the thermistors R5 and R7.

The de-energisation of the heater R2 fulfils two purposes. Firstly, during the period when the de-frosting heaters are in operation the bridge circuit is switched by the contacts S5 from the function of detecting the build-up of ice on the evaporator to that of a resistance thermistor including the temperature sensitive element R10 for detecting a rise in temperature of the evaporator which follows the completion of ice melting, and it is therefore desirable that the values of the resistors R5 and R7 which are acting as reference resistances in the bridge are unaffected by the heater R2.

The second purpose of disconnecting the heater R2 is that when a fan is used for impelling the air through the evaporator, which fan is switched off during the de-frosting operation, then when the de-frosting operation is completed and the relays L1 and L2 revert back to their refrigerating function there is a delay before the air flow attains its normal velocity. If the heater R2 is inserted as soon as the detecting head is brought back into operation by the contacts S5, then the low air velocity that momentarily exists on starting up the fan can initiate an unwanted de-frosting operation. However, by switching the heater R2 off during this stage the temperature difference between R5 and R7 is small and therefore the signal derived from the bridge locks the relays L1 and L2 onto the refrigerating function once this has been initiated. The thermal mass of the heater R2 is arranged so that the delay time required for the heater to come up to operative temperatures is in excess of the time required for the fan to obtain its normal running speed.

When the ice on the evaporator has been melted the resultant increase in temperature of the thermistor R10

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decreases the resistance of the chain R8, R9 and R10 to a value such that the relay L1 is de-energised by the transistor TR1 so as to re-introduce the resistor R6 into the bridge circuit, and by de-energising the relay L2 breaks the contacts S3 and S4 and makes the contact S1 thereby to de-energise the de-frosting elements and to re-energise the heater R2. In this condition the refrigerating operation is re-established.

I claim:

1. In refrigerating apparatus having an evaporator unit and means defining a passage through which air flows over the surface of said evaporator unit, said passage becoming increasingly restricted to the passage of air as ice accumulates on the surface of said evaporator unit, heater means for defrosting the evaporator unit, a control circuit for said heater means, a detector head arranged in the path of the air passing over said evaporator unit and comprising a heating element adapted to increasingly raise the temperature of air passing said head as the volume through said passage decreases with accumulation of ice on the evaporator unit, and a heat sensitive unit coupled to said control circuit and exposed to air heated by said heating element, said heat sensitive unit being operable to activate said circuit to energize said heating means to defrost the evaporator unit when said air temperature at the heat sensitive unit reaches a predetermined value.

2. In the apparatus defined in claim 1, means responsive to a predetermined rise in the temperature of the heated evaporator unit for deenergizing said heater means.

3. In the apparatus defined in claim 1, said heat sensitive unit comprising a thermistor disposed in one arm of a bridge circuit another arm of which contains another thermistor shielded from said heated air, the output of said bridge circuit being electrically connected to said control circuit.

4. In the apparatus defined in claim 3, said bridge circuit having a third arm which during normal refrigeration contains a resistor, and means operative when air heated by said heating element reaches a predetermined temperature for substituting into said third arm a resistance assembly containing a third thermistor, means mounting said third thermistor to respond to increases in temperature of the surface of said evaporator unit by said heater means, and means actuated by said third thermistor when said evaporator unit surface reaches a predetermined temperature for deenergizing said heater means.

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