

[54] DEFROST CONTROL
[72] Inventor: Frank T. Check, Jr., Orange, Conn.
[73] Assignee: Dynamics Corporation of America,
New York, N.Y.
[22] Filed: Aug. 20, 1970
[21] Appl. No.: 65,420
[52] U.S. Cl. 62/156, 62/209, 62/276
[51] Int. Cl. F25d 21/06
[58] Field of Search.....62/139, 156, 208, 209, 276,
62/277, 278

3,335,576 8/1967 Phillips.....62/156
3,553,975 1/1971 Szkzmoto.....62/156

Primary Examiner—Meyer Perlin
Attorney—Richard P. Schulze

[57] ABSTRACT

A defrost control for a refrigerator wherein first and second thermistors are mounted in conductive contact with the evaporator coil and a third thermistor is mounted so as to be responsive to the ambient temperature within the unit. Defrost is initiated when a predetermined relative value occurs indicating the temperature differential between the evaporator and the ambient temperature. The thermistor transmits signals to a logic section which controls a defrost relay. A third thermistor deactivates the relay at a predetermined evaporator temperature.

[56] References Cited
UNITED STATES PATENTS
3,203,195 8/1965 Armentrout.....62/156
3,363,429 1/1968 Wechsler.....62/156
3,222,882 12/1965 Sutton 62/156

6 Claims, 4 Drawing Figures

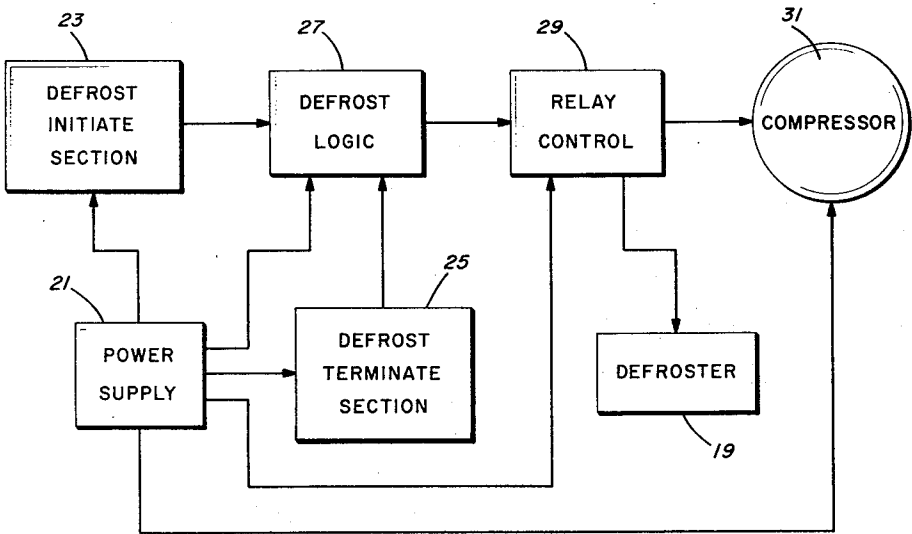


FIG. 1

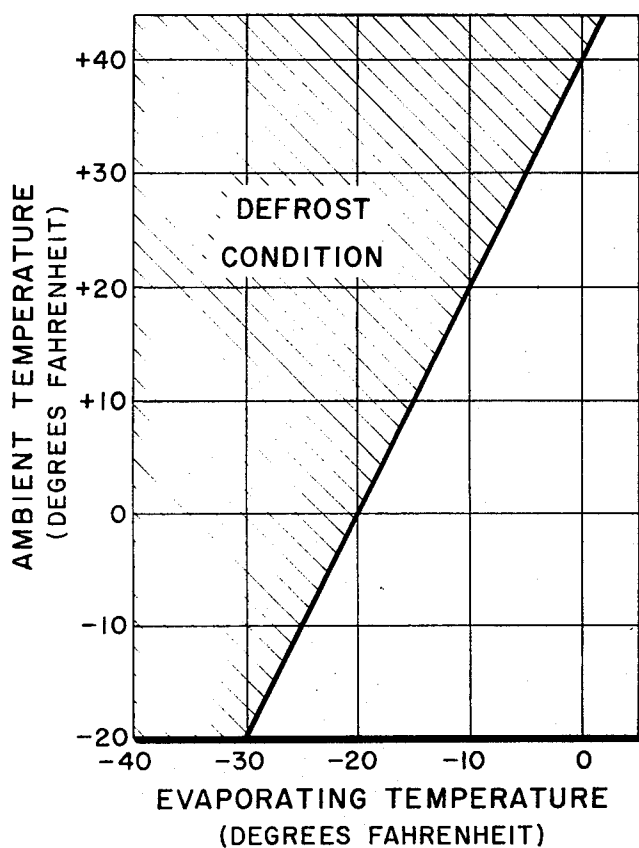
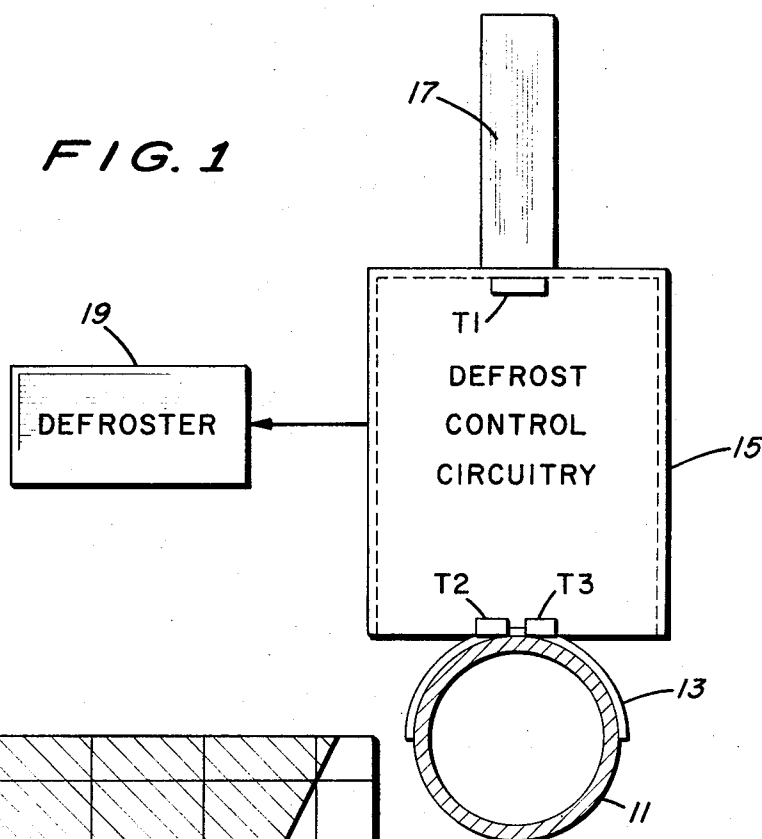


FIG. 2

Temperature Response of
Defrost Initiate Section

INVENTOR

FRANK T. CHECK, Jr.

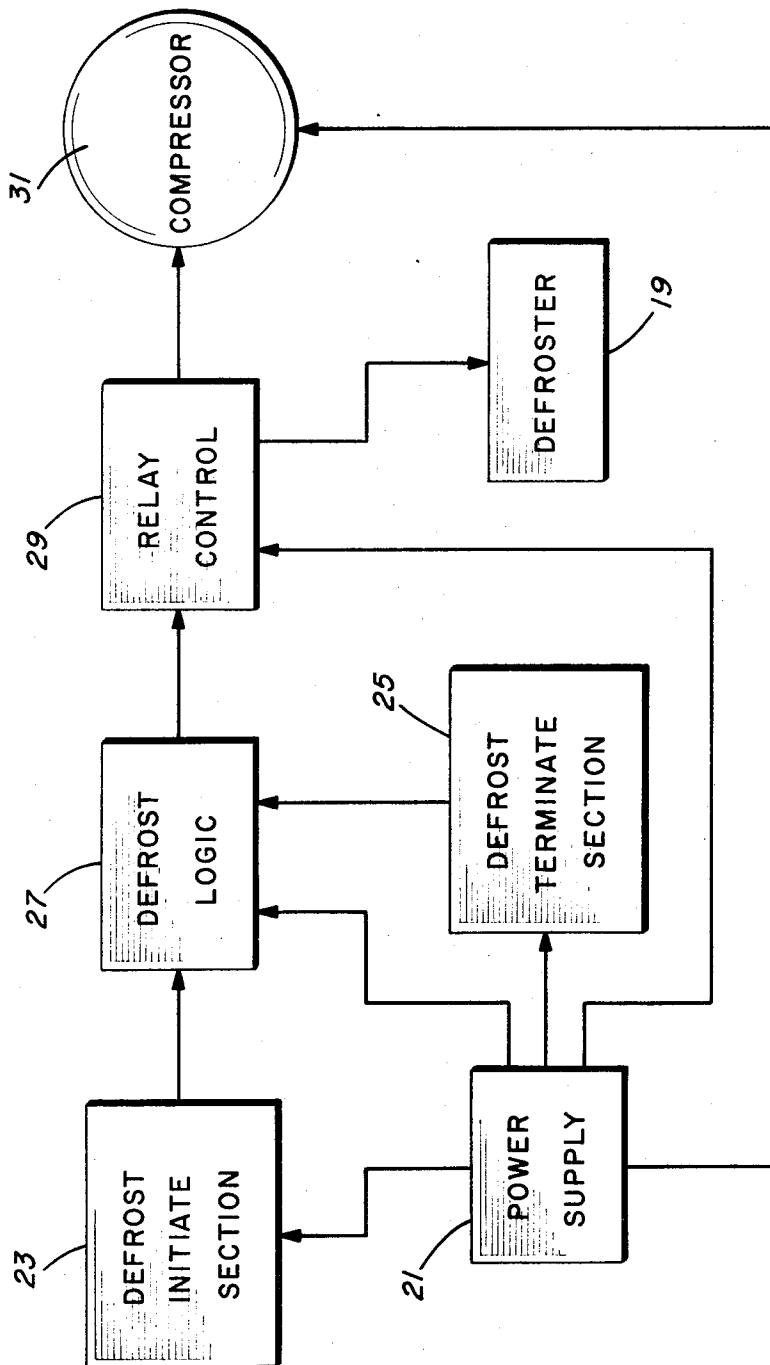
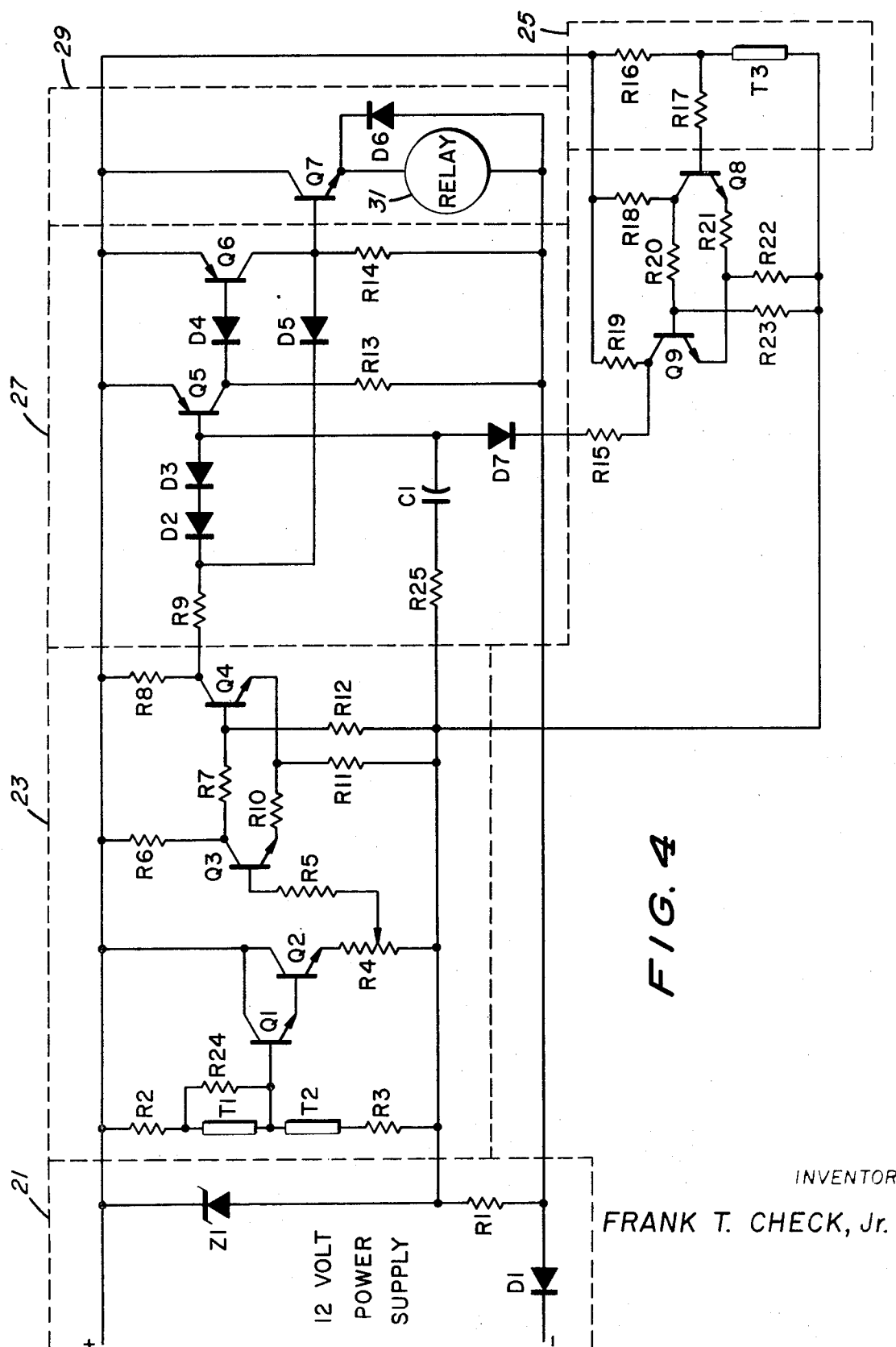


FIG. 3

INVENTOR
FRANK T. CHECK, Jr.



DEFROST CONTROL

This invention relates broadly to defrost controls for refrigerating devices and more specifically to a defrost control which is actuated in response to a predetermined temperature differential between the temperature of the evaporating coil and the ambient temperature within the unit.

In all refrigerating equipment, there is the common problem of frost accumulating of the evaporator coils to such an extent that the efficiency of the unit decreases rapidly and the unit can even become ineffective. To overcome this almost every refrigerating unit contains a defrosting means controlled by a defrost cycle which is designed to eliminate the frost by adding heat in one manner or another so as to remove the frost from the coils.

One of the well-known means for defrosting the refrigerator unit is to use an electric resistance heater which may be actuated so as to melt the frost at the same time that the compressor or the like is shut down. Other means for defrosting may also be used such as reversing the refrigeration cycle so as to heat the evaporating coil and thus melt the frost which has accumulated thereon.

One of the problems in any defrost device is to establish the time during which defrost should occur and the rate or intervals of time which should pass before any further defrost is needed. One common type of defrost cycle is simply a timing device whereby, after a certain period of time of refrigeration has occurred, the compressor is closed down and the defrost mechanism is activated. One problem with a device of this type is that the need for defrost varies extremely depending upon the temperatures involved and the humidity conditions within the refrigeration system. Therefore, a straight timing device may be actuated when it is not needed and may not be actuated when the need is the greatest.

In order to overcome this disadvantage, a number of methods of automatic defrost control dependent upon various temperature conditions have been devised.

Since the amount of frost which accumulates on the evaporator coils in effect acts as an insulator, this frost tends to prevent the heat from the compartment from reaching the evaporator coils. Accordingly, the temperature of the compartment is raised and, at the same time, the temperature of the coil is reduced. This fact has been used in the past as a bases for numerous types of defrost control mechanisms. One type of such mechanisms uses a thermistor or the like which is mounted on the coils or very near the coils so that, as the frost builds up and covers the coil, the thermistor will sense the temperature change.

Other types of devices have been used wherein two temperature detectors are used and are spaced at different distances from the coil itself, and the differential between these two temperature sensors is used to initiate defrost control.

However, there exists a definite relationship between the ambient temperature of the compartment and the absolute temperature of the coil relative to the defrost requirements. In the systems familiar to me, the controls either relate directly to the temperature of the coil or to the temperature of the ambient condition of the unit. This type of device does not take into account the variables which enter into the requirements for defrosting a refrigeration device.

Accordingly, an object of the present invention is to provide a means for defrosting a refrigeration device using controls which are dependent upon a predetermined difference between the ambient temperature of the unit and the absolute temperature of the coil.

A further object of this invention is to provide a sensing device of a solid state nature which may be mounted directly on a coil and includes thermistor devices for determining temperature differentials.

These and other objects of the invention will be obvious from the following discussion when taken in conjunction with the drawings wherein:

FIG. 1 is a schematic illustration of one means of mounting the defrost control system on an evaporating pipe;

FIG. 2 is a graph which demonstrates the variables between the ambient temperature and evaporating temperature which control the defrost cycle;

FIG. 3 is a block diagram of the basic control of the present defrost system; and

FIG. 4 is a schematic of one specific implementation of the control device of the present invention.

Basically, the present invention comprises a defrost control for a refrigerating unit including an evaporating coil, which includes means for detecting the absolute temperature of said evaporating coil, means for detecting the ambient temperature within the refrigerating unit, and defrosting means which are interconnected with the detecting means so as to be actuated in response to a predetermined temperature differential between the temperature of said evaporating coil and the ambient temperature of the unit, and further including means for deactuating the defrosting means at a predetermined temperature of the evaporating coil.

Turning now more specifically to the drawings, FIG. 1 shows schematically a preferred method of mounting the control within the refrigerating unit. There is shown an evaporating pipe 11 with an arcuate cylindrical heat conducting sheet 13 surrounding part of the evaporating pipe. The unit 15 and attached sheet 13 are mounted directly on the evaporating pipe 11 so that thermistors T2 and T3 are in solid contact with the heat conducting material 13.

Remote from thermistors T2 and T3 is a further thermistor T1 which is shown as mounted on a heat conducting rod or plate 17 which extends into the interior of the refrigerating unit so as to attain the ambient temperature within the unit.

A defroster 19, which may be of the electric resistance type or any of the well-known defroster control means is indicated schematically.

FIG. 2 is a graph which illustrates the defrost condition relative to ambient temperature in degrees Fahrenheit, and the temperature of the evaporating coil in degrees Fahrenheit. As may be seen, as the ambient temperature increases, the necessity for defrost occurs at a higher evaporating temperature. FIG. 2 should be understood to be only representative of the temperature response required for a particular unit and the temperature response may be changed to comply with a different unit with no change in the basic design of the control.

FIG. 3 is a schematic block diagram indicating the general relationship of the control for the defrost. A power supply, which may be a standard 12 volt D.C. supply in mobile units, is connected to a defrost initiate

section 23, a defrost terminate section 25, a defrost logic section 27, and a control relay 29 which directly actuates or deactuates defroster 19. Also schematically shown is a compressor 31 which is connected to the power supply and is also coupled to the relay control 29.

Upon application of power to the unit, the relay 29 is deenergized unless a defrost condition exists. A defrost condition exists when the ambient and evaporating temperatures fall within the cross-hatched area of the curve shown in FIG. 2. Once the defrost condition occurs, the defrost cycle begins whereby the relay 29 is energized and locked in the energized position. The defrost cycle is ended by the defrost terminate section 25 when the evaporator temperature has risen above a predetermined set point.

Turning now to FIG. 4, the power section 21 is shown as designed to operate directly from a 12 volt battery for use in a mobile unit. However, it may be used from any A.C. source through appropriate A.C.-D.C. converter coupled to the power supply. Diode D1 protects the circuit from reverse polarity. Zener diode Z1 provides a regulated supply for the critical low level circuitry.

In the defrost initiate section, the temperature response is provided by detecting the voltage level at the junction between the upper and lower arms of a voltage divider comprising resistors R2 and R3 and R24 and thermistors T1 and T2. As indicated in FIG. 1, thermistor T1 senses the ambient temperature within the refrigerator unit, and thermistor T2 senses the temperature of the evaporating coil.

The emitter follower coupled to the output of the bridge consists of transistors Q1 and Q2. Resistor R4 prevents loading down of the temperature sensing network and provides a convenient means for altering voltage level to match that of the subsequent voltage level detector.

The voltage level detector consists of a Schmitt trigger wherein transistor Q3 is normally off and transistor Q4 is on. When the ambient and evaporating temperatures are such that the point defined by them lies in the cross-hatched area of FIG. 2, transistor Q3 turns on and transistor Q4 turns off. This turns off transistor Q5 which in turn turns on transistors Q6 and Q7.

Transistor Q5 is locked to the off position through diode D5 which holds the base of transistor Q5 near emitter potential through transistor Q6 which is on. Diodes D2, D3 and D4 are used to change voltage levels as desired.

The unit terminates defrost cycle when the evaporator temperature rises above a predetermined set point, which point is determined by resistor R16 and thermistor T3. As the evaporator temperature rises above the set point, transistor Q8 turns off, and transistor Q9 comes on, which then turns transistor Q5 on, thereby turning transistors Q6 and Q7 off, the relay 31 is deenergized, and the circuit is then released from the defrost cycle.

Hysteresis may be incorporated in the Schmitt trigger by including transistors Q8 and Q9 to provide a more desirable characteristic for keeping transistor Q5 on and locking the unit out of the defrost cycle until the evaporator temperature goes below a set temperature.

It should be further pointed out that the voltage divider network was devised to provide the temperature differential signal for a specific purpose. Since the Schmitt trigger switches at fixed voltage input, the ratio of the resistance of the upper arm (R2, T1, R24) to that of the lower arm (T2, R3) equals a constant. The equation for each leg of the network to meet the desired temperature response of the defrost initiate section as shown by the curve in FIG. 2 is:

$$R(k, T) = \frac{k^3}{(T/10 + 4) \ln k/3.01}$$

where $R(k, T)$ is resistance, k is constant and T is temperature in degrees Fahrenheit. The constant k is chosen in terms of dV/dT wherein V is the voltage input to the Schmitt trigger and T is the evaporator temperature. This equation is a straight line function when plotted (R vs T , k constant) on log-log paper. The restrictive characteristics of T1 and T2 versus temperature are modified to give a straight line plot on log-log paper. This is done by adding resistances R2 and R3. Resistance R24 is added to improve the characteristics at the low temperature end, since resistance R2 and R3 do not provide the desired characteristics at the low end of the temperature range involved.

As a general requirement, it was determined that in order to get the optimum value of the constant k , the temperature coefficient of the thermistors T1 and T2 should be large.

As can be seen, the present invention provides a compact and exact control for defrost conditions in a refrigerating unit. The electronic control circuitry and temperature sensing elements are all mounted in the same package. The only external leads required are power leads and leads to the relay, or if the relay is within the package to the relay contacts.

As far as mounting is concerned, an alternative method would be to package the electronic circuitry in one package and use remote sensors to monitor ambient and evaporating temperatures.

The above description and accompanying drawings are illustrative only and various other methods could be used to perform the functions as set forth in the present invention. Accordingly, the invention is to be limited only by the scope of the following claims.

I claim:

1. A defrost control for a refrigerating unit including an evaporating coil comprising defroster means, first and second thermistors mounted in conductive contact with said evaporator coil, and responsive to the temperature therein, a third thermistor mounted so as to be responsive to the ambient temperature with said unit, a voltage divider including said first and third thermistors, control means coupled to said voltage divider and responsive to a predetermined voltage level output of said voltage divider, relay means coupled to said defroster means and responsive to the output of said control means, and means coupling said third thermistor to said relay means for deenergizing said relay means at a predetermined evaporator coil temperature.

5

2. A defrost control for a single compartment refrigerating unit including an evaporating coil comprising

means for detecting the absolute temperature of said evaporating coil,

means for detecting the ambient temperature within said unit,

defrosting means,

means for actuating said defrost means in response to a predetermined temperature differential between the temperature of said evaporating coil and said ambient temperature, and

means for deactuating said defrosting means at a predetermined evaporating coil temperature.

3. The control of claim 2 wherein said temperature detecting means comprise thermistors and associated electrical circuitry.

6

4. The control of claim 2 wherein

said means for detecting the temperature of said evaporating coil and said means for detecting said ambient temperature comprise first and second thermistors connected in an electrical bridge, and said means for actuating said defrost means comprises a relay responsive to the voltage output of said bridge.

5. The control of claim 4 further comprising voltage level detecting means coupled between said bridge and said relay.

6. The control of claim 4 further comprising a third thermistor in conductive contact with said evaporating coil and coupled to said relay for deenergizing said relay when said evaporator coil rises above a predetermined temperature.

* * * * *

20

25

30

35

40

45

50

55

60

65