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2,679,731

REFRIGERATOR DEFROSTING APPARATUS

Filed Sept. 8, 1950

2 Sheets-Sheet 1

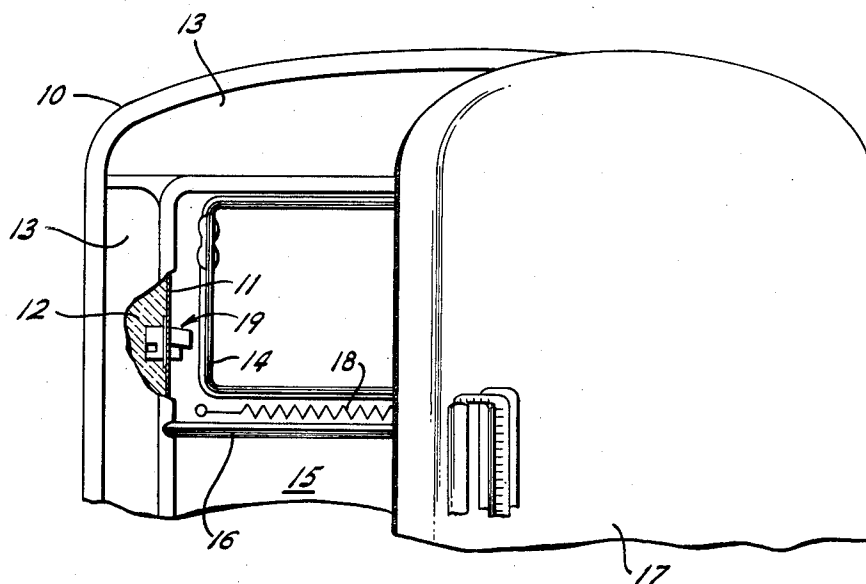


FIG. 1.

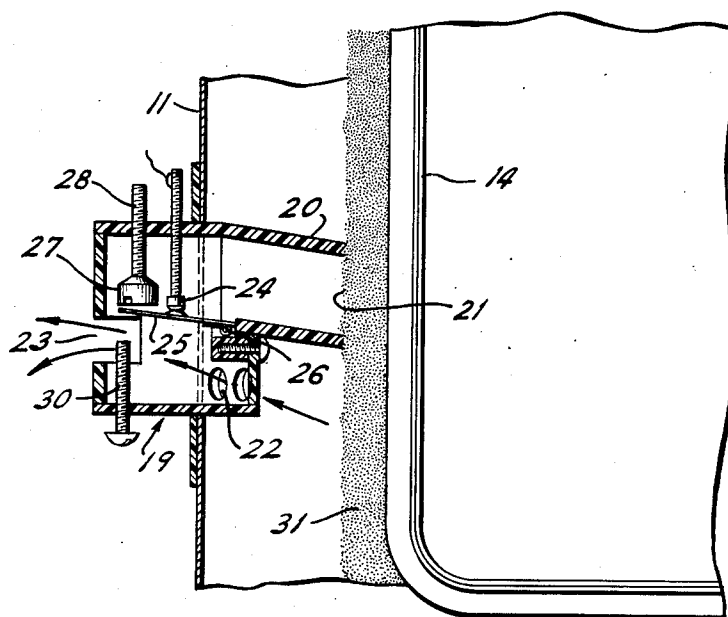


FIG. 2.

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2 Sheets-Sheet 2

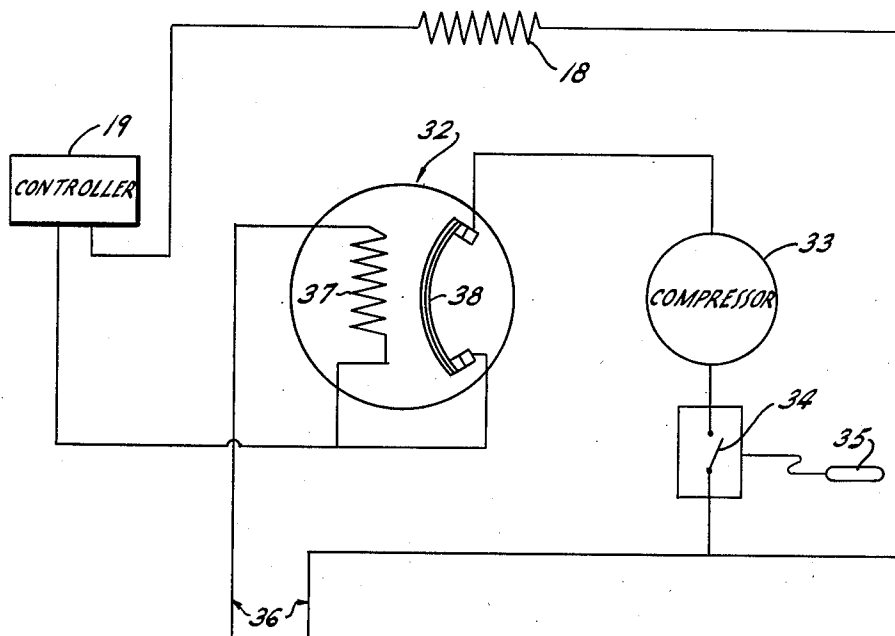


FIG. 3.

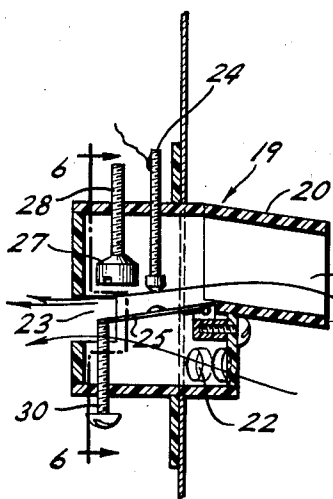


FIG. 4.

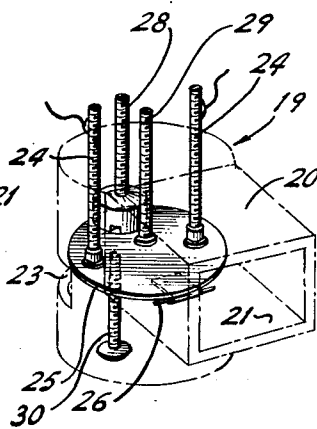


FIG. 5.

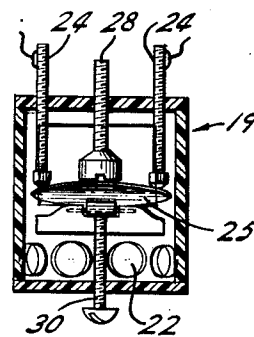


FIG. 6.

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REFRIGERATOR DEFROSTING APPARATUS

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7 Claims. (Cl. 62-4)

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The invention hereinafter disclosed and claimed relates to refrigeration and, more particularly, is concerned with refrigerators of the type having provision for automatic removal of frost deposited upon the surfaces of the evaporator or other element used to produce refrigeration.

It is now well recognized that it is desirable to provide within a refrigerator cabinet not only a main storage compartment maintained at temperatures above the freezing point of water, in order to provide for the proper preservation of fresh fruits, vegetables and other foodstuffs which should not be subjected to sub-freezing temperatures, but also a compartment maintained at sub-freezing temperatures suitable for the preservation of frozen foods over a long period of time. Commonly the latter compartment takes the form of an enclosed rectangular evaporator maintained at temperatures well below the freezing point of water and which evaporator, through the agency of air circulating throughout the refrigerator, is utilized to cool not only the space defined by its walls but also the aforesaid main or higher temperature compartment. While such constructions have become more or less standard in the industry they are subject to a serious disadvantage in that moisture present in the main higher temperature compartment is deposited upon the sub-freezing evaporator in the form of frost. Periodical removal of this frost is necessary in order to maintain the operating efficiency of the refrigerator, and such defrosting has frequently been accomplished by shutting down the refrigerating system. Since extended discontinuities of operation of the system result in thawing of frozen foods with attendant deterioration, and since the defrosting operation has frequently been troublesome and time-consuming, it has recently been recognized that automatic and relatively frequent defrosting of the evaporator is desirable. Such defrosting can conveniently be accomplished by subjecting the evaporator to a considerable quantity of heat over a relatively short period of time and, while such heating of the evaporator is not a difficult problem, the means for controlling the initiation and duration of the defrosting operation has generally left much to be desired.

A number of approaches have been made to this control problem among which might be mentioned the use of timers, ratchet devices and the like, effective to discontinue operation of the refrigeration system and apply heat to the evaporator after a predetermined period of operation.

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Such devices are inherently rather complex and expensive and, in addition, suffer from the disadvantage that defrosting cycles may be initiated when the quantity of frost accumulated on the evaporator is not great enough to warrant defrosting. These difficulties and disadvantages can be overcome by the provision of means automatically operable to initiate and control the defrosting operation in response to accumulation of a predetermined thickness of frost upon the evaporator, and, it is with this class of apparatus that the present invention is concerned.

It is the primary object of my invention to provide a defrost controlling device which is operable in accordance with the degree of frost deposition and which is unusually simple, inexpensive and reliable. In the achievement of the foregoing general objectives, the apparatus of my invention utilizes a novel switch device which is of such a nature as to be conditioned for operation by the accumulation of a predetermined thickness of frost upon the evaporator and, when thus conditioned, is effective to energize a defrosting circuit automatically in response to a change in air pressure which occurs within the refrigerator cabinet under usage conditions. With more particularity, the invention is featured by the provision of means providing an air flow passage having an opening confronting the cooling unit, or evaporator, through which opening or passage air normally flows when the refrigerator door is moved, as for example when the door is closed. A switch element is movably mounted in the path of movement of the air which flows through said passage, said element being adapted to initiate the defrosting operation when the frost upon said unit has restricted said opening to an extent sufficient to prevent that degree of air flow which normally takes place through said passage when the refrigerator door is closed.

It is also an object of my invention to provide an automatic defrost controller which is effective to energize the defrosting circuit only when the temperature conditions within the cabinet are such as to warrant subsection of the apparatus to a defrosting operation.

It is a further object of my invention to provide a defrost controlling device which is conditioned for operation automatically, by the mere starting of the refrigerating apparatus after shipment of the machine.

In its preferred embodiment the apparatus of this invention, briefly described, comprises: means providing a pair of passages through which air

normally flows as a result of a change in air pressure occurring within the cabinet when the refrigerator door is closed, one of said passages terminating in close proximity to the cooling unit in a position such that accumulation of a predetermined thickness of frost upon the cooling unit is effective substantially to prevent flow of air through the said one passage; and a movable switch member so disposed as to be contacted by the air flowing through said passages, said switch member being actuatable—when the door to the refrigerator is closed—in response to the resultant pressure differential created in said passages by the aforesaid blocking of the said one passage.

The foregoing objects and features of my invention, together with certain subordinate details of construction thereof are hereinafter illustrated and described in the accompanying drawings in which:

Figure 1 is a fragmentary elevational view of a refrigerator embodying the invention;

Figure 2 is an enlarged view of a portion of the apparatus illustrated in Figure 1, and with the controlling device of the invention shown in section;

Figure 3 is a wiring diagram illustrating certain control circuitry utilized in the apparatus of my invention;

Figure 4 is a sectional view of the control device, and showing said device in open circuit position;

Figure 5 is a perspective view of the controller, partially in phantom; and,

Figure 6 is a sectional view of the controller taken generally as indicated by the line 6—6 of Figure 4.

Now making more particular reference to the drawings, and especially to Figures 1 and 2 thereof, it will be seen that the invention is therein illustrated as embodied in a domestic refrigerator comprising an outer shell 10 and an inner shell or liner member 11, spaced inwardly of and insulated from the outer shell 10 by any suitable insulation, shown at 12. As is customary, a breaker strip 13 of low thermal conductivity extends about the forward edge of the cabinet and bridges the gap between the outer shell 10 and the inner liner 11. The refrigerator also includes a compressor-condenser unit of any desired type and, as will be understood, this unit is connected in refrigerant flow circuit with the evaporator shown at 14. The compressor-condenser unit and the refrigerant flow conduits have been omitted from the drawings to simplify the same, and in view of the fact that the invention is not concerned with the refrigeration system, per se.

As clearly appears in Figure 1, inner liner member 11 defines a storage compartment 15 within the upper portion of which is disposed the aforesaid evaporator 14, a baffle shown at 16 serving to separate the evaporator from the lower or main food storage compartment. Preferably the baffle is of such a nature to provide for controlled circulation of air between the spaces above and below the same and, in this way, the evaporator 14 is utilized in cooling the entire refrigerator. As will be recognized, the evaporator 14 is subject to accumulation of frost thereon as a result of condensation of moisture present in the circulating air.

The front access opening of the cabinet is provided with a door 17 adapted to seal the space defined by the inner liner and seating against

the cabinet in the general plane of the aforesaid breaker strips 13. As will later appear, manipulation of this door plays an important part in controlling the defrosting operation automatically.

Disposed intermediate the compartment 15 and the lower surface of evaporator 14 is a resistance heating element 18, said element being shown diagrammatically, in the interest of simplicity in illustration. Insofar as the broader principles of the present invention are concerned, this heater element may take a variety of forms although a metal clad type sealed against the entrance of air and moisture has proven very satisfactory for the purposes of the invention. The heater element is also included in the circuitry shown in Figure 3.

In particular accordance with the invention, the illustrated refrigerator is provided with a novel defrost controlling switch shown, generally, at 19 and which, in the embodiment illustrated, comprises a substantially closed housing of electrically non-conductive material, the housing being mounted in an aperture provided in a side wall of inner liner member 11 and in a position such that it is disposed adjacent to the confronting side wall of evaporator 14. The housing is provided with a laterally extending passage 20 terminating in an opening 21 which latter directly confronts the wall of the evaporator in slightly spaced relation thereto. Beneath said passage 20 the housing is provided with a plurality of openings 22, and it will be noted that the housing is further provided with an opening 23 through which is afforded communication with the space between the outer shell 10 and inner liner 11.

During opening and closing movements of the main refrigerator door 17, there occurs a change in air pressure within the compartment defined by inner liner 11 and this pressure change is communicated to the interior of housing 19 through the aforesaid ports or openings 21 and 22 and with resultant flow of air through said openings. Air entering the housing is outletted through opening 23 into the insulated space between the outer shell and inner liner. Under conditions such that there is no substantial accumulation of frost upon the evaporator, and as will be understood by a consideration of the arrows representing air flow, in Figure 4, there is a flow of air, when the main door is closed, inwardly through opening 21 and thence through opening 23, and also inwardly through the openings 22 and out of the aforesaid opening 23.

Returning now to a consideration of the controlling device, per se, it will be seen that the conductive housing is provided with a pair of screw threaded adjustable contact elements 24—24 which, together with a novel pivoted switch member 25, comprise the switch which initiates and controls the defrosting operation. As clearly appears in Figure 5, the major portion of housing 19 is circular in cross-sectional shape and the pivoted switch element or blade 25 is circular in plan and extends horizontally through the housing at a level intermediate the level of the openings 21 and 22. Preferably, although not necessarily, this blade or element comprises a bi-metal disk of known type which disk, in response to changes in temperature, is adapted to have its midportion move over center with a snap action. The disk is pivotally mounted, as at 26 (Figure 5), near that edge which is disposed adjacent to passage 20 and is thus mounted with

freedom for movement between a lower open-circuit position, illustrated in Figure 4, and an upper circuit-closing position shown in Figure 2. Means is provided releasably to retain the disk in the upper position, this means taking the form of a small permanent magnet 27 mounted for vertical adjustment movements through the agency of a screw threaded shaft 28. For a purpose which will appear more fully hereinafter the housing 19 is also provided with a downwardly extending screw threaded member 29 which comprises a stop limiting the upward movement of the disk and providing a reaction point used when the disk snaps over center. This stop 29 appears in Figure 5. An upwardly extending adjustable stop element 30 limits the downward movement of the disk 25.

Defrosting is automatically initiated, as and when required, in response to accumulation of frost upon the evaporator 14. A coating of frost is represented at 31 in Figure 2 and, as clearly appears from the figure, the frost has accumulated to a thickness such as to block off the opening 21 in passage 20. After frost has accumulated to the extent shown, the next succeeding closing movement of the main door 17 results in flow of air through the lower apertures 22 and outwardly of the exit port 23, but no flow takes place through the upper opening 21.

As will be understood by a comparison of Figures 2 and 4, the pressure variation which occurs within the cabinet when the door 17 is closed, and under conditions such that there is little if any frost accumulation upon the evaporator, results in subjecting the portions of the housing 19 which lie above and below the disk 25 to substantially the same pressure and, accordingly, air flows through the ports 22, as well as through the opening 21, inwardly of the housing and is outletted through the exit opening 23. Under such conditions there is no substantial difference of pressure across the switch disk 25 and, consequently, the disk remains in its lower or normal position. When, on the other hand, frost has accumulated to the extent illustrated in Figure 2, the blocking off of opening 21 results in a difference of pressure being applied across the disk 25, that is, unequal pressures are applied to the opposite faces of said disk, with the result that air moving inwardly through the openings 22 raises the pivotally mounted disk 25 to the position shown in Figure 2, in which position the disk bridges the contacts 24—24 and thus initiates the defrosting operation. As indicated hereinabove the disk is releasably retained in this upper circuit-closing position by the permanent magnet 27.

Under normal operating conditions of the refrigerator, the temperature of the bi-metal disk, due to its proximity to the evaporator, will assume a value within a range dependent upon the temperature of the evaporator, the spacing between the evaporator and the controlling device, the effectiveness of the cabinet insulation, and like factors. In one representative embodiment which has given good results in practice, the temperature of the bi-metal disk under normal refrigeration conditions is 25° F., or somewhat below that value. The disk is so calibrated that, under such conditions, it presents a concave side upwardly and as a result, when the disk is moved to its upper position (as a result of closing of the door and accumulation of frost sufficient to block opening 21) the center portion of the disk does not strike the upper limiting stop 29 and the edge

portions of the disk bridge the contacts 24—24 with the result that the defrosting circuit is made. In any particular design there is also a disk temperature which corresponds to completion of the defrosting operation, that is, a temperature which the disk attains when the coating of frost has been completely removed. In the illustrated embodiment this temperature is in the region of 50° F. When, due to the heat applied to the evaporator to effect defrosting, the disk reaches this upper control temperature it snaps over center to a condition in which the side which confronts the contacts 24—24 is convex. As a result, and during such over center movement, the mid-portion of the disk reacts against the centrally located upper stop element 29 and effects movement of the disk to its lower position, with resultant opening of the defrosting circuit. As the evaporator regains its normal operating temperature the disk, while in said lower position, again moves over center to present a concave side upwardly, thus being reset in position such as to enable it to bridge the contacts 24—24 when the next defrosting cycle is initiated. The disk, of course, remains in the lower position until such time as the frost has again accumulated to a degree such that closing of the door results in an appreciable pressure difference across the disk, at which time the latter is again moved to its upper position to repeat the defrosting cycle above described.

While the use of a bi-metal disk is preferred, it is to be borne in mind that, in the broader aspect of the present invention, other switch blades or elements might be employed. For example, the bi-metal disk might be replaced by a simple metal leaf, provision being made for control of the defrosting circuit by momentary contact. Similarly, while there are advantages in designing the apparatus to operate in accordance with the difference of pressure created within the cabinet when the door is closed, the pressure difference which occurs when the door is opened could also be employed to control the position of the disk, without departure from the essential and broader concepts of the invention.

While the constructional principles and operational features of the invention will be understood from the foregoing description, a brief description of the control circuitry may to advantage be set forth. Respecting the wiring diagram (Figure 3), there is diagrammatically illustrated therein the controller 19, the resistance heater 18, an overload protective device of known type, shown at 32, a motor compressor 33 and a conventional temperature cycle-control 34, together with an associated bulb 35 responsive to the temperature of the evaporator 14.

Under normal operating conditions of the refrigerator, current from the left side of the supply line 36 flows through a heater coil 37 arranged in high heat conducting relation with respect to a bi-metallic overload protective blade 38, through the contacts associated with said blade, through the compressor 33, the cyclically operable temperature control switch 34, and thence to the other side of the line. As will be recognized, this is common practice.

When defrosting is required, the compressor may or may not be in operation. Assuming that the compressor is in operation, a circuit is completed through the contacts of the controller 19, in the manner already described and, under these conditions there is a division of current flowing through the heater winding 37, part of the cur-

rent flowing through the bi-metallic blade 38 and the compressor, as described, and a portion of the current flowing through the defrost heating coil 18 and thence returning to the other side of the line. As a result of the fact that the defrosting coil 18 draws considerable power (for example, 660 watts) the surge of current through the heater coil 37 of the overload protective device is sufficient to open the contacts of the bi-metallic blade 38 and to maintain them in open position throughout the defrosting operation. Thus the compressor, if it be in operation when defrosting is initiated, is shut off and remains off until the contacts in the controller 19 are again opened at the termination of the defrosting operation. When the latter contacts reopen, cooling of the heater coil 37 resets the blade 38 and provides for normal cycling of the refrigeration system.

In the event that upward movement of the disk 25 should occur when the refrigerator—due perhaps to abnormally heavy usage—is at a temperature so elevated as to make it undesirable to subject the apparatus to a defrosting operation, the disk 25, as a result of such abnormally high temperature, will present a convex side upwardly toward the contacts 24—24 and, the convex side bears against the stop member 29; although the permanent magnet will retain the disk in said upward position the defrosting circuit will not be closed. Upon restoration of normal temperature conditions the disk, as set forth above, moves over center, without dropping to its lower position, so that the face which confronts the contacts is concave and the contacts are thus closed to permit the defrosting operation to take place. As above indicated the disk moves to its lower position, after defrosting is completed, to be reset by "pull down" of the temperature of evaporator 14.

During shipping, or other movement of the refrigerator, the disk may inadvertently be moved toward its associated contacts and held in that position by the permanent magnet 27. As a result of the high ambient temperature normally encountered when the apparatus is not in operation, for example during shipment, a convex side of the disk is presented toward the contacts and the circuit is therefore not closed immediately. Upon attainment of normal refrigerating temperatures the disk moves over center and the defrosting circuit is completed. While the defrosting operation which may be initiated under such circumstances may not be entirely necessary, it will be of very short duration, due to the rapid rise in evaporator temperature which takes place in the absence of a coating of frost, and normal operation of the box is therefore established in a short period of time as soon as the disk has reached the upper control temperature limit (50° F.).

From the foregoing description it will be understood that by the present invention there is provided not only a new and useful refrigerator in which air pressure changes occurring within the cabinet are utilized to provide direct and highly reliable indication and control of the quantity of frost present upon the evaporator, but also that the invention has provided a novel switch device characterized by unusual simplicity and low cost.

While the foregoing specification is concerned with a single representative embodiment, it will be understood that the invention is susceptible of changes and modifications without departing

from the essential concepts thereof. For example, and in the broadest aspect of the invention, the changes in cabinet air temperature which are utilized to actuate the control switch need not necessarily take place as a result of movement of the refrigerator door. Changes in air pressure could be brought about by other means such as a periodically operable diaphragm. Use of the door for this purpose is highly advantageous and is therefore to be preferred, but certain important advantages of the invention may be realized without such use. It will be recognized, however, that the invention contemplates changes and modifications which come within the terms of the appended claims.

I claim:

1. In a refrigerator, an inner liner member defining a storage compartment having an access opening, a door normally closing said opening, a cooling unit within said compartment and upon which frost accumulates during normal operation of the refrigerator, means providing a pair of passages leading through a wall portion of said inner liner member and through which passages air flows as a result of change of pressure occurring within said compartment when the door is closed, one of said passages terminating in close proximity to the cooling unit in a position such that accumulation of a predetermined thickness of frost upon the cooling unit is effective substantially to prevent flow of air through the said one passage, and a movable switch member so disposed as to be contacted by the air flowing through said passages, said switch member being actuatable, when the door to the refrigerator is closed, in response to the resultant pressure differential created in said passages by blocking of the said one passage by the stated accumulation of frost.

2. In refrigerator apparatus, a cabinet defining a storage compartment and including a door, means for cooling said cabinet and including surface portions disposed therewithin and subject to frost accumulation during normal operation of the apparatus, means periodically operable to defrost said surface portions, and means responsive to the thickness of accumulated frost to initiate operation of said defrosting means, said last means including: a housing and passage means communicating with the space within said compartment and with the space outside thereof, cabinet air tending to flow through said passage means, into said housing and thence into the space outside said compartment in response to closing of the door; and a switch element and associated contacts within said housing, said switch element being movable between an open position in which the defrosting means is not energized and a closed position in which said defrosting means is energized, said passage means including a portion so disposed as to be closed by the accumulation of a predetermined thickness of frost on said surface portions, with resultant change in the flow of cabinet air which normally occurs during the closing of said door, and said switch element being so constructed and arranged as to move to a closed position with respect to the associated contacts when the passage means has thus been closed.

3. Refrigerator apparatus in accordance with claim 2, and further characterized in that said switch element comprises a bi-metallic thermosensitive member, a portion of which is movable with a snap action with respect to another portion thereof, in response to an increase in tem-

perature of said cooling means, to reset said switch element by effecting movement of the same to the stated open position.

4. In a refrigerator including a door, the combination of: a cooling unit upon which frost accumulates; means providing an air flow passage having an opening confronting the cooling unit and through which opening and passage air flows when the refrigerator door is moved; a switch element pivotally mounted in the path of air flowing through said passage and effective to initiate a defrosting operation when the frost upon said unit has restricted said opening to a degree sufficient to prevent substantial flow of air through said passage in response to movement of said door, thereby causing pivotal movement of said switch element from an open-circuit position to a circuit closing position, said switch element comprising a bi-metallic member a portion of which is movable with a snap action with respect to another portion thereof in response to thermal changes occurring within said refrigerator; and stop means against which said switch element may react, during the said snap action movements, to cause pivotal movement of said member back to its open-circuit position.

5. In a refrigerator including a compartment provided with a door, the combination of a cooling unit within said compartment and upon which frost accumulates during normal operation of the refrigerator, structure providing air flow passage means having an opening confronting the cooling unit and an opening in communication with space outside of said compartment, and through which openings and passage means air normally flows when the refrigerator door is moved, and a switch member movably mounted in the path of movement of air flowing through said passage means, said member being effective to initiate a defrosting operation when the frost upon said unit has restricted said opening to a degree sufficient to prevent substantial flow of air through said passage means in response to movement of said door.

6. In a refrigerator, a storage compartment having an access opening normally closed by a door, means presenting a cooling surface within said compartment and upon which frost accumulates during normal operation of the refrigerator, means providing a pair of passages leading outside said compartment and through which pas-

sages air flows as a result of change in pressure occurring within said compartment when the door is closed, one only of said passages terminating in close proximity to said cooling surface in a position such that accumulation of a predetermined thickness of frost upon said surface is effective substantially to prevent flow of air through the said one passage, and a movably mounted switch member so disposed as to be contacted by the air flowing through both of said passages, said member being adapted to remain in open-circuit position under conditions such that air flows through both said passages, frost blockage of the said one passage serving to prevent flow of air through that passage and to effect movement of said member to a circuit closing position.

7. In a refrigerator having a compartment including an evaporator and provided with a door, closure of said door effecting a transient increase in air pressure within said compartment, means defining a passageway within said compartment, said passageway normally being in open communication with the interior of said compartment and with space outside thereof, a movably mounted member disposed within said passageway and dividing the same into parallel passage portions, the inner end of one passage portion being disposed adjacent said evaporator, air normally being free to escape from said compartment through both passage portions in parallel in response to closure of said door, frost accumulation upon said evaporator preventing such flow of air through said one passage portion, and thereby causing movement of said member when the door is closed and said one passage portion is blocked.

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