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E. J. MOORMAN ETAL

3,138,006

REFRIGERATING APPARATUS INCLUDING DEFROST MEANS

Filed April 30, 1962

4 Sheets-Sheet 1

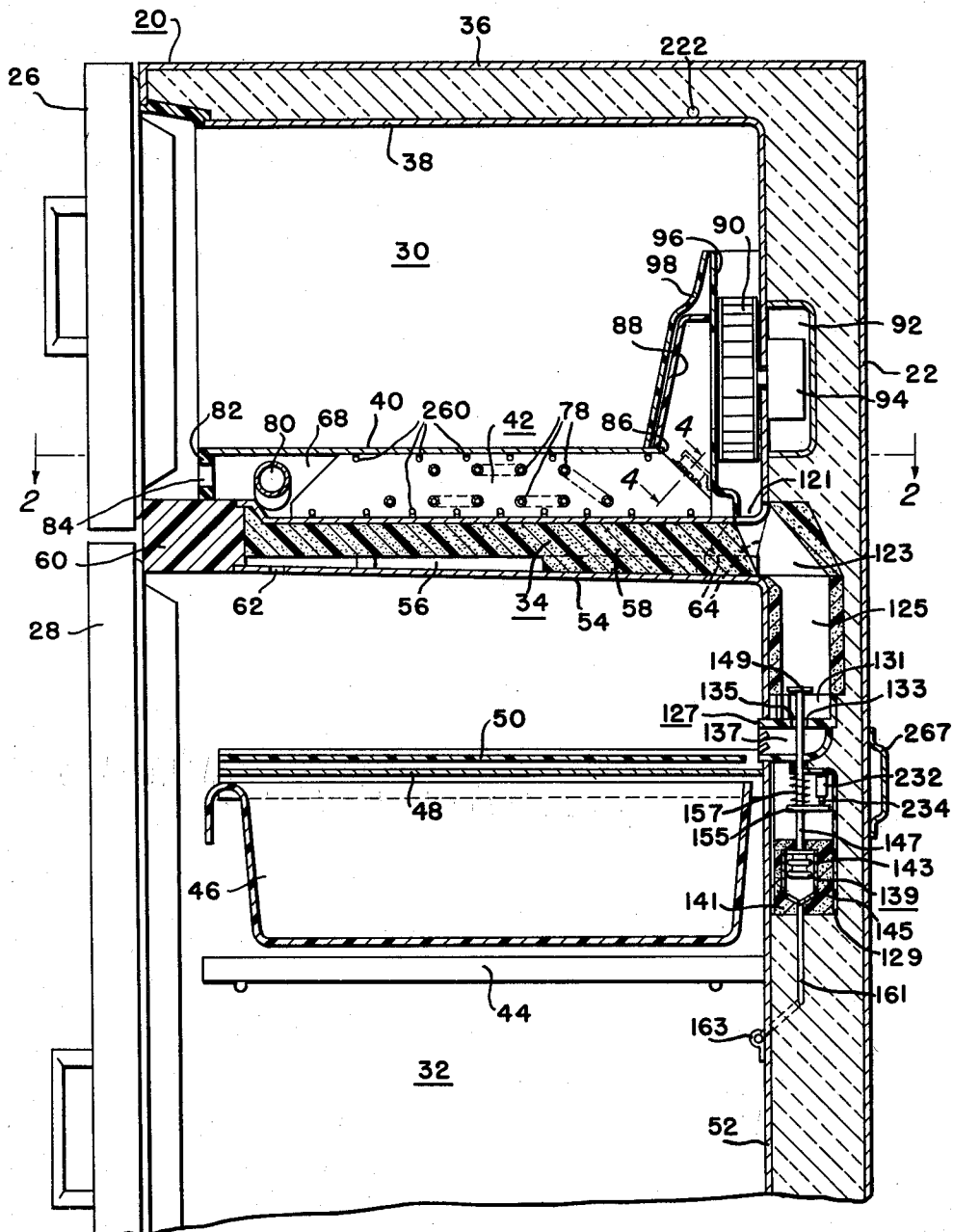


Fig. 1

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4 Sheets-Sheet 2

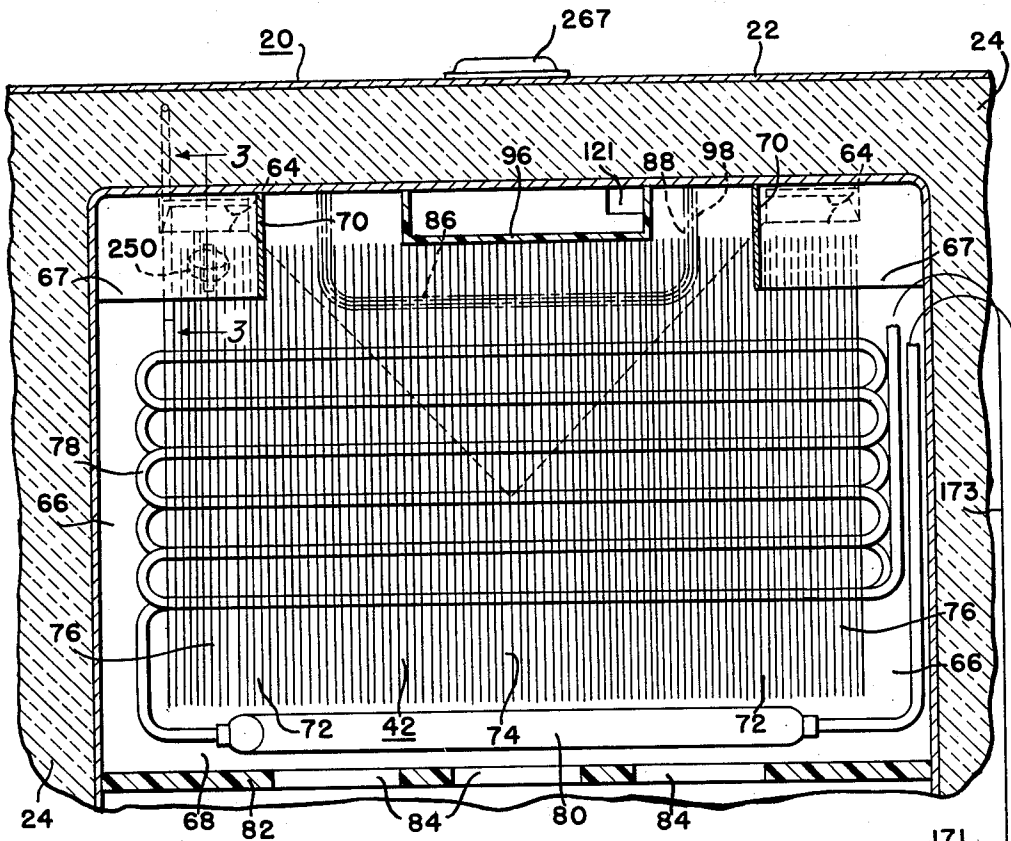


Fig. 2

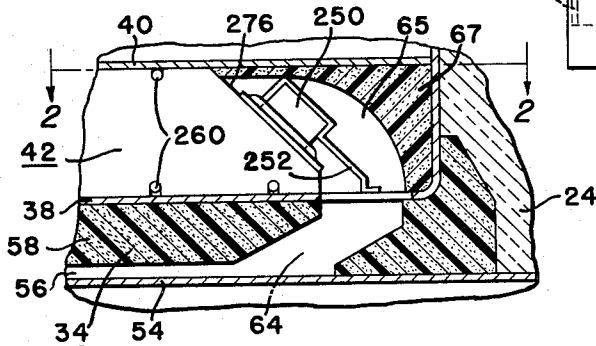


Fig. 3

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4 Sheets-Sheet 3

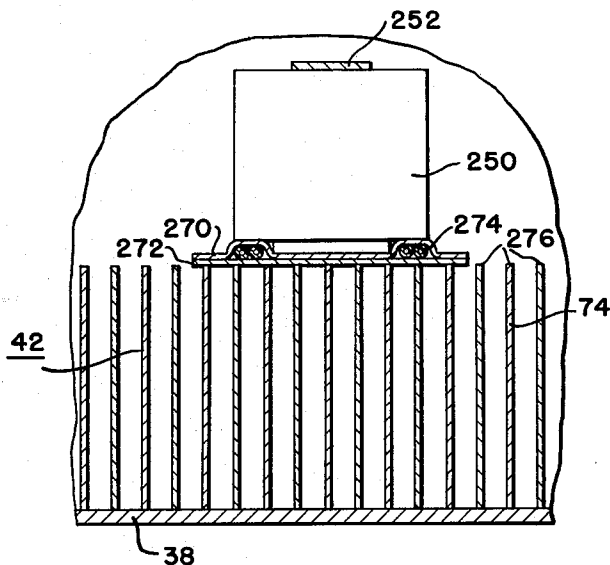


Fig. 4

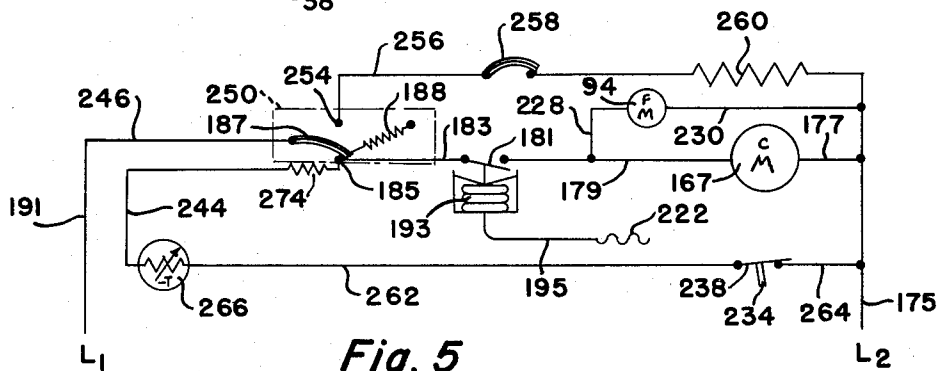


Fig. 5

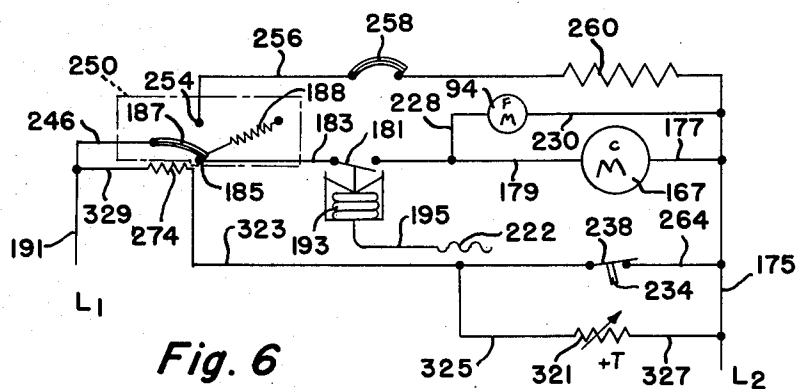


Fig. 6

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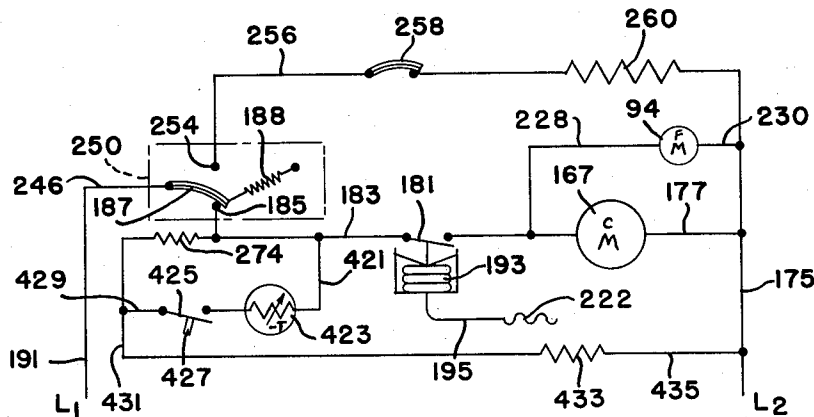
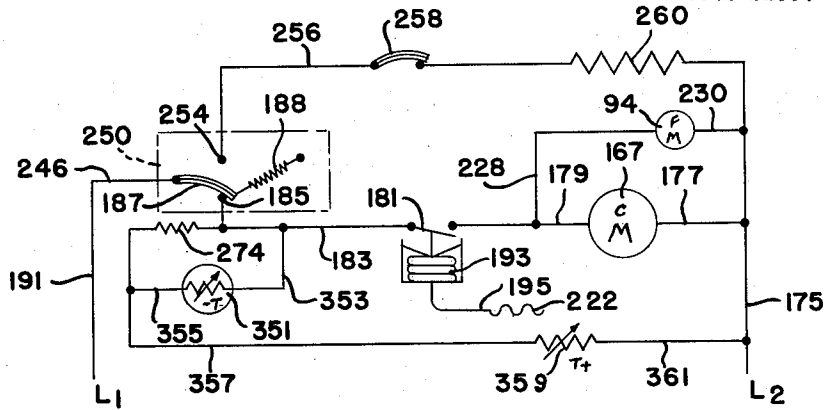
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REFRIGERATING APPARATUS INCLUDING DEFROST MEANS

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4 Sheets-Sheet 4



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3,138,006

REFRIGERATING APPARATUS INCLUDING DEFROST MEANS

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14 Claims. (Cl. 62—156)

This invention pertains to refrigerating apparatus and more particularly to means for defrosting the evaporator of a refrigerator, especially of the single evaporator frost-free two compartment type.

Although many devices have been devised for defrosting an evaporator when there is a predetermined build up of frost thereon, none of such devices has achieved any widespread commercial success. Instead, whether needed or not, it has been customary to defrost the evaporator at timed intervals even though this is wasteful and unnecessarily raises the temperatures of the compartments during such defrost periods.

It is an object of this invention to provide a refrigerator with a reliable defrosting system which will operate only when the evaporator becomes sufficiently frosted that it can no longer keep the desired refrigerating temperatures regardless of the effect of varying ambient temperatures and humidities upon the control and the refrigerator.

It is another object of this invention to provide a refrigerator with a reliable defrosting system which will operate only upon a combination of the frost condition of the evaporator and an abnormal high temperature condition of one of the refrigerated compartments.

It is another object of this invention to provide a refrigerator with a reliable defrost control adapted to be coated by and affected by the frost upon the evaporator and further modified by heating the control in response to changes in ambient temperature or in response to the temperature in one of the refrigerated compartments.

These and other objects are attained in the form shown in the drawings in which the air from the above freezing compartment is first drawn through the fins on the edge or side portions of the evaporator to cool and remove moisture from this humid air by the deposit of frost upon the fins. This air is mixed at the front of the mixing compartment with the cold dry air which is drawn from the below freezing compartment. The combined mixed air passes rearwardly through the central section of the evaporator to the inlet of the fan located at the rear of the above-freezing compartment. The fan has one upwardly extending outlet discharging upwardly into the below freezing compartment and a second downwardly extending outlet extending through passages to the above-freezing compartment. The above-freezing compartment is kept between predetermined temperature limits above freezing by a thermostatically controlled air valve which regulates the discharge of the air over the meat container into this compartment.

According to our invention, as the principal defrost control, there is provided a snap-acting, double throw, bimetal, thermostatic switch having a wide differential. This switch is mounted upon the edges of the fins of the evaporator at the point where the air from the above-freezing compartment enters the evaporator and the mixing chamber. This is the point at which frost first begins to collect upon the evaporator and normally is the point at which most of the frost is deposited. This switch has first and second contacts which are alternately energized upon a rise in temperature to about 55° F. and to a fall in temperature to about 28° F. The refrigerating system is connected to the energy supply upon the rise in temperature to 55° F. and remains connected until the temper-

ature falls to 20° F. When the temperature falls to 28° F., the defrost system is connected to the energy supply for defrosting the evaporator. When this thermostat is free of frost, it is warmed by the relatively warm air from the above-freezing compartment so it is prevented from going to the defrost temperature. After frost accumulates, the rate of air flow is reduced and the thermostat is shielded from this warm air by the frost covering thereon so that its temperature is lowered.

To prevent premature defrosting by this thermostat, we provide a small electric heater in heat transfer with it which is normally energized. However, when the above-freezing compartment rises to an abnormally high temperature, the air valve will move to an abnormally wide-open position in which it engages and opens a switch connected in series with the heater associated with the thermostat so that the temperature of the thermostat will rapidly be lowered by the cooling of the evaporator to approximately 28° F. which will cause it to snap to its defrost position. In its defrost position, the thermostat energizes a defrost heater associated with the evaporator to melt the frost from the evaporator. When the evaporator has risen to approximately 55° F., substantially all of the frost will have been melted therefrom and the thermostat will be operated to return the system to normal refrigeration. To further control the refrigerating system, there is connected in series with the motor-compressor unit a thermostat switch responsive to the temperature of the below-freezing compartment. The heater associated with the thermostat may also be controlled by temperature responsive resistances responsive to ambient temperatures either with or without the use of the air valve switch. The air valve switch may also be made normally open and connected in shunt with this heater.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings wherein a preferred embodiment of the present invention is clearly shown.

In the drawings:

FIGURE 1 is a vertical side sectional view through a single evaporator, frost-free two compartment refrigerator embodying one form of our invention;

FIGURE 2 is an enlarged fragmentary top sectional view of FIGURE 1 taken substantially along the section line 2—2;

FIGURE 3 is a fragmentary side vertical sectional view taken along the line 3—3 of FIGURE 2;

FIGURE 4 is a fragmentary inclined side sectional view taken along the line 4—4 of FIGURE 1 showing the defrost limiter switch and its heater;

FIGURE 5 is a wiring diagram for the refrigerator shown in FIGURES 1 to 4;

FIGURE 6 is a modified wiring diagram for the refrigerator shown in FIGURES 1 to 4;

FIGURE 7 is a third modified wiring diagram for the refrigerator shown in FIGURES 1 to 4; and

FIGURE 8 is a fourth modified wiring diagram for the refrigerator shown in FIGURES 1 to 4.

Referring now to the drawings and more particularly to FIGURES 1 to 4, there is shown an insulated refrigerator cabinet 20 provided with an insulated rear wall 22, insulated side walls 24, an insulated top wall 36 and upper and lower front doors 26 and 28 enclosing an upper frost-free below-freezing compartment 30 and a lower above-freezing compartment 32. The bottom insulated wall is not shown but separates the bottom of the above-freezing compartment 32 from the top of the machinery compartment beneath as in conventional refrigerator construction. Between the compartments 30 and 32, there is provided an insulated horizontal partition wall 34.

The below-freezing compartment 30 is enclosed by a metal liner 38 provided with a metal false bottom wall 40 resting upon the top of the vertical fins of the refrigerant evaporator 42 which in turn rests upon the bottom of the inner liner 38. The above-freezing compartment 32 is provided with a plurality of shelves, such as the shelf 44, and a meat container 46 located above the shelf 44 provided with a lid 48 and shield 50 over the lid. The above-freezing compartment 32 is enclosed within an inner liner 52 having its top wall 54 made largely false by the provision of the passages 56 in the insulation 58 of the partition wall 34. The top wall 54 of the liner extends forwardly to the mullion 60.

Air from the above-freezing compartment 32 passes upwardly through the slots 62 in the front of the top wall 54. After passing through these slots 62, the warm air flows rearwardly through the passages 56 over the top wall 54 of the liner 52 to the apertures 64 extending upwardly through the rear corners of the insulation 58. This warm air keeps the top wall 54 warm enough to prevent condensation of moisture thereon. From the apertures 64, the air moves forwardly through the passages 65 in the corner insulation pieces 67 located in the rear corners of the mixing compartment 68. This air then flows forwardly through the side passages 66 of the mixing compartment 68 which are formed between the false bottom metal wall 40 and the bottom of the liner 38. Laterally, these passages are formed by two vertical dividers 70 at the rear which extend forwardly into contact with the adjacent vertical fins 72 which divide the evaporator 42 into a central section 74 and the edge portion 76. These vertical fins extend from the front to the rear and are all provided with beveled edges, both at the front and the rear, to facilitate defrosting. The fins are all mounted upon horizontal serpentine refrigerant coils 78 connecting at their outlet with the accumulator 80 located in front of the evaporator 42 in the front of the mixing compartment 68.

The space in front of the evaporator 42 in the front of the mixing compartment 68 provides for the flow of air from the side passages 66 into the central rearwardly extending passageway embracing the central fins 74. Between the front edge of the false bottom wall 40 and the mullion 60 is a grille 82 provided with three horizontal inlet openings 84 directly in front of the central section 74 of the evaporator 42. This provides an inlet for the cold dry air from the below-freezing compartment 30 into the front space of the mixing compartment 68 directly in front of the rearwardly extending central passage 74 and directly adjacent the cold accumulator 80. The air flowing forwardly through the side passages 66 is precooled and dried by the side portions 76 of the evaporator 42 before it reaches the front of the mixing compartment 68 and mixes with the cold dry air flowing from the below-freezing compartment 30 through the inlets 84. The mixture of air from the edge portions 76 and from the inlets 84 then flows rearwardly through the central portion 74 of the evaporator 42 to the space at the rear of the evaporator 42. With this arrangement, the rear corner portions of the evaporator 42 tend to be warmed by the relatively warm humid air from the above-freezing compartment 32. Considerable moisture from this air is deposited in the form of frost on the edge portions 76 of the evaporator 42 before this air reaches the central portion 74. This makes it likely that the frost accumulation in the central portions 74 will be at a slower rate than the frost accumulation in the side passages 66. This increases the assurance that the temperatures in the below-freezing compartment 30 will be maintained at a safe value.

The rear of the false bottom wall 40 is provided with a centrally located notch 86 covered by the inlet shroud 88 of the centrifugal fan 90 driven by the fan motor 94 located in a recess 92 in the rear wall 22. The fan 90 is provided with an upwardly extending discharge outlet

96 for discharging the greater portion of the cold air drawn from the rear of the mixing compartment 68 into the below-freezing compartment 30. The inlet shroud 88 and the discharge outlet 96 are enclosed within an ornamental cover 98 of plastic which prevents the air from the below-freezing compartment 30 from contacting and depositing frost on the cold surfaces of the inlet shroud 88 and the discharge outlet 96. The fan 90 has a second downwardly extending discharge outlet 121 connecting through the passages 123 and 125 in the insulation pieces in the rear wall 22 with the inlet of an air valve 127.

This air valve 127 includes a plastic body 129 provided with an air inlet 131 connecting with the valve seat 133 enclosing a valve seat opening 135 connecting with the discharge chamber 137. The bottom of the valve body 129 is provided with an expansible chamber fluid motor 139 surrounded by the foam type of insulation 141 lodged within the valve body 129. The fluid motor 139 includes an internal bellows 143 and an external container 145. The bottom of the bellows 143 is connected by a valve stem 147 with a valve element 149 located above the valve seat 133. The lower portion of the valve stem 147 is provided with the lower spring follower 155 which supports the lower end of the compression-type coil spring 157 within the valve body 129. The upper portion of the coil spring 157 is supported by the valve body 129. The bottom of the container 145 of the fluid motor 139 is connected by the capillary tube 161 extending through the insulated rear wall 22 to the thermostat bulb 163 mounted upon the rear wall of the liner 52 of the above-freezing compartment 32. The valve 127 is calibrated to be fully closed when the temperature of the bulb 163 is reduced to 34° F. and to be fully open when the temperature reaches 39° F. This air valve 127 throttles the flow of cold air from the fan 90 so as to prevent the above-freezing compartment 32 from falling below freezing temperatures and, particularly, for normally maintaining the temperature thereof between the limits of 34° and 39° F.

The evaporator 42 is provided with liquefied refrigerant from a refrigerant liquefying apparatus which includes a sealed compressor unit 165 containing an electric driving motor 167 for drawing evaporated refrigerant from the accumulator 80 through the suction conduit 169 and for compressing the refrigerant and forwarding the compressed refrigerant to a condenser 171 where the compressed refrigerant is condensed and forwarded through the capillary tube supply conduit 173 to the inlet of the refrigerant tubing 78 of the evaporator 42. The opening of the doors 26 and 28 and the storage of moist packages within the storage compartments 30 and 32 provide a source of moisture which through the circulation of air migrates to various portions of the evaporator 42.

According to our invention, there is provided a small substantially cylindrical metal container 250 supported by the bracket 252 in contact with two thin sheets of foil 270 and 272 between annular spaced portions of which there is a small electric heater 274 of about a four-watt rating surrounding the projecting portion of the container 250. The bracket 252 holds the sheet of foil 272 in contact with the beveled rear edges 276 of the fins in the left side portion 76 of the evaporator 42 within the passage 65 which receives the relatively warm humid air from the above-freezing compartment 32. Within this metal container 250 is a snap-acting bimetal switch member 187 of the double throw type. This bimetal 187 may be of the snap-acting disk type having an inherent snap action or it may be provided with a snap-action spring 183 so that it is held in contact either with the lower contact 185 or the upper contact 254. Preferably, this double throw switch is calibrated so that, upon a fall in temperature to 28° F., when in contact with the lower contact 185, it will snap up into engagement with the upper contact 254. It will remain in contact with the

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upper contact 254 until its temperature is raised to about 55° F. at which condition the bimetal 187 will snap down into engagement with the lower contact 185.

The metal container 250 is located so that through the foil 270 and 272 and the fins of the evaporator 42 it is responsive to the temperature of the evaporator 42. Through the flow of air from the above-freezing compartment conducted through the slots 62 and the passages 56, 64 and 65, the metal container 250 and the closed bimetal switch 187 are also responsive to the temperature of the air in the above-freezing compartment 32. As the evaporator 42 becomes coated with frost, the metal container 250 likewise becomes coated with frost because it is maintained substantially at the temperature of the evaporator 42. This coating of frost tends to reduce the rate of air flowing through the passage 65 and thereby causes the temperature of the evaporator 42 to have a greater influence upon the temperature of the metal container 250 than the air flowing through the passage 65. The operation of the bimetal switch 187 is further controlled and modified by the heat provided by the small electric heater 274.

According to our invention, this snap-acting bimetal switch 187, so subjected to the temperatures of the air in the passage 65 and the temperature of the evaporator 42 as modified by reduced rate of air flow and secondarily by the coating of frost and as influenced by the temperature of the heater 274, is used to stop the normal refrigeration when a detrimental amount of frost has collected on the evaporator 42 and to start a defrosting operation for defrosting the evaporator 42 so as to remove the frost therefrom. This occurs when the bimetal switch 187 has its temperature lowered to 28° F. or some other selected low temperature. This snap-acting bimetal switch 187 is also used to detect the completion of the defrosting and to terminate the defrosting operation and to resume refrigeration by snapping back from its upper contact 254 to its lower contact 185. This switch 187 and its contacts 185 and 254 as well as the heater 274 may be connected in the electric circuit supplying the refrigerating system in several different ways to produce the desired defrosting control. One specific example is illustrated in the wiring diagram, FIGURE 5, in which the lower contact 185 is connected by the conductor 183 through the snap-action switch 181 and the conductor 179 with one terminal of the compressor motor 167. The second terminal of compressor motor 167 is connected through the conductor 177 with the first supply conductor 175. The fan motor 94 is connected to operate at the same time as the compressor motor 167 and has one of its terminals connected by the conductor 228 to the conductor 179 and its other terminal connected by the conductor 230 to the first supply conductor 175.

The upper contact 254 is connected through the conductor 256, the normally closed safety switch 258 to one terminal of the defrost heater 260 which has its second terminal connected to the supply conductor 175. This sheathed defrost heater 260 extends in serpentine fashion through the notches in the upper and lower edges of all the fins of the evaporator 42 as indicated in FIGURES 1 and 3. However, instead of employing the sheathed heater 260 for defrosting, a solenoid or other type of electrically energized actuator may be substituted for initiating and terminating other types of defrosting systems such as the hot gas type of defrost system or a reversing valve which will reverse the refrigerating cycle to cause the evaporator 42 to be heated while the condenser 171 is cooled. The safety switch 258 is provided to prevent overheating of the heater 260. The bimetal thermostat 187 is connected through the conductor 246 with the second supply conductor 191. The snap-acting switch 181 is operated by the bellows 193 to which is connected a capillary tube terminating in a bulb 222 which is mounted on the outside of the liner 38 directly above the discharge outlet of the fan 96 so that it is sub-

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stantially responsive to the temperature of the below-freezing compartment 30 and can operate to control the compressor motor 167 so as to maintain the compartment 30 between desired temperatures such as -2° and +11° F.

The heater 274 is controlled so as to secure the initiation of the defrost period under the desired conditions. As shown in FIGURE 5, one terminal of the heater 274 is connected to the contact 185 while the second terminal is connected by the conductor 244 to a thermistor 266 which in turn connects through the conductor 262, the normally closed switch 238 and the conductor 264 with the first supply conductor 175. The thermistor 266 may be enclosed in the receptacle 267 provided on the outside of the rear wall 22 of the cabinet 20 so that it is directly responsive to the ambient or room temperature in which the cabinet is located. The normally closed switch 238 is housed in the container 232 and is operated to open position when its operating plunger 234 is engaged by an extension of the spring follower 155 upon the valve stem 147 of the air valve 127. This is arranged so that this engagement by the overtravel of the stem occurs when the temperature of the compartment 32 is about 40° F. and causes the valve element 149 to be moved beyond its normal wide open position. This indicates that the evaporator 42 has become sufficiently frosted that it no longer can carry the full refrigerating load to maintain the compartment 32 between the desired temperatures of 34° and 39° F. It also indicates that the air being supplied through the passage 125 to the air valve 127 is abnormally warm.

With this type of arrangement, the heater 274 provides sufficient heat under normal circumstances to keep the container 250 and the bimetal 187 at a high enough temperature to prevent it from being cooled to the tripping point of 28° F. and particularly to cause it to remain in contact with the lower contact 185 to provide electric energy for the compressor motor 167. When the evaporator 42 and container 250 are free of frost, there is sufficient warm air normally circulating from the above-freezing compartment 32 to prevent the bimetal switch 187 from tripping even though the door 28 should be open for a considerable period of time sufficient to cause the normally closed switch 238 to be opened. However, when the evaporator 42 and container 250 become coated with frost, the reduced flow of warm air from the compartment 32 will have less influence and when the heater 274 is de-energized by the opening of the switch 238, the bimetal 187 will be cooled down to a tripping point of 28° F. causing it to snap away from its lower contact 185 and into engagement with its upper contact 254 to stop the refrigeration by the compressor motor 167 and to start defrosting of the evaporator 42 by the energization of the defrost heater 260 or the initiation of any other form of defrosting. The defrosting of the evaporator 42 by the defrost heater 260 or other form of defrosting continues until the bimetal 187 is heated to its tripping point of 55° F. causing the bimetal switch 187 to snap away from its upper contact 254 to de-energize the heater 260 and into contact with its lower contact 185 to resume the operation of the compressor motor 167 and the fan motor 94.

Where it is contemplated that the refrigerator may operate under very low room temperature and humidity conditions, such as between 50° and 60° F., the thermistor 266, which is in the form of a negative temperature responsive resistance, is connected in series with the heater 274 to reduce the current flow through the heater 274 under low room temperature conditions. With refrigerators of certain characteristics, the compartment 32 may not reach the temperature of 40° F. even when the evaporator 42 is very much in need of defrosting. Under cold room temperature conditions, the thermistor 266 reduces the current flow through the heater 274 sufficiently that when the container 250 becomes sufficiently coated with

frost, it will cause the bimetal switch 187 to receive so little heat from the heater 274 that it will be cooled below the tripping point of 28° F. and snap upwardly into engagement with the defrost contact 254 to initiate a defrost cycle even though the switch 238 has not opened. This provides an arrangement wherein the evaporator 42 will be defrosted automatically only whenever defrosting is required even though the refrigerator may at times operate in abnormally cold environments.

Should it be found that the heater 274 should be provided with more heat at lower ambient temperatures and less heat at higher ambient temperatures, a positive temperature responsive resistance such as indicated by the reference character 321, in FIGURE 6, may be substituted for the negative temperature responsive resistance 266 in the circuit as shown in FIGURE 5. The positive temperature responsive resistance increases in resistance with a rise in temperature and therefore will reduce the current flow through the heater 274 as the ambient temperature rises. This positive temperature responsive resistance likewise could be located within the enclosure 267 on the back of the refrigerator.

Where there is difficulty in terminating the operation of the defrost heater or defrost operation quickly enough under any particular conditions, a circuit arrangement such as shown in FIGURE 6 may be substituted for the circuit arrangement shown in FIGURE 5. In this arrangement the temperature responsive resistance 266 may be either included in the circuit as shown in FIGURE 5 or it may be omitted when no such control for the beginning of the defrost period is necessary. In FIGURE 6 similar parts and circuits bear the same reference characters as the corresponding parts in FIGURE 5. However, as shown in FIGURE 6, the second terminal of the heater 274 is connected by the conductor 323 to the air valve operated switch 238. Connected in parallel with the switch 238 is a positive temperature responsive resistance 321 having the conductor 325 connecting to the conductor 323 and the conductor 327 connecting to the first supply conductor 175. With this arrangement during the refrigerating period, the current through the heater 274 is substantially unaffected by the presence of the temperature responsive resistance 321 since the resistance 321 is substantially shorted out by the closed condition of the switch 238. Should the temperature of the compartment 32 rise above normal sufficiently to open the switch 238, the temperature responsive resistance 321 will be energized. It will permit a small amount of current to flow through the heater 274 after the switch 238 is opened. This is made possible by the connection of the second terminal of the heater 274 through the conductor 329 directly with the second supply conductor 191. The heater 274 is not connected to the contact 185 as is the arrangement in FIGURE 5. When the resistor 321 is of the positive temperature responsive type at lower ambient temperatures, it will allow a slightly greater flow of current through the heater 274 to provide a shorter defrost period to remove a lesser amount of frost which may accumulate in a cold ambient temperature. The decrease in current through the heater 274 under high room temperature conditions by the increase in the resistance of the positive temperature responsive resistance 321 will extend the defrost period under high room temperature conditions. However, should there occur a condition in which the frost accumulation is less in the high ambient room temperature conditions than in the low ambient room temperature conditions, a thermistor or negative temperature responsive resistance, such as indicated by the reference character 266 in FIGURE 5, may be substituted for the positive temperature responsive resistance 321 in FIGURE 6.

By careful control of the flow of current to the heater 274, the switch 238 may be omitted as shown in the circuit illustrated in FIGURE 7. In the circuit shown in

FIGURE 7, the corresponding parts of the circuit and corresponding elements are provided with the same reference numerals as were used and applied in FIGURE 5. The circuit differs in that a negative temperature responsive resistance 351 is connected in parallel circuit relation with the heater 274 by the conductor 353 connecting with the conductor 183 and the conductor 355 connecting with the conductor 357 which connects the second terminal of the heater 274 with a positive temperature responsive resistance 359 which in turn is connected by the conductor 361 to the first supply conductor 175. The negative temperature responsive resistance 351 and the positive temperature responsive resistance 359 are preferably both located in the enclosure 267 so that they are responsive to the ambient or room temperature. Through the use of these two temperature responsive resistances, an amount of current is allowed to flow through the heater 274 which is sufficient to heat the bimetal 187 an amount to prevent the bimetal 187 from tripping when there is little or no frost on the coil, and the bimetal is warmed by the warm air flow. When a greater accumulation of frost on the container 250 and the evaporator 42 accumulates, the amount of heat provided by the heater 274 will be insufficient to prevent the bimetal 187 from going below its 28° tripping point and tripping from its lower contact 185 into engagement with its upper contact 254 to begin a defrost cycle. The positive temperature responsive resistance 359 will provide a slightly reduced amount of heat as the ambient or room temperature rises so as to provide more frequent defrosting under such conditions. Further refinement is provided by thermistor 351 which by-passes more of the current from the heater 274 as the room temperature rises.

The wiring diagram shown in FIGURE 8 is generally similar to the wiring diagram shown in FIGURE 7 and that shown in FIGURE 5 and the corresponding parts bear the same reference characters. However, in FIGURE 8 there is provided a shunt circuit for the heater 274 in which a conductor 421 connects the conductor 183 to one terminal of the thermistor 423 having its other terminal connected to the normally open switch 425. This normally open switch 425 remains in the open position during all normal positions of the air valve 127, such as from 34° to 39° F. However, when the air valve 127 moves beyond its normal wide open position, such as when the temperature reaches 40° F. at the bulb 163, the switch 425 is closed to close this shunt circuit. The switch 425 is provided with an operating projection 427 which under this condition is engaged by the spring follower 155 to accomplish the closing. It is connected by the conductor 429 to the conductor 431. This conductor 431 connects the one terminal of the heater 274 to the resistance 433 which in turn connects through the conductor 435 to the first supply conductor 175.

In this circuit, for example, the heater 274 may have a value of 1650 ohms while the resistance 433 may have a value of 1650 ohms also. The thermistor 423 is arranged to have its resistance reduced as the temperature rises from 50° to 110° F. This thermistor 423 is preferably located in the container 267 along with the resistance 433, if desired. The resistance 433 may be a positive temperature responsive resistance similar to that of the resistance 359 in FIGURE 7. In this circuit, the heater 274 will provide about one and a half or two watts to heat the container 250 sufficiently to prevent the operation of the switch 187 from the lower position to the upper position when there is little frost upon the evaporator 42. However, should the air valve 127 operate the switch 425 to the closed position, the heater 274 will be short circuited, thereby greatly reducing its heating effect. The amount of heat through the heater 274, when the switch 425 is closed, will be regulated by the resistance of the thermistor 423 and the resistance 433. The thermistor 423 will delay the tripping of the switch 187 more in a cold room than in a hot room. If the evaporator

42 is relatively free from frost, the reduction in heat from the heater 274 may not be sufficient to cause the switch 187 to trip into the defrost position. This is due to the heating effect of the warm air flowing in contact with the defrost switch 250. However, when the coil is frosted, the reduced air flow over the switch 250 as well as the additional coating of frost will have an effect which will permit the switch 187 to be cooled further so as to trip into the upper defrost position in engagement with the contact 254 to energize the defrost heater 260 and to disconnect the compressor motor circuit 167 from the supply conductor 191. When the evaporator 42 is heated substantially to a temperature of 55° F., the switch 187 will return to its lower position in contact with the lower contact 185 to restore the system to normal. If desired, the thermistor 423 may be omitted or it may be replaced by a positive temperature responsive resistance, likewise located in the enclosure 267.

Although the frosting characteristics of various sizes and types of refrigerators will vary considerably in different climates, by making a study of the temperature conditions of the switch 187 in the particular model under consideration under varying conditions, it is possible to determine the proper size of heater for this switch and to determine the best circuit and the proper values of the positive and negative temperature responsive resistances to be used in the circuit chosen. Through such a selection, the defrosting will occur only at the optimum conditions when the frost has accumulated to such an extent that the evaporator 42 can no longer maintain the desired refrigeration temperatures. This will avoid unnecessary defrosting and provide efficient operation of the refrigerating system.

While the embodiment of the present invention as herein disclosed constitutes a preferred form, it is to be understood that other forms might be adopted.

What is claimed is as follows:

1. Refrigerating apparatus including insulating means enclosing a below-freezing storage compartment and an above-freezing storage compartment insulated from each other, cooling means for cooling said below-freezing compartment to below-freezing temperatures and said above-freezing compartment to above-freezing refrigerating storage temperatures comprising refrigerant liquefying means and refrigerant evaporating means operated normally at temperatures below freezing so as to accumulate frost thereon, and means concurrently responsive to a predetermined high temperature of said above-freezing compartment and a predetermined low temperature of said evaporating means for defrosting said evaporating means.

2. Refrigerating apparatus including insulating means enclosing a below-freezing storage compartment and an above-freezing storage compartment insulated from each other, cooling means for cooling said below-freezing compartment to below-freezing temperatures and said above-freezing compartment to above-freezing refrigerating storage temperatures comprising refrigerant liquefying means and refrigerant evaporating means operated normally at temperatures below freezing so as to accumulate frost thereon, and means concurrently responsive to a predetermined high temperature of said above-freezing compartment and a predetermined low temperature of said evaporating means and the ambient temperature outside said storage compartment for defrosting said evaporating means.

3. Refrigerating apparatus including insulating means enclosing a below-freezing storage compartment and an above-freezing storage compartment insulated from each other, cooling means for cooling said below-freezing compartment to below-freezing temperatures and said above-freezing compartment to above-freezing refrigerating storage temperatures comprising refrigerant liquefying means and refrigerant evaporating means operated normally at temperatures below freezing so as to accumulate frost thereon, temperature responsive means for alternately

operating said cooling means or defrosting said evaporating means, said temperature responsive means comprising a thermosensitive means responsive to the temperature of said evaporating means, means for heating said thermosensitive means for delaying the defrosting of said evaporating means, and means responsive to a predetermined high temperature of said above-freezing compartment for reducing the heating of said thermosensitive means.

4. Refrigerating apparatus including insulating means enclosing a below-freezing storage compartment and cooling means for cooling said below freezing compartment to below-freezing temperatures comprising refrigerant liquefying means and refrigerant evaporating means operated normally at temperatures below freezing so as to accumulate frost thereon, thermostatic means for alternately operating said cooling means or defrosting said evaporating means, said thermostatic means comprising a thermosensitive means located in metal to metal conductive relationship with and responsive to the temperature of said evaporating means, means for heating said thermosensitive means for delaying the defrosting of said evaporating means, and means responsive to temperature conditions outside said compartment for varying said heating means.

5. Refrigerating apparatus including insulating means enclosing a below-freezing storage compartment and cooling means for cooling said below-freezing compartment to below-freezing temperatures comprising refrigerant liquefying means and refrigerant evaporating means operated normally at temperatures below freezing so as to accumulate frost thereon, thermostatic means for alternately operating said cooling means or defrosting said evaporating means, said thermostatic means comprising a thermosensitive means responsive to the temperature of said evaporating means, means for heating said thermosensitive means for delaying the defrosting of said evaporating means, and means responsive to a rise in temperature outside said compartment for reducing the heating of said thermosensitive means by said heating means.

6. Refrigerating apparatus including insulating means enclosing a below-freezing storage compartment and cooling means for cooling said below-freezing compartment to below-freezing temperatures comprising refrigerant liquefying means and refrigerant evaporating means operated normally at temperatures below freezing so as to accumulate frost thereon, thermostatic means for alternately operating said cooling means or defrosting said evaporating means, said thermostatic means comprising a thermosensitive means located in metal to metal conductive relationship with and responsive to the temperature of said evaporating means, means for heating said thermosensitive means for delaying the defrosting of said evaporating means, and means responsive to a rise in temperature outside said compartment for increasing the heating of said thermosensitive means by said heating means.

7. Refrigerating apparatus including insulating means enclosing a below-freezing storage compartment and an above-freezing storage compartment insulated from each other, cooling means for cooling said below-freezing compartment to below-freezing temperatures and said above-freezing refrigerating storage temperatures comprising refrigerant liquefying means and refrigerant evaporating means operated normally at temperatures below freezing so as to accumulate frost thereon, a two-position thermostatic means responsive to a high temperature of said evaporating means for movement into a first position and responsive to a low temperature of said evaporating means for movement into a second position, said thermostatic means having means for operating said cooling means when in said first position, means for defrosting said evaporating means, said thermostatic means having means effective in said second position for rendering effective said defrosting means, heating means in heat transfer relation with said thermostatic means for counteracting

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some of the cooling effect of said evaporating means, and means responsive to a predetermined high temperature of the above-freezing compartment for reducing the heating of said heating means.

8. Refrigerating apparatus including insulating means enclosing a below-freezing storage compartment and an above-freezing storage compartment insulated from each other, cooling means for cooling said below-freezing compartment to below-freezing temperatures and said above-freezing compartment to above-freezing refrigerating storage temperatures comprising refrigerant liquefying means and refrigerant evaporating means operated normally at temperatures below freezing so as to accumulate frost thereon, a thermostatic snap-acting double-throw switch responsive to the temperature of said evaporating means having first and second switch contacts alternately energized in response to changes in temperature, electrical operating means for said liquefying means electrically connected to said first switch contact, defrosting means for said evaporating means electrically connected to said second contact, an electric heater in heat transfer relation with said thermostatic switch, a normally closed switch for controlling said electric heater, and means responsive to the temperature of said above-freezing compartment for opening said normally closed switch.

9. A refrigerator including insulating means enclosing a below-freezing storage compartment and an above-freezing storage compartment insulated from each other, means forming a mixing compartment separated from said compartments, an evaporator portion adapted to accumulate frost associated with said mixing compartment, means for circulating air from said below and above-freezing compartments through said mixing compartment and returning the air in proportion to maintain said compartments at below and above-freezing refrigerating temperatures, a snap-acting double-throw thermostatic switch responsive to evaporator temperature having first and second switch contacts alternately energized in response to changes in temperature, an electrically operated refrigerant liquefying means operatively connected to said evaporator portion and electrically connected to said first switch contact, means for defrosting said evaporator portion electrically connected to said second switch contact, an electrical heating means associated with said thermostatic switch, and switch means responsive to the temperature of one of said compartments for controlling said heating means.

10. A refrigerator including insulating means enclosing a below-freezing storage compartment and an above-freezing storage compartment insulated from each other, means forming a mixing compartment separated from said compartments, an evaporator portion adapted to accumulate frost in heat transfer with said mixing compartment, means for circulating air from said below and above-freezing compartments through said mixing compartment and said evaporator portion and returning the air to maintain said compartments at below and above-freezing refrigerating temperatures, a snap-acting double-throw thermostatic switch having thermosensitive means in heat transfer with an air inlet face of said evaporator portion and exposed to the air circulated from said above-freezing compartment into said mixing compartment and having first and second contacts alternately energized, an electrically operated refrigerant liquefying means operatively connected to said evaporator portion and electrically connected to said first switch contact, means for defrosting said evaporator portion electrically connected to said second switch contact, and means responsive to the temperature of the above freezing compartment for varying the operation of said thermostatic switch.

11. A refrigerator including insulating means enclosing a below-freezing storage compartment and an above-freezing storage compartment insulated from each other, means forming a mixing compartment separated from said compartments, an evaporator portion adapted to ac-

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cumulate frost associated with said mixing compartment, means for circulating air from said below and above-freezing compartments through said mixing compartment and returning the air in proportion to maintain said compartments at below and above-freezing refrigerating temperatures, a snap-acting double-throw thermostatic switch having thermosensitive means in heat transfer with said evaporator portion and exposed to the air circulated from said above-freezing compartment into said evaporator portion compartment and having first and second contacts alternately energized, an electrically operated refrigerant liquefying means operatively connected to said evaporator portion and electrically connected to said first switch contact, means for defrosting said evaporator portion electrically connected to said second switch contact, an electric heating means in heat transfer relation with said thermosensitive means for affecting the operation of said thermostatic switch, and means responsive to the temperature of one of said storage compartments for controlling said heating means.

12. A refrigerator including insulating means enclosing a below-freezing storage compartment and an above-freezing storage compartment insulated from each other, means forming a mixing compartment separated from said compartments, an evaporator portion adapted to accumulate frost associated with said mixing compartment, means for circulating air from said below and above-freezing compartments through said mixing compartment and returning the air in proportion to maintain said compartments at below and above-freezing refrigerating temperatures, a snap-acting double-throw thermostatic switch having thermosensitive means in heat transfer with said evaporator portion and exposed to the air circulated from said above-freezing compartment into said evaporator portion compartment and having first and second contacts alternately energized, an electrically operated refrigerant liquefying means operatively connected to said evaporator portion and electrically connected to said first switch contact, means for defrosting said evaporator portion electrically connected to said second switch contact, an electric heating means in heat transfer relation with said thermosensitive means for affecting the operation of said thermostatic switch, and means responsive to temperatures outside said compartments for varying said heating means.

13. A refrigerator including insulating means enclosing a below-freezing storage compartment and an above-freezing storage compartment insulated from each other, means forming a mixing compartment separated from said compartments, an evaporator portion adapted to accumulate frost in heat transfer with said mixing compartment, means for circulating air from said below and above-freezing compartments through said mixing compartment and returning the air to maintain said compartments at below and above-freezing refrigerating temperatures, a snap-acting double-throw thermostatic switch having thermosensitive means in heat transfer with an air inlet face of said evaporator portion and exposed to the air circulated from said above-freezing compartment into said mixing compartment and having first and second contacts alternately energized, an electrically operated refrigerant liquefying means operatively connected to said evaporator portion and electrically connected to said first switch contact, means for defrosting said evaporator portion electrically connected to said second switch contact, an electric heating means in intimate heat transfer relation with said thermosensitive means for affecting the operation of said thermostatic switch, and means for varying the heating rate of said heating means for controlling the operation of said thermostatic switch.

14. Refrigerating apparatus including insulating means enclosing a below-freezing storage compartment and an above-freezing storage compartment insulated from each other, cooling means for cooling said below-freezing compartment to below-freezing temperatures and said above-

freezing compartment to above-freezing refrigerating storage temperatures comprising refrigerant liquefying means and refrigerant evaporating means operated normally at temperatures below freezing so as to accumulate frost thereon, a thermostatic snap-acting double-throw switch responsive to the temperature of said evaporating means having first and second switch contacts alternately energized in response to changes in temperature, electrical operating means for said liquefying means electrically connected to said first switch contact, defrosting means for said evaporating means electrically connected to said second contact, an electric heater in heat transfer relation with said thermostatic switch, a normally open switch connected in electrical shunt circuit arrangement with said electric heater, and means responsive to the tempera-

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ture of said above-freezing compartment for closing said normally open switch.

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