

Feb. 27, 1962

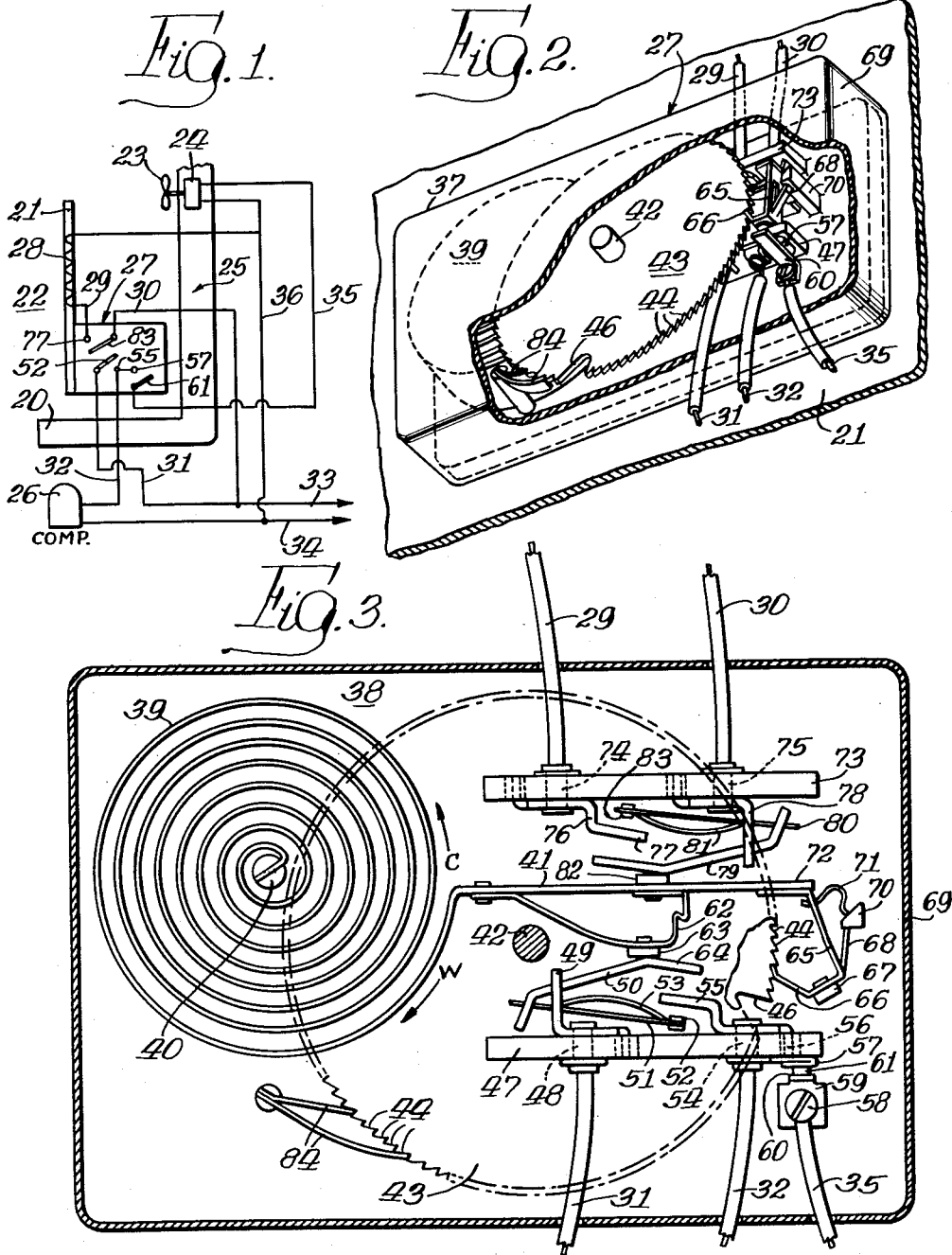
E. F. HUBACKER

3,022,640

HOME APPLIANCE

Filed Aug. 11, 1959

4 Sheets-Sheet 1



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Feb. 27, 1962

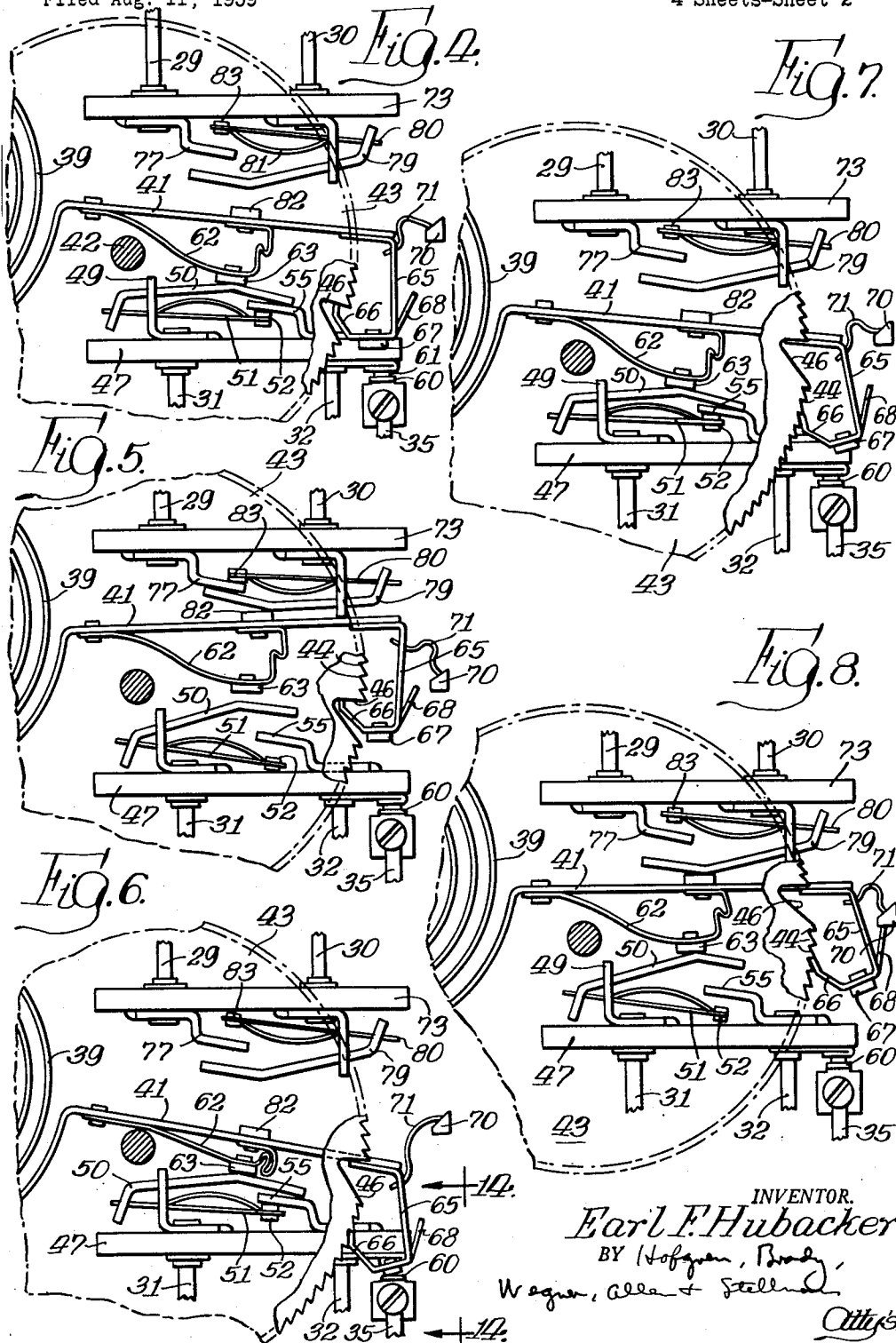
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3,022,640

HOME APPLIANCE

Filed Aug. 11, 1959

4 Sheets-Sheet 2



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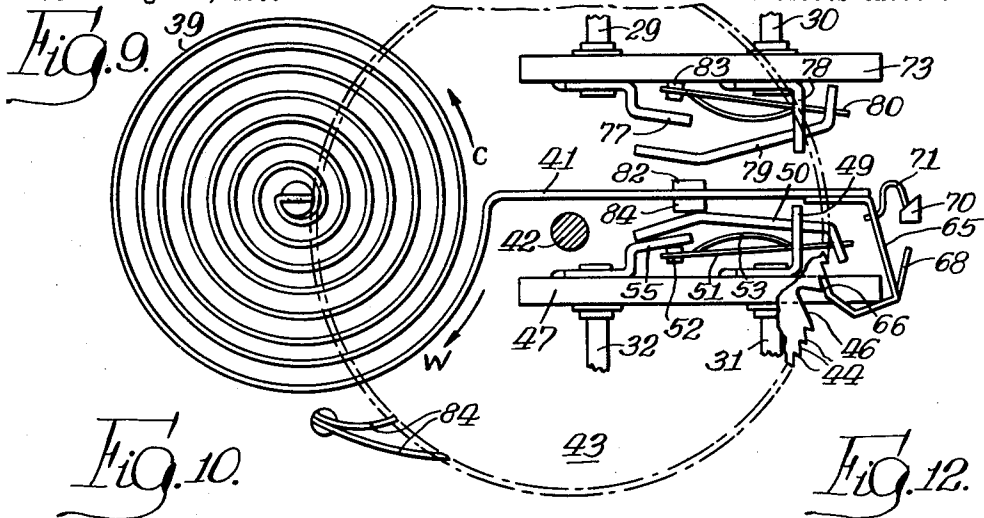
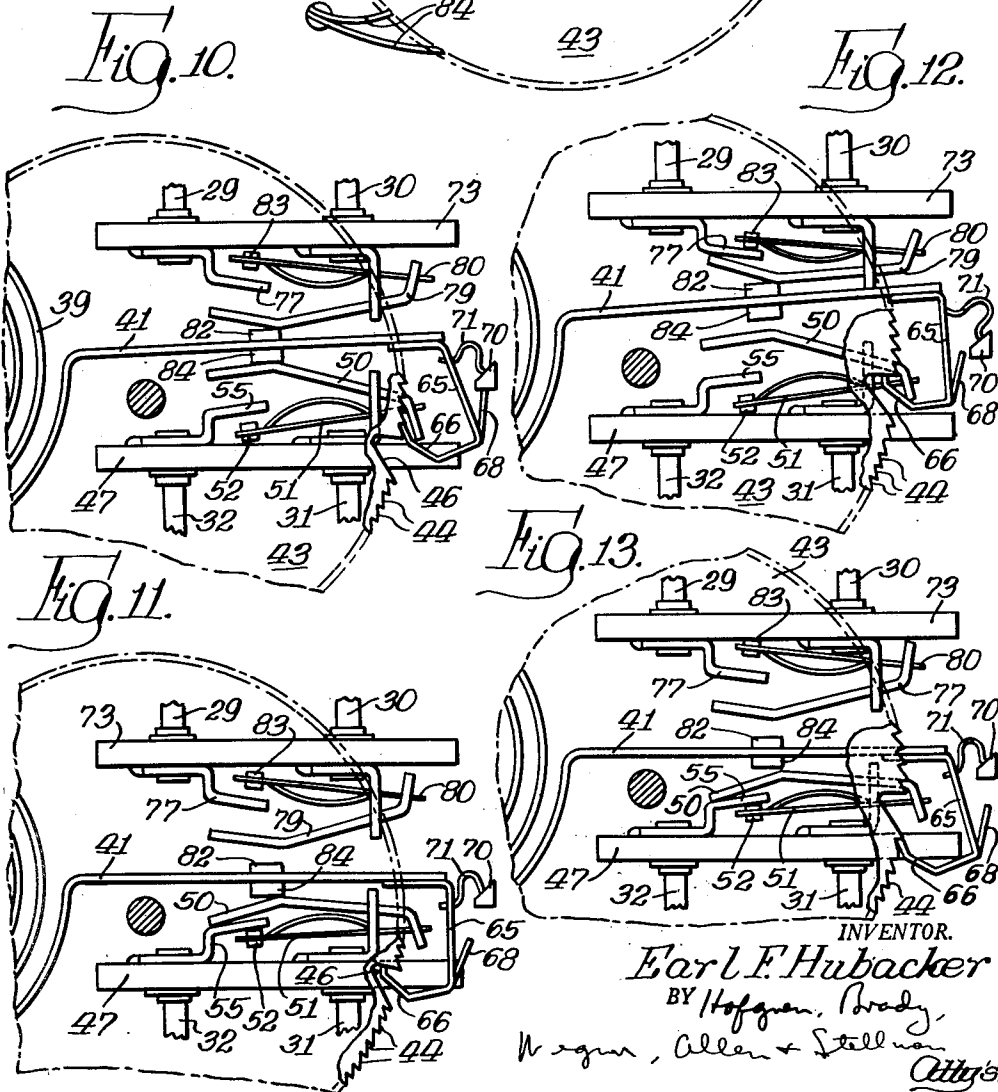
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HOME APPLIANCE

Filed Aug. 11, 1959

4 Sheets-Sheet 3



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HOME APPLIANCE

Filed Aug. 11, 1959

4 Sheets-Sheet 4

*Fig. 14.*

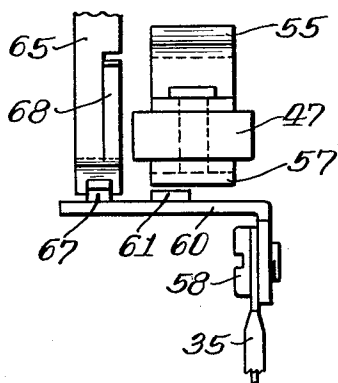
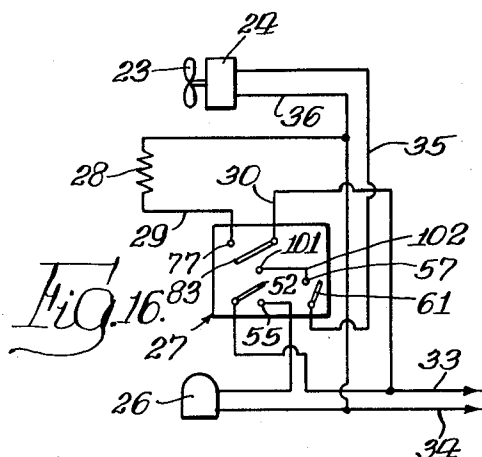
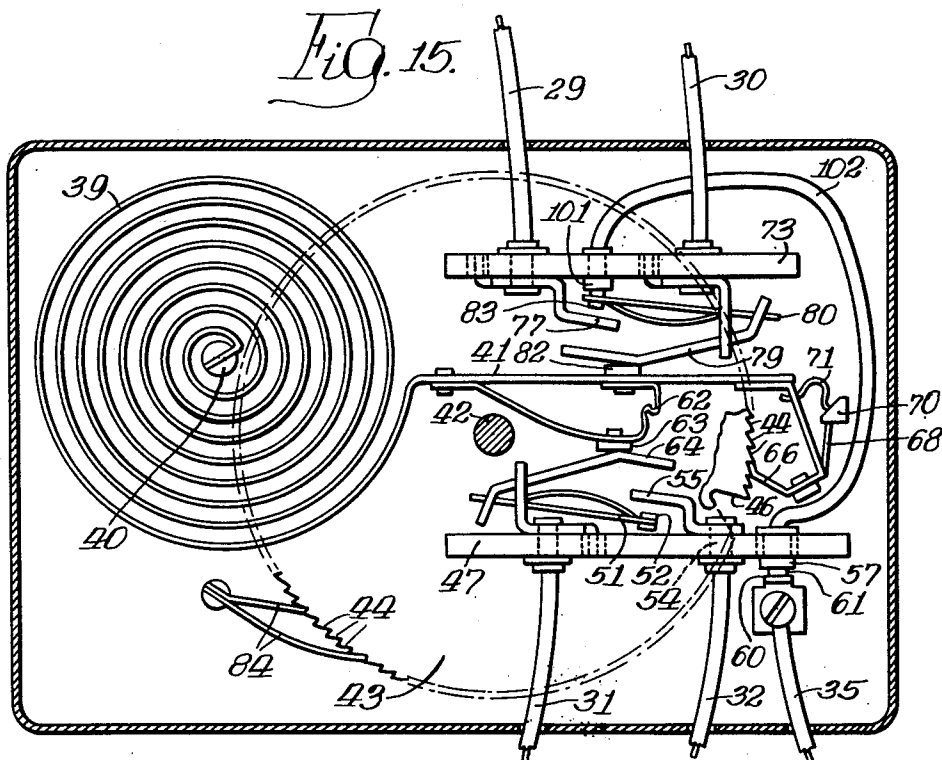


*Fig. 15.*



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3,022,640

## HOME APPLIANCE

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Filed Aug. 11, 1959, Ser. No. 833,022  
17 Claims. (Cl. 62-156)

This invention relates to a defrost control apparatus for warming an electrically controlled refrigerating means to remove frost therefrom after a plurality of refrigerating cycles.

In one type of defrosting system for removing frost periodically from refrigerated surfaces it is customary to employ an electric heater in heat transfer relationship to the surfaces and to energize the heater periodically in order to melt the frost. This periodic heating can be done manually, but it is preferably done automatically. The control apparatus of this invention provides a simple and highly efficient means for periodically energizing a defrost heater after a plurality of refrigerating cycles in order to remove the frost. The control apparatus of this invention also is arranged to defrost only at the end of a cold cycle, so that all of the contents of the refrigerator, freezer or the like are at low temperatures. By reason of this the necessary refrigerated surfaces are defrosted before the contents have time to become too warm during the defrosting cycle. Another important advantage of the apparatus of this invention is that the entire operation of refrigeration and defrosting is controlled solely by temperature changes. In a preferred embodiment, where the control apparatus also controls the operation of an air circulating fan, the temperature changes are also employed to control the operation of this fan.

One of the features of this invention is to provide improved defrost control apparatus comprising a first switch in the circuit to the electrically controlled refrigerating means, a normally open second switch in an electric defrost heater circuit, means for closing said first switch at a first temperature and opening said first switch at a lower second temperature, said opening and closing being repeated during said plurality of cycles, and means for closing said second switch at the end of said plurality of cycles and substantially immediately subsequent to an opening of the first switch while the refrigerating means is at substantially its coldest cycle temperature to initiate a defrost cycle.

Another feature of the invention is to provide an improved defrost control apparatus comprising a first switch in the circuit to the electrically controlled refrigerating means, a normally open second switch in an electric defrost heater circuit, thermally responsive means movable through a path in one direction to close said first switch at a predetermined first temperature and movable in the opposite direction to open said first switch at a lower second temperature, said opening and closing being repeated during said plurality of cycles, said movable means moving toward closing of the second switch during said movement in the opposite direction, a movable control member moved by said movable means only during said movement in the opposite direction, stop means in said path engaged by said movable means during said movement in the opposite direction to prevent said closing of the second switch, and means associated with said control member shifting the movable means out of said path at the end of said plurality of cycles to clear the stop means and close the second switch.

Yet another feature of the invention is to provide improved defrost control apparatus comprising a first switch in the circuit to the electrically controlled refrigerating means, a normally open second switch in an electric defrost heater circuit spaced from said first switch, a rotatable generally circular control member adjacent said

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switches having a plurality of teeth and a depressed area on its periphery, thermally responsive means movable through a path in one direction to close said first switch at a predetermined first temperature and movable in the opposite direction to open said first switch at a lower second temperature, said opening and closing being repeated during said plurality of cycles, said movable means moving toward closing of the second switch during said movement in the opposite direction, a pawl adjacent said periphery forming a part of said movable means urged toward the control member and engaging a tooth therein for movement of the control member only during movement of the movable means in said opposite direction, the pawl also engaging said depressed area, stop means in said path engaged by said pawl during said movement in the opposite direction while the pawl is in engagement with a tooth to prevent said closing of the second switch, the entrance of the pawl into the depressed area permitting the pawl to move out of said path to clear the stop means and close the second switch to initiate said defrost cycle, and over center spring means acting on said thermally responsive means urging said thermally responsive means toward engagement with each of said switches as said thermally responsive means approaches the respective switch and resisting movement away from said switches.

A further feature of the invention is to provide an improved defrost control apparatus comprising a first switch in the circuit to the electrically controlled refrigerating means, a normally open second switch in an electric defrost heater circuit, a normally closed third switch in an air circulating fan circuit, thermally responsive means movable to close said first switch at a predetermined first temperature and open said first switch at a predetermined lower second temperature, said opening and closing being repeated during said plurality of cycles, said movable means moving in a direction toward closing said second switch during said opening of the first switch, means preventing said closing of the second switch prior to the completion of said plurality of cycles, means closing the second switch at said completion to initiate a defrost cycle, means opening the second switch and closing the first switch to end said defrost cycle, and means opening the third switch upon said ending of the defrost cycle.

Other features and advantages of the invention will be apparent from the following description of certain embodiments thereof taken in conjunction with the accompanying drawings. Of the drawings:

FIGURE 1 is a diagrammatic view of a portion of the refrigeration system containing the defrost control apparatus of this invention.

FIGURE 2 is a fragmentary perspective view of one embodiment of the control apparatus of this invention with portions broken away for clarity of illustration.

FIGURE 3 is an enlarged sectional elevational view of this embodiment with portions broken away for clarity of illustration.

FIGURE 4 is a fragmentary view similar to the right-hand end of FIGURE 3 but showing the parts in a third position from their positions shown in FIGURES 2 and 3.

FIGURE 5 is a view similar to FIGURE 4 but showing the parts in a fourth position.

FIGURE 6 is a view similar to FIGURE 4 but showing the parts in a fifth position.

FIGURE 7 is a view similar to FIGURE 4 but showing the parts in a sixth position.

FIGURE 8 is a view similar to FIGURE 4 but showing the parts in a seventh position.

FIGURE 9 is a view similar to FIGURE 3 but showing a second embodiment of the invention.

FIGURE 10 is a fragmentary view similar to the right-

hand end of FIGURE 9 but showing the parts of this second embodiment in a second position.

FIGURE 11 is a view similar to FIGURE 10 but showing the parts in a third position.

FIGURE 12 is a view similar to FIGURE 10 but showing the parts in a fourth position.

FIGURE 13 is a view similar to FIGURE 10 but showing the parts in a fifth position.

FIGURE 14 is a fragmentary side elevational view of a part of the structure of FIGURE 6 taken from approximately line 14—14 of FIGURE 6.

FIGURE 15 is a view similar to FIGURE 3 but showing a third embodiment of the invention.

FIGURE 16 is a diagrammatic view illustrating the wiring diagram of this third embodiment.

In FIGURE 1 there is shown diagrammatically the relationship of the defrost control apparatus to a refrigerator of the type disclosed and claimed in E. F. Hubacker and J. E. Krug application Serial No. 807,671, filed April 20, 1959, and assigned to the same assignee as the present invention.

The control apparatus, of course, is usable on other types of refrigerating systems. In the system illustrated in FIGURE 1 there is provided the usual insulated walls 20, a vertically mounted evaporator 21 adjacent the rear wall of the refrigerated space 22 and an air circulating fan 23 operated by an electric motor 24 mounted in this rear wall 25. As is described fully in the above-mentioned copending application the fan 23 which is here shown as a propeller type fan is used to circulate air in heat transfer relationship with the evaporator 21 and through the refrigerated couples. The refrigeration system includes the usual electrically powered compressor 26 as well as the other normal components of the refrigeration system that are not shown here as they form no part of the present invention.

The defrost control apparatus 27 is shown enlarged in FIGURE 1 with the switches shown diagrammatically. The apparatus 27 here is the embodiment illustrated in detail in FIGURES 2-8 inclusive. This embodiment of the control apparatus is used here as it controls the operation of a fan motor 24 as well as the compressor 26. The system of FIGURE 1 also includes an electric heater wire illustrated diagrammatically at 28 in thermal contact with the evaporator 21 for removing frost from the evaporator when the heater is energized. The heater is connected in circuit to the control apparatus 27 by means of leads 29 and 30. The compressor is also connected to the control apparatus 27 by means of leads 31 and 32. The system is connected to a source of electric power by means of leads 33 and 34 for supplying power to the compressor 26, fan motor 24 and electric heater 28 by way of the control apparatus 27. With this arrangement one side of the fan motor 24 is connected by a lead 35 to the control apparatus 27 while the other side of the fan circuit is connected by lead 36 directly to the electric power lead 34.

The control apparatus has a heat transfer bottom surface 37 mounted directly on the evaporator 21 so that this surface is at substantially the same temperature as the evaporator. Mounted on this rear plate 38 whose rear surface forms the contacting surface 37 is a coiled bimetal 39 having its inner end rigidly mounted as indicated at 40 and its outer end extended radially to form a flat lever 41. The bimetal 39 and the lever 41 comprise a thermally responsive means. As indicated in FIGURE 3, the lever 41 moves upwardly during a drop in temperature and moves downwardly during a rise in temperature so that the lever 41 reciprocates arcuately due to expansion and contraction of the plurality of coils of the spiral bimetal 39.

Rotatably mounted adjacent the extending lever 41 about a shaft 42 is a rotatable control member 43 in the form of a flat disk having a plurality of extended teeth

44 on its peripheral edge and a relatively deep depressed area 46 of V-shape is also on this peripheral edge.

Mounted adjacent the control member 43 and beneath the lever 41 as viewed in the various figures is an insulating strip 47 to which are attached the compressor leads 31 and 32. The lead 31 is provided with a conducting member 48 extending through the strip 47 and is provided on its upper end with a mounting bracket 49 for a pivoted lever 50. Also mounted on bracket 49 is an electric contact strip 51 carrying a contact 52 on its inner end. This lever 51 is pivoted relative to both the bracket 49 and lever 50 and is provided with a bowed spring 53 forming a part of the lever 51.

The other compressor lead 32 is also provided with a conducting member 54 extending through the insulating strip 47 and is attached to a contact bracket 55 which is adjacent the other contact 52. This bracket has a portion 56 extending back through the strip 47. This portion 56 as well as the outer end of the conducting member 54 is connected to a transverse strip 57 on the surface of the member 47 that is adjacent the incoming compressor leads 31 and 32. The fan lead 35 is attached by means of a clamping screw 58 to an L-shaped electric contact 59 having an outwardly extending leg 60 that makes electrical contact with a bottom contact member 61 on the strip 57. As is shown most clearly in FIGURE 2 this leg 60 extends forwardly beyond the edge of the strip 47 for a short distance. The switch 52-55 controls both the fan circuit and the compressor circuit while the switch 57-61 in series therewith controls only the fan circuit.

The bottom of the lever 41 carries a collapsible spring strip 62 which carries a button 63 for contacting the extending end 64 of the lever 50. The outer end of the lever 41 extends beyond the periphery of the control member 43 and has mounted thereon a downwardly extending pawl 65 having an inturned end 66 adapted to engage a tooth 44 or the depressed area 46 depending upon the position of the control 43 relative to this pawl. The pawl 65 adjacent the end 66 is provided with a contact button 67. The pawl also has an outwardly and upwardly extending finger 68 forming a part thereof on the side of the pawl opposite the control member 43. Also mounted adjacent the pawl 65 on the casing 69 which encloses the control apparatus is a strip 70. A compression over center spring 71 extends between this strip 70 and the base of the pawl 65 adjacent where it is attached to the extended end 72 of the lever 41.

Mounted on the opposite side of the lever 41 and also spaced therefrom is another insulating strip 73. Attached to the inner end of the member 74 which is the end adjacent the lever 41 is a contact bracket 76 having a contact portion 77. Attached to the other conducting member 75 also on the inner end is a bracket 78 on which are pivotally mounted a lever 79 and contact lever 80 and spring 81. Mounted on the surface of the lever 41 adjacent the lever 79 is a contact button 82 adapted to bear against the extended end of the lever 79. In the position shown in FIGURE 3 the control apparatus is at a position at the end of a cooling cycle wherein the compressor is off and the upward movement of the lever 41 has been stopped by engagement of the finger 68 with the stop 70. As the bimetal 39 slowly warms up the lever 41 moves downwardly as viewed in FIGURE 3 to the position shown in FIGURE 4 where the pawl end 66 extends into the depressed area 46. The pawl 65 is made of spring metal and because of its springiness is always urged inwardly toward the control member 43 so that the pawl will always engage a tooth 44 or extend into the depressed area 46.

In the position shown in FIGURE 4 the spring 62 and button 63 have caused movement of the lever 50 in a clockwise direction as viewed in this figure to cause movement of the contact lever 51 is a counterclockwise

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direction. This causes contact 52 to engage the contact bracket 55 and close the circuit through the compressor leads 31 and 32. This also closes the electrical circuit through the fan lead 35 by reason of the engagement of the contacts 57 and 61.

As the bimetal 39 cools the lever 41 is moved upwardly as shown in the various figures. As the pawl has been permitted to move inwardly by reason of the pawl end 66 entering the depressed area 46 the finger 68 now clears the stop 70 so that the lever 41 can continue its upward movement. This causes the heater contacts 77 and 83 to close as shown in FIGURE 5, thereby energizing the heater to melt frost on the evaporator 21. The over center spring 71 resists this upward movement of the lever 41 until a temperature is reached that is equivalent to the coldest temperature in the refrigerating cycle. Then, when the lever 41 has been moved to the position shown in FIGURE 5, the spring 71 urges the lever upwardly to hold the heater contacts 77 and 83 closed. Thus the over center spring 71 functions to hold closed the engaged contacts, either the contacts 52 and 55 or the contacts 77 and 83, and resists opening of these contacts until a predetermined force has been exerted on the spring to cause it to reverse its position.

Heater contacts 77 and 83 are held closed by the over center spring 71 until the temperature of the bimetal 39 has reached a temperature to insure that all of the frost has been removed. During the build-up of temperature to this maximum defrost temperature, the tendency is for the lever 41 to move away from the insulating strip 73. Once this maximum temperature has been reached the over center spring 71 is overcome and is reversed so that the parts are moved to the position shown in FIGURE 6. This maximum defrost temperature is sufficient to overcome the resistance of spring 62 and cause it to collapse as shown in FIGURE 6 so that the contact button 67 moves a sufficient distance to engage the leg 60 of the contact strip 56 and bend it down to disengage the fan contact 61 from contact strip 57 as shown in FIGURES 6 and 14. This stops operation of the fan so as to prevent air being blown over the warm evaporator 21. This downward movement of the lever 41 to the position shown in FIGURES 6 and 14 again closes the contacts 52 and 55 to again start the compressor. In the meantime the downward movement of the lever 41 has caused the end 66 of the pawl 65 to move out of the depressed area 46 to engage another tooth 44.

Then, as the evaporator becomes colder and colder the lever 41 moves upwardly as shown to the position shown in FIGURE 7 thereby causing counterclockwise rotation of the control member 43. This upward movement of the lever 41 from the position shown in FIGURE 6 first releases the contact strip leg 60 to again close the contact 61 to the fan motor so that the fan resumes operation. In FIGURE 7 there is illustrated this intermediate position of the parts where the compressor contacts are still closed and the fan contact is closed. As the evaporator continues to get colder lever 41 continues to move until it reaches the position shown in FIGURE 8 where the finger 68 engages the stop 70. At this point the compressor contacts 52 and 55 are opened so as to stop operation of the compressor.

With the compressor not operating, the evaporator 21 and thus the bimetal 39 begin warming up. This causes reverse or downward movement of the lever 41 until the parts have again reached the position shown in FIGURE 7 where the compressor contacts are again closed. Thus, through the succeeding refrigeration cycles the lever 41 reciprocates between the position shown in FIGURE 7 at the beginning of a refrigeration cycle and the position shown at FIGURE 8 at the end of a refrigeration cycle. The engagement of the finger 68 with the stop 70 prevents closing of the contacts 77 and 83 to the heater until the control member ratchet wheel 43 has made a complete revolution to again bring the depressed area

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46 in line with the end 66 of the pawl. When this occurs as has been previously described the pawl 65 can then bend inwardly as shown in FIGURE 4 so that subsequent movement of the lever 41 in the cold direction will permit closing of the heater contacts as shown in FIGURE 5 by reason of the finger 68 clearing the stop 70 and initiating the defrosting cycle.

Thus, as can be seen, one of the important features of this invention is that the defrost cycle is only initiated at the cold end of a refrigerating cycle. This results in the contents of the refrigerator being at their coldest temperature before the evaporator is warmed during the defrost cycle. Also, in this embodiment the operation of the fan is stopped so as to prevent excessive amounts of heated air being blown over the contents of the refrigerator.

In order to prevent reverse rotation of the control member ratchet wheel 43 there is provided a pair of check springs 84 having widely spaced ends as illustrated in FIGURE 3 to engage teeth 44. These widely spaced ends are provided so that they can span the depressed area 46 and always engage at least one tooth 44 to prevent this reverse rotation.

In the preferred embodiment there is always provided a large excessive plurality of teeth 44 so that each time the pawl 65 moves in the warm direction to engage a tooth for rotating the member 43 through an increment of distance the pawl will pass over several teeth before engaging the one that rotates the member 43 in the colder direction. This is done so that there will be no close tolerances required as would be necessary if the pawl engaged successive teeth each time it was reciprocated. In one embodiment the control member 43 had approximately 200 teeth and the pawl spanned from 3 to 5 teeth during each refrigeration cycle. Thus a defrost cycle was initiated in this embodiment after every approximately 50 refrigeration cycles.

The second embodiment of the control apparatus as illustrated in FIGURES 9-13 is essentially the same as that shown in the first embodiment except that in this second embodiment there is no fan circuit and thus no necessity of opening a fan switch. In the illustrated embodiment of FIGURES 9-13 the parts corresponding to the parts of the first embodiment are numbered with the same numerals.

In this second embodiment the parts when in the position of FIGURE 9 has the electric circuit completed through the leads 31 and 32 to the compressor because of the closing of the compressor switch contacts 52 and 55. In this embodiment the bottom spring 62 of the first embodiment is omitted and is replaced by a button 84 on the bottom of the lever 41. In this second embodiment in FIGURE 9 the pawl 65 engages the last tooth 44 before the depressed area 46. With the compressor operating, the evaporator 21 gets colder and this causes the lever 41 to move upwardly as viewed in FIGURE 9 to the intermediate position shown in FIGURE 10. In this position the compressor contacts are open and this movement rotates the control member 43 in a clockwise direction. The upward movement of the lever 41 is stopped by engagement of the finger 68 on the pawl with the stop 70. Thus when the parts are in the position shown in FIGURE 9 the evaporator is at approximately warm condition in the refrigerating cycle, while when the parts are in the position shown in FIGURE 10 the evaporator is at approximately its coldest temperature in the refrigerating cycle.

As the circuit to the compressor is interrupted when the parts are in the position shown in FIGURE 10, the evaporator begins to warm toward the high temperature in the refrigeration cycle. This causes the lever 41 to be moved down to the position shown in FIGURE 11. In this position the pawl end 66 enters the depressed area 46 by reason of the resiliency of the pawl always urging the pawl toward the control member 43. During this down-

ward movement to the position shown in FIGURE 11 the compressor switch contacts 52 and 55 are again closed. This again starts the operation of the compressor to reduce the temperature of the evaporator 21. This thereupon causes the lever 41 to move up again against the action of the over center spring 71 and causes it to reverse itself. The lever 41 continues to move up as the finger 68 now clears the stops 70. This causes the button 82 to contact the heater lever 79 to close the heater contacts 77 and 83. The defrosting operation is the same as explained earlier in connection with the first embodiment of the invention. As the temperature of the evaporator gets beyond the maximum defrosting temperature, the lever 41 moves down again to the position shown in FIGURE 13 to close the compressor contacts 52 and 55 and initiate a new refrigerating cycle. At the same time the pawl 65 is moved out of the depressed area 46 to engage a succeeding tooth. In this embodiment, as in the first embodiment, each refrigeration cycle operates in the manner described to rotate the control member 43 an increment of one rotation and during each refrigeration cycle the stop 70 prevents closing of the heater circuit until the depressed area 46 again comes in position to be engaged by the pawl 65.

In the following description of the third embodiment of the invention as illustrated in FIGURES 15 and 16 the same numerals will be used for similar parts previously described in connection with the first embodiment. Furthermore, attention will be directed to figures of the first embodiment in order to illustrate the different positions of parts of the third embodiment that are common to the first embodiment.

In the third embodiment, as shown in FIGURES 15 and 16, the air circulating fan 23 operates continuously during the successive refrigeration cycles so that it operates independently of the compressor 25. The only time that the fan is stopped is during and immediately following a defrost cycle which, as previously described, occurs after a plurality of refrigeration cycles.

The third embodiment of the invention is quite similar to the first embodiment of FIGURES 2-8 inclusive. However, certain changes have of course been made in order to provide for the above-described continuous operation of the fan. Thus in the third embodiment the terminals 57 and 55 are isolated from each other instead of being interconnected. An electrical contact 101 is provided mounted on the upper insulating strip 73 adjacent the movable contact 83 that is located on the end of rockable lever 80. Contact 101 is connected by a lead 102 to contact 57 on the lower strip 47. With this arrangement when lever 41 is both in an intermediate position (FIGURE 2) and in a downward position caused by warming of the bimetal 39 so that the button 82 is out of engagement with lever 79 (as shown in FIGURE 4 of the first embodiment) contact 83 engages contact 101 due to the raised position of lever 80. This engagement of contact 83 with contact 101 energizes the circuit to the fan. When lever 79 is turned in a clockwise direction as shown in the drawings lever 80 is turned in a counterclockwise direction to draw contact 83 away from contact 101 and against contact 77. Engagement of contact 83 with contact 77 energizes the heater through lead 29. Thus, it is impossible for both the fan and heater to be energized simultaneously.

The operation of this third embodiment of the invention is as follows. During the normal refrigeration cycles lever 41 is moved upwardly by action of the bimetal 39 during the cooling portion of the cycle and is moved downwardly during the warming portion, all in the manner previously described. During each downward movement the pawl 65 moves over a plurality of teeth 44 to engage one tooth at the extreme downward limit of its movement. Then during cooling the lever 41 moves upwardly and engagement of the pawl 65 with a tooth 44 causes corresponding movement of the control member

43. Thus the action here is the same as that previously described in the first two embodiments.

During downward movement of the lever 41 contact 63 bears against lever 50 to rotate this lever in a clockwise direction around its mounting bracket 49. This causes contact lever 51 to move in a counterclockwise direction and engage contact 52 with contact 55 (FIGURE 4). As contacts 55 and 52 are closed the compressor circuit is energized so that the evaporator 28 is immediately cooled. As the evaporator cools lever arm 41 moves upwardly, thereby causing reverse movement of lever 50 to draw contact 52 away from contact 55. This disengagement of contacts 52 and 55 opens the compressor circuit (see FIGURE 5). As the fan 23 of the third embodiment is not a part of the compressor circuit but is controlled only by the normally closed switches 83-101 and 57-61 that are in series with each other, the fan runs continuously during the refrigeration cycles regardless of whether the compressor is running.

As previously described in the first and second embodiments upward movement of lever 41 caused by cooling of the evaporator during periods when the compressor is operated is stopped by engagement of finger 68 with stop 70 (see FIGURE 8). However, after a plurality of these refrigeration cycles, as previously described in connection with the first and second embodiments, a defrost cycle begins. During the defrost cycle contact 83 is moved out of engagement with contact 101 to stop the fan operation. Initiation of the defrost cycle is as follows. At the end of the plurality of refrigeration cycles the pawl 65 enters the depressed area 46 on the periphery of the control member 43 (see FIGURE 4). At this time the finger 68 is inwardly of stop 70 so as to be in position to clear this stop during upward movement of the lever 41. As is shown in FIGURE 4 when the pawl 65 is first in the area 46 the circuit to the compressor is closed. As the evaporator continues to cool the lever 41 is moved upwardly in the manner previously described. The upward movement of the lever 41 continues to its fullest extent because the finger 68 clears stop 70 (see FIGURE 5) so that button 82 engages lever 79 and turns it in a counterclockwise direction to draw contact 83 away from fan contact 101 and into engagement with contact 77. This movement breaks the circuit to the fan so that the fan stops operating and closes the circuit to the heater through lead 29 to start the defrost cycle.

As in the previously described first embodiment the defrost temperature causes the lever arm 41 to move rapidly downwardly due to the operation of over center spring 71. This downward movement of lever 41 (to the position as shown in FIGURE 6) breaks the electrical connection between contacts 83 and 77 thereby stopping the defrost heating and engages contact 83 with contact 101. This engagement of contacts 83 and 101 would normally start the operation of the fan 23. However, the extreme downward movement of the lever 41 has caused the collapse of spring 62 so that button 67 engages leg 60 and forces it downwardly to break the electrical connection between contacts 61 and 57 as illustrated in FIGURES 4 and 14 of the first embodiment. This of course prevents the fan from operating. As the downward movement of the lever 41 also closes contacts 52 and 55 the compressor circuit is again energized so that the evaporator begins to cool. With this cooling the lever 41 again moves upwardly and this releases the button 67 from leg 60 to close the contacts 57 and 61 to again start the operation of the fan.

In the claims the switch 52-55 is identified as the first switch, the switch 77-83 is the second switch, the switch 57-61 is the third switch and the switch 83-101 is the fourth switch.

Having described my invention as related to the embodiments shown in the accompanying drawings, it is my intention that the invention be not limited by any of the

details of description, unless otherwise specified, but rather be construed broadly within its spirit and scope as set out in the accompanying claims.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. Defrost control apparatus for warming an electrically controlled refrigerating means to remove frost therefrom after a plurality of refrigerating cycles, comprising: a first switch for the circuit to the electrically controlled refrigerating means; a normally open second switch for an electric defrost heater circuit; means for closing said first switch at a first temperature and opening said first switch at a lower second temperature, said opening and closing being repeated during said plurality of cycles; and means for closing said second switch at the end of said plurality of cycles and substantially immediately subsequent to an opening of the first switch while the refrigerating means is at substantially its coldest cycle temperature to initiate a defrost cycle.

2. Defrost control apparatus for warming an electrically controlled refrigerating means to remove frost therefrom after a plurality of refrigerating cycles, comprising: a first switch for the circuit to the electrically controlled refrigerating means; a normally open second switch for an electric defrost heater circuit; thermally responsive means movable to close said first switch at a predetermined first temperature and open said first switch at a predetermined lower second temperature, said opening and closing being repeated during said plurality of cycles, said movable means moving in a direction toward closing said second switch during said opening of the first switch; and means preventing said closing of the second switch prior to the completion of said plurality of cycles.

3. Defrost control apparatus for warming an electrically controlled refrigerating means to remove frost therefrom after a plurality of refrigerating cycles, comprising: a first switch for the circuit to the electrically controlled refrigerating means; a normally open second switch for an electric defrost heater circuit; thermally responsive means movable through a path in one direction to close said first switch at a predetermined first temperature and movable in the opposite direction to open said first switch at a lower second temperature, said opening and closing being repeated during said plurality of cycles, said movable means moving toward closing of the second switch during the movement in said opposite direction; a movable control member moved by said movable means only during the movement in said opposite direction; stop means in said path engaged by said movable means during the movement in said opposite direction to prevent said closing of the second switch; and means associated with said control member shifting the movable means out of said path at the end of said plurality of cycles to clear the stop means and close the second switch.

4. Defrost control apparatus for warming an electrically controlled refrigerating means to remove frost therefrom after a plurality of refrigerating cycles, comprising: a first switch for the circuit to the electrically controlled refrigerating means; a normally open second switch for an electric defrost heater circuit; thermally responsive means movable through a path in one direction to close said first switch at a predetermined first temperature and movable in the opposite direction to open said first switch at a lower second temperature, said opening and closing being repeated during said plurality of cycles, said movable means moving toward closing of the second switch during the movement in said opposite direction; a rotatable control member rotated by said movable means only during the movement in said opposite direction; stop means in said path engaged by said movable means during the movement in said opposite direction to prevent said closing of the second switch; means urging said movable means against the control member to cause said

movement; and means providing a recessed area in said control member into which said movable means enters to shift the movable means out of said path at the end of said plurality of cycles to clear the stop means and close the second switch.

5. Defrost control apparatus for warming an electrically controlled refrigerating means to remove frost therefrom after a plurality of refrigerating cycles, comprising: a first switch for the circuit to the electrically controlled refrigerating means; a normally open second switch for an electric defrost heater circuit; a rotatable generally circular control member having a plurality of teeth and a depressed area on its periphery; thermally responsive means movable through a path in one direction to close said first switch at a predetermined first temperature and movable in the opposite direction to open said first switch at a lower second temperature, said opening and closing being repeated during said plurality of cycles, said movable means moving toward closing of the second switch during the movement in said opposite direction; a pawl forming a part of said movable means urged toward the control member and engaging a tooth thereon for movement of the control member only during the movement of the movable means in said opposite direction, the pawl also engaging said depressed area; and stop means in said path engaged by said pawl during the movement in said opposite direction while the pawl is in engagement with a tooth to prevent said closing of the second switch, the entrance of the pawl into the depressed area permitting the pawl to move out of said path to clear the stop means and close the second switch to initiate said defrost cycle.

6. The apparatus of claim 5 wherein sufficient of said teeth are provided so that on each of the movements in said opposite direction the pawl passes over a plurality of teeth.

7. Defrost control apparatus for warming an electrically controlled refrigerating means to remove frost therefrom after a plurality of refrigerating cycles, comprising: a first switch for the circuit to the electrically controlled refrigerating means; a normally open second switch for an electric defrost heater circuit spaced from said first switch; a rotatable generally circular control member adjacent said switches having a plurality of teeth and a depressed area on its periphery; thermally responsive means movable through a path in one direction to close said first switch at a predetermined first temperature and movable in the opposite direction to open said first switch at a lower second temperature, said opening and closing being repeated during said plurality of cycles, said movable means moving toward closing of the second switch during movement in said opposite direction; a pawl adjacent said periphery forming a part of said movable means urged toward the control member and engaging a tooth thereon for movement of the control member only during movement of the movable means in said opposite direction, the pawl also engaging said depressed area; and stop means in said path engaged by said pawl during movement in said opposite direction while the pawl is in engagement with a tooth to prevent said closing of the second switch, the entrance of the pawl into the depressed area permitting the pawl to move out of said path to clear the stop means and close the second switch to initiate said defrost cycle.

8. The apparatus of claim 7 wherein spring means are provided urging said thermally responsive means toward engagement with each of said switches as said thermally responsive means approaches the respective switch.

9. Defrost control apparatus for warming an electrically controlled refrigerating means to remove frost therefrom after a plurality of refrigerating cycles, comprising: a first switch for the circuit to the electrically controlled refrigerating means; a normally open second switch for an electric defrost heater circuit spaced from said first switch; a rotatable generally circular control member ad-

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128 adjacent said switches having a plurality of teeth and a depressed area on its periphery; thermally responsive means movable through a path in one direction to close said first switch at a predetermined first temperature and movable in the opposite direction to open said first switch at a lower second temperature, said opening and closing being repeated during said plurality of cycles, said movable means moving toward closing of the second switch during the movement in said opposite direction; a pawl adjacent said periphery forming a part of said movable means urged toward the control member and engaging a tooth therein for movement of the control member only during movement of the movable means in said opposite direction, the pawl also engaging said depressed area; stop means in said path engaged by said pawl during the movement in said opposite direction while the pawl is in engagement with a tooth to prevent said closing of the second switch, the entrance of the pawl into the depressed area permitting the pawl to move out of said path to clear the stop means and close the second switch to initiate said defrost cycle; and over center spring means acting on said thermally responsive means urging said thermally responsive means toward engagement with each of said switches as said thermally responsive means approaches the respective switch and resisting movement away from said switches.

10. The apparatus of claim 9 wherein spring means are provided urging said thermally responsive means toward engagement with each of said switches as said thermally responsive means approaches the respective switch.

11. Defrost control apparatus for warming an electrically controlled refrigerating means to remove frost therefrom after a plurality of refrigerating cycles, comprising: a first switch for the circuit to the electrically controlled refrigerating means; a normally open second switch for an electric defrost heater circuit; a normally closed third switch in an air circulating fan circuit; means for closing said first switch at a first temperature and opening said first switch at a lower second temperature, said opening and closing being repeated during said plurality of cycles; means for closing said second switch at the end of said plurality of cycles and substantially immediately subsequent to an opening of the first switch while the refrigerating means is at substantially its coldest cycle temperature to initiate a defrost cycle; and means for opening the fan circuit during and immediately after said defrost cycle including means for opening said third switch upon the first closing of the first switch following a defrost cycle.

12. Defrost control apparatus for warming an electrically controlled refrigerating means to remove frost therefrom after a plurality of refrigerating cycles, comprising: a first switch for the circuit to the electrically controlled refrigerating means and an air circulating fan circuit; a normally open second switch for an electric defrost heater circuit; a normally closed third switch for said air circulating fan circuit; thermally responsive means movable to close said first switch at a predetermined first temperature and open said first switch at a predetermined lower second temperature, said opening and closing being repeated during said plurality of cycles, said movable means moving in a direction toward closing said second switch during said opening of the first switch; means preventing said closing of the second switch prior to the completion of said plurality of cycles; means closing the second switch at said completion to initiate a defrost cycle; means opening the second switch and closing the first switch to end said defrost cycle; and means for opening the fan circuit during and immediately after said defrost cycle including means for opening the third switch upon said ending of the defrost cycle.

13. Defrost control apparatus for warming an electrically controlled refrigerating means to remove frost therefrom after a plurality of refrigerating cycles, comprising: a first switch for the circuit to the electrically controlled

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refrigerating means; a normally open second switch for an electric defrost heater circuit; a normally closed third switch for an air circulating fan circuit; thermally responsive means movable through a path in one direction to close said first switch at a predetermined first temperature and movable in the opposite direction to open said first switch at a lower second temperature, said opening and closing being repeated during said plurality of cycles, said movable means moving toward closing of the second switch during said movement in the opposite direction; a movable control member moved by said movable means only during the movement in said opposite direction; stop means in said path engaged by said movable means during the movement in said opposite direction to prevent said closing of the second switch; means associated with said control member shifting the movable means out of said path at the end of said plurality of cycles to clear the stop means and close the second switch; means opening the second switch and closing the first switch to end said defrost cycle; and means for opening the fan circuit during and immediately after said defrost cycle including means associated with said thermally responsive means for opening said third switch upon said ending of the defrost cycle.

14. Defrost control apparatus for warming an electrically controlled refrigerating means to remove frost therefrom after a plurality of refrigerating cycles, comprising: a first switch for the circuit to the electrically controlled refrigerating means; a normally open second switch for an electric defrost heater circuit; a normally closed third switch for an air circulating fan circuit; a rotatable generally circular control member having a plurality of teeth and a depressed area on its periphery; thermally responsive means movable through a path in one direction to close said first switch at a predetermined first temperature and movable in the opposite direction to open said first switch at a lower second temperature, said opening and closing being repeated during said plurality of cycles, said movable means moving toward closing of the second switch during said movement in the opposite direction; a pawl forming a part of said movable means urged toward the control member and engaging a tooth thereon for movement of the control member only during said movement of the movable means in said opposite direction, the pawl also engaging said depressed area; stop means in said path engaged by said pawl during said movement in the opposite direction while the pawl is in engagement with a tooth to prevent said closing of the second switch, the entrance of the pawl into the depressed area permitting the pawl to move out of said path to clear the stop means and close the second switch to initiate said defrost cycle; means opening the second switch and closing the first switch to end said defrost cycle; and means for opening the fan circuit during and immediately after said defrost cycle including means associated with said thermally responsive means for opening said third switch upon said ending of the defrost cycle.

15. Defrost control apparatus for warming an electrically controlled refrigerating means to remove frost therefrom after a plurality of refrigerating cycles, comprising: a first switch for the circuit to the electrically controlled refrigerating means and to an air circulating fan circuit; a normally open second switch for an electric defrost heater circuit; a normally closed third switch for said air circulating fan circuit; means for closing said first switch at a first temperature and opening said first switch at a lower second temperature, said opening and closing being repeated during said plurality of cycles; means for closing said second switch at the end of said plurality of cycles and substantially immediately subsequent to an opening of the first switch while the refrigerating means is at substantially its coldest cycle temperature to initiate a defrost cycle; and means for opening said third switch upon the first closing of the first switch following a defrost cycle.

16. Defrost control apparatus for warming an electrically controlled refrigerating means to remove frost therefrom after a plurality of refrigerating cycles, comprising: a first switch for the circuit to the electrically controlled refrigerating means; a normally open second switch for an electric defrost heater circuit; a normally closed third switch for an air circulating fan circuit; thermally responsive means movable through a path in one direction to close said first switch at a predetermined first temperature and movable in the opposite direction to open said first switch at a lower second temperature, said opening and closing being repeated during said plurality of cycles, said movable means moving toward closing of the second switch during said movement in the opposite direction; a pawl forming a part of said movable means urged toward the control member and engaging a tooth thereon for movement of the control member only during said movement of the movable means in said opposite direction, the pawl also engaging said depressed area; stop means in said path engaged by said pawl during said movement in the opposite direction while the pawl is in engagement with a tooth to prevent said closing of the second switch, the entrance of the pawl into the depressed area permitting the pawl to move out of said path to clear the stop means and close the second switch to initiate said defrost cycle; means opening the second switch and closing the first switch to end said defrost cycle; and means for opening the fan circuit during and immediately after said defrost cycle including means associated with said thermally responsive means for opening said third switch upon said ending of the defrost cycle.

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cally controlled refrigerating means to remove frost therefrom after a plurality of refrigerating cycles, comprising: a first switch for the circuit to the electrically controlled refrigerating means; a normally open second switch for an electric defrost heater circuit; a normally closed third switch for an air circulating fan circuit; means for closing said first switch at a first temperature and opening said first switch at a lower second temperature, said opening and closing being repeated during said plurality of cycles; means for closing said second switch at the end of said plurality of cycles and substantially immediately subsequent to an opening of the first switch while the refrigerating means is at substantially its coldest cycle temperature to initiate a defrost cycle; a normally closed fourth switch in said fan circuit; means for opening said fourth switch upon said closing of said second switch; and means for opening said third switch upon the first closing of the first switch following a defrost cycle.

17. Defrost control apparatus for warming an electri-

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cally controlled refrigerating means to remove frost therefrom after a plurality of refrigerating cycles, comprising: a first switch for the circuit to the electrically controlled refrigerating means; a normally open second switch for an electric defrost heater circuit; a normally closed third switch for an air circulating fan circuit; means for closing said first switch at a first temperature and opening said first switch at a lower second temperature, said opening and closing being repeated during said plurality of cycles; means for closing said second switch subsequent to said plurality of cycles; a normally closed fourth switch for said fan circuit; and means for opening said fourth switch upon said closing of said second switch.

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