July 6, 1937. E. PICK 2,085,868

REFRIGERATING APPARATUS AND METHOD OF OPERATION THEREOF

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FIG. 1.

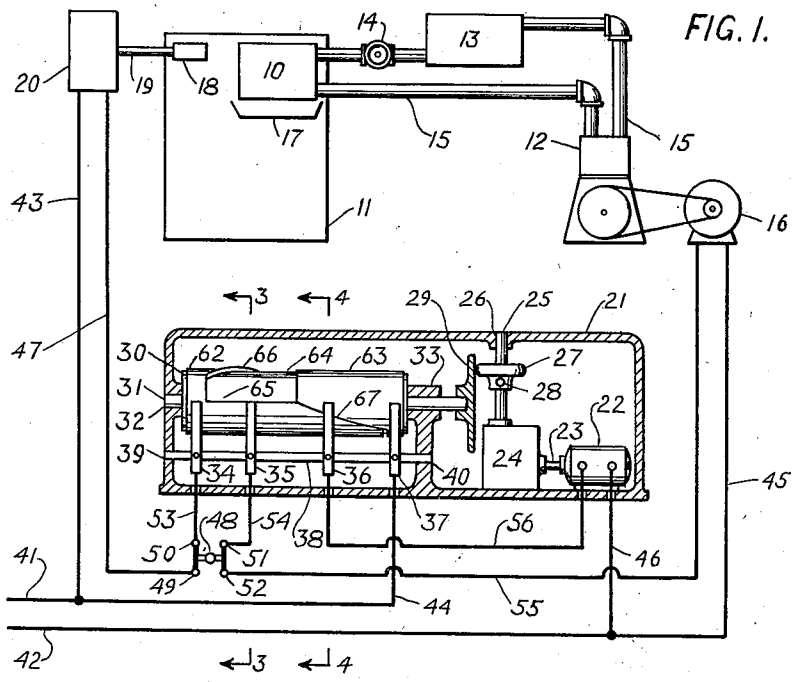


FIG. 3.

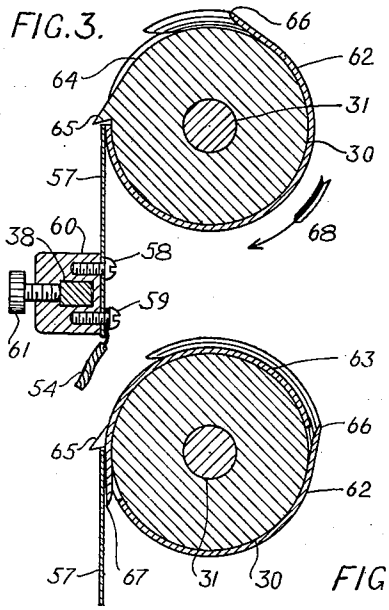


FIG. 4.

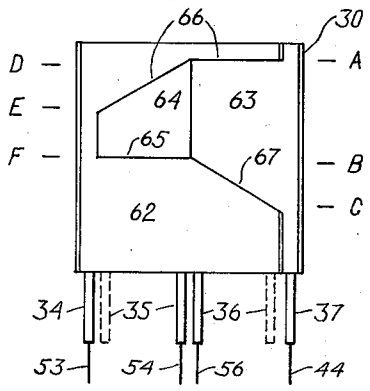


FIG. 2.

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FIG. 5.

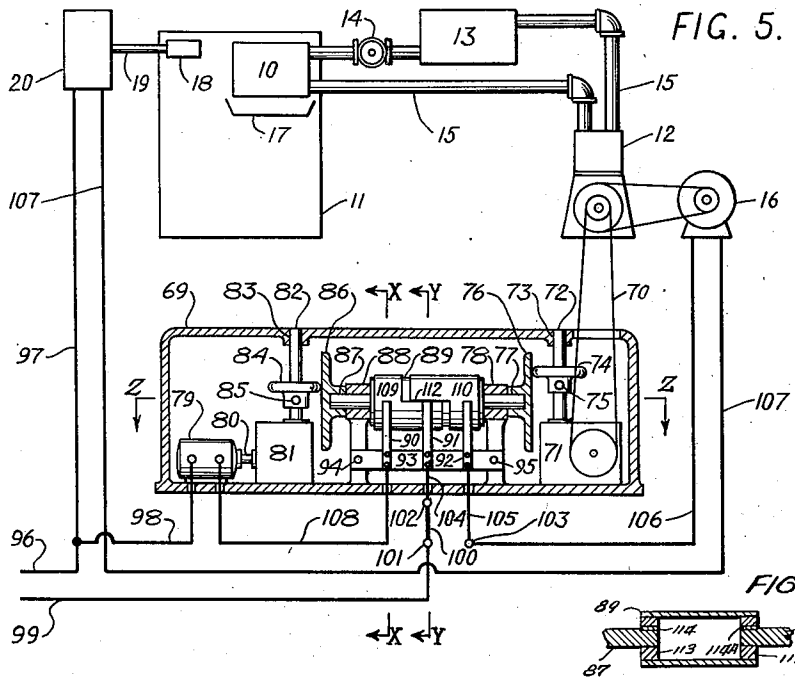


FIG. 5A

FIG. 7.

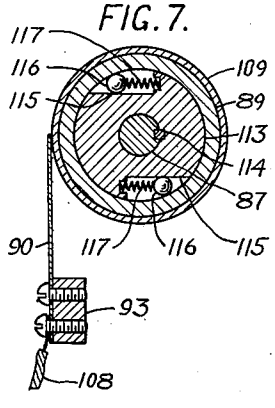


FIG. 8.

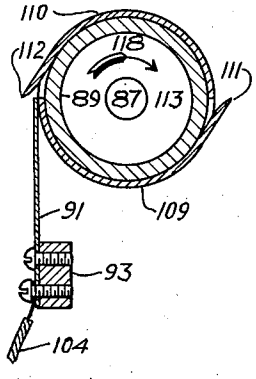


FIG. 6.

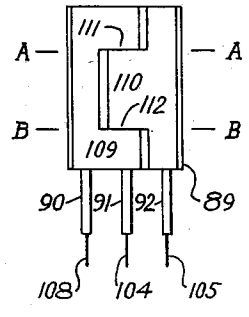
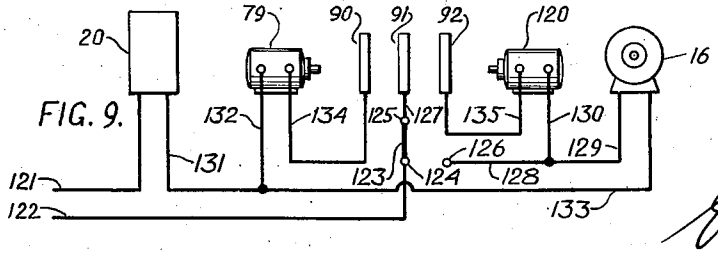


FIG. 9.



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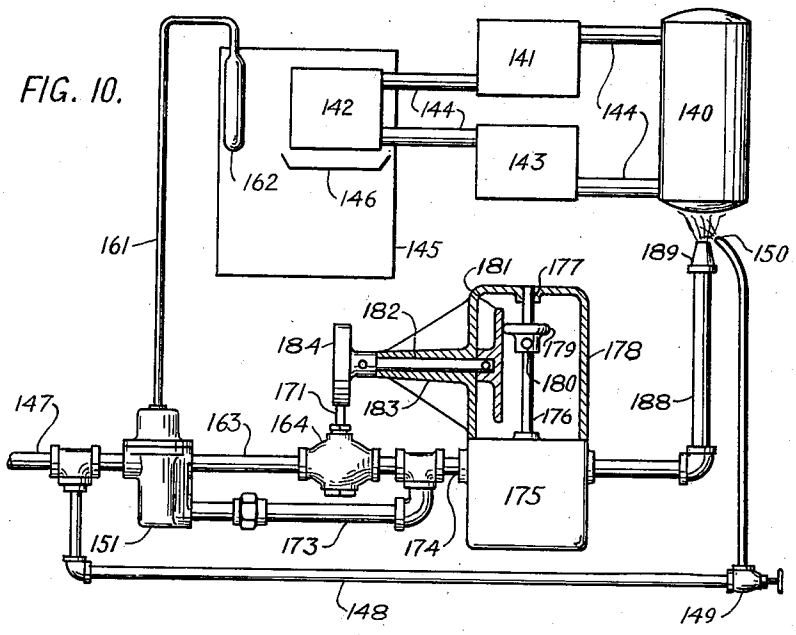
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FIG. 10.



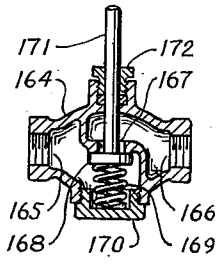


FIG. 11.

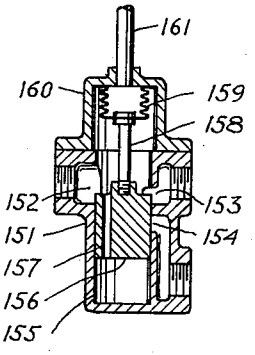


FIG. 13.

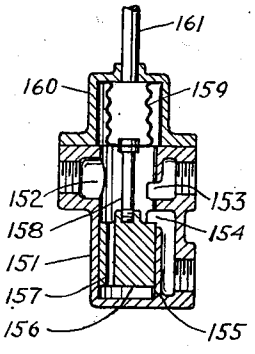


FIG. 14.

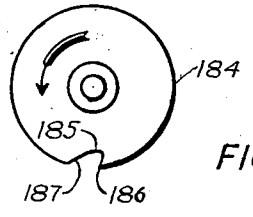


FIG. 12.

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Patented July 6, 1937

2,085,868

UNITED STATES PATENT OFFICE

2,085,868

REFRIGERATING APPARATUS AND METHOD OF OPERATION THEREOF

Eric Pick, New York, N. Y., assignor to Servel, Inc., New York, N. Y., a corporation of Delaware

Application November 14, 1933, Serial No. 698,006
Renewed May 7, 1937

17 Claims. (Cl. 62—4)

This invention relates to improvements in refrigerating apparatus and method of operation thereof; and it comprises integrating the operation of a refrigerating apparatus and initiating defrosting when said integral has reached a predetermined value; all as more fully hereinafter set forth and as claimed.

Refrigerating apparatus have usually a cooler which is maintained at a temperature below the freezing temperature of water. When air carrying a proportion of water vapor corresponding to a dew point higher than the temperature of the cooler comes in contact with the cooler condensation takes place, and the moisture condensed on the cooler freezes. With the cooler installed in a closed cabinet, every opening of the door admits outside air while some of the chilled air escapes from the cabinet. Thus, additional water vapor is introduced into the cabinet and eventually deposited on the cooler as frost.

A further source of moisture is in the cabinet itself when foodstuffs or other moist substances are placed therein for safekeeping. As a rule the cooler is placed near the top of the cabinet. Air near the cooler is chilled whereby its density is increased causing it to fall to the bottom of the cabinet. Upon its travel away from the cooler the air increases in temperature and again picks up moisture when it comes in contact with moist substances. This warmer and moisture laden air rises back to the top of the cabinet due to its decreased density, and some of its moisture content is condensed on the cooler. Thus the thickness of the coating of frost or ice on the cooler gradually increases.

It is customary to defrost the cooler periodically by interrupting the refrigerating effect which causes a gradual rise in temperature of the cooler, and when its temperature exceeds the freezing temperature of water the frost melts and the resulting water drips off. When all frost has been removed from the cooler in this manner the refrigerating effect is re-established whereby the apparatus is placed in normal operation again.

Users find the task of defrosting a cumbersome one, and are apt to postpone it until an excessive coating of frost has been formed. The greater the thickness of the frost layer is, the more resistance to the flow of heat it presents. Thus, an excessive coating of frost on the cooler decreases the efficiency of the apparatus as well as increases the consumption of energy for a given refrigerating effect. Furthermore, a longer defrosting period is required to remove a thicker frost coating, and since, during a substantial portion of the defrosting period the temperature is higher within the cabinet than the maximum permissible to avoid rapid deterioration of food or the like placed in the cabinet, a long defrosting period is in most cases objectionable.

When the user has no other means of determining the removal of all frost but visual inspection of the cooler he is apt to prolong the defrosting period unnecessarily, thereby carrying an undesirably high temperature for an excessive period of time which results in an accelerated deterioration of food within the cabinet.

In an attempt to overcome the disadvantages of haphazard manual control of defrosting it has been proposed to initate defrosting at regular intervals of time, for instance once every 24 hours, and to terminate defrosting when a predetermined interval of time has elapsed since initiation. This, however, is not a satisfactory solution of the problem. In order to insure the complete removal of all frost, the duration of the defrosting period must then be long enough to permit melting of a maximum possible quantity of frost collected during any period of normal operation between defrostings. Consequently, if in the course of any period of normal operation a quantity of frost smaller than this maximum has formed on the cooler, which is often the case, this frost will be completely melted long before the ensuing period of defrosting is terminated. It is clear, therefore, that with this type of control one of the main drawbacks of manual control is not eliminated, viz. the excessively high temperature of both cooler and cabinet for an unnecessarily extended portion of the defrosting period.

It is an object of this invention to provide novel and improved control means for the initiation as well as termination of defrosting at the most suitable respective times.

Another object of this invention is a novel method of operating a refrigerating apparatus with greater convenience, economy and efficiency.

Still further objects of this invention will become apparent from the following disclosure which shows the manner in which I attain the aforementioned objects.

I have found that when a refrigerating apparatus is in use under normal operating conditions, the quantity of frost formed on the cooler is substantially in proportion to the integral of the periods of operation of an intermittently running motor driving the apparatus, or the integral of energy supplied to the apparatus. According to my invention I, therefore, provide automatic control means adapted to, first, integrate the periods

of operation of, or the flow of energy to, a refrigerating apparatus, second, to interrupt the flow of energy when the integral has reached a predetermined total, and third, to maintain this interruption for a suitable interval of time for the purpose of defrosting. In this manner defrosting is initiated when a substantially constant and predetermined quantity of frost has formed, and the apparatus is returned, by the control means, to normal operation after a duration of defrosting sufficient to permit the melting of all frost.

In the accompanying drawings, wherein similar numerals refer to similar parts throughout the several views,

Figure 1 is a schematic view of my invention, partly in section, in combination with a refrigerating apparatus of the compression type;

Figure 2 is a developed view of the controller drum of Figure 1;

Figures 3 and 4 are enlarged sections taken, respectively, along lines 3—3 and 4—4 of Figure 1;

Figure 5 is a schematic view of another modification of my invention, partly in section, in combination with a refrigerating apparatus of the compression type;

Figure 5A is a section taken along line Z—Z of Fig. 5 with the contact strips 109 and 110 removed;

Figure 6 is a developed view of the controller drum of Figure 5;

Figures 7 and 8 are enlarged sections taken along lines X—X and Y—Y, respectively, of Figure 5;

Figure 9 is a modification of certain parts of the embodiment of my invention illustrated in Figure 5;

Figure 10 is a schematic view of a further modification of my invention, partly in section, in combination with a refrigerating apparatus of the absorption type;

Figure 11 is a section, in the plane of Figure 10, of the shut-off valve of Figure 10;

Figure 12 is a side elevational view of the cam of Figure 10; and

Figures 13 and 14 are sections through the control valve of Figure 10, in the plane of Figure 10, showing the valve in two different operating positions.

It is to be noted that in the drawings actual relative proportions of the various parts have not always been maintained, the showing being more or less diagrammatic and certain details having been enlarged in the interest of greater clearness.

Referring now to Figure 1, a cooler 10 within a suitably heat insulated cabinet 11 is part of a system of refrigeration including a compressor 12, a condenser 13 and a pressure reducing valve 14, all interconnected by pipe connections 15. The compressor 12, driven by an electric motor 16, is adapted to circulate a suitable refrigerant, such as SO_2, through this system. A tray 17 is located in the cabinet 11 beneath the cooler 10 to collect moisture dripping from the cooler during defrosting. This type of refrigerating apparatus, well known to those skilled in the art, is usually equipped with thermostatic control means to maintain the temperature within the cabinet 11 between predetermined limits. Such thermostatic control means, preferably of the type shown and described in the patent to McCabe No. 1,734,016, dated October 29, 1929, may comprise a temperature responsive element 18 located in the cabinet 11 and having an operating connection 19 with a snap action switch mechanism 20 adapted, during normal operation, to close an electric circuit including the motor 16 at a predetermined high temperature of element 18, and to open the circuit at a predetermined low temperature of the element.

I provide a mechanism for the automatic control of defrosting which is shown enclosed in a casing 21. A constant speed auxiliary electric motor 22, preferably of the synchronous type, has its shaft 23 connected to a speed reducing unit 24 which may comprise a plurality of worms and worm gears or pairs of spur gears. Shaft 25 leaving the speed reducing unit 24 has a counter bearing 26 in the casing 21. A friction wheel 27 is adjustably secured to shaft 25 by a set screw 28 and is adapted to drive a disk 29 at a slow and uniform speed whenever the motor 22 is energized. The disk 29 and a controller drum 30 are securely attached to a shaft 31 supported in the casing 21 by bearings 32 and 33. Four brushes 34, 35, 36 and 37 cooperate with the controller drum 30. These brushes are mounted on a bar 38 secured to the casing 21 at 39 and 40.

Conductors 41 and 42 are supplied with electric energy by a suitable source (not shown). The conductor 41 is connected by conductor 43 with the switch mechanism 20 and by conductor 44 with brush 37. The conductor 42 is connected by conductor 45 with the main electric motor 16 and by the conductor 46 with the auxiliary electric motor 22. The four-point control switch 48 has contact point 49 connected by conductor 47 with switch mechanism 20, contact point 50 by conductor 53 with brush 34, contact point 51 by conductor 54 with brush 35, and contact point 52 by conductor 55 with the main motor 16. Conductor 56 interconnects the brush 36 and the auxiliary electric motor 22.

As shown in Figure 3, the brush 35 has a spring 57, preferably made of phosphor-bronze, and attached by screws 58 and 59 to a block 60 made of electrically insulating material, such as hard rubber or synthetic resin. The block 60 is secured by a set screw 61 to the bar 38 which is preferably of square cross section in order to prevent turning of the block 60 on the bar 38, and to maintain the spring 57 firmly in contact with the controller drum 30. The conductor 54 is held in contact with the spring 57 by the head of screw 59. Brushes 34, 36 and 37 are preferably of the same construction as brush 35.

The controller drum 30 is made of electrically insulating material, e. g. hard rubber, and carries metallic contact plates 62 and 63. The preferred shape of these contact plates is clearly shown in the developed view of the controller drum 30, illustrated in Figure 2. The contact plates 62 and 63 leave an area 64 of the controller drum 30 uncovered. One end of this area carries a ridge 65. Edge 66 of plate 62 and edge 67 of plate 63 are raised from the controller drum 30 (see Figures 3 and 4), and the plates 62 and 63 are thus electrically disconnected from each other. The raised edges 66 and 67 as well as the ridge 65 cause a snap action when the springs 57 of the brushes pass over them during revolution of the controller drum 30 which prevents burning of the points of contact by excessive sparking.

During revolution of the controller drum 30 in the direction of arrow 68 (Figure 3) the brush 34 remains permanently in contact with plate 62, the brush 35 passes alternately over plate 62 and the

insulated area 64, the brush 36 alternately contacts plates 62 and 63, and the brush 37 remains permanently in contact with plate 63. While the brushes 34 and 37 are always left in the positions shown in the drawings, brushes 35 and 36 may be set on bar 38 to either of the extreme positions illustrated in Figure 2 by solid and dotted lines, respectively, or to any intermediate positions, such as shown in Figure 1. The purpose of this adjustability will be explained later.

The system illustrated in Figures 1 to 4 operates as follows. In the position shown in Figures 1, 3 and 4 the brush 35 has just snapped from the insulated ridge 65 on to contact plate 62. As the switch mechanism 20 closes periodically, electric current passes from the source through conductors 41 and 43, switch mechanism 20, conductor 47, switch points 49 and 50, conductor 53, brush 34, contact plate 62, brush 35, conductor 54, switch points 51 and 52, conductor 55, main motor 16, and conductors 45 and 42 back to the source. The main motor 16 runs and produces a refrigerating effect in the cooler 10. There is a continuous flow of current from the source through conductors 41 and 44, brush 37, contact plate 63, brush 36, conductor 56, auxiliary motor 22, and conductors 46 and 42 back to the source. This maintains the auxiliary motor in continuous operation until it has advanced the controller drum 30 to the position in which brush 36 snaps from the edge 67 of plate 63 on to plate 62, breaking the last named circuit. The contact of brush 36 with plate 62 places the auxiliary motor 22 in parallel electric connection with the main motor 16, and both motors in electric series connection with the switch mechanism 20.

Both motors run now whenever the thermostatic switch mechanism 20 completes the circuit, motor 16 producing a refrigerating effect, and auxiliary motor 22 integrating the operating periods of motor 16 in the advancing of the controller drum 30. Operation continues in this manner until the drum 30 has been turned to the position wherein brush 36 snaps from the edge 66 of plate 62 on to plate 63, causing the auxiliary motor 22 to run continuously, while the main motor remains under the control of switch mechanism 20. After a further, now more rapid advancement of drum 30 brush 35 snaps from the edge 66 of plate 62 on to the insulated area 64 whereby the circuit for the main motor 16 is interrupted, regardless of the action of switch mechanism 20. Defrosting takes place while the circuit for the main motor 16 remains interrupted for a period of time determined by the continuous operation of the auxiliary motor 22. When the latter has further advanced controller drum 30 back to the position illustrated in Figure 1, the brush 35 snaps from the insulated ridge 65 on to plate 62, re-establishing connection for the main motor 16 under control of the switch mechanism 20 whereupon refrigerating operation is resumed. This cycle of operations is repeated as long as the control switch 48 remains in the position shown in Figure 1.

By turning the control switch 48 through 90° from the position shown in Figure 1, connection is established between the contact points 49 and 52, and between the contact points 50 and 51. This places the main motor 16 and the thermostatic switch mechanism 20 in direct electric series connection, by-passing the controller drum 30 and rendering the automatic control of defrosting inoperative. The refrigerating apparatus is thus in permanent operation under control of the thermostatic switch mechanism 20, the current flowing from the source through conductors 41 and 43, switch 20, conductor 47, contact points 49 and 52, conductor 55, main motor 16, and conductors 45 and 42 back to the source. Defrosting may then be carried out under manual control by turning the control switch 48 through 45° in which position all four contact points are disconnected from each other and the circuit for the main motor 16 is interrupted. The apparatus is then returned to normal refrigerating operation by turning the control switch 48 again through 45° after a period of defrosting or shut-down determined according to the judgment of the operator.

It is to be noted that the auxiliary electric motor 22 is not controlled by the control switch 48 while brush 36 contacts the plate 63. Therefore, if the controller drum is in defrosting position its movement by auxiliary motor 22 cannot be stopped by any minipulation of the control switch 48, and the controller drum 30 is automatically advanced to the position wherein brush 36 has snapped from edge 67 of plate 63 on to contact plate 62. This places the controller drum 30 in readiness for automatic control of a period of refrigerating operation.

When the brush 36 is in the position shown by solid lines in Figure 2 the auxiliary motor 22 runs continuously while the brush 36 contacts the controller drum 30 between lines A and B. Upon passing line B, the brush 36 contacts the plate 62, and the auxiliary motor 22 runs thereafter intermittently for limited periods of time whenever the thermostatic switch mechanism 20 completes the circuit. If the brush 36 is shifted to the position shown in dotted lines the auxiliary motor 22 runs continuously while the controller drum 30 moves between lines A and C, and the period of normal operation between the periods of defrosting is thereby shortened.

Brush 35, in the position shown by solid lines in Figure 2, interrupts the circuit for the main motor 16 while the controller drum 30 turns between lines D and F. If the brush 35 is moved to the position shown by dotted lines the period of defrosting is shortened as represented by the circumferential distance E—F.

The rate of rotation of the controller drum 30, during operation of auxiliary motor 22, can be decreased or increased by shifting the friction wheel 27 on shaft 25 so that it drives disk 29 nearer its periphery or nearer its center, respectively. Thus, the duration of the entire operating cycle may be adjusted by shifting the friction wheel 27, while the durations of defrosting and of normal operation may be varied independently of each other by the respective adjustment of brushes 35 and 36 on bar 38. In this manner the mechanism may be adjusted to so control the operation of the refrigerating apparatus as best suits any individual operating conditions.

In the modification shown in Figure 5, a speed reducing unit 71 in casing 69 is driven through belt 70 by the main electric motor 16. Shaft 72 leaving the speed reducing unit 71 has a counter bearing 73 in the casing 69 and carries a friction wheel 74 secured by a set screw 75 and adapted to drive a disk 76 on shaft 77 rotatably supported in bearing 78. An auxiliary constant speed motor 79 drives in a similar manner by its shaft 80 a speed reducing unit 81 with its shaft 82 supported in a bearing 83. A friction wheel

84, secured to shaft 82 by means of a set screw 85, is adapted to drive a disk 86 attached to a shaft 87 rotatably supported in a bearing 88. The shafts 77 and 87 carry a controller drum 89 in a manner to be described later. Brushes 90, 91 and 92 cooperate with the controller drum 89 and are mounted on a bracket 93 made of electrically insulating material and attached to the casing 69 and 94 and 95.

Conductors 96 and 99 are connected to a source of electric energy (not shown). The conductor 96 is connected by conductor 97 with the thermostatic switch mechanism 20 and by conductor 98 with the auxiliary electric motor 79. The conductor 99 leads to contact point 101 of a control switch 100 which has a second contact point 102 connected by conductor 104 with the brush 91, and a third contact point 103 connected by conductor 105 with the brush 92 and by conductor 106 with the main electric motor 16. Conductor 107 connects the main electric motor 16 with the thermostatic switch mechanism 20, and a conductor 108 interconnects the auxiliary electric motor 79 with the brush 90.

The controller drum 89 is made as a hollow cylinder of electrically insulating material, for instance a tube of laminated fibre, and carries contact plates 109 and 110 of the shape shown in Figure 6. The plates 109 and 110 have their respective edges 111 and 112 raised away from the controller drum 89 as shown in Figure 8 whereby the two plates are electrically disconnected from each other.

As shown in Figure 7 the shaft 87 carries within drum 89 a one-way drive clutch 113 secured by the key 114. The clutch 113 has two recesses 115 fitted with balls or rollers 116 and springs 117. Shaft 77 carries within drum 89 a one-way drive clutch 113A of similar construction and secured to shaft 77 by a key 114A (see Fig. 5A). It will be noted that when the shaft 87 is rotated in the direction of the arrow 118 (Figure 8), the balls 116 wedge themselves in between the recesses 115 and the inside face of the drum 89, due to friction and the force of the springs 117, thereby establishing a driving connection. If, on the other hand, the drum 89 is rotated by shaft 77 through its one-way drive clutch 113A in the direction of the arrow 118, the balls 116 are forced by friction against the springs 117, compressing them, and the drum 89 turns freely while one-way drive clutch 113 stands still. In this manner the controller drum 89 may be turned in the direction of the arrow 118 by either shaft 77 or 87 while the other shaft stands still.

During normal operation of the apparatus illustrated in Figures 5 to 8 the main motor 16 turns the controller drum 89 while the brush 91 contacts plate 110 whenever the circuit is completed by the thermostatic switch mechanism 20, current flowing from the source through conductor 99, contact points 101 and 102, conductor 104, brush 91, plate 110, brush 92, conductors 105 and 106, main motor 16, conductor 107, switch 20, and conductors 97 and 96 back to the source. In this manner the advancement of controller drum 89 is in proportion to the integral of the time periods during which the main motor 16 runs and produces a refrigerating effect. When the drum 89 has reached the position illustrated in Figures 5, 7 and 8 the brush 91 slips from plate 110 over edge 112 on to plate 109; the circuit for the main motor 16 is broken. Defrosting takes place for a period of time determined by the continuous operation of the auxiliary motor 79, the current flowing from the source through conductor 99, contact points 101 and 102, conductor 104, brush 91, plate 109, brush 90, conductor 108, auxiliary motor 79, and conductors 98 and 96 back to the source. The operation of the auxiliary motor 79 advances the controller drum 89 until, after a time controlled period of defrosting, the brush 91 slips from plate 109 over edge 111 on to plate 110 whereupon the auxiliary motor 79 is stopped and normal refrigerating operation is resumed.

The duration of normal operation as well as the duration of defrosting may be varied independently of each other by the respective adjustment of the friction wheels 74 and 84 on their respective shafts 72 and 82.

If the control switch 100 is turned from the connection 101—102 to the connection 101—103 the control drum 89 rotates whenever the thermostatic switch 20 completes the circuit for motor 16 without, however, exercising any control over the operation of the apparatus. Defrosting may be initiated manually by so placing switch 100 that it does not connect either pair of contact points.

In the modification illustrated in Figure 9 the control mechanism is similar to that illustrated in Figures 5 to 8, and the showing has been restricted to those details which are different. Here a second auxiliary motor 120 is provided, preferably of the type of a watt hour meter, which has a driving connection with the speed reducing unit 71, the belt 70 being eliminated. The one electric power lead 121 is connected to the thermostatic switch mechanism 20 while the other lead 122 is connected to contact point 124 of the control switch 123 which has a second contact point 125 connected by conductor 127 to brush 91, and a third contact point 126 connected by conductors 128 and 129 to the main motor 16 and by conductor 130 to the auxiliary motor 120. Conductor 131 leading from switch mechanism 20 has a connection 132 with motor 79 and a connection 133 with motor 16. Conductor 134 leads from motor 79 to brush 90 and conductor 135 connects the brush 92 with the auxiliary motor 120.

During refrigerating operation of the apparatus shown in Figure 9 the motor 120 is in series connection with motor 16 and integrates the energy consumption of motor 16 in the advancement of drum 89. During defrosting the constant speed motor 79 drives drum 89, its current passing through the switch 20 which is closed because of the high temperature existing in cabinet 11 during defrosting.

If the control switch 123 is turned from the connection 124—125 to the connection 124—126 both motors 79 and 120 are by-passed and only the main motor 16 operates when switch 20 completes the circuit. Defrosting may then be carried out under manual control by turning the control switch 123 to a half-way position wherein it establishes no connection.

Referring now to Figure 10, a condenser 141, a cooler 142, an absorber 143 and a generator 140, all interconnected by pipes 144, are parts of a refrigerating apparatus of the absorption type such as more fully described in the patent to von Platen et al. No. 1,609,334, dated December 7, 1926. The cooler 142 is placed in a cabinet 145 and a tray 146 is arranged to collect frost dripping from the cooler 142. The tray 146 may

be removed and emptied manually or it may be fitted with an overflow connection adapted to discharge to a suitable place of disposal for the waste water.

Combustible gas is supplied by a pipe 147 leading to a control valve 151 and having a branch pipe 148 leading through an adjusting valve 149 to a pilot burner 150. As shown in Figures 13 and 14, the control valve casing 151 has ports 152, 153 and 154 leading into a cylindrical bore 155. Reciprocable within bore 155 is a piston 156 with a hole 157 running through its full length. The piston 156 is connected by the piston rod 158 to a bellows 159 secured to a valve bonnet 160. The space within the bellows 159 is connected by a tube 161 to a bulb 162. The space within the bellows 159, the tube 161 and the bulb 162 is filled with an operating fluid adapted to expand and contract with rise and fall of temperature. All connections between the last named three elements are preferably made permanent by brazing or the like in order to prevent any escape of operating fluid. The port 152 communicates with the gas supply pipe 147 and the port 153 is connected by a pipe 163 with a shut-off valve 164.

The shut-off valve casing 164 has an inlet connection 165 and an outlet connection 166, adapted to communicate with each other through port 167 closable by a valve disk 168 under the force exerted by a spring 169 which is retained within a cap 170 (see Figure 11). A valve stem 171 secured to the valve disk 168 passes through a stuffing gland 172.

A pipe 173 communicating with the control valve port 154, and the shut-off valve outlet 166 are connected by a nipple 174 to a gas meter 175 which has its outlet connected by a pipe 188 to a burner 189 arranged to supply heat to the generator 140.

A shaft 176 driven by the meter 175 has a bearing 177 in the casing 178 and carries a friction wheel 179 secured by a set screw 180. The friction wheel 179 is adapted to drive a disk 181 secured to shaft 182 which is supported in bearing 183 and carries at its outer end a cam 184. As shown in Figure 12, the cam 184 has a notch 185 with a sharp edge 186 at one side and an inclined face 187 at the other side. The cam 184 is adapted to control the operation of the shut-off valve 164.

During normal refrigerating operation of the apparatus illustrated in Figures 10 to 14, the control valve piston 156 is in the position shown in Figure 13 wherein port 153 is partly throttled so that gas is supplied to the burner 189 at a rate of flow regulated to maintain the desired refrigerating effect, the gas flowing from the source through pipe 147, ports 152 and 153, pipe 163, shut-off valve 164, nipple 174, meter 175, and pipe 188 to the burner 189. The shut-off valve is kept open by the cam 184 the periphery of which depresses the valve stem 171 and thereby holds the valve disk 168 unseated. If the temperature within the cabinet 145 drops the fluid in bulb 162 contracts and the bellows 159 likewise contracts thereby pulling the piston 156 upward and further throttling the flow of gas through port 153. If the temperature within the cabinet 145 rises the piston 156 is lowered by the expansion of the fluid in bulb 162 and the flow of gas is increased. Thus, the temperature within the cabinet 145 is maintained within predetermined limits. The hole 157 serves to equalize the pressure on both sides of the piston 156 and to permit escape of the gas within the bore 155 and below the piston 156 when the piston is being lowered. In this manner normal refrigerating operation proceeds, the gas consumption of the apparatus being integrated by the meter 175 and the cam 184 being rotated in proportion to the gas consumption. Finally, after a predetermined quantity of gas has passed through the meter 175 which quantity is adjustable by a shifting of the friction wheel 179, the notch 185 passes past the stem 171 which slips over the sharp edge 186 thereby causing the valve disk 168 to close the port 167 under the action of the spring 169. The flow of gas to the burner 189 is thereby interrupted and defrosting proceeds.

During defrosting the temperature within the cabinet 145 gradually rises and finally, at a temperature corresponding to the melting of all frost, the fluid within the bulb 162 has expanded to such an extent that the piston 156 reaches the position shown in Figure 14 wherein it opens port 154 and permits a flow of gas from the source through pipe 147, ports 152 and 154, pipes 173 and 174, meter 175, and pipe 188 to the burner 189. The adjusting valve 149 is originally so set that it maintains a pilot flame burning at the burner 150. When the flow of gas is reestablished after defrosting in the manner just explained, this pilot flame at the burner 150 lights the gas admitted to the burner 189 and normal refrigerating operation is initiated. The flow of gas through the meter 175 causes turning of the cam 184 by the meter and the inclined face 187 pushes the valve stem 171 downward thereby opening the shut-off valve 164. The arrangement is such that the shut-off valve 164 is opened by the cam 184 before the flow of gas has produced a refrigerating effect sufficient to lower the temperature within the cabinet 145 to an extent which causes the piston 156 by its rise to close the port 154.

Control of defrosting according to my invention permits defrosting at frequent times and after formation of a comparatively thin coating of frost. Thus, the average thickness of frost is smaller than with haphazard manual control. Furthermore, defrosting is terminated substantially at the time when all frost is melted and the refrigerating effect is interrupted for a minimum length of time only. This results in improved operation and improved food preservation.

While I have shown several forms of my invention, it will be noted that various changes may be made therein, particularly in the type and arrangement of the control means. Adjustability of the durations of normal operation and of defrosting may be dispensed with when the operating conditions of the apparatus are known in advance. Other modifications in the details of construction and arrangement of parts will readily occur to those skilled in the art. Reference is, therefore, made to the appended claims for a definition of the limits of my invention.

What I claim is:

1. In a refrigerating apparatus comprising a cooler wherein a refrigerating effect is produced by a supply of energy to the apparatus, thermostatic means adapted to alternately establish and interrupt the supply of energy to the apparatus, motor driven means independent of the thermostatic means and adapted to interrupt the refrigerating effect periodically for controlled periods, and connections for effecting movement of the motor driven means by energy supplied under control of the thermostatic means.

2. In combination with a refrigerating apparatus adapted to be operated by a flow of energy and comprising a cooler, a motor, thermostatic means adapted to alternately establish and interrupt the flow of energy to the motor, and control means driven by said motor and adapted to interrupt the flow of energy to the apparatus after a predetermined number of revolutions of the motor.

3. In combination with a refrigerating apparatus operable by flow of energy and comprising a cooler, a motor and mechanism adapted to be driven thereby, thermostatic control means adapted to alternately establish and interrupt flow of energy to the apparatus and to maintain the motor in operation while energy flows to the apparatus, said mechanism being adapted to interrupt flow of energy to the apparatus after a predetermined number of revolutions of the motor and to subsequently re-establish flow of energy to the apparatus.

4. In combination with a refrigerating apparatus intermittently operated by a source of electricity and having a cooler, electric circuits including a thermostatic switch, an electric motor and switching mechanism driven thereby, said thermostatic switch being adapted to alternately switch on and switch off the supply of electricity and said switching mechanism being adapted to cause operation of the motor while electricity flows to the apparatus and to interrupt the flow of electricity to the apparatus after a predetermined number of revolutions of the motor.

5. In a refrigerating apparatus driven by a main electric motor, an auxiliary electric motor, a thermostatic switch, switching mechanism adapted to be driven by the auxiliary motor, and electric connections including both said motors, the thermostatic switch and the switching mechanism, the thermostatic switch being adapted to control flow of electricity to both said motors and the switching mechanism being adapted to interrupt flow of energy to the main electric motor for a period of time determined by continuous operation of the auxiliary electric motor.

6. In a refrigerating apparatus driven by an intermittently operating main electric motor, an auxiliary electric motor, switching mechanism adapted to be driven by the auxiliary motor, electric connections including the switching mechanism and both said motors, said switching mechanism being adapted to establish a circuit including both said motors, then establish a circuit through the auxiliary motor and interrupt the circuit through the main motor, and then again establish a circuit including both said motors.

7. In a refrigerating apparatus driven by a main electric motor, an auxiliary electric motor, switching mechanism driven by the auxiliary motor, a thermostatic switch, and electric connections including a source of electric energy, the thermostatic switch, the switching mechanism and both said motors, the switching mechanism being adapted in one position thereof to establish a circuit including the source of energy, both said motors in parallel arrangement and the thermostatic switch in series arrangement with both motors, and in another position thereof to interrupt the circuit through the main motor and to maintain a circuit including the source of energy and the auxiliary motor.

8. In a refrigerating apparatus operated by a source of energy and comprising a cooler, a thermostat adapted to alternately establish and interrupt flow of energy to the apparatus, a meter adapted to integrate energy flowing to the apparatus, means independent of said thermostat and adapted to interrupt flow of energy to the apparatus, and an operating connection between the meter and said means.

9. In a refrigerating apparatus operated by combustion of gas and comprising a cooler, a gas supply pipe, a shut-off valve in said supply pipe, a gas meter in said supply pipe, and an operating connection between the meter and the shut-off valve whereby the meter is adapted to close the valve when a predetermined quantity of gas has passed through the meter.

10. In a refrigerating apparatus operated by combustion of gas and comprising a cooler, a gas supply pipe, a shut-off valve in said supply pipe, a gas meter in said supply pipe, an operating connection between the meter and the shut-off valve whereby the meter is adapted to alternately open and close the shut-off valve when predetermined quantities of gas have passed through the meter, a by-pass connection around the shut-off valve, a control valve in said by-pass connection, and means for closing the control valve subsequently to the opening and prior to the closing of the shut-off valve, and for opening the control valve subsequently to the closing and prior to the opening of the shut-off valve.

11. In the combination of claim 10, a cabinet, the cooler being located in the cabinet, and a temperature responsive element located in the cabinet and adapted to actuate the means for closing and opening the control valve.

12. A method of operating a refrigerating apparatus intermittently operated by a supply of energy and having a cooler subjected to the formation of frost thereon, which comprises integrating the periods of time during which energy is supplied to the apparatus and interrupting the supply of energy to the apparatus for the purpose of effecting defrosting when the integral has reached a predetermined value.

13. A method of operating a refrigerating apparatus operated by a supply of energy and having a cooler subjected to the formation of frost thereon, which comprises integrating the supply of energy to the apparatus, and interrupting the supply of energy to the apparatus for the purpose of effecting defrosting when the integral has reached a predetermined value.

14. A method of operating a refrigerating apparatus operated by a supply of energy and having a cooler subjected to the formation of frost thereon, which comprises measuring the temperature produced at the cooler, alternately supplying energy to the apparatus when said temperature has reached a predetermined high value and interrupting the supply of energy to the apparatus when said temperature has reached a predetermined low value, integrating the periods of time during which energy is supplied to the apparatus, and interrupting the supply of energy to the apparatus for the purpose of effecting defrosting when the integral has reached a predetermined value.

15. A method of operating a refrigerating apparatus operated by a supply of energy and having a cooler subjected to the formation of frost thereon, which comprises measuring the temperature produced at the cooler, regulating the supply of energy to the apparatus so as to maintain said temperature between predetermined

limits, integrating the supply of energy to the apparatus, and interrupting the supply of energy to the apparatus for the purpose of effecting defrosting when the integral has reached a predetermined value.

16. In combination with a refrigerating apparatus driven by an electric motor, a switching mechanism and electric driving means therefor, said switching mechanism being adapted to alternately establish and interrupt flow of electricity to the motor, and to maintain flow of electricity to said driving means while flow of electricity to the motor is interrupted by the switching mechanism.

17. In combination with a refrigerating apparatus driven by an electric motor, a thermostatic switch, a switching mechanism and electric driving means therefor, said switching mechanism being adapted to alternately establish one circuit including the thermostatic switch and the electric motor, and another circuit including the electric driving means but excluding the thermostatic switch and the electric motor.

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