REFRIGERATING MECHANISM

Filed Oct. 29, 1938 5 Sheets-Sheet 1

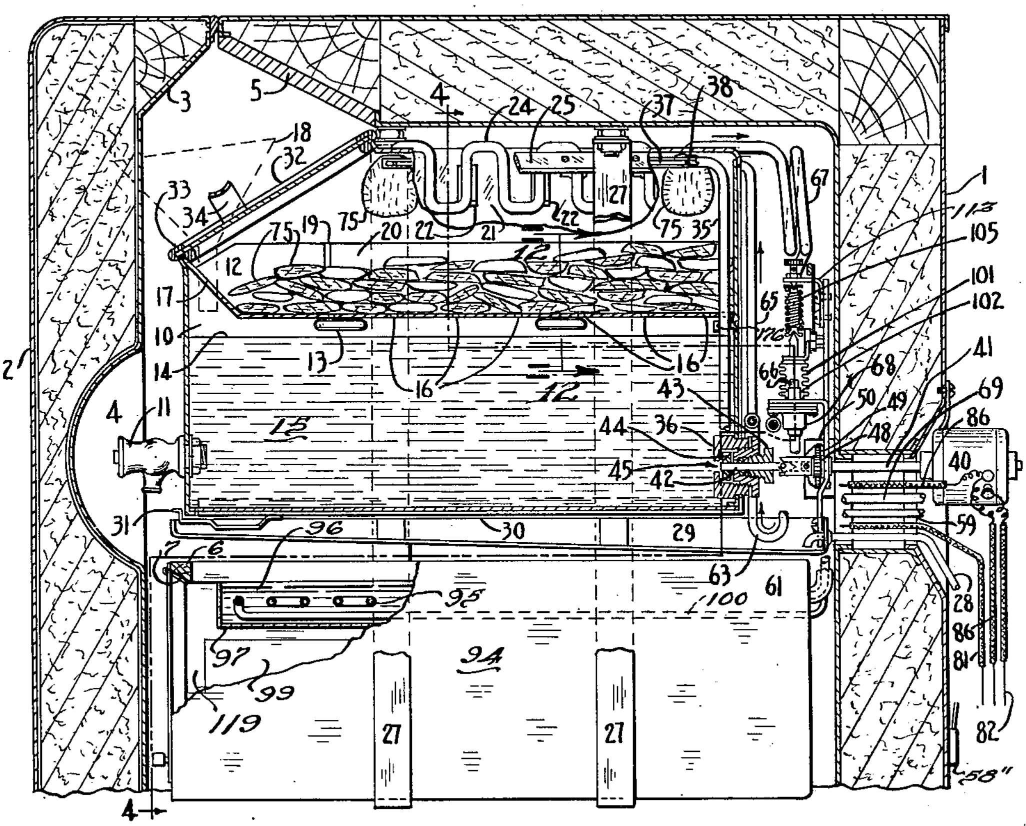

FIG. 1

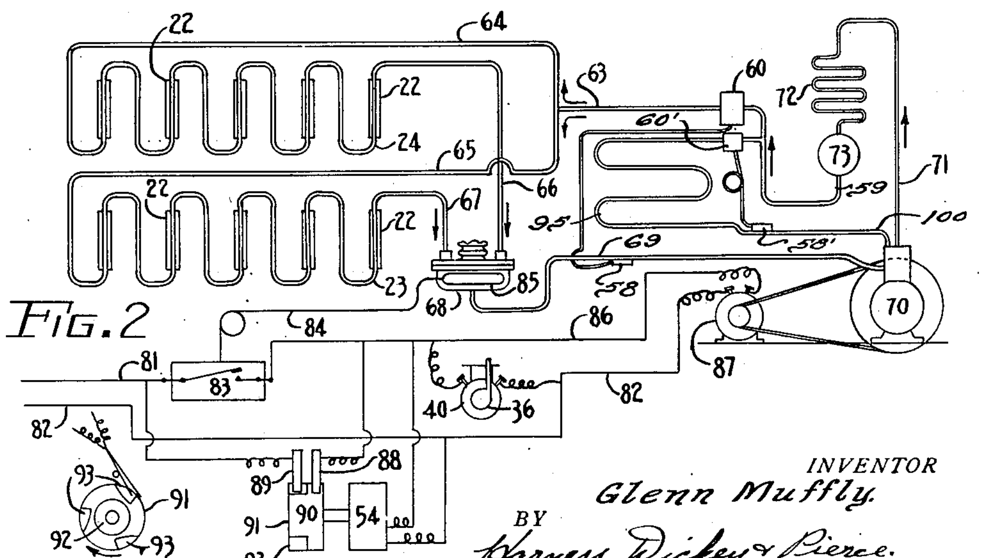

FIG. 2

FIG. 3

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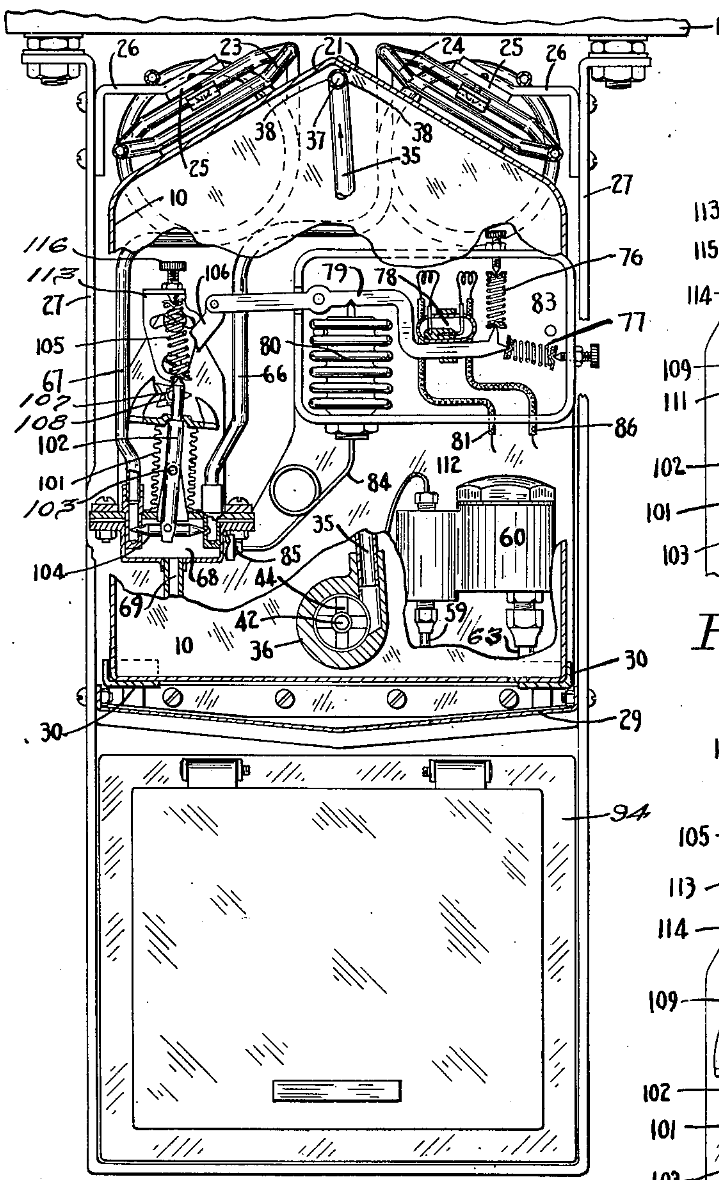

FIG. 4

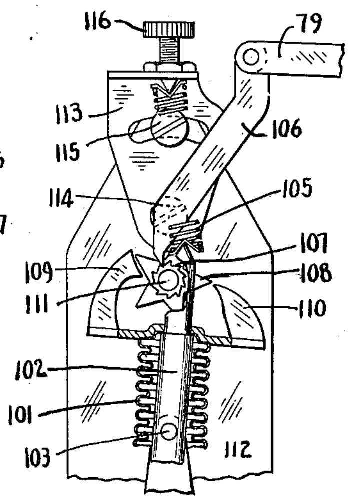

FIG. 5

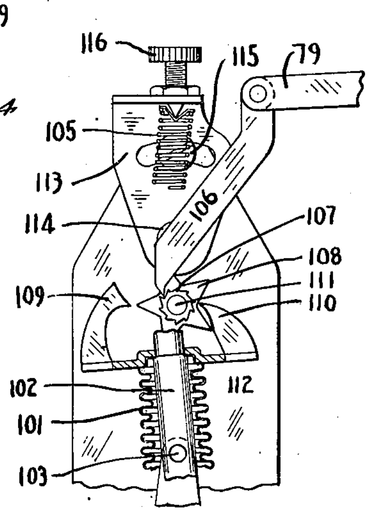

FIG. 6

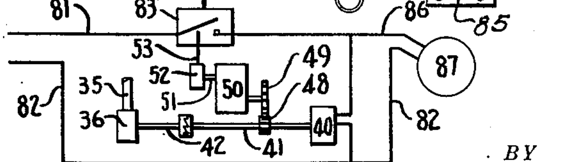

FIG. 7

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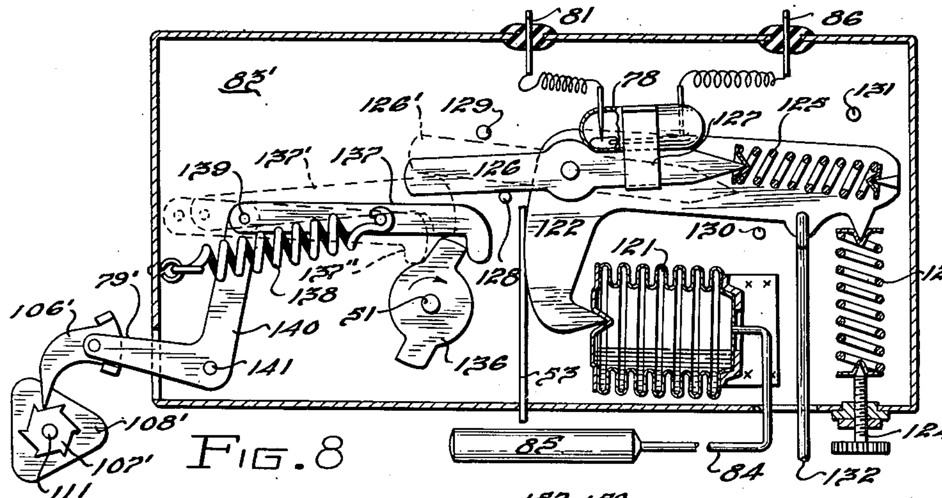

FIG. 8

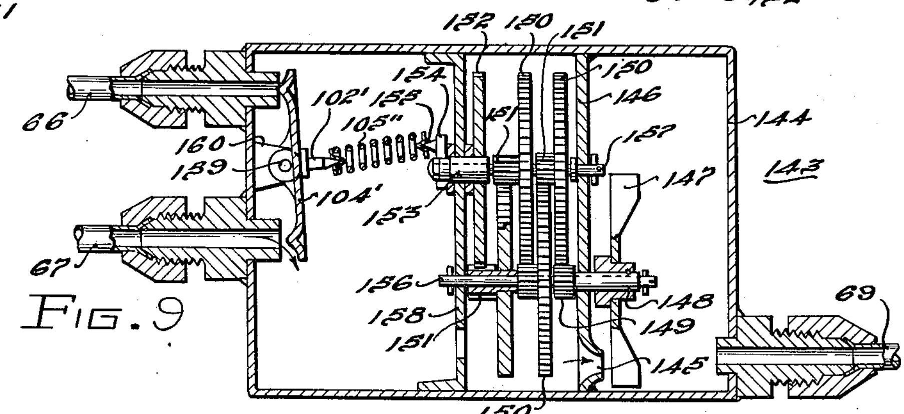

FIG. 9

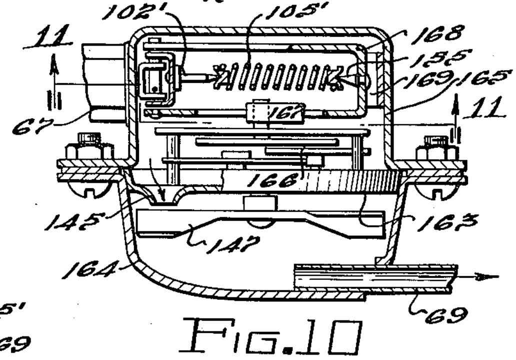

FIG. 10

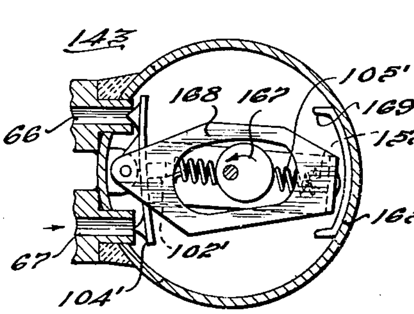

FIG. 11

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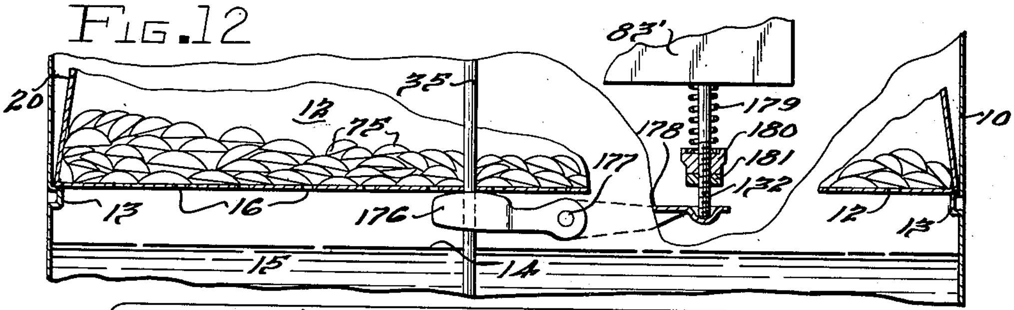
FIG. 12



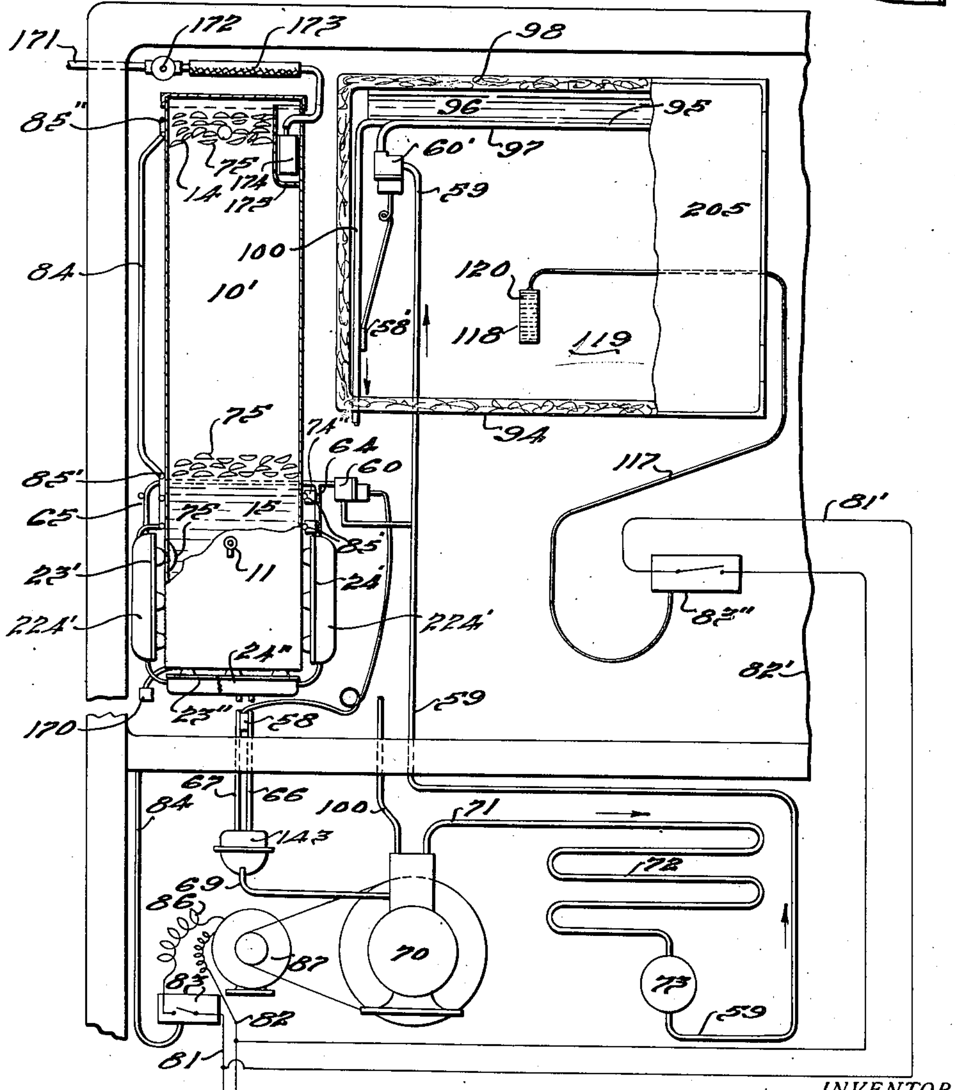


FIG. 13

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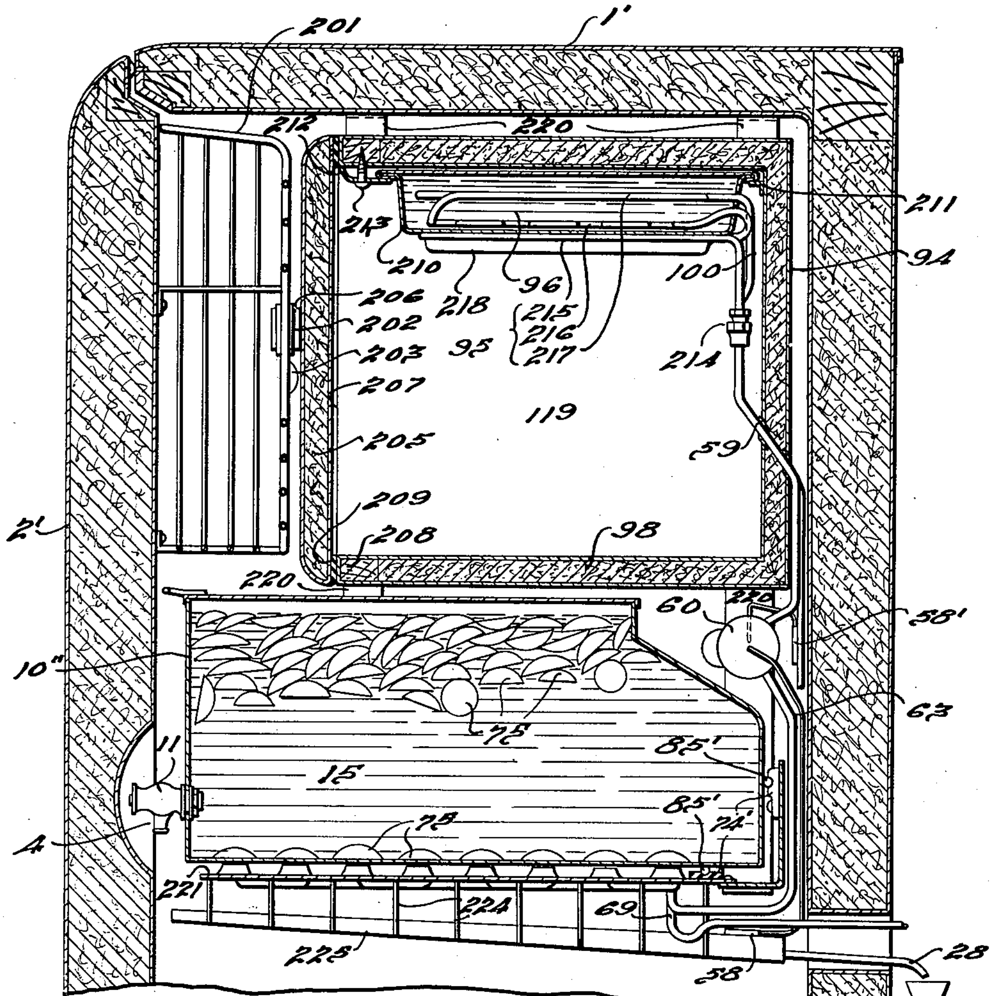

FIG. 14

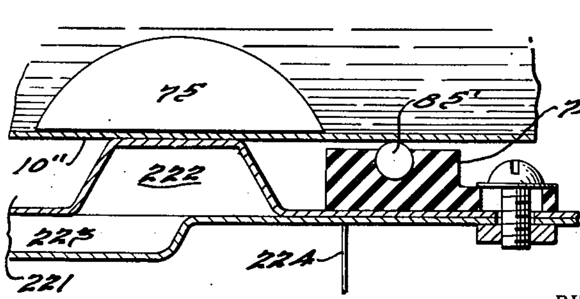

FIG. 15

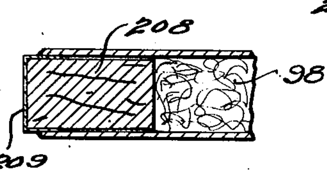

FIG. 16

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UNITED STATES PATENT OFFICE

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REFRIGERATING MECHANISM

Glenn Muffly, Springfield, Ohio

Application October 29, 1938, Serial No. 237,629

23 Claims. (Cl. 62—2)

This invention relates to refrigerating mechanism and particularly to such mechanism as is applicable to the production of ice as well as to the provision of a new and novel manner of producing ice and controlling the operation of the mechanisms during such production.

An object of the present invention is to provide an improved manner of controlling the ice making operations in response to the amount of ice in storage.

Another object of the invention is to provide an improved arrangement of ice making surfaces relative to an ice storage receptacle.

Another object of the invention is to provide an improved arrangement of ice making surfaces, an ice storage receptacle, and a water tank.

Another object of the invention is to provide an improved manner of removing or harvesting ice from surfaces on which the ice is formed.

Another object of the invention is to provide an improved manner of controlling ice making and ice removal cycles of operation of the ice forming mechanism.

Another object of the invention is to provide an improved manner of controlling the ice making operation in response to the weight of ice in storage.

Another object of the invention is to provide an improved manner of controlling the ice making operations in response to the mass of ice in storage by taking advantage of differences in temperatures of water at different levels in a receptacle due to the difference in density of water at different temperatures.

Another object of the invention is to provide an improved circulating system whereby water is circulated from a bath against an ice making surface and back to the bath again.

Another object of the invention is to provide an improved starting and stopping means for the system whereby the starting is thermally controlled and the stopping is time controlled.

Another object of the invention is to provide an improved manner of controlling actuation of an expansion valve in which the thermal arrangement is so located that it is mainly affected by the ambient temperature and acts to increase the flow of refrigerant through the valve when the ambient temperature rises.

Other objects of the invention will become apparent from the following specification, the drawings relating thereto, and the claims hereinafter set forth.

In the drawings in which like numerals are used to designate like parts in the several views throughout:

Figure 1 is a side elevation, mainly in section, of a refrigerator cabinet and an automatic ice-maker of the improved type described herein, having ice-making surfaces on the inner sides of upper wall of the tank, forced water circulation, and an ice storage rack or basket removably supported within the removable tank.

Fig. 2 is a diagrammatic view of the refrigerant circuit and of the electrical circuit of the ice-maker shown in Fig. 1 and of the refrigerating system connected therewith to operate the ice-maker.

Fig. 3 is an end view of the commutator seen in Fig. 2.

Fig. 4 is a front elevation, somewhat enlarged, on the line 4—4 of the ice-maker assembly seen in Fig. 1, with the tank and other parts broken away to disclose the controls and parts of the refrigerant path.

Fig. 5 is an enlarged front view of the valve actuating mechanism seen in Fig. 4, shown in position just prior to opening of the left-hand valve port, which is similar to the position just prior to opening of the motor circuit as seen in Fig. 4.

Fig. 6 is a view similar to Fig. 5 except that parts are shown in the positions they assume after the left-hand port has been opened.

Fig. 7 is a simplified diagram of the wiring seen in Fig. 2, showing that only one switch is necessary and that all of the auxiliary apparatus may be driven by one motor.

Fig. 8 is an enlarged detail drawing of a switch mechanism adapted to fit into the diagrammatic view seen in Fig. 7 and to operate a valve mechanism similar to the one seen in Fig. 4.

Fig. 9 is a diagrammatic view of a self-actuating valve mechanism designed to act in response to the velocity and density of refrigerant vapor flowing from the ice-maker evaporator which may be substituted for the valve mechanism seen in Figs. 1, 2, and 4, and which requires no connection with the thermostatic switch.

Fig. 10 is a simplified arrangement of the elements seen in Fig. 9.

Fig. 11 is a sectional view on the line 11—11 of Fig. 10.

Fig. 12 is a broken sectional view taken on the line 12—12 of Fig. 1, showing details of a means for connecting the lever 176 of Fig. 1 with a push rod 132 of Fig. 8 for the purpose of employing the weight of stored ice to modify the action of the control 83', causing the compressor to operate more when the ice supply is low.

Fig. 13 is a front elevation, partly in section and partly diagrammatic, showing another means of control in response to the amount of ice in storage and additional details of the control of the sharp freezer.

Fig. 14 is a sectional view in side elevation showing another arrangement of the parts in Fig. 13 with further details.

Fig. 15 is a fragmentary sectional view of the ice-maker evaporator and related parts taken from Fig. 14.

Fig. 16 is a detail of the door framing of freezer 94 taken from Fig. 14 showing a method of construction adaptable to the door or door opening of an insulated enclosure.

Referring to Fig. 1, the cabinet 1 is fitted with door 2, which has the inverted L portion 3 and the clearance pocket 4, as shown in my several co-pending applications. The water tank 10 differs from these other disclosures in having an integral roof, on the inner side of which ice blocks are formed above the water level, and in other particulars covered by the following description.

The tank 10 is provided with the faucet 11, but ice is stored in the basket 12, which is removably supported in the tank by means of raised stops 13 and lever 176 so that the ice is stored above the normal water lever 14 of the water supply 15.

The basket 12 is preferably made of perforated metal or it is provided with a number of drain holes 16. It might be made of wire, but I prefer the sheet metal construction. At the front of the basket 12 its bottom is inclined upward and a larger hole 17 is provided for convenience in inserting a funnel (shown by dotted lines indicated by the numeral 18) for filling the water reservoir and for convenience as a finger-hold to remove the basket 12 from the tank 10.

At 19 the side walls 20 of the basket 12 are bent inwardly so that the upper edges of the basket are spaced inwardly from the inner walls of the tank 10 from the point 19 to the rear end of the basket, so that water draining down the side walls of the tank from the ice-making surfaces at its top will not flow into the basket but outside of it down to the body of water 15.

The angular walls 21 of the tank are contacted externally by the metal pads 22, which are soldered or otherwise attached to the evaporators 23 and 24, which are here represented as tubes bent to form circuitous refrigerant paths and to hold the pads 22 in a firm, but more or less springy, contact with the tank roof on its two sides. These two evaporators are supported by the bars 25, which are in turn supported by the brackets 26 (Fig. 4) attached to the hangers 27.

These hangers 27 also support the drain pan 29 and the two angles 30 which form a track upon which the tank 10 is supported and upon which it will slide forward when the spring clip 31 is pushed downward to release the tank. The pressure of the pads 22 must be light enough to allow the tank to be thus removed at any time when the evaporators 23 and 24 are defrosted so that the pads are not frozen fast to the tank.

The evaporators 23 and 24 are alternately or simultaneously refrigerated by any of the methods described in my earlier applications and further described later herein. Water is pumped from the bottom of the tank through the tube 35 by the pump 36 to the tube 37 attached to the inner wall of the tank top between the two angular walls 21. This water is delivered in jets through holes 38 drilled through the sides of tube 37, one hole being in line with each of the pads 22 and so placed that a jet of water strikes the under side of angular wall 21 at a point just above each of the areas refrigerated by means of the contact pads 22.

Some of the water thus sprayed upon the inside of wall 21 is frozen and adheres to the wall on the side that is being refrigerated, while the jets striking the opposite wall 21 serve to cause any ice previously frozen thereon to melt free and fall into the storage basket 12. The ice forms on the refrigerated spots only, freezing into separate blocks, of which five are shown on each side of the tank. The shape of the ice blocks can be controlled by design of the pads 22, and form of the wall and the direction, force, and volume of the jets, the preference being for attractive shapes suitable for use in drinking glasses.

The pump 36 is driven by the motor 40 which runs whenever the main motor of the refrigerating system does, as seen in Fig. 2, thus water is sprayed on the tank roof whenever either the evaporator 23 or the evaporator 24 is refrigerated. This flow of water should be ample to keep air bubbles washed off of the ice blocks being frozen and to free the ice blocks previously frozen on the opposite side of the tank, but not so great as to seriously retard the freezing of new ice. A proper flow of water over the ice in process of freezing insures the formation of clear ice.

The tank 10 is provided with an opening at an angle in the front, closed by the lid 32, which is surrounded by the gasket 33 and provided with a handle 34. When open, the lid is removed or swung on hinges up against the angular breaker strip 5 of the cabinet, where it may be retained if desired by a suitable spring means, but I prefer to let it fall to the closed position so that users will not leave it open. This lid is lifted to afford access to the ice, which is removed with a large spoon or any suitable ladle.

The pump 36 is driven by the motor 40 through shaft 41 which has a jaw clutch engagement with shaft 42 of the pump. A water-tight joint around shaft 42 is assured by the packing nut 43 and its packing gland. The impeller 44, mounted on shaft 42 draws water in through the port 45 and delivers it to tube 35. The pump and its shaft 42 are removable with the tank 10 by virtue of the jaw clutch engagement with shaft 41 of the motor 40. As shown in Fig. 1, there is a pin through the shaft 42 in position to engage opposed notches in the hollow end of shaft 41. These notches are repeated all the way around the end of 41 and the entering end of 42 is pointed, so that engagement is assured without any special attention when the tank 10 is pushed into place, where it is secured against sliding forward by the catch 31.

On the shaft 41 is a pinion 48 meshing with the gear 49 which it drives. The gear box 50, which is shown broken away on the near side in Fig. 1, encloses this pair of gears and additional gears, not shown, for speed reduction to a very low speed on the order of one revolution per hour. This low speed drive is for the purpose of actuating the valve mechanism by means such as I have shown in previous applications or for actuating a switch as shown in Fig. 2, or both. The electric clock 54 of Fig. 2 is the equivalent of gear box 50 and its drive from motor 40, the only difference being that in the diagrammatic view in Fig. 2, the motor and gear reduction are all included in the clock 54 and a separate motor 40 is shown for driving the pump 36.

The refrigerant path may be followed in part in Fig. 1, but can be more readily traced in Fig. 2, as follows: High pressure gas from compressor 70 passes through tube 71 to condenser 72, where it is liquefied and the liquid enters the cabinet through tube 59, going to expansion valves 60 and 60', which are here shown connected in parallel though they might be connected in series.

That part of the low pressure liquid passing through tube 63 flows into one of the evaporators 23 or 24 (23' or 24' in Fig. 13) according to which is open at the valve 68 (143 in Fig. 13) and the vaporized refrigerant returns through tube 69 to the higher pressure suction port of the compressor 70, here shown as a port in the side of the cylinder to be uncovered by the piston near the bottom of its stroke.

Another portion of the liquid refrigerant passes through the expansion valve 60' to the sharp freezer evaporator 95 and returns through tube 100 to the lower pressure suction port of compressor 70, here indicated as a valve in the cylinder head. On the suction stroke (or portion of rotation in the case of a rotary compressor) the compressor draws in nearly a cylinder full of low pressure vapor from the colder evaporator 95, after which a further movement of the compressor uncovers the high pressure suction port and takes in a volume of higher pressure vapor from the warmer evaporator associated with the ice-maker and/or an evaporator which serves to cool the air in the main food compartment.

Since there is, in accordance with common practice, a check valve where gas from tube 100 enters the cylinder, gas from the higher pressure suction line 69 cannot pass into the lower pressure suction line 100. Gas from both suction lines is compressed and discharged through tube 71 to the condenser. The expansion valve 60 is of the thermostatic type, having its bulb 58 clamped against suction tube 69, or tubes 66 and 67 (Fig. 13). Expansion valve 60' is likewise of the thermostatic type, but is designed to stop refrigerant flow at a lower temperature of its bulb 58' which is clamped against suction tube 100. This arrangement serves to divide the refrigerant flow between the two expansion valves as required by their respective evaporators to avoid frost-back and to prevent excessive refrigeration of the warmer (main) food storage space.

Alternative arrangements are to locate the bulb or tube section used as a bulb of either valve in its refrigerated space remote from tube 69 or 100 as the case may be, outside of the cabinet, exposed to ambient air, to the condenser, to outside wall temperature of the cabinet, or to suction line temperature, as indicated at 58''. In these cases the bulb is warmer than the valve and the charge of volatile fluid must be great enough to fill the colder spaces with liquid so as to act on the temperature changes of a warmer portion of tube or bulb. Response is to the temperature at a meeting of liquid and vapor. A lower temperature of a part filled with liquid has no effect, neither does a higher temperature of a part filled with vapor, except for conductivity along the tube.

By locating the bulb 58 remote from tube 69, exposed to cabinet air only and with the larger charge of volatile fluid, as above described, it is possible to provide against the possibility of freezing food in the main storage space when extra running time is required for space 119. Still another method of locating the bulb 69 is to mount it against the tank wall in the manner shown for control bulb 85' in Fig. 15. This has the effect of starting the formation of ice at a relatively high evaporation temperature and reducing this temperature as the ice discs grow in size, which is advantageous in the making of clear ice at the maximum allowable freezing rate.

Assuming that the valve mechanism 68 (or 143 of Fig. 13) has snapped to the position in which tube 67 is open for flow of refrigerant vapor to tube 69 and that the condensing unit is in operation, it will be seen that evaporator 23 or 23' is being refrigerated and evaporator 24 or 24' is idle. When the condensing unit is operating, the motor 40 (Figs. 1, 2 and 7) is also in operation, driving the pump 36, hence water is being delivered to the freezing surfaces and ice blocks 75 are in process of freezing on the lefthand (far) side of the tank as seen in Fig. 1. At the same time, the water jets striking any ice blocks remaining on the righthand side of the tank roof will melt them free from the tank wall 21 and cause them to drop into the basket 12, while the water flows down the inner walls of tank 10, outside of basket 12.

The ice stored in basket 12 is not further refrigerated, hence it melts gradually and the water of meltage returns to the main water supply 15 in the lower part of the tank 10 to be recirculated by the pump 36. In case the ice supply builds up to a level higher than the sides of basket 12 the ice blocks 75 will contact the side walls of tank 10 and be in the path of water flowing down these sides, thus causing a more rapid melting of ice to balance the over-supply and to hasten cooling of the cabinet so that the lowered temperature will prolong the idle periods of the condensing unit, thus preventing the accumulation of more ice than can be accommodated and compensating for higher room temperatures. Ice does not normally fall into the space between side walls of tank 10 and basket 12 because the curvature at junction of tank top and sides hastens the dropping of ice and prevents it from following the tank walls.

Since it is the flowing water which is frozen and the surfaces on which the ice freezes are cooled by the higher temperature evaporators, the ice will freeze in a clear state. There being no strains of expansion nor of forcibly breaking loose imposed upon the ice, it will not be crazed and will remain clear.

The water which has passed over the freezing surfaces will be cooled thereby and will in turn cool the side walls of the tank 10, which insures a substantially constant condition of cooling of cabinet air, even when the water supply in tank 10 has been allowed to fall below its proper level. The faucet 11 is placed a distance above the bottom of tank 10 so that users will be warned cf a low water supply by slow running of water drawn from the faucet for drinking purposes before the supply has fallen low enough to interfere with cabinet cooling.

The main cooling of cabinet air is obtained from its contact with the exterior or tank 10, on which dew will collect. This moisture will drain into pan 29, forming a trap at tube 28 and flowing out through this tube at a given level. The condensate thus taken from the cabinet is reevaporated to room air by means which I have disclosed in my co-pending application No. 8,879.

The wiring connections between the various electrical units of the system are more clearly shown in Fig. 2, where it is seen that the line conductor 81 goes directly to the thermostatic switch 83, from which the conductor 86 leads to the main motor 87 and to auxiliary motors 40 and 54. The other side of the line 82 leads directly to the opposite pole of motor 87, but is also connected to one pole of motor 40 and (if a separate clock motor is used) to clock motor 54. In either case, it is seen that the pump 36 and the commutator 90 are driven whenever the main motor 87 operates and at no other time. The two or three motors are connected in parallel with each other and are all started by the closing of switch 83.

The thermostatic switch 83 may be a conventional assembly such as is commonly used in household refrigerators. Its capillary tube 84 connects with the bulb 85 which is shown as contacting the valve assembly 68. This is equivalent to the common practice of clamping the control bulb to the suction line, as this valve assembly is the junction of the two suction tubes with the main suction tube 69. The control 83 is adjusted to have a narrow range between cut-in and cut-out temperatures with the cut-in temperature at the point it is desired to have the unit start. This starts motors 87 and 40 and the clock 54. The latter turns the commutator 90 at a fixed low speed on the order of one revolution per hour so that in a very few minutes the commutator will have moved from the position shown to the position at which brush 89 contacts the outer metal ring 91 again. Since branch 88 is always in contact with ring 91, this closes an electrical path around the switch 83 and motors will continue to run after the thermostatic switch 83 has reopened, which it does in a few minutes due to its narrow temperature range.

This operation continues until the brush 89 drops into the next notch (see Fig. 3), breaking the circuit to initiate another idle period. This provides a definite timed ice-freezing period. The motors operate for a fixed period, here shown as twenty minutes for one revolution per hour of the commutator 90, each time they are started, but the frequency with which they are started depends upon the temperature rise of the cabinet air affecting the bulb 85. Thus cabinet temperature is controlled by regulating the number of running periods per day and ice block size is established by the fixed length of run.

In actual practice, it may be preferred to connect the clock mechanism 50 or 54 with the switch 83 so that this same switch is opened by the timing mechanism after having been closed by the temperature rise. Such an arrangement is shown in Figs. 7 and 8 and described later herein.

Figure 4 is a front view of the low side assembly of Fig. 1 partly in section. The tank 10 is broken away to show the parts within and behind it, including some parts which are not seen in Fig. 1 because they have been broken away there. Fig. 4 is on a somewhat larger scale than Fig. 1. This view shows more detail of the valve assembly 68 and the thermostatic switch 83 as well as the pump 36.

The control 83 is here shown as comprising a bellows 80 connected by the tube 84 with the bulb 85. Upon a rise of temperature of bulb 85 a volatile liquid therein evaporates to increase the vapor pressure within bellows 80 and push upward on the rocker arm 79. This movement causes the switch 78 to close the contact which connects the wires 81 and 86. This movement is resisted by the spring 76 and to a lesser extent the start of the movement is resisted by the toggle spring 77. By means of an adjustment screw the compression of spring 76 may be increased to raise the temperature at which the switch closes and opens. A similar adjustment screw increases the compression of the spring 77 to widen the gap between the temperatures at which the switch opens and closes.

An extension of the rocker 79 in the opposite direction from its pivot provides an actuating means for the valve assembly 68. Further detail of this action is seen in Figs. 5 and 6, but this figure shows the valve parts themselves. The bellows 101 surrounds the stem 102 and is soldered to it as well as to the housing of the assembly 68. The stem 102 is pivoted at 103 so that it may be rocked sideways, this movement being limited by the seating of the double-ended valve 104, which is pivoted to and moved by the lower end of the stem 102.

In the position shown in Fig. 4 the valve 104 is seated at its left end, closing the outlet port of tube 67 while the port of tube 66 is open. This means that the right hand evaporator 24 is connected with the suction line while the left hand evaporator 23 is blocked at its outlet by the valve 104. Since we see the switch 78 closed in this view it is obvious that the right hand evaporator and the sharp freezer evaporator 95 are being cooled while the evaporator 23 is inactive, allowing ice already formed by the previous run to melt loose from the left side of the tank roof 21 and fall into the basket 12 if it has not already done so during the idle period that followed the freezing of ice on the left side.

The stem 102 is held in the position shown in Figs. 4 and 5 by the toggle spring 105, but if the upper (pointed) end of the stem 102 is pushed to the left, the spring will then hold the stem in the position seen in Fig. 6, holding the valve 104 against its seat at the right and closing the outlet of tube 66.

Referring again to Fig. 5, it is seen that the pawl 106 on the left end of the rocker arm 79 is in position to engage the ratchet wheel 107, which is pressed into the star wheel or cam 108, the two being free to rotate as one piece upon the fixed stud 111. Now referring back to Fig. 4, it is seen that the switch 78 is still closed, hence the refrigerating system is in operation and the bellows 80 is due to contract further. This lifts the pawl 106 clear of the ratchet wheel 107, but after the switch has opened and the bulb 85 warmed up to the required temperature the bellows will reexpand, bringing the pawl down into engagement with the ratchet wheel again. These parts are so timed that the pawl 106 will move the ratchet wheel 107 one tooth to the left before the switch 78 is reclosed.

Figure 6 shows the position of the ratchet mechanism after the above described movements have occurred. In rotating the ratchet wheel one tooth (one tenth of a revolution as shown) to the left the star wheel has been moved one-half of a tooth so that it engaged the left fork 109, causing the toggle to snap to the left, as seen in Fig. 6. This has opened the port of tube 67 and closed the outlet port of tube 66. This is timed to occur just prior to the reclosing of the switch 78 of thermostat 83, hence the next following operating period of the refrigerating system will cause ice to freeze on the left hand side of the tank roof. The valve assembly 68 and the thermostat 83 are mounted on the plate 112 which is in turn supported by the pan 28.

Also mounted on the plate 112 is the adjustable bracket 113 which pivots upon the screw 114 and is clamped in position by screw 115. This bracket carries the screw 116, by means of which the compression of spring 105 may be adjusted. The sidewise adjustment of the upper part of the bracket 113 is for the purpose of locating the point of screw 116 at the correct midway position for the proper action of the toggle spring 105. It will be noted that the faces of forks 109 and 110 are curved on the surfaces where they are contacted by the star wheel 108. This curvature should be such that the resistance to rotation of the star wheel is the same on the two sides, which equalizes the load on the control arm 79 and allows the control to cut in at the same temperature on the starts for right and left sides. The adjustment of bracket 113 is a further provision for equalizing the temperature of starting on the two sides of the ice-maker.

Figure 7 is the equivalent of the electrical portion of Fig. 2 and illustrates a simplification of the wiring diagram to match Fig. 1 more exactly. The main conductors 81, 86 and 82 make the same connections as shown in Fig. 2 and can be traced on Fig. 1 so far as the wiring is shown in that figure. The thermostatic switch 83′ is the only switch required, serving the same purpose as does switch 83 in Figs. 2 and 4 in closing the circuit to start the motors; but in Fig. 7, I have shown a mechanical means for opening the switch of 83′ to stop the motors instead of allowing it to open thermostatically ahead of the mechanically timed opening of the circuit with a second switch connected in parallel with it, as shown in Fig. 2.

The operation of the system as illustrated in Fig. 7 is as follows: Thermostatic switch 83′ is closed by a rise of temperature of bulb 85 in response to a general rise of cabinet air temperature, the switch being so designed that it remains in the closed position regardless of the subsequent cooling of bulb 85, which may contact tube 69, the tank wall, or another refrigerated part and be insulated from box air by an enveloping part or parts 74 to insure against the idle periods being too short. The closing of the switch starts both motors 87 and 40, the latter driving the pump 36 through the shaft and clutch parts before described in connection with Figs. 1 and 2 and also driving the gear reduction mechanism of box 50 as likewise described. Gear reduction 50 is here shown as acting mechanically to open the switch of thermostat 83′ instead of being provided with a driven switch of its own.

Symbol 52 designates a "load-and-fire" mechanism driven from the gear box 50 in a way to act after a given length of time to snap the push rod 53 upward suddenly and then retract it at once. One movement suitable for doing this is that actuating the part 137 in Fig. 8. The action is to open the switch 83′ and stop both motors, the mechanism 52 stopping with the rod 53 in its lower position. The system now stands idle until the thermostatic switch is again closed in response to a rise of temperature of bulb 85, which rise may be retarded by insulation 74 to insure ample time for freeing all surfaces of the ice formed thereon.

This reclosing acts as shown in Fig. 4 to actuate the valve mechanism and shift the refrigerating effect to the opposite side of the ice-maker. The control 83′ is in this case so constructed that it is acted upon thermostatically only to close it and is acted upon mechanically to open it, remaining in whichever position it is left until acted upon by the other force from the one which last acted upon it.

Further details of such a control are found in Fig. 8, wherein the action just described may be obtained by omitting the rod 132 and allowing switch 78 to be closed only by expansion of bellows 121, while thermostatic opening is prevented by locating the stop 131 to engage 122 earlier, thus stopping the bell crank 122 before it has moved counterclockwise far enough to cause 126 to snap to the position 126′, to which it can then be moved only by the upward movement of part 137 or of rod 53, which is actuated by an equivalent load-and-fire mechanism in 52 of Fig. 7.

Figure 8 shows a thermostatic and mechanical control assembly adapted to performing the functions hereinbefore described and in addition this control is adapted to perform in connection with the devices illustrated in the views that follow after it in the drawings, omitting some of its parts in some cases.

The assembly seen in Fig. 8 is identified as 83′, although the figure includes some parts such as the pawl, ratchet wheel, and cam of the valve mechanism, which are not necessarily part of 83′.

The bulb 85 is connected by means of the tube 84 with bellows 121, which moves bell-crank 122 in a clockwise direction due to the usual charge of volatile fluid as the temperature of bulb 85 rises. This movement must compress spring 123 as adjusted by screw 124 to the desired temperature condition. As spring 123 is compressed the right-hand end of spring 125 is lowered, causing rocker 126 to snap from the dotted position 126′ to the solid position shown, which closes switch 78, carried by clip 127, completing the circuit thru wires 81 and 86 which are also seen in earlier views. Rocker 126 is stopped by stop 128 in the operating position (switch closed) and by stop 129 in the open position of switch 78.

The cooling of bulb 85 causes a reverse movement of bell-crank 122 under influence of spring 123 and/or rod 132, which will become more apparent from later more detailed description. When the right-hand end of spring 125 has been raised past the center line of rocker 126 the rocker snaps to the right, stopping against pin 129 in the dotted position with the switch open. The switch may also be opened by one of the two other forces described below, and it may be closed by a reduction of the upward push on rod 132, as will appear later.

Shaft 51 of Fig. 8, which is also seen in Fig. 7, rotates slowly (at say one revolution per hour) in a clockwise direction under power of one of the driving forces previously described, carrying cam 136. A lobe or hook of cam 136 engages the angular end of rod 137 and moves it to the right to the position shown, stretching the spring 138. This action continues until cam 136 has moved a little farther than the position shown, at which point rod 137 slips out of engagement with cam 136 and is moved by spring 138 through the position 137′ to position 137″. In passing the position 137′ the rod 137 strikes the left end of rocker 126, moving it to the position 126′ and opening the switch. While this is happening the pin 139 moves to the left, carrying bell-crank 140 with it, which causes arm 79′ (corresponding to 79 in other views) to move downwardly, pushing pawl 106′ (corresponding to 106) against the ratchet wheel 107′, moving it one tooth-space to the left, which rotates cam 108' one-sixth of a turn counter-clockwise.

Ratchet wheel 107' and cam 108' may replace wheel 107 and cam 108 in previous views, being mounted to rotate as a unit on pin 111, which appears in the earlier views. The forks 109 and 110 may be slightly modified in shape to be actuated by the three-lobed cam 108' instead of by the five-lobed cam or "starwheel" 108. The ratchet wheel has, in either case, twice as many teeth as there are lobes on the cam and it is only required that there be an odd number of lobes on the cam.

As seen in previous views, the opening of switch 78 stops the shaft 51, hence cam 136 does not move until the switch 78 is reclosed by expansion of bellows 121 or by a lessening of the upward push on rod 132. The latter occurs when the supply of ice in storage is reduced by use or by meltage, as will be explained in connection with Fig. 12. The thermostatic and ice-weight action of control 83' is independent of parts 136 to 141 inclusive and of shaft 51, hence these parts may be omitted when other means is provided for actuation of the ice-maker valve mechanism. These parts are omitted when a valve mechanism such as is seen in Figs. 9, 10 and 11 is employed and when the valve mechanism is omitted and sufficient idle time assured for melting ice from all surfaces at once, as first shown in one of my earlier applications.

The assembly seen in Fig. 9, here shown in a somewhat diagrammatic manner, may be substituted for the parts seen in Figs. 5 and 6 and the valve assembly of Fig. 4, omitting the mechanical connection with control 83 or 83'. The rocker valve 104' serves the same purpose as valve 104 of Fig. 4, closing one or the other of the outlet ports of tubes 66 and 67 and leaving the other open for communication with the suction passage 69. The actuation of the valve is here obtained in a different manner, independently of the starting and stopping of the condensing unit, being timed in relation to the density and volume of refrigerant vapor passing to suction tube 69.

As seen in Fig. 9 the port of tube 67 is open into the gas-tight casing 144, and the gas must pass thru orifice 145 in the wall 146, which divides the casing 144 into two parts in a substantially gas-tight manner except for this port 145. The jet of gas striking vanes of the gas-wheel 147 produces rotation of this gas-wheel so long as gas is being removed through the passage 69 by action of the condensing unit. The fan (gas-wheel) is mounted rigidly upon sleeve 148, which also carries pinion 149. Pinion 149 drives gear 150, which is rigidly connected with pinion 151. This pinion drives another gear 150 and so on till the last pinion 151 drives gear 152, which is the same as gears 150 except that it is mounted on sleeve 153 instead of to another pinion. Sleeve 153 carries crank arm 154 on which is mounted the point 155. Shafts 156 and 157 are fitted freely in all of the parts thru which they pass, including the cross member 158 in which shaft 156 has a bearing and wall 146 in which shaft 157 has a bearing. Sleeves 148 and 153 are free to rotate upon their respective shafts as well as in their respective bearings in wall 146 and cross-member 158 respectively.

The gear ratio and the gas-driven wheel 147 are designed to produce a very slow rotation of sleeve 153 on the order of one revolution per hour for average running conditions of gas density and velocity in the system for which the assembly is designed. The compression spring 105'' is fitted with a cupped retainer at each end and held between points 155 and 102', thus being in position to hold the rocker 104' at one or the other of its two extreme positions, closing the port of 66 or 67 as the case may be. The circular travel of point 155 is on a radius such that the rocker 104' is caused to snap to the opposite position twice in each full rotation of sleeve 153. Thus each of the ports of passages 66 and 67 will be open into housing 144 alternately during a portion of a revolution of sleeve 153, providing an ice-making period and an ice-freeing period for each of the two ice-maker evaporators. In this case the design is such that the length of an ice-freezing period is ample to provide a satisfactory ice-freeing period of the same length on the opposite surfaces of the ice-maker.

Figure 9 is included for the purpose of showing the train of gearing more clearly than it can be shown in Figs. 10 and 11, which represent much more exactly the form of housing and arrangement of parts preferred in practice. The gearing seen in Fig. 10 is arranged to perform exactly the same function as the gears in Fig. 9, as do the gas-wheel 147 and the orifice 145. The dividing wall 163 serves the same function as wall 146 of Fig. 9 and in addition is the sole support for the gearing assembly. Wall 163 fits into the lower half 164 of the gas-tight housing and is retained by the upper half 165 which is gasketed to 164 and secured together by means of screws and nuts, of which two are shown.

It is not necessary to trace the gearing between gas-wheel 147 and eccentric 167, but the gearing assembly 166 serves to produce approximately the same rate of eccentric rotation that we had of crank 154 rotation in Fig. 9. This eccentric acts upon the U-shaped arm 168 to move one end of the spring 105' first in one direction and then in the other so that it acts upon the point 102' and the valve rocker 104' exactly as before described. The slot in one side of the part 168 is non-symmetrically formed to produce about the same ratio of movement for snapping in each direction. The stop 169 attached to part 165 retains the arm 168 and prevents spring 105' from moving it too far in either direction prior to assembly of parts 164 and 165 to each other.

The type of valve mechanism illustrated by Figs. 9 to 11 inclusive is suitable for use in connection with any type of condensing unit, either intermittent or continuous in operation and of either the compression or absorption type, including adsorption systems and three-fluid systems. It has no external connection with a moving part and exposes no delicate bellows or diaphragm to the refrigerant. The cycling of the ice-maker is thus independent of the cycling of the condensing unit. It may be desired to regulate the operation of the condensing unit to stop it when a maximum supply of ice has been accumulated, but this stopping and starting need not be synchronized with the cycling from side to side of the ice-maker during one running period. With the control by means of ice weight hereinafter described in connection with Fig. 12, it is possible to dispense entirely with the usual thermostatic control of the condensing unit, or a thermostatic control may be made subject to cabinet air temperature independently of evaporator temperature, providing a more uniform cabinet air temperature control than is possible with any of the conventional thermostatic controls.

On account of the very light load on the fast-moving parts and the very slow motion of the more heavily loaded parts, it is possible to operate the valve mechanisms as shown by Figs. 9 to 11 inclusive with practically no lubrication, but some lubrication is obtained from the refrigerant itself and more from the oil which circulates with the refrigerant in most systems. The outlet at 69 may be so located that some oil is trapped within the gear housing in position for one or more of the gears to dip in this oil. Such an arrangement is shown in Fig. 9. Bearings of Figs. 10 and 11 may be hardened or jewelled or made of a self-lubricating material such as a graphite-impregnated bronze, or they may be of ball or roller types which will operate under these light loads with no lubrication.

Figure 12 shows details of control means that are broken away in Fig. 1, where a broken portion of lever 176 may be seen just below the ice basket 12. The ice basket is seen in Fig. 1 supported by the four embossed stops 13 in tank walls, but when the ice supply is low the basket is raised from the two stops near the rear of the tank 10 by the lever 176, and spring 179, as seen in Fig. 12.

The lever 176 is urged upwardly by the downward push of spring 179 on the rod 132 and lever 178, which are located outside of the tank at the rear and connected with lever 176 by the rocker shaft 177, passing through the rear wall of the tank. The lower end of spring 179 is retained by the collar 180, threaded to the rod 132 and locked in position by nut 181, providing means for adjustment of the compression of spring 179.

When the weight of ice supported by basket 12 reaches a desired maximum the lever 176 is depressed, compressing spring 179 and urging the push rod 132 upward, tending to move the control 83' to its "off" position, as may be seen in Fig. 8. Under this condition the bulb 85 must attain a higher than usual temperature in order to cause the bellows 121 to expand and close the switch 78, but in the event of sufficient rise of cabinet air temperature this will occur, starting the system in spite of the full supply of ice.

On the other hand, removal of a considerable part of the ice supply from basket 12 will allow spring 179 to lift the basket 12 with less temperature rise of bulb 85, removing some of the resistance to closing of switch 78 and causing earlier and more frequent starts. In case a very large portion of the ice is removed, lever 178 may be lowered to an extent that allows switch 78 to reclose at once after the snapping back of rod 137 so that the freezing periods on right and left follow each other without the usual idle periods between them.

One result of this method of control is that the system is caused to run more following the removal of a large amount of ice and another is to cause the building up of a larger than normal supply of ice in the event that cabinet air temperature is raised by some such condition as an extra warm day or placing an extra large supply of food in the cabinet to be cooled. These effects produce desired results in both cases. as follows:

When an extra amount of entertaining is done. calling for the use of an extra amount of ice, the system starts to run more often or even continuously to replenish the ice supply. When the cabinet air is warmer than usual the control is urged to the "on" position and the ice supply increased.

The latter of these effects has a compensating effect on cabinet air temperature as follows: The building up of a larger than normal supply of ice causes the ice level to overflow the basket, bringing ice into direct contact with the side walls of tank 10 and into the path of the water which flows down the sides of the tank on the inside. This reduces the temperature of the water supply and of the side walls of the tank, particularly where the ice contacts them directly, with the result that cabinet air is more rapidly cooled.

The distance between the top of the ice basket 12 and the ice-making surfaces at the top of the tank 10 may be increased as desired to provide any required range of variable air-cooling capacity by varying the ice-refrigerated area to fit varying conditions. This has the effect of varying the cooling element capacity to fit the cabinet load conditions, whether the load be in the form of warm foods put in or a higher room temperature.

With the dual suction or multiple effect type of compressor here shown and employing the higher temperature suction for ice making, the ice is frozen slowly enough to be clear, even without mechanical agitation such as I have provided herein and in earlier applications. This means that the ice is very near the maximum density point of ice. Combined with a uniformity of shape this causes the weight of ice to bear an almost constant ratio to the weight of water required to float it in the tank.

Figure 13 shows how this principle may be employed to accomplish a control of the refrigerating system by a measurement of ice-and-water mass to maintain substantially a constant weight of ice stored in flotation. In considering this figure two facts must be kept in mind, first, that a mixture of pure ice and water with the ice in small pieces is always at exactly 32 degrees F., subject only to very minor corrections for ambient atmospheric conditions; and second, that the maximum density of water is 39.2 degrees F., which means that water at 35 to 45 degrees F. is heavier than the 32 degree water in which the ice is floating, hence the warmer water settles to the bottom of the tank.

I employ this principle in Figure 13 to measure the volume of floating ice by means of the temperature at either of two levels on the tank wall, the level of the lowermost floating ice or the uppermost ice level above the water level.

The tank 10' of Fig. 13 is filled with water to a constant level by means of float valve 174. Since the floating ice displaces exactly its weight of water this level does not change when more of the water is converted into floating ice, it being understood that the water level is such as to allow space for that part of the ice extending above the water line. The height of ice above the water level bears a definite relation to the depth of ice below the water level, hence the volume of ice can be measured by placing a thermometer against the outside tank wall at either top or bottom level.

Conversely, the amount of ice can be controlled by means of a thermostat bulb located against the tank wall, provided the thermostat has the required temperature range and the refrigerating system controlled thereby is of ample capacity. Such a location is shown by the upper one of the three horizontal legs of the tube 84 indicated at 85′ on the left side of tank 10′. The tube 84 is itself bent in "hair-pin" fashion and clamped against the outer wall of tank 10′ to serve as the bulb of thermostatic switch 83. The charge of volatile fluid in this tube and the thermostatic switch 83 is closely regulated as to quantity so that within the temperature range in which it is to operate there will be, in addition to the vapor charge, an amount of liquid somewhat less than enough to fill a single one of the horizontal legs 85′ or a single one of the equal horizontal legs 85″.

This liquid will condense in the coldest portion of the tube 84, which may be the lower leg 85″ or the upper leg 85′, whichever is most cooled by the ice in the tank 10′. It is to be noted that the tank wall will be somewhat colder at the bottom ice level than at the top ice level, due both to the conductivity of the water and to the higher air temperature contacting the outside of the tank at its top, hence the ice may build up above the upper leg 85″ to a greater extent than it builds downward below the lower leg 85′ to accomplish the same result. The control may be obtained at either level, but I prefer to omit the legs 85″ and all of tube 84 down to the upper leg 85′ and rely upon the bottom level only.

Only one of the three legs 85′ is really required for the control of maximum ice supply, but I prefer to employ at least two legs 85′ and so locate the lowermost one that it is affected by the formation of new ice on the inner side of the tank wall. The lowermost piece of ice 75 visible in Fig. 13 is seen attached to the tank wall. As this piece of ice increases in size due to the refrigeration of that part of the wall by the evaporator 23′ it will be seen that the liquid charge will eventually move to the lowermost leg 85′ and thermostat 83 will cut out because of this independently of any cooling effect produced by the floating ice. The adjustment of control 83 is assumed to be such that it will not cut in again until this piece of ice has detached itself from the wall and floated upwardly.

This one thermostatic switch thus controls the size of ice disks formed and the amount of ice accumulated. The system is stopped in response to the completion of one batch of ice, started by the freeing of the ice, and so on till it is stopped by the accumulation of the desired maximum supply of ice. This would be the operation if all of the evaporators 23′ 23″ 24′ and 24″ were active each time the system were operated and the location of the lowermost leg 85′ were such as to be affected by the last of the ice disks to float free. It would with this method of operation be advisable to employ a little higher cut-in setting so as to be sure that all of the ice floats ahead of the next start.

It is possible to employ only a single leg 85′ or just a bulb (as 85 of previous views), allowing the ice level to come down lower. The one leg or bulb would act on ice formation and flotation until the lowered level (increased supply) of ice would first retard and then prevent the start of the next run. After the ice has melted or been used to a sufficient amount the bulb would warm up and restart the system.

The above assumes, as before stated, that ice forms on all surfaces simultaneously, but the showing in Fig. 13 includes means for cycling between two sets of surfaces without stopping the system, which may be desired in case a condensing unit of small size is employed and it is desired to keep it running while the ice melts free. The valve mechanism 143, previously described herein, is shown connected with the two suction tubes 66 and 67. Tube 66 draws gas from evaporators 24′ and 24″, which are in series with each other while the two of them are in parallel with the evaporators 23′ and 23″ served by tube 67. Evaporator 24″ contacts areas on the forward half of the tank bottom and evaporator 23″ contacts the rear half of the tank bottom.

When the valve mechanism 143 is employed to operate the two sets of ice-making surfaces alternately while the system continues to operate, there is no need for the lowermost leg 85′ and a single bulb or leg 85′ may be used at the uppermost of the three positions shown, to stop the system after building up the desired maximum ice supply. If the lowermost leg 85′ is used to insure against freezing the ice disks too large due to the timing of valve mechanism 143 being too rapid and repeating on the same side before ice has all floated, it would be necessary to have a similar leg 85′ located adjacent to evaporator 24′ and for convenience in looping the tube 84 two such legs are shown on the right-hand side of tank 10′ with adjustable insulating blocks 74″ in Fig. 13.

It is thus seen that the tube 84 may be looped to make any desired number of contacts with the tank 10′ for operation on the desired type of cycle, with or without valve 143 or other means for causing the ice freezing areas to act in rotation. The thermostat 83 may be the sole means of starting and stopping the system or an additional switch such as 83″ may be connected in the circuit to produce further control effects. As shown in Fig. 13 the switch 83″ is connected in parallel with switch 83 and is operated in response to freezing compartment temperature combined with the temperature of the main food compartment.

To understand the functioning of switch 83″ it is necessary to note that the bulb 118 located in the frozen food space 119 is larger than usual and is nearly filled with liquid, leaving only 1% or less of its internal volume filled with the vapor of this liquid. The charge of bulb 118 is a liquid selected for its vapor pressure and for a relatively high thermal expansion of liquid in the temperature range from 0 to 10 degrees F., such as, ethane, propane, Freon 12, ammonia, isobutane, or methyl chloride. The normal operating pressure within the bulb 118, its tube 117 and the connected parts of control 83″ is such that a rise of temperature to 20° F. will not produce a vapor pressure high enough to close the switch of 83″. A rise of less than this will, however, cause expansion of the liquid charge in the bulb 118 sufficient to push some of the liquid out into the tube 117 far enough to be affected by the higher temperature of the main food compartment, which is maintained above 32° F. Liquid will then vaporize in the tube, producing a vapor pressure high enough to actuate the thermostat 83″ and start the system.

The thermostat 83″ is adjusted to close at a pressure equivalent to the vapor pressure of the liquid 120 at about 36° F. and to cut out at about 33° F. Since the main food compartment of the refrigerator is normally maintained at 38 to 42° F. it is seen that the switch 83″ closes whenever the temperature of freezing compartment 119 rises to 10 or 15° F. provided that the main food compartment is not colder than 36° F., and the switch will re-open upon either the fall of the freezer temperature to below 10° F. or fall of the main food compartment temperature to 33° F. The result is that freezer temperature is controlled to something below 10° F., subject only to the provision that it will not be cooled to a temperature that represents a freezing temperature in the main food compartment. No harm results from dropping the freezer temperature to zero or below, but the main food compartment must be kept above freezing.

When the valve 143 is used it is not necessary to have any part of the tube 84 nor its bulb contact the tank. In this method of operation the tube 84 acts as its own bulb actuating the control 83 in response to cabinet air temperature, employing an adjustment or setting control 83 to cut in at a suitable maximum such as 42 degrees and cut out at the desired minimum, which may be selected at something like 36 to 40 degrees. This allows some variation in the amount of ice supply accumulated, but the variation is in the right direction, providing more ice in hot weather than in cool weather.

The thermostatic expansion valve 60 regulates evaporating pressure in the evaporators 23', 23'', 24' and 24'' subject to the temperature of the active suction line 66 or 67, both of which are contacted by the bulb 58, and to cabinet air temperature. A second thermostatic expansion valve 60' and its bulb 58' regulate the lower pressure in evaporator coil 95 which is immersed in the eutectic mixture 96 in the tank 97 with its suction end connected by means of tube 100 to the low pressure inlet of compressor 70. The suction tube 69 leads from the valve 143 or from the ice-maker evaporators, as the case may be, to the higher pressure inlet port of compressor 70, which is here shown as a port that is uncovered by the piston near the end of its downward stroke. After the cylinder has been nearly filled with the low pressure gas from the colder evaporator this port is uncovered by the piston and additional, higher pressure gas taken in through tube 69 in a manner known as the "multiple effect" method, which does not require the usual two-temperature valve between the outlets of the warmer and the colder evaporators.

Obviously the system could be operated with such a two-temperature valve, using a single suction port compressor, but I prefer the method shown because of its higher efficiency. The space 119 is enclosed by an insulated wall and is fitted with an insulated door 205, shown broken away. The eutectic freezing solution 96 is preferably of the jelly type and with a freezing point of about zero F. to 10 degrees above, thus keeping the space 119 well below freezing for several hours with the system idle and providing refrigerating effect that is normally stored up for instant use in freezing foods more quickly than they could be frozen by the evaporator 95 lacking this hold-over.

The two legs 85' of the tube 84 on the right-hand side of the tank 10' are shown protected to a considerable extent from the influence of cabinet air by the insulating blocks 74'', one for each bulb or leg 85'. These blocks are movable vertically for the purpose of adjusting them individually along with their bulbs or legs 85'. In this way it is possible to regulate the size of ice disks by moving the lower bulb and the maximum ice supply by moving the upper bulb or leg 85'. A similar adjustment is possible with a single leg 85', but in that case an upward movement to increase the ice size would reduce the maximum ice supply and conversely a downward adjustment to increase the maximum ice supply would reduce the size of ice disks.

The insulation 74'' is so designed that it protects that part of the tube 84 at the leg 85' which contains the liquid at the time thermostat 83 cuts out, keeping it cold long enough to allow all of the ice disks 75 to melt free and float before the control 83 cuts in again in response to the combined action of water temperature and cabinet air temperature. When the system is started with a fresh supply of water in tank 10' this water is usually warmer than the running average, which causes the ice to melt free in less time as well as causing the control 83 to cut in sooner. A proper design is such that the floating free of ice always precedes the cut-in of control 83 at all temperatures of cabinet air and of the tank wall where contacted by the colder and consequently active leg 85'.

The water level in tank 10' is held constant by the float valve 174, which is protected from floating ice by the perforated shield 175. Water main 171 may be closed manually by the valve 172 fot the purpose of disconnecting the hose 173 to remove the tank 10' from the cabinet for cleaning. The tank may be drained without removal from the cabinet by means of cock 170, thus removing sediment from the bottom of the tank. When the water supply contains minerals in excess of saturation at freezing temperature there will be a purification of the water due to the fact that only a small part of the water is frozen at one time. Freezing in this manner forces minerals out of the ice into the unfrozen water, where they settle to the bottom of the tank. The ice and the water at the level of the faucet 11 and above are thus purified so that ice or water removed from the tank is purer than the supply of water from pipe 171.

When the control switch 83 is operated on cabinet air temperature, allowing the quantity of ice on hand to vary, it is found that the depth of ice supply diminishes when the refrigerator is operated in a cool room and increases when operated in a hot room. This means that in the warmer room there is a greater area of tank 10' cooled by direct contact with ice and a lesser area cooled by the water below the ice, which is always warmer than 32 degrees. The cooling effect on cabinet air thus varies to provide more cooling effect when the heat leakage into the cabinet is greater, which is a desirable condition.

Fig. 14 shows a system similar to that seen in Fig. 13, but with the parts differently arranged in the cabinet for the purpose of making the ice supply accessible without the special type of door seen in Fig. 1. The sharp-freezer 94 is set back farther from the outer door of the cabinet, allowing room for the basket 201 which is attached to the door, and for access to the tank 10''. The cover of tank 10'' is loose so that it can be lifted at the front and pushed back to allow pouring in water or removing ice. The tank is shallower but much wider than the one seen in Fig. 13. Ice is formed on the bottom only and control is by means of two legs 85' held against the tank by insulators 74' which are adjustable for ice quantity and ice sizes as before described.

The door 2' of the cabinet and the door 205 of the sharp freezer 94 are assumed to be hinged at the right (near) side, and the striker strip 202 attached to the basket 201 is located so that it strikes the latch 206 of the door 205 in case the outer door 2' is closed without previously closing the door 205. As the doors near their closed positions the latch 206 of the inner door swings to the left (far side) clear of the basket 201 and the rubber bumper 203, mounted on the basket, completes the closing of the door 205 to the point where it is latched by 206.

The door 205 is fitted with a gasket 207 as is usual on outer doors of refrigerators. This gasket makes contact with the frame 208 as the door is closed, but not with the wood or other material of which the main body of this frame is constructed. The frame 208 is faced with a thin metallic covering 209 with which the gasket 207 makes contact. This metallic or equivalent facing is moisture-proof and sealed in an air-tight manner to the inner and outer metal shells bounding the insulated walls of the freezer 94 as seen in Fig. 16. The facing 209 may be a thin sheet of metal, an electrically deposited coating, a sprayed metal coating, or any type of facing which has the required characteristics of sealing the frame and the insulation in the walls of freezer 94 against entry of air and moisture and of reducing thermal conductivity between the inner and outer metal sheets which enclose the insulation in the walls of the freezer 94.

The wood or other frame 208 may be prepared by suitable treatment, as with plumbago, for receiving an electrodeposited facing which covers its entire exposed surface and extends somewhat rearward around the corners for sealing or soldering to the sheet metal lining and exterior, as seen in Fig. 16. A channel of thin sheet metal such as stainless steel may be used in place of the plating, or a cement may be substituted for the solder.

The tank 210 contains the freezing solution previously described and the sections 216 and 217 of the colder evaporator 95. This tank is held in place by the angle 211 attached to the rear lining of the freezer 94 and by the clamping strip 212 which is removably secured by screws 213. By removing the clamping strip 212 and disconnecting the unions 214 at the inlet and outlet of the expansion coil 95 (comprising sections 215, 216 and 217) the tank 210 may be removed from the freezer assembly and from the cabinet. This facilitates repairs or substitution of a new tank assembly 210 in which there may be a freezing solution 96 of different characteristic as to freezing temperature, or tanks of different sizes may be interchanged. The bottom of tank 210 is fitted with fins 218 for increasing heat transfer rate between the air of freezer compartment 119 and the coil 215 on the outside bottom of tank 210 or the mixture 96 within it.

When a load is placed in the compartment 119 and the control has caused the system to start, the first expansion of refrigerant within the freezer occurs in the section 215 of the evaporator 95. This section is exposed to air within the space 119, which it will cool more rapidly than if all of the evaporator were within the tank. In addition to exposing this part of the evaporator coil to air, I provide the fins 218, soldered to the bottom of tank 210 between the legs of coil 215 or directly to the coil 215. These fins and the coil section 215 assist in cooling the air of compartment 119 both when the system is in operation and between runs when the heat absorbing capacity of the material 96 is called upon to do this cooling.

Liquid refrigerant from expansion valve 60′ which is in this figure hidden by the expansion valve 60, being located outside of the freezing space 119 instead of in it as in Fig. 13, enters loops 215 from tube 59, then goes to the crosswise loops 216 on the inside of tank bottom and finally to the upper loops 217, which extend from front to back like loops 215. This arrangement of expansion coil on and in a tank of freezing solution causes the solution to freeze from the bottom upwardly and avoid expansion strains on the tank. The arrangement here shown represents an improvement over my disclosure in Patent No. 1,827,097, issued October 13, 1931, wherein the method of freezing from the bottom upward is shown.

The freezer assembly 94 and evaporator 221 are supported from the top of the cabinet or top and side wall by means of the straps 220. These straps are not attached to the tank 10″ which merely rests upon the evaporator 221 and may be withdrawn from the cabinet without disconnecting anything. Evaporator 221 is provided with round raised areas contacting the bottom of tank 10″ and providing between the two sheets of metal forming 221 the expansion spaces 222, of which one is seen in Fig. 15. These expansion spaces are joined by passages 223 embossed in the lower sheet of the evaporator 221.

As described in connection with Fig. 13, the size of ice disks 75 is regulated by location of the bulb 85′ adjacent to one of the evaporator contacts. Fig. 15 is an enlarged detail of Fig. 14, showing the bulb 85′ held against the bottom of tank 10″ by the adjustable insulating block 74′, which is adjustable to vary the distance of bulb 85′ from the evaporator contact against the tank. Evaporator 221 is formed or fitted with an upwardly extending leg for supporting another insulating block 74′ and a second bulb or section of tube 85′. These bulbs 85′ act in the same way as described in connection with Fig. 13 to control the size of ice discs and the maximum ice supply. The insulating blocks 74′ serve to retard warming up of the bulbs 85′ and thus insure time for the melting free of ice disks 75 during idle periods of the system, as insulators 85′ do in Fig. 13, yet they allow the system to start in response to a rise of cabinet air temperature.

The evaporator 221 is equipped with fins 224 for the triple purpose of stiffening evaporator 221, providing additional heat transfer to it from cabinet air, and supporting drip pan 225, which is drained by tube 28 to the drip evaporator 226 located outside of the cabinet. This drip evaporator is described in my copending application No. 8,879.

Formal changes may be made in the specific embodiments of the invention described without departing from the spirit and substance of the broad invention, the scope of which is commensurate with the appended claims.

What is claimed is:

1. A refrigerating system, ice making means refrigerated by said system, ice storage means, a refrigerator cabinet cooled at least in part by the meltage of ice in said storage means, and means for varying the rate of ice production under the influence of the weight of ice in said storage means.

2. In an automatic ice maker, a surface upon which ice is frozen, a reservoir for water to be frozen, pumping means for causing water from said reservoir to flow over said surface, the parts being so arranged that unfrozen water from said surface is returned to said reservoir, cyclically controlled means for refrigerating said surface

intermittently, and a power element for actuating said cyclically controlled means.

3. A refrigerating system, a refrigerator cabinet cooled by said system, a removable water tank in said cabinet, water level controlling means for said tank, a water supply pipe, a shut-off valve for said pipe, and a detachable connection between said valve and said tank.

4. A refrigerating system, a cabinet cooled by said system, a tank removably mounted in said cabinet and adapted for the storage of a liquid, pump means attached to said tank for circulating said liquid, and drive means for said pump, said drive means having a detachable connection between said pump and a part attached to said cabinet for the purpose of allowing easy removal of said tank from said cabinet and reestablishing the driving connection when the tank is replaced in the cabinet.

5. In an automatic ice maker, a surface wetted by water in motion, means for refrigerating said surface to form ice thereon, means for interrupting said refrigerating effect to allow said ice to free itself from the surface and fall into an ice storage compartment, cycle controlling means for causing these operations to be repeated automatically, and a power means for actuating said cycle controlling means.

6. In an automatic ice maker of the type described, two groups of refrigeratable surfaces, means for refrigerating said surfaces in rotation by groups, and a fluid passage carrying a fluid warmer than 32 degrees F. and located between the said groups of surfaces in a thermal relationship tending to overcome the tendency of the idle group to be cooled by the actively refrigerated group.

7. A refrigerating system, an ice maker operated thereby to freeze and release ice automatically, control means including an element affected by temperature changes and protected against too-rapid response to a rise of temperature for the purpose of insuring the freeing of ice prior to starting the freezing of more ice, and means for adjusting the position of said element.

8. In an automatic ice maker, ice-making means arranged to freeze and to release small pieces of ice, a removable water tank associated with said ice-making means, and means so constructed and arranged that water is supplied from said tank for the making of ice and water thus supplied and not frozen is returned to said tank, ice storage means located at a higher level than that of water stored in said tank, the arrangement being such that water resulting from the meltage of ice in said storage means is returned to the water supply in said tank.

9. In an automatic ice maker, a plurality of refrigerated surfaces, means for cyclically refrigerating said surfaces, a water tank located below said refrigerated surfaces, means for causing water from said tank to flow over said surfaces, and removable ice storage means located at a lower level than said surfaces and higher than the level of water in said tank.

10. In an automatic ice maker and water cooler, an ice storage compartment, a water storage reservoir located mainly at a lower level than said ice storage compartment, and means for circulating water from said reservoir to said ice maker and through said ice storage compartment back to said reservoir.

11. In a refrigerating system, a tank of freezable material, an evaporator connected with said system, said evaporator comprising a plurality of sections including a section nearer the inlet end of said evaporator and a section nearer the outlet end of same, the section nearer the inlet being arranged in heat transferring relationship with a wall of said tank to cause said material to first freeze adjacent to said wall and said other section being arranged so that it is substantially surrounded by said material at a distance from said wall to cause later freezing of that portion of said material surrounding it.

12. A refrigerating system, a cabinet cooled by said system, a space within said cabinet cooled by said system to a lower temperature than other space within said cabinet, and control means for said system including a container located in heat exchange relationship with the colder said space and a fluid-tight extension from said container extending into heat exchange relationship with the warmer said space, said container and extension being charged with a volatile fluid in such quantity that the liquid portion of said fluid charge is restricted to said container and an adjacent part of said extension when said lower temperature space is within its normal temperature range and expands farther into said extension at higher temperatures by virtue of the thermal expansion of said fluid in its liquid phase.

13. In an ice making system, a surface on one side of which ice is frozen, a system for supplying water to and refrigerating said surface at a plurality of areas to form separate pieces of ice and for subsequently melting the crystalline bond between the formed ice and said surface so that the ice is freed to slide on said surface, and a curve in said surface non-conformant with the form of the surface at the ice forming areas for the purpose of breaking the adhesive bond of liquid film between the ice and surface when the ice slides over the latter.

14. In an automatic ice maker, a wall having an under surface inclined to the horizontal, a reservoir for water to be frozen, means for causing water from said reservoir to flow over said surface, the parts being so arranged that unfrozen water from said surface is returned to the reservoir, cyclically controlled means for refrigerating said surface intermittently, and a power element for actuating the cyclically controlled means.

15. In an automatic ice maker, a tank forming a part of said ice maker and adapted for the freezing of ice therein, a refrigerant evaporator arranged in thermally conductive relation with respect to a portion of said tank, means for causing refrigerant to flow through said evaporator, a device for starting and stopping the flow of refrigerant through said evaporator including a thermally affected member thermally in contact with the wall of said tank externally thereof, and means locating said member with respect to said tank adjustable to permit the relative position of said member with respect to ice in said tank to be varied.

16. In an automatic ice maker, a tank forming a part of said ice maker and adapted for the freezing of ice therein, a refrigerant evaporator arranged in thermally conductive relation with respect to an ice making area within said tank, means for causing refrigerant to flow through said evaporator, a device for starting and stopping the flow of refrigerant through said evaporator including a thermally affected member thermally in contact with a wall on which said

area is located, and means locating said member with respect to said tank adjustable to permit the relative position of said member with respect to ice on said area to be varied.

17. In an automatic ice maker, a water tank forming a part of said ice maker and adapted for the freezing and storing of ice therein, a refrigerant evaporator arranged in thermally conductive relation with respect to an ice making area within said tank for the purpose of forming ice thereon, means for causing refrigerant to flow through said evaporator, a device for starting and stopping the flow of refrigerant through said evaporator including a thermally affected member positioned to be thermally affected by ice in said tank, and means locating said member with respect to said ice adjustable to permit the relative position of said member with respect to said ice to be varied.

18. In an automatic ice maker of the class described, a surface providing a plurality of relatively small areas spaced from one another, means for effecting localized refrigeration of each of said areas whereby to enable a separate piece of ice to be frozen on each of said areas upon the application of water thereto, means for applying water to said areas, an ice storage means located at a lower level than said areas positioned to receive ice released from said areas, means for periodically discontinuing refrigeration of said areas to allow the release of ice therefrom and for starting refrigeration of said areas after the release of said ice therefrom, and a source of energy to actuate said periodically actuated means.

19. In an ice maker, a surface adapted to have ice frozen thereon, means for refrigerating said surface, thermally actuated means for rendering said refrigerating means effective, and time actuated means for rendering said refrigerating means ineffective, ice formed on said surface being released therefrom during the periods when said refrigerating means is ineffective.

20. In a refrigerating mechanism, in combination, a refrigerant evaporator, means effective to cause a flow of refrigerant through said evaporator, thermally responsive means for initiating a flow of refrigerant through said evaporator, and means for stopping said flow of refrigerant through said evaporator after a predetermined period of flow therethrough, the last mentioned means being operable to prevent restarting of said flow of refrigerant through said evaporator before the end of a predetermined minimum idle period.

21. In an automatic ice maker, a surface adapted to have ice formed thereon, means for effecting a flow of water over said surface in quantities in excess of that required to form ice thereon, means for refrigerating said surface to form a portion only of said water into ice thereon, means for periodically discontinuing said refrigeration to release said ice from said surface, power means for actuating said discontinuing means, and means for storing said released ice out of the path of said excess water.

22. In an automatic ice maker, a surface adapted to have ice formed thereon, means for effecting a flow of water over said surface in quantities in excess of that required to form ice thereon, means for refrigerating said surface to form a portion only of said water into ice thereon, means for periodically discontinuing said refrigeration to release said ice from said surface, and control means for starting and stopping said refrigerating means and said flow effecting means.

23. In a refrigerating system, in combination, a cabinet, an automatic ice maker in said cabinet, storage means in said cabinet for ice produced by said ice maker and providing relative slow meltage of said ice, and means effective upon the accumulation of more than a predetermined amount of said ice in said storage means to provide an increased rate of ice meltage.

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