

Dec. 30, 1958

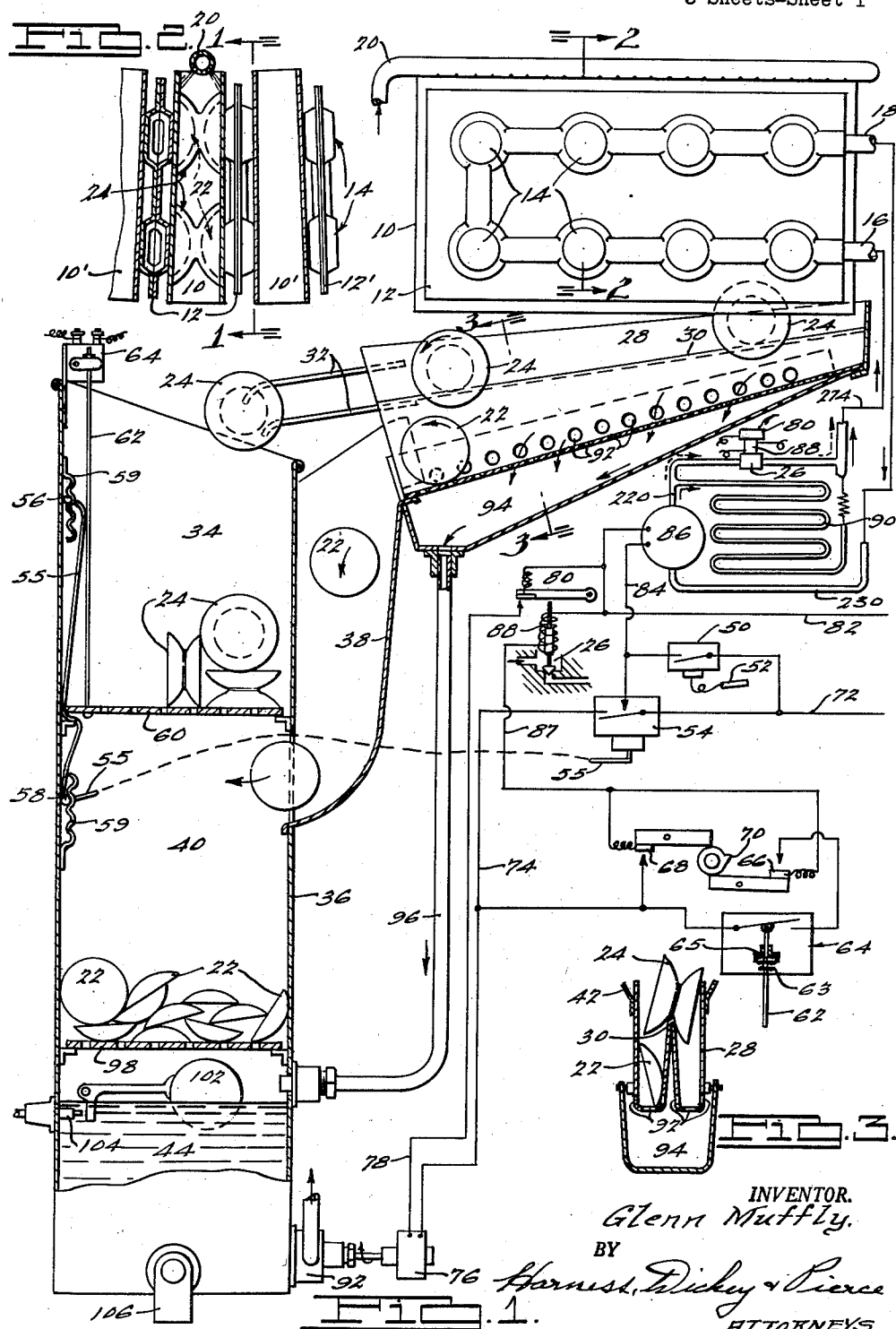
G. MUFFLY

2,866,322

REFRIGERATOR AND ICE MAKER

Filed July 20, 1954

3 Sheets-Sheet 1



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3 Sheets-Sheet 2

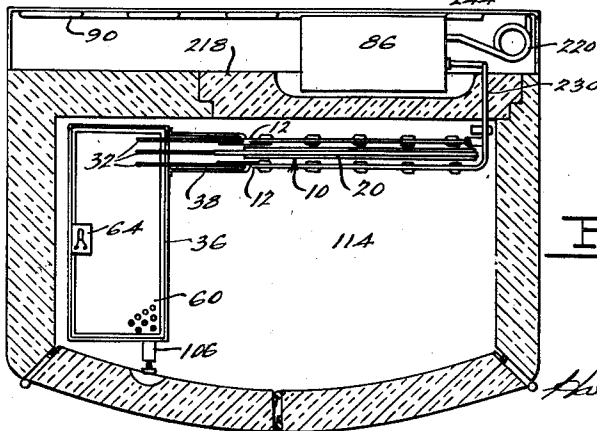
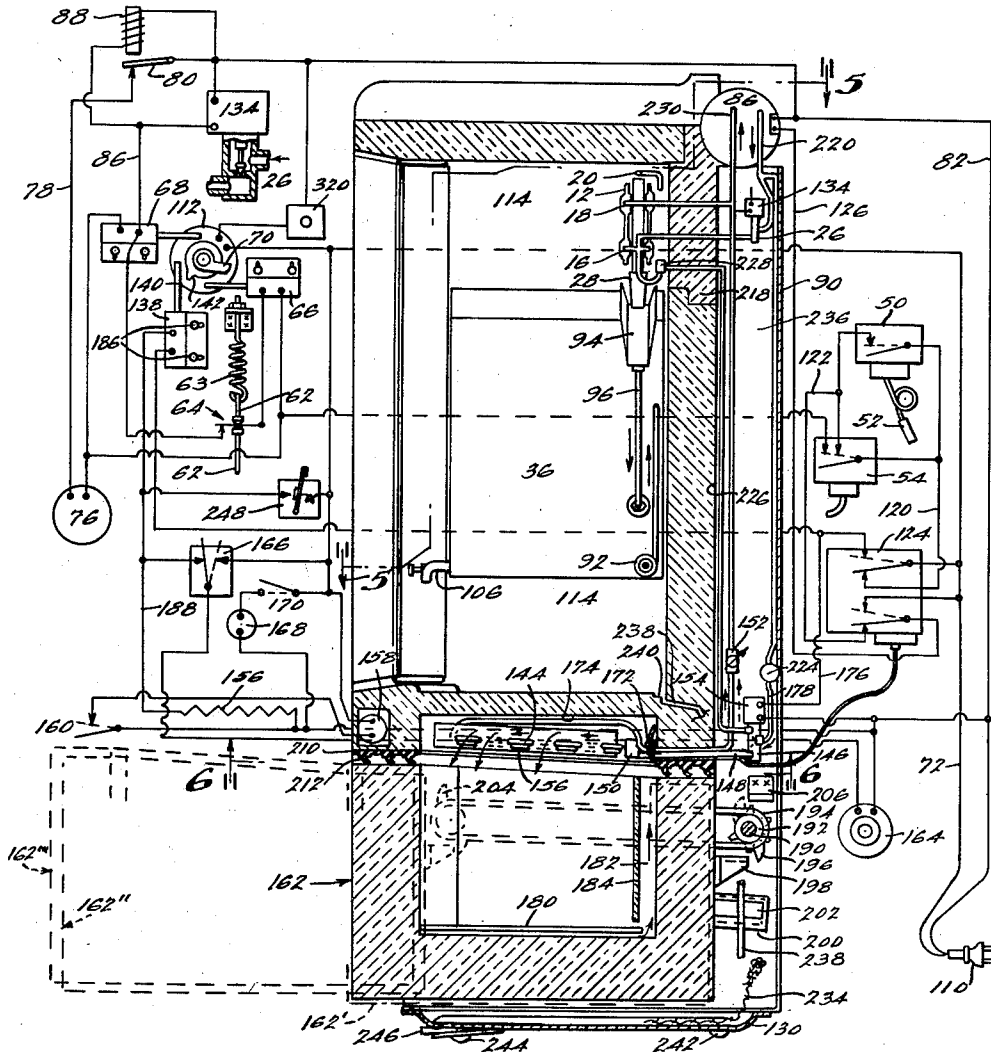


FIG. 5.

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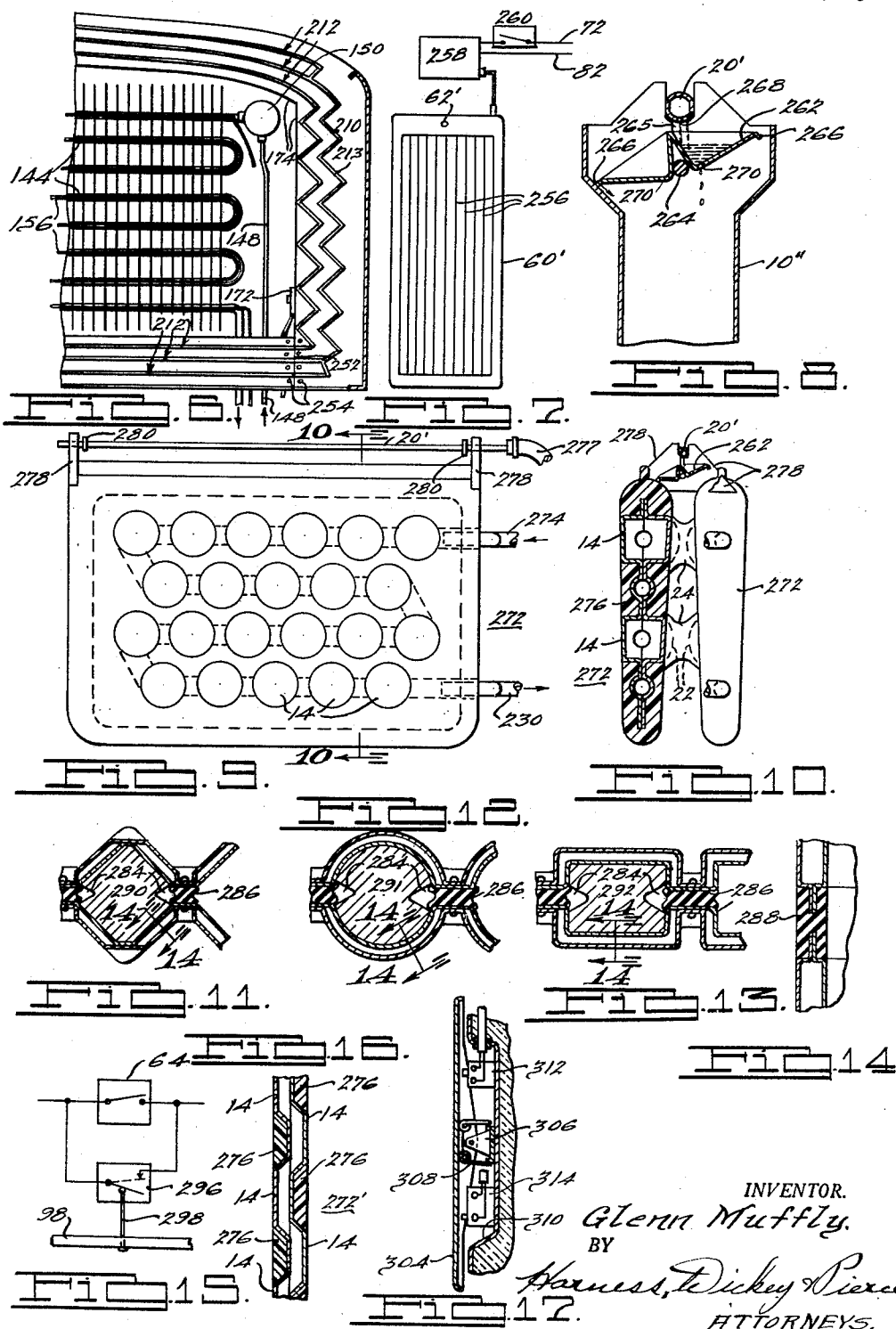
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REFRIGERATOR AND ICE MAKER

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2,866,322

REFRIGERATOR AND ICE MAKER

Glenn Muffy, Springfield, Ohio

Application July 20, 1954, Serial No. 444,422

9 Claims. (Cl. 62—137)

This invention relates to a new type of refrigerator and to ice-making apparatus adapted to be combined therewith or built as a separate machine of any desired capacity, also to controls of refrigerators having both freezers and ice makers.

References are made in this specification directly or indirectly to some of my U. S. patents and pending applications listed below:

Issued U. S. patents

2,349,367, issued May 23, 1944, Control on colder of 2 bulbs.

2,359,780, issued Oct. 10, 1944, Ice dropped, stop on ice weight.

2,368,675, issued Feb. 6, 1945, Hot liquid to release ice.

2,672,016, issued Mar. 16, 1954, Hot liquid to release ice.

2,672,017, issued Mar. 16, 1954, Hot liquid release, bin control.

Pending U. S. applications

S. N. 74,528, filed Feb. 4, 1949, Drawer type freezer (issued May 31, 1955, as Patent No. 2,709,343).

S. N. 174,944, filed July 20, 1950, Spool-shaped ice, hot liquid release (issued December 18, 1956, as Patent No. 2,774,223).

S. N. 178,498, filed Aug. 9, 1950, Drawer type freezer (issued October 9, 1956, as Patent No. 2,765,633).

S. N. 195,664, filed Nov. 14, 1950, Spool-shaped ice in household refrigerator (issued November 30, 1954, as Patent No. 2,695,502).

S. N. 235,910, now Patent No. 2,644,760, filed July 10, 1951, Power-actuated double doors.

S. N. 244,964, filed Sept. 4, 1951, Hot liquid release, reversing valve (issued June 11, 1957, as Patent No. 2,795,112).

S. N. 369,056, filed July 20, 1953, Control on ice bin (issued March 18, 1958, as Patent No. 2,826,899).

S. N. 388,361, filed Oct. 26, 1953, Div. of 2,672,017, above (issued April 9, 1957, as Patent No. 2,787,890).

S. N. 404,985, filed Jan. 19, 1954, Div. of S. N. 195,664, above (to issue May 6, 1958, as Patent No. 2,833,126).

The present application discloses a number of improvements over the inventions of these earlier patents and applications and is directed mainly to a new type of household refrigerator having a separately insulated, automatically defrosted freezer combined with a non-freezing food storage space in which there is an automatic ice-maker, with co-related control of all three. Some of the objects of this invention are:

To provide an evaporator which is used at one time for making ice while incidentally cooling the air within the refrigerator, and used at another time to cool the air without making ice.

To provide control means for modifying the operation of the ice maker to cause the production of either solid blocks of ice for use as "ice cubes" or the production of thin disks of ice for use in flake or crushed ice form.

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To provide means for not only separating ice from water, but for separating large and small pieces of ice, directing such pieces to their appropriate storage compartments.

To provide for transfer of ice from one to another of the storage compartments as it is reduced to smaller sized pieces.

To provide control means responsive to the amounts of ice in storage in separate compartments, acting when there is a reduction of the ice supply in any compartment to cause the production of more ice of the size required to replenish the supply in that compartment and to stop ice production when each compartment is full.

To provide adjustable means for varying the amount of ice required in any storage compartment to operate the control to stop the production of ice in the size range stored in that compartment.

To provide a new system of control which responds at one time to changes in the weight of ice stored in a given compartment and at another time to changes in the volume of ice in storage.

To combine an ice maker with a refrigerator-freezer and separately control all three in response to the needs of each.

To provide improved automatic means for defrosting the evaporator of the freezer of such a refrigerator without wetting the frozen foods stored therein.

To provide for dissipating defrost water from the evaporator of the ice maker and defrost water from the freezer evaporator while preventing such water from contaminating the water to be frozen in making ice.

To provide a drawer-type freezer with a new form of gasket and mechanical means for freeing the gasket from contacting surfaces to which it may be frozen.

To provide a safety device which illuminates the freezer drawer when opened for defrosting of its evaporator.

To provide an improved automatic defrosting system for the freezer of a two-zone refrigerator.

To provide an improved, lower cost type of sheet metal evaporator for use in an ice maker.

To provide an evaporator having ice-making areas on both sides and with a lower percentage of inactive area.

To provide for freezing ice directly on evaporator surfaces while retaining the advantages of controlled ice size and shape.

To provide for feeding water to ice-making surfaces in surges, thus improving ice clarity and system efficiency.

To eliminate the cost of a separate tank, tube, flue or other surface on which ice is frozen.

To provide a sheet metal evaporator of which the two sheets are formed by the same die.

To provide a wedge-shaped evaporator for use in ice makers comprising various multiples of small units.

To provide for freezing separate pieces of ice in closer juxtaposition, with water flowing between such pieces, and thereby producing more ice per day in apparatus of a given size.

To provide an ice-making evaporator having areas directly contacted by water to form ice, with intervening areas protected by thermal insulating material.

To provide for closer control of ice size and shape, producing thicker pieces of ice with less variation in other dimensions.

With this and other objects in view, I now describe the drawings as follows:

Fig. 1 is a general view, partly in section, of an ice-making system adapted for use in a commercial ice maker or in a household refrigerator.

Fig. 2 is a sectional view taken on the line 2—2 of Fig. 1, and also showing how additional ice-making evapora-

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tors and flues or tanks may be added when it is desired to build a system of greater capacity.

Fig. 3 is a sectional view on the line 3—3 of Fig. 1, showing how the single and double ice disks are separated on the way to their respective storage compartments. It also shows how drip water is collected from the evaporators.

Fig. 4 is a vertical sectional view of a refrigerator-freezer cabinet showing a system such as that of Fig. 1 installed therein and including the wiring diagram.

Fig. 5 is a horizontal sectional view of Fig. 4 taken on the line 5—5 thereof.

Fig. 6 is a bottom view of the gasket which seals the freezer drawer, taken on the line 6—6 of Fig. 5.

Fig. 7 is a top view of the upper shelf of the ice storage compartment of Fig. 6, showing an optional ice cutting device.

Fig. 8 is an enlarged detail of the water distributor.

Fig. 9 is an elevation of an evaporator assembly forming an ice maker without use of the tank or sleeve.

Fig. 10 is an end view, partly in section, of Fig. 9.

Fig. 11 is a fractional horizontal section of another evaporator for an ice maker not requiring the tank or sleeve.

Fig. 12 is similar to Fig. 11, showing ice made in a round section instead of square.

Fig. 13 is another variation of Fig. 11, showing evaporators designed to make ice in a rectangular section.

Fig. 14 is an enlarged sectional view taken on the line 14—14 of any of the Figures 11, 12 or 13.

Fig. 15 shows an optional switch for use in Fig. 1 or Fig. 4.

Fig. 16 is a modified section of an evaporator.

Fig. 17 is a detail of a two-way switch for controlling the opening of the doors and the freezer.

Figure 1 is a front elevation, partly in section, of an ice maker such as might be installed in a household refrigerator, with diagram of the refrigerating system and controls. Ice is formed in the tank or sleeve 10, which is here shown as open at the bottom for ice to drop out instead of float up, hence the sides taper outwardly toward the bottom. On each side of the sleeve 10 and contacting it at spaced ice-making areas are the sheet metal evaporators 12, which are here shown as identical and each made of two identical stampings formed to provide the flat, round areas 14 and connecting passages for flow of refrigerant. The areas 14 of one evaporator line up exactly with similar areas of the evaporator on the opposite side of the sleeve 10, it being assumed that there are only two evaporators 12 and one sleeve 10 in Fig. 1, though an extra evaporator 12' and two more of the sleeves 10' are indicated in Fig. 2 to illustrate the fact that these evaporators are two-sided and can be placed between two tanks or sleeves to make ice in each.

Suitable headers are provided to connect the two inlets 16 and to connect the two outlets 18 with the liquid flow control device and the suction side of the compressor respectively. Water is distributed over the inner side walls of the sleeve 10 by means of the perforated spray tube 20 while the evaporators are in operation to form ice on the inside of the sleeve 10, first in small disks, which grow in thickness to form disks such as are indicated by the dotted lines at 22 in Fig. 2. After further growth these disks join to form a double-thickness disk of the shape shown at 24. Periodically the valve 26 is opened to admit hot high pressure refrigerant vapor to the evaporators on both sides of the sleeve 10 to release the ice formed therein. Preferably the flow of water is stopped while ice is being released. This is an economy feature which will be explained later. As the ice disks melt free from the sides of the sleeve 10 they fall into the trough 28, of which a section is seen in Fig. 3. Double disks strike the ridge 30 of trough 28 and roll or slide down this ridge and the wires 32 to the upper compartment 34 of the storage tank 36. Single disks and

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the halves of any double disks that break apart as they fall will roll or slide down the trough 28 on the two sides of the ridge 30 into the chute 38 and thence to the middle compartment 40 of tank 36. Defrost drippage from the evaporators is collected by small gutters 42 (Fig. 3) and disposed of separately from the recirculated water which flows into storage compartment 44.

Referring now to the controls and wiring diagram of Fig. 1 and assuming the refrigerator in which this apparatus is installed to have been started warm, it is obvious that switch 50, which has its bulb 52 located in cabinet air, will be closed. Also switch 54, connected by tube 55 with its two bulbs 56 and 58, adjustably secured by spring clips 59 in the ice bins 34 and 40, will be closed until such time as both bulbs are cooled by the accumulation of ice in storage. Further, since not much ice has accumulated in the upper bin 34, there is not enough weight on shelf 60 so that the portion of this weight carried by the rod 62 will compress spring 63 and move the switch 64 to its closed position. The collar 65 is adjustable on rod 62 to vary the weight of ice required to close switch 64. The fact of switch 64 being open means that closing of switch 66 closes no circuit, hence we can consider only the effect of the closing of switch 68 in response to the rotation of cam 70, which is assumed to be driven steadily at one revolution per hour.

During all of the hour except the two or three minutes that switch 68 is closed, the current flow from line 72 is through switch 54 to wire 74, through water pump motor 76, wire 78, switch 80 and back to line 82. At the same time current flows through switch 54 to wire 84, through the motor of motor-compressor unit 86 and back to line 82. The former of these two circuits is broken as a result of the closing of switch 68, but the latter is constant, thus keeping the compressor running during the ice-releasing period. Now we consider the effects of closing switch 68, which connects wire 74 with wire 87 to energize solenoid 88, which opens switch 80 to stop motor 76 and at the same time lifts valve 26 to open the path for hot gas to flow from condenser 90 and unit 86 to inlet 16 of the evaporators on both sides of sleeve 10. This heats the spots on which ice has been formed and releases the double disks of ice, which roll into the bin 34. It should be noted that switch 50 plays no part in this and can be either open or closed so long as switch 54 remains closed. Also note that nothing happens when the cam 70 closes switch 66, so long as switch 64 is open.

Now let us consider what happens when the weight of double disks of ice on shelf 60 causes switch 64 to close. The operation continues as before except that solenoid 88 is energized for two short periods in each hour, thus causing the release of ice to occur while it is still in the form of single disks 22, which fall into bin 40 instead of bin 34. It is assumed that the switch 64 is so adjusted that it does not close until the ice disks 24 in bin 34 have covered the bulb 56, hence when the ice disks 22 in bin 40 cover bulb 58 both bulbs will be chilled to nearly 32° F., at which point switch 54 opens. The volatile fluid charge of 54, 56 and 58 is in such quantity that its liquid portion will more than fill one of the bulbs and partly fill the other, hence both bulbs must be chilled down nearly to 32° F. in order to open switch 54. When either of these two bulbs warms up as a result of ice removal, the switch 54 recloses and ice production resumes, making single disks 22 if switch 64 is still closed, but making double disks 24 if switch 64 has meantime opened as a result of the removal or meltage of ice from above shelf 60.

When switch 54 opens in response to the accumulation of a full supply of ice the switch 50 may or may not be open, depending upon whether or not bulb 52, located in the air within the refrigerator, has been cooled down to the desired cut-out temperature. In case the switch

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50 is closed at the time switch 54 opens, or in case switch 50 closes at any time while switch 54 is open, the effect is to allow current to flow from line 72 to wire 84, through the motor of 86 and back to line 82 thus operating the compressor and cooling the air within the refrigerator. It is noted that when switch 54 is open the motor 76 is not energized, hence water pump 92 is idle and no water is delivered to the spray pipe 20. In this case only air contacts the evaporators 12 and the sleeve 10, which acts as extended surface to aid in cooling the air.

During the freezing of ice there is a constant flow of water from the spray tube 20 and the unfrozen portion of this water falls into the trough 28 in which there are many small holes 92 for the escape of water into the lower trough 94, from which it drains through tube 96 to the compartment 44 of the tank 36. The movable shelf 60 and the similar shelf 98 forming the bottom of bin 40 are perforated or otherwise open to allow water of meltage to flow from bins 34 and 40 into the lower section 44 of tank 36 and it is preferred to make the side walls of this tank water-tight up to a level which will accommodate any unusual ice meltage such as that occurring when current is off. A door or hand hole opening above this level is provided in the front of compartment 40 and if desired such a front opening may also be provided for the upper bin 34.

Within compartment 44 is a float 102 which opens the valve 104 to admit water when the level drops below normal due to making ice or drawing water from the faucet 106.

Figure 2 shows in addition to the section of sleeve 10 and the two evaporators 12 sections of additional sleeves 10' and an additional evaporator 12', which may be assembled in the positions shown when it is desired to use two or more similar sleeves in one assembly to construct a machine of larger capacity, using mostly the same parts. The evaporators 12—12' are shown as made by welding together two identical stampings, which puts the contact spots of the two stampings in parallel planes, hence the sleeves 10' are slightly inclined from the vertical position of sleeve 10. This is permissible when only three or four sleeves are assembled together with the double-sided evaporators between, but in the case of still larger assemblies it may be advisable to make the evaporators thicker at the top to compensate for the taper of the sleeves. This is easily done and the two stampings still made from the same die by providing the die with removable inserts to alter the positions of passages which connect the end ones of flat areas 14.

Another design, which allows the evaporator stampings to remain identical, is to eliminate the taper of the sleeves 10. This calls for care to see that the sides of the sleeves are flat and parallel to avoid sticking of the ice after its release. The choice will depend in part upon the number of horizontal rows of ice-making areas and whether the hot gas for releasing ice is introduced at the top or the bottom of the evaporators.

This will be discussed further in connection with the figures appearing on sheet 3 of the drawings.

Fig. 4 is a vertical sectional view of a household refrigerator of the two-zone type, showing location of the ice maker of Fig. 1, with diagram of the wiring system. The type of cabinet shown is that of my copending U. S. application Serial Number 235,910, filed July 30, 1951, and is assumed to be equipped with similar operating mechanism for the two main doors. The lower portion of the cabinet, including the freezer drawer, is similar to my copending applications Serial Number 74,528, filed February 4, 1949 (now Patent No. 2,709,343, issued May 31, 1955) and Serial Number 178,498, filed August 9, 1950 (now Patent No. 2,765,633, issued October 9, 1956), but shows an improved form of operating mechanism and defrosting system.

The wiring diagram of Fig. 4 differs from that of Fig. 1 mainly in showing additional connections for the freezer

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drawer and its evaporator. When the plug 110 is inserted in a live outlet and the refrigerator has been entirely cooled down, including the making of a full supply of ice, the various controls will be in "off" position and the only portion of the system energized will be the clock 112, which runs all the time. Assuming now that the air in the main food space 114 first calls for cooling, the warming of bulb 52 causes switch 50 to close, whereupon current flows from line 72 over the wire 120 to switch 50, thence to the wire 122 and through freezer control 124 and wire 126 to the motor-compressor unit 86, returning over wire 82 to the line. This starts operation of the system to cool the evaporators 12, but does not energize the pump motor 76, hence no water flows over the ice-making surfaces and the evaporators cool only the air of the space 114, which is free to flow over the cooling surfaces. During this operation there will be some frost formed on the evaporators, but it will melt off during the next idle period and drip into the two gutters 42 (Fig. 3), located on opposite sides of the ice chute 28, from which it drains to the heavy corrugated base pan 130 and evaporates to room air. This defrosting of the ice-maker evaporators also occurs between runs of the ice maker, while ice is being released, thus separating the drip water condensed from the air from the water to be used in making ice and avoiding the collection of food tastes in the ice.

Either during the run for air cooling or after it has been completed, let us assume that the ice-maker switch 54 closes in response to the reduction of the ice supply in either the upper compartment 34 or the lower compartment 40. This will occur in response to the reduction of either ice supply due to the fact that the liquid portion of the charge of switch 54 is sufficient to fill one of the bulbs 56 or 58 entirely with liquid and only sufficient to fill the other (warmer) one of the two bulbs partly with liquid, while the balance of the control, including the tube 55 and the bellows or similar expansible space of the control, is filled with vapor only. Thus the response which starts making ice is to the warmer one of the two bulbs which is not sufficiently covered by ice to hold it below the cut-in temperature.

At the time of closing of the thermostatic switch 54 of the ice maker, assuming that the upper compartment 34 contains a full supply of ice, the weight switch 64 will be closed, as shown in Fig. 4. This means that the cam 70, rotated one turn per hour, will alternately close circuits through switches 66 and 68 at half-hour intervals. Each switch remains closed for a fixed period of say two minutes, allowing about twenty-eight minutes of ice freezing time between the releasing periods. This causes a thin disk of ice to be formed on each of the opposed ice-making spots and a double number of pieces of ice will be released before they have joined to make half the number of double-thickness disks. Upon closing of either switch 66 or 68 the solenoid 88 will be energized to open the switch 80 and stop the water pump motor 76. At the same time the solenoid 134 (in parallel with 88 so operation is the same as in Fig. 1) is energized to open the hot gas valve 26, allowing hot, high-pressure refrigerant vapor to enter the evaporators 12 through the tubes 16. While this defrosting to release ice occurs the compressor continues to operate, supplying hot gas for the defrosting. Upon re-opening of the closed switch 66 or 68 the valve 26 and the switch 80 are reclosed by gravity, thus restarting the cooling of the ice-maker evaporators and the operation of the water pump.

Assuming now that during the ice-making run, as above outlined, some ice is removed from the upper compartment 34 containing the double-thickness disks. This will lighten the load on shelf 60 and may allow the spring 63 to lift it and open the switch 64 to break the circuit through switch 66 and thus prevent one of the half-hour ice-releasing periods from occurring. This lengthens the ice-making period to about 57 or 58 minutes and causes

the formation of ice in the double-disk size. Because slightly more time may be required to release the double-thickness disks, it may be advisable to keep the switch 68 adjusted to a slightly longer closed (defrost) period than is the switch 66. It will be understood that the switch 138 has no part in ice making, as its arm 140 is actuated by the cam 142, driven at a much lower speed which may be one to seven days per revolution.

During all of the ice-making operations of the system, the ice disks which are released fall into the trough 28, which has a section shaped like the letter W. Single thickness pieces of ice fall into one side or the other of this trough and roll or slide into the lower ice-storage compartment 40 by way of the chute 38 leading to it. Double-thickness disks falling into the trough are supported by and slide or roll on the middle ridge 30 of the trough and are thereby guided into the upper storage compartment 34 by the wires or rods 32. Should any double-thickness ice of less than standard weight be formed during shorter-than-normal freezing periods, as at the start or the ending of an ice-making run, and such pieces break apart upon falling into the trough 28 the two halves will go into the lower compartment 40 along with the other thin disks. Because of this feature of separating the thick and thin pieces of ice, it is not necessary to employ the control features of some of my earlier applications which provide for stopping the ice-making periods exactly at their ends to insure the making of only full-sized ice.

During all operation of the ice maker and of its evaporators to cool cabinet air, the evaporator 144 of the freezer will remain inactive because solenoid valve 146 is not energized and therefore it closes the inlet of tube 148 which carries liquid refrigerant to the freezer expansion valve 150. Also check valve 152 prevents refrigerant vapor from flowing back into the evaporator 144 to be condensed therein. Note that freezer control 124, as shown in Fig. 4, is merely closing contacts in the ice-making and cabinet air cooling circuits for operation of the evaporators associated with the ice maker, and that all connections with solenoid 154, heater coil 156, and switch 138 operated by the clock, are broken in the double-throw double-pole switch of the control 124. The only elements of the freezer portion of the cabinet which can be energized automatically with the control 124 in the position shown are the lamp 158, which is turned on by the switch 160 whenever the drawer 162 is opened, and the motor 164 which opens drawer 162 when switch 166 is manually moved to the dotted position. At all times the lamp 163, located within the main food space 114 of the refrigerator, is turned on by the switch 170 when either of the two doors are opened, in line with the common practice.

Assuming now that the freezer bulb 172, located within the recess 174 of the cabinet floor, warms up to the cut-in point of the freezer air temperature and actuates the control 124 to move both of its switch blades to their dotted positions. This will occur when the warmer portion of the air within the freezer reaches the cut-in temperature, which may be near 0° to 10° F. The result is to break the connections through wire 122 which cause the ice maker evaporators, defrost valve 26 or pump motor 76 to operate, and to close the circuits leading to the freezer solenoid 154, to the freezer defrost switch 138, and to the motor 164 which actuates the drawer during the defrosting of evaporator 144.

One effect of the operation of control 124 to the dotted positions of the switch blades is to close the circuit through wire 176 to energize the solenoid 154 and lift the valve which opens the passage for liquid refrigerant to flow from the tube 178 to the tube 148 leading to the expansion valve 150, thus starting the cooling of evaporator 144 to the required lower temperature than is generally desired in the ice-making evaporators which also cool the main food space 114 of the refrigerator. Simultaneously

with the start of liquid flow to evaporator 144 the compressor circuit is closed to start or continue its operation. Normally the cooling of freezer evaporator 144 will continue until the bulb 172 is cooled down to the desired cut-out point, which may be from -10° to -20° F. During operation of evaporator 144 it will be seen that the colder air drops into the drawer to cool the frozen foods contained therein and that warmer air flows from below the shelf 180 upwardly through the flue 182, which is divided from the frozen food space by the wall 184, which may be of insulating material. This upward flow of the warmer portion of the cold air strikes the bulb 172 and when this air temperature has fallen to the desired cut-out point the control 124 is actuated to return to the positions shown by full lines in Fig. 4.

The above description assumes that no defrosting of the freezer evaporator has occurred during the operating cycle of evaporator 144, as this defrosting happens at widely spaced intervals. It will be seen that switch 138 is closed by cam 142 once during each rotation of the clock shaft which carries it. This shaft is the tubular one, as commonly used in clock construction to drive the hour hand or a still slower hand showing days of the week. It is preferred to use a clock mechanism designed for a 24-hour hand or a day-of-the-week hand, while the cam 142 is quite sharp-pointed and the switch 138 is adjusted in position (by means of screws 186 and their slots) to allow only a few minutes during which the circuit is closed through wire 188 to the heating coil 156, located below the tubes of evaporator 144 in good thermal relationship to them.

The freezer drawer is mounted on a roller slide mechanism usually comprising three channel members of which one is fixed to the cabinet, one fixed to the drawer and one floating between on rollers. The usual "hump" which lifts and retains the drawer in closed position is here duplicated at the full open position. It will be seen that when switch 138 is closed it also completes the circuit through switch 166 and motor 164, which is preferably back-gearred to the shaft 190 carrying the sprocket wheel 192 in such a manner as to be reversible. Upon energizing of motor 164 the shaft 190 is rotated clockwise, moving the inclined belt or chain 194 to carry the lug 196 against the bracket 198 mounted upon the rear of the drawer 162 and extending to the far (left) side of the drawer into the path of the lug 196. This pushes the drawer in the opening direction, first moving the roller slide mechanism of which outer fixed channel 200 and the floating member 202 are seen, off of the "humps" which lift the drawer as it closes, letting it drop to the position 162'. Further chain travel pushes the drawer to the nearly full open position 162'', where the drawer is slightly elevated above its closed position by virtue of the inclined track 200 on which it is guided and supported. At this point 162'', the second lug 204 strikes the stop 206, which is welded to the far (left) side of the outer shell of the cabinet and thereby causes the motor 164 to stall, the motor being designed to stand such a locked-rotor condition for the required length of time. The motor remains stalled, holding the drawer open at position 162'', during the few minutes required to defrost the freezer evaporator. Defrost water thus falls into the heavy metal pan 130 which forms the main base of the cabinet instead of falling onto the frozen foods in the drawer. Upon completion of the defrost period of predetermined length the switch 138 reopens, stopping the heating of coil 156 and deenergizing the motor 164, whereupon cooling of evaporator 144 resumes and the drawer recloses under the influence of gravity due to the inclination of the track upon which it is carried by rollers. This inclination is sufficient to cause the inertia of drawer reclosure to lift the drawer from the position 162' to the fully-closed position 162 in which it is shown by solid lines.

When the cam 142 makes one revolution per twenty-

four hours the switch 138 closes once a day, preferably at two or three o'clock in the morning, when it will not interfere with normal operations in the kitchen, but as a safety precaution in the event that someone comes into the kitchen in the dark and might fall over the open drawer, I have provided the switch 160, which is located on the far side of the drawer in hidden position, to be closed when the drawer is part way open and remain closed until the drawer is nearly closed, thus causing the lamp 158 to be lighted whenever the drawer is opened, either automatically or by hand.

Since it is not normally necessary to defrost the freezer evaporator at such short intervals as one day, the wiring is so arranged that the defrosting occurs only when the control 124 is in position to allow the freezer to operate. Thus the defrosting will be more frequent when the freezer is being cooled more frequently, thereby increasing the probability of a defrost. If during the night the freezer control is "on" one-eighth of the time the freezer evaporator will be defrosted about once in eight days. On other nights the drawer will not be mechanically opened nor the defrost heater energized. Since it should not normally be required to defrost the freezer oftener than once a month, this provision is ample. At the end of each freezer defrost the bulb 172 will be warmer than usual, which means that the cooling of the freezer will always continue after the defrost until the air rising from the drawer through the flue 182 is again down to the cut-out temperature. In case a seven-day or a thirty-day shaft is used to drive the cam 142 the wiring can be changed to cause a defrost each time the switch 138 is closed.

For normal access the drawer 162 may be pulled open by hand to the position 162' shown by dotted lines, at which full-open position it is retained by a "hump" in the track similar to that which keeps the drawer in its closed position. This opening of the drawer does not cause defrosting, but it does light the lamp 158 to aid in seeing the drawer contents. A slight push moves the open drawer off of the "hump" to the position 162'', from which it is reclosed by gravity. The chain 194 and its lugs do not move when the drawer is opened by hand.

An optional feature, which may be added if desired, is the switch 166, by means of which the user may energize the motor 164 at any time, causing the drawer to be opened by power and held open until the switch is snapped back to the solid line position to allow the drawer to reclose under the influence of gravity, all without energizing the heater coil 156 and regardless of what controls may be on or off. This is a refinement to accompany the power opening and closing of the two upper doors of the cabinet, as described in copending applications of mine listed above. The switch 166 is preferably located beside the lamp 158 or in the face of the cabinet at a higher level, out of reach of small children, and is arranged to snap from one position to the other. It will not interfere with defrosting nor with any other functions which are time or temperature controlled, except that the freezer drawer can not be cooled while open. To provide against carelessness of the user in forgetting to reclose the drawer, the switch 166 may be of the timing variety, such as those used on electric toasters, so that the drawer will be closed automatically at the end of a pre-selected time limit. The same provision can be made for the mechanical reclosing of the two main upper doors in combination with the mechanical self-opening feature disclosed in my earlier patent applications above listed.

The mounting of the drawer 162 on rollers with an inclined telescoping track and the "humps," which slightly lift it at the fully closed and fully open positions, is shown in part, and will be understood by reference to the similar telescoping tracks, usually of channel form, which are commonly used on letter file drawers. In the case

of letter files the tracks are horizontal and normally have the "humps" at the closed position only. The difference here is that I propose to mount these tracks on a slight incline to lift the drawer as it is opened, and to locate the "humps" at both ends of the travel, so that the drawer is slightly lifted and retained in position by the humps in both its closed and its fully open positions. The nearly-open position 162' of Fig. 4 is just prior to the lifting of the drawer which occurs as it is moved to the fully open position 162'' in which it is retained.

Use is made of gravity and of the power of motor 164 in breaking the drawer free from any ice or frost which has formed on the top edge of the drawer and on the gasket. The new type of gasket shown at 210 is provided to facilitate this breaking free as the drawer is opened either by hand or under power. The thin flexible ribs 212 of the gasket are bent to the positions shown by the closing of the drawer, hence are so curved as to tear away readily from any frost bond between them and the drawer. The initial movement in the opening direction will flex these ribs and then the dropping of the drawer off of the "hump" to the position 162' will further aid in tearing the gasket free. Since the cabinet width is commonly about twice the inside front-to-back depth of the freezer drawer this takes care of most of the gasket. A similar effect is obtained where the gasket is in contact with the near and far ends of the drawer as seen in Fig. 4 by forming the gasket with zig-zag ribs at any angle of say 45°. This, in conjunction with the inclined tops of the end walls of the drawer, makes it relatively easy to break the drawer free from any freezing shut that may occur. The use of a plurality of ribs also aids in this by preventing kitchen air from reaching the coldest of the ribs.

Assuming that the cabinet air switch 50 recloses in response to a rise of temperature in the main food space and ice-maker switch also recloses in response to a demand for more ice while the freezer is being cooled (with or without defrosting evaporator 144) and then the freezer control goes back to the position shown by solid lines in Fig. 4, the effect will be to start making ice, which also acts to cool the air in the food space. The first pieces of ice made are apt to be small pieces, due to the accidental stopping of the latest run in the middle of an ice-making cycle, but the next batch of ice will be double disks if any are required to reclose the switch 64. If switch 64 is already closed because of the upper compartment being full, the first complete run on ice making will be to make a batch of the single-thickness disks.

Should operation of the ice maker cool the cabinet air touching bulb 52 to the extent of causing switch 50 to reopen, the compressor will stop when the demand for ice is satisfied, otherwise the system will continue to operate on cooling the ice-maker evaporators with the water pump idle, thus completing the cooling of cabinet air to the desired cut-out temperature. Because the stored ice is at exactly 32° F. and ice making includes defrosting, there is no danger that the continued operation of the ice maker will cause foods stored in the main compartment 114 to freeze.

Figure 5 is a top view taken on the line 5-5 of Fig. 4, showing the locations of the ice maker and the ice storage compartments as well as the type of double front doors referred to in the specification. It will be noted that the removable wall section 218 need be only of the size shown to allow removal of the entire refrigerating system from the cabinet. Comparing this view with Fig. 4 it will be seen that the motor-compressor unit 86 discharges compressed refrigerant vapor through the tube 220 leading to the condenser 90 except at such times as the solenoid valve 26 is open for the hot gas to flow into the ice-maker evaporators 12. From the liquid receiver 224 at the bottom of the condenser, liquid flows normally through tube 226 to the expansion valve 228 of the ice maker, but when solenoid 154 is energized to actuate the

valve 146, allowing flow to the tube 148 and stopping flow to tube 226, liquid flows through tube 148 to the expansion valve 150 of the freezer.

Vapor returning from the ice maker evaporators flows through the tubes 18 and 230 to the suction side of the compressor. Meantime the check valve 152 prevents the vapor which leaves the ice maker evaporators from entering the colder freezer evaporator. When the freezer evaporator is operating the valve 146 closes the passage between the liquid tube 178 and the liquid tube 226, thereby preventing flow of liquid refrigerant to the ice-maker evaporators. The system operates at either the very cold or the moderately cold temperature, according to the needs of the main and the freezer compartments, with the result that higher efficiency is obtained than in systems wherein the compressor must always operate at the lowest suction pressure employed in the system.

Drip water collected from defrosting of all of the evaporators falls into the pan 130 and from there is evaporated to room air with the aid of the mat 234 which by capillary action spreads the water in the path of the air flow induced by the stack effect of the condenser, which forms a chimney 236 up the rear of the cabinet. With ample air flow thus induced and a suitable mat for picking up the water it is not necessary to provide for heating the pan of water, but this is easily done by extending one of the hot tubes into the pan, if it is thought to be necessary.

The drain tube 238 delivers drip water from the lining of the cabinet where collected in the gutter 240 and also from the two gutters 42, seen in Fig. 3, to the fabric 234 from which the drip evaporates to room air. This fabric is of a nature to carry water up from the base pan 130 by capillary action to evaporate into the air stream induced by the up-draft in the chimney 236.

The freezer drawer is preferably made with its side walls and bottom thicker or better insulated than other walls of the cabinet, there being no insulation in the cabinet side walls at the level of the drawer. This insures that the frozen foods in the drawer will not be started to thaw during any normal periods during which the drawer is open. The bottom of the main food space, directly above the freezer evaporator, need not be heavily insulated because leakage of heat from the main food space into the freezer only aids in cooling the lower portion of the food space. It is only necessary to see that foods in the bottom of the main food space do not freeze.

The compressor may be allowed to run during both ice release and freezer defrost periods. This aids in releasing ice and causes no serious loss of efficiency during freezer defrost due to the very small percentage of the time that the freezer evaporator is on the defrost portion of its cycle. If desired the same method of hot gas defrosting can be employed for both the freezer and the ice maker by some duplication of parts. It will be seen that liquid will not flow through the expansion valve 150 to the freezer evaporator while it is being defrosted and any pressure within the evaporator 144 in excess of that in the suction tube 226 will flow through the check valve 152 and be drawn in by the compressor.

When a refrigerator is installed in most kitchens it is found that some levelling up is necessary. Usually four dome-like feet are provided with screws for making this adjustment, but they take up some of the height and are not easily accessible for adjustment. I have therefore shown the two rear "domes" 242 as stamped into the heavy metal of the drip pan 130 which forms the base of the cabinet and have shown similar domes in two small stampings 244 to be welded to the bottom of the pan at its front. These front domes are adjustable in height by means of the wedges 246, which may be driven in from the front as required. The wedges are preferably slotted to be held in place by small tongues on the stampings 244 as the stampings are spot-welded to the pan. The adjustment thus provided should be sufficient to tilt the cabinet

forward as well as backward at either front corner, thus providing the full range of adjustment for any ordinary condition of floor unevenness. Very slight serrations crosswise of the upper side of each wedge and in matching positions on the bottom of the pan will prevent the wedges from working loose after they are once adjusted.

Switch 248 is a service provision for emergency defrosting. It is manually closed and self-opening by means of a clock or thermal release. When closed it starts a defrost period of the freezer evaporator, including the opening of drawer 162 if it is not already open. At the end of the timed defrost period the switch 248 snaps back to its normal position. This switch is seldom used and may be omitted, as service men can produce an artificial defrost period by other means when required.

Figure 6 shows the freezer drawer gasket 210 as seen from the bottom of Fig. 4 with the drawer 162 removed. The only part of the cabinet shown in section is the right-hand side of the outer shell, which is contiguous to the base pan 130 of Fig. 4. Looking upward into the recess 174, which houses the freezer evaporator, we see the gasket 210 and its flexible ribs 212, portions of which are made in zig-zag form 212' where extending from front to back. The reason for this is to retain in these front-to-back portions of the gasket as much of the flexibility of the crosswise ribs 212 as is possible. Due to the height, thinness and flexibility of these ribs and the fact that they bend sidewise as the drawer is closed, they are easily torn free from the top of the drawer as the drawer is opened, first dropping and then moving forward. At the right, rear corner (front in Fig. 6) the gasket is cut at 252 and the ends secured by means of screws or other fasteners 254. This allows a portion of the gasket to be released and bent back for removal of the tubes and wires associated with the evaporator 144, the bulb 172, and the heater coil 156, which connections are located in a notch covered by the gasket. The zig-zag portion 212' of the gasket is located directly above the side walls of the freezer drawer, leaving a plain portion of the gasket 210 exposed above the side spaces between the drawer and the side walls of the outer shell of the cabinet, the gasket also serving as a thermal breaker between the outer shell and the pan-shaped lining of the recess 174.

Figure 7 shows a modification of the upper ice shelf 60, here identified as 60' and equipped with resistance wires 256 to which very low voltage current is supplied by the transformer 258 under control of switch 260, which is connected with the line 72-82. This switch may be manually operated or made responsive to variations of ice quantity in compartment 40, using one of the methods which I have previously disclosed, to obtain an increased supply of ice in small pieces. In Fig. 7 I have shown the hole 62' located at the rear end of shelf 60', which means that the control 64 and rod 62 are located at the rear end of storage tank 36 instead of at one side, as in Fig. 1, putting them more out of the way.

Figure 8 shows the upper portion of a sleeve 10'', which is similar to 10 of Fig. 2, with the sides extended upward and outward to accommodate the tilting water distributor 262, carried by the freely supported shaft 264, which rests in notches 265. This distributor is shaped to form two troughs and is free to rock from the extreme left position shown to a corresponding position at the right, being stopped each way by contact of the notched edge 266 with an angular side portion of 10''. In the position shown, water from the left hand trough flows as indicated by the curved arrow through the notches at 266 to wash over ice being formed on the left side of sleeve 10'' while the right hand trough is being filled with water from the tube 20', which in this case has one row of holes 268. Meantime some of the water escapes from this trough through a number of quite small holes 270 to drip into 10'' and onto the ice being formed therein on the right side. The pattern of this dripage can be modified by the hole locations and their relative

sizes, but the total of such drippage is considerably less than the rate at which water is supplied through the holes 268, hence the right hand trough fills with water and the weight of this water finally causes the distributor 262 to tilt to its extreme right position, dumping the accumulated water down the right side of the sleeve 10" and over the ice being formed on that side.

This intermittent flushing of the ice, first on one side and then the other, produces a better washing of air bubbles from the ice surfaces than a steady flow of the same average volume and allows a short interval between the surges of water for the water which adheres to the ice to solidify, with the result that ice of clearer quality is frozen more rapidly.

Figure 9 is a side view of a modified evaporator 272, which is paired with a similar one hidden by it. This figure will be better understood by reference to Fig. 10, which is an end view of the assembly with one of the evaporators shown in section, on the line 10-10 of Fig. 9. Low pressure refrigerant, mainly in liquid phase, flows from the expansion valve or restrictor through the tube 274 and associated header to the inlets of the evaporators at the top and refrigerant vapor leaves through the lower header and tube 230.

The evaporators 272 are similar to evaporators 12 of Figs. 1 and 2, but are made thicker at the top so that a considerable number may be assembled in a group without the progressively greater tilt indicated in Fig. 2. Another feature, best seen in Fig. 10, is the elimination of the tank or sleeve such as 10 and 10' of Fig. 2. This is accomplished by covering each evaporator with an insulating jacket 276 of a plastic material which acts as a thermal insulator and is impervious to water. It is preferably a substance which hardens with a smooth surface and to which ice does not readily adhere. There are many rubber and plastic materials of suitable nature and most of them have the characteristic of shrinking slightly as they harden, which is desirable because it insures that the areas between the surfaces 14 of the evaporators do not project beyond the plane of the surfaces 14.

By eliminating the metal walls between the evaporators and the ice and using the thermally non-conducting material to form the jacket 276 the shape of the ice is modified in the direction of reducing the diameter of the disks and causing them to build faster in thickness, hence the diameters of the areas 14 are increased on evaporators 272 as compared with evaporators 12 for a given diameter of ice disks, thereby effecting a further increase in the rate of ice production. It is also possible, because of the material forming the intervening areas being non-conductive, to place the areas 14 closer together in Figs. 9 and 10 than in Figs. 1 and 2 without danger of the separate ice disks joining each other across the surfaces to such a degree that they will not break apart as they fall upon being released. These features adapt Figs. 9 and 10 for use in commercial ice makers, whereas Figs. 1 and 2 are better adapted for use in household refrigerators, where ice-making capacity is not so important and it is advantageous to expose more of the evaporator surfaces for the purposes of cooling the air within the refrigerator.

Figure 10 also shows the use of the tilting distributor 262 for water, as shown in more detail in Fig. 8. As in Fig. 8, the shaft 264 of 262 is preferably supported in notches so that it may easily be lifted out of place for introduction of a double-sided brush to clean the ice-making surfaces. It is also desirable to provide a swivel or flexible connection, such as hose 277, for the tube 20 or 20' so that it may be swung or lifted out of the way for the same reason. In Figs. 8, 9 and 10 the tube 20' and the shaft 264, of which the former is considerably larger in diameter, are shown supported in the same stepped slots 265. The tube 20' is slightly flattened so that the upper section of the slot 265 holds it from rotating. In Fig. 8 the slots are made directly in the end walls of the sleeve 10",

while in Figs. 9 and 10, having no sleeve, the slots 265 are in the brackets 278.

The choice as to whether liquid refrigerant enters the evaporator at the top, as in Fig. 9 or at the bottom, as in Fig. 1, depends in part on the size of the unit, in part upon whether the ice is floated up or dropped down, and in part upon the method used for heating the evaporator to release the ice. In a large unit of commercial type similar to Figs. 9 and 10, but probably having many more ice making areas on each evaporator, with ice dropping out of the bottom, it is preferred to use the hot liquid method of releasing ice, as shown in some of my issued patents such as U. S. 2,672,016 and 2,672,017, issued March 16, 1954, and pending U. S. applications S. N. 174,944, filed July 20, 1950 (now Patent No. 2,774,223, issued December 18, 1956), S. N. 244,964, filed Sept. 4, 1951 (now Patent No. 2,775,112, issued June 11, 1957) and S. N. 388,361, filed October 26, 1953 (Division of 2,672,017, now Patent No. 2,787,890, issued April 9, 1957). However, in the present application the emphasis is on letting the ice drop instead of floating it out the top of a tank, hence it is preferred to release the bottom row of disks first, introducing the hot gas or hot liquid at the bottom of the evaporator. When the flow of liquid is reversed to release ice, as in some of these earlier applications of mine, this then means that during the cooling portion of the cycle low pressure liquid enters at the top and during the ice releasing portion of the cycle hot liquid enters at the bottom.

Figures 11, 12 and 13 are quite similar except that they show the making of ice in square, round and oblong cross sections, respectively. These differ from Figs. 9 and 10 in using one entire side of the evaporator for ice contact instead of using only the raised areas of each side. They also differ in producing ice of fixed shape with fixed dimensions in the plane of the drawings, as shown at 290, 291 and 292, yet they can also be used with the short cycle to make two thin pieces instead of one thick piece of ice.

The two evaporators which form any one of these three Figures 11, 12 or 13 are identical, each being formed of two stampings welded together where the two sheets contact each other. Several such pairs of evaporator elements are stacked, one above the other, as shown by Fig. 14, which is a section of any of the three, as indicated on Figs. 11, 12 and 13.

Ice forms on each evaporator and then joins, leaving an opening 284 through which water flows, thus there is no hole in the ice cube, but a groove on each side. The rubber or similar spacers 286 are poor conductors of heat, hence ice is very slow to form on them, and the same is true of the spacers 288 (Fig. 14) which separate the evaporators as stacked one upon another.

Figure 15 shows a switch 296, which is of the snap-over variety, arranged to stay in either open or closed position. It is connected by means of rod 298 with shelf 98 of Fig. 1 and its spring effect is adjusted so that a full supply of ice on shelf 98 will move it to the open position shown. It stays in this position except when manually moved to the dotted position, in which it shorts out switch 64 of Fig. 1 or Fig. 4, thus causing the ice-maker to operate on the short cycles, making only single-thickness disks of ice until compartment 40 is full and shelf 98 weighted heavily enough to open switch 296 so that switch 64 again becomes effective and the ice-maker returns to its normal operation of filling compartment 34 with double disks before making more single disks.

The purpose of switch 296 is to enable the user to hasten the making of the single-thickness disks of ice when there is a special need for them. At the same time it may be desired to close switch 260 of Fig. 7 for the purpose of reducing the double disks already on hand in compartment 34 to smaller pieces. The rod 298 may be so connected that the weight of ice on shelf 98 opens both switches 260 and 296 to stop both the making of

small pieces of ice and the cutting of large pieces into small size when shelf 98 supports slightly more than its normal maximum load.

It will be noted that in Fig. 4 I have shown the motor-compressor unit 86 located at the top rear of the cabinet instead of at the rear of the freezer drawer as in applications S. N. 74,528 (now 2,709,343) and S. N. 178,498 (now 2,765,633). The main reason for this is to increase the front-to-back inside dimension of the drawer and thus provide more storage space for frozen foods. I further propose to make the outside front-to-back dimension of the drawer greater than the corresponding dimension of the upper portion of the cabinet and to indent the rear outer wall of the drawer to provide room for the motor 164, which generates very little heat as compared with the unit 86, thus providing still more freezer capacity in a given height. It is also proposed that instead of making the freezer walls thicker they be insulated with a better insulating material, even though this is more expensive than the insulation used in the balance of the cabinet.

Figure 16 illustrates a modification of the evaporator 12 which may be used when economy of space is more important than the economy of using one die to form both of the sheets which make an evaporator. This modification is particularly applicable when the ice-making areas 14 are separated by the plastic material 276 and no tank or sleeve 10 is used. By staggering the embossed spots on one side of the evaporator relative to those on the other side it is possible to make one embossment form the refrigerant passage between two of the embossments of the other sheet.

This same idea of Fig. 16 also applies to evaporators on the order of Figs. 11 to 14, in which case the vertical flues of adjacent rows are staggered and nest together, which is particularly obvious with reference to Fig. 11. It will also be understood that the insulation 286 and 288 may be omitted if the evaporators are covered with plastic 276, leaving only the ice-making areas exposed, as in Figs. 9 and 16. In that case the plastic 276 may form the divisions between vertical flues, or these vertical separating members may be omitted if other means is provided to support the two adjacent evaporators with the proper spacing between them.

Figure 17 shows a switch mechanism which may be mounted on the outer side of one of the doors, on both doors, or on the outer shell of the cabinet beside one or both doors. The rocker 304 is designed for actuation by the user's arm contact. It is pivoted to the bracket 306 and may be retained in the neutral position shown by means of a spring 308. The bracket 306 is preferably welded to the outer shell of the cabinet or door in a depression 310 formed therein. Assuming the rocker to be located vertically on a horizontal axis as shown, the user pushes on its upper end to close switch 312, which corresponds with the switch 112 of my copending U. S. application S. N. 235,910, filed July 10, 1951. This switch need be held closed for only a fraction of a second to start the opening of the two doors, whereupon the doors are fully opened by power as explained in this copending application. If, however, the user desires to open the freezer drawer she presses on the lower end of rocker 304 to close the switch 314. This switch, unlike 312, stays closed after being pushed in and includes a spring motor or electrical means for holding it closed for a preselected length of time, after which it snaps back to its normal open position. The switch 314 is similar to switch 166 of Fig. 4 in this respect and is connected to energize motor 164, this causing the drawer 162 to open to the position 162'', where it remains until the switch 314 snaps back to its open position, allowing the drawer to reclose. It is thus seen that the user, coming to the refrigerator with both hands full, can open either the drawer or the doors by a touch of her elbow on the rocker 304. She can, in fact, open both the freezer drawer and the

doors by pushing on the lower end of rocker 304 and then on its upper end. The drawer will reclose itself and the doors will reclose in response to a slight push on either door, as explained in the earlier application S. N. 235,910.

The shaft 190 of Fig. 4, or the speed reduction gearing through which motor 164 drives 190, is preferably equipped with an energy storage device such as a coil spring surrounding shaft 190. This spring is energized by the rotation of shaft 190 in the direction which opens the drawer 162 to position 162''. When the motor 164 is deenergized this spring rotates shaft 190, the gearing and motor 164 in reverse so that the frictional load of such reversal need not be carried by the gravitational force which recloses the drawer. If desired the lug 196 may be linked to the bracket 198 so that the spring pulls the drawer 162 closed instead of merely getting out of the way of the gravity closing of the drawer. In this case it would not be necessary to incline the elements 200-202 and the hump at full-open position 162''' could be omitted, but I prefer to retain the inclined track and to keep the drawer free from the lug 196 so that the drawer can be more easily opened and closed manually when desired or in case of current failure.

While I have described the power element 112 as a "clock" and referred to cam 70 as making one revolution per hour, it is understood that cam 70 may be driven at any desired speed and that the speed may be adjustable to provide longer or shorter cycles of the ice maker. For instance the variable resistance or other controller 320 may be connected as shown in Fig. 4 and the adjustment of speed may be wide enough to effect a 2 to 1 change, even using this adjustment in place of the switches 64 and 68 to effect the change from double to single thickness ice. Any known type of speed changing device may be likewise employed to modify the lengths of ice-making cycles.

It is intended in Fig. 1 that the chutes 28 and 94 be made readily removable for cleaning the inside of the flue or sleeve 10, in line with the previous mention of tube 20 or 20' being flexible connected, as shown in Fig. 9.

The water tank 44 may likewise be removable separately from compartments 34 and 40, in which case care should be taken to keep the moisture which condenses on the outside of 34-40 from dripping into tank 44. This feature is illustrated in Fig. 3 by the separation of drip water from circulating water, using the gutters 42 to catch the drip of water condensed from the air.

In making the water tank 44 separately removable it is also the plan to make the tube 96 (Fig. 1), a tube connected with the inlet of pump 92, and the water supply tube leading to valve 104 come down into the tank from the top, also supporting the float valve from the top, so that the tank 44 may be removed by dropping it away from these connections. Since the faucet 106 should be located some distance above the bottom of space 144, as shown in Fig. 4, there is room to drop the tank 44 and then remove it from the cabinet in a forward direction.

Another feature planned is to make the base pan 130 deep enough to hold all of the water which might overflow the tank 44 in the event of current failure which allows all of the ice to melt. No great depth is necessary for this, as the pan is practically the full size of the cabinet, extending almost to the outer walls at the rear and on the two sides. At the front it can extend as far forward as the bulge of the drawer front, thus providing the maximum of support to keep the cabinet from tipping forward when the freezer drawer is opened to its limit and heavily loaded. A part of the accidental ice meltage is cared for by having the float-controlled level some distance below the top of the tank, as shown in Fig. 1.

Where a single tank or flue is used, each of the two evaporators may be formed of a flat sheet, with or without fins attached to cool air, and a stamping which in-

cludes all of the embossed areas for ice making and all of the embossed passages for refrigerant flow, thus the two stampings can be identical.

I claim:

1. In an ice maker, a vertical passage bounded by surfaces of a plastic material of low thermal conductivity with isolated opposed refrigerated spots formed of metal flush therewith, and means for circulating water through said passage while the isolated spots are refrigerated, whereby separate solid masses of ice are formed within the passage, said surfaces and spots being so relatively arranged that as said masses of ice approach their maximum growth the circulated water contacts only ice and said plastic surfaces, whereby opposed solid masses of ice are joined to produce larger masses with one or more external grooves through which water flows in contact with said ice and with said low conductivity material.

2. In an ice maker of the type having opposed isolated refrigerated areas on which ice is frozen in the form of thin round disks and then joined in pairs at a thickened area of each disk to form spool-shaped pieces of ice from pairs of thin disks, ice storage means including two compartments, and ice harvesting means including an inclined gravity conveyor comprising a middle track and side rails adapted to support and carry said spool-shaped pieces to one of said compartments while allowing said thin disks to drop at either side of said track into a chute, thus being separated from the spool-shaped pieces and delivered to the other of said compartments.

3. In an ice breaker, control means for regulating said ice maker to selectively freeze water in the form of thin disks or double-thickness disks of ice, each said double-thickness disk being formed by freezing two thin disks together at thickened central areas of each and so having a circumferential groove, a pair of ice storage bins, and an ice harvesting structure for conveying said pieces of ice selectively to said bins, said structure comprising a gravity chute having a cross section formed like the letter W whereby its middle ridge provides a track to support the thicker pieces of ice at their grooves and deliver them to one of said bins while allowing the thin disks to drop, thus delivering the thin pieces to the other of said bins.

4. In an ice maker of the type producing clear ice in small solid pieces of uniform shape and releasing said pieces intact in a continuous cyclic operation, means forming a pair of facing refrigerated vertical surfaces on which ice is formed, a double trough member tiltable upon an axis between the troughs located above and between the planes of said surfaces, and means for delivering water to one trough or the other according to which way the double trough is tilted, each trough being in position to alternately receive water from said water delivery means while its mating trough is in position to spill water onto one of said vertical surfaces and this relationship being reversed by the tilting of the double trough as a result of the increasing weight of water in the trough which is receiving water while the other trough is spilling its water, whereby water is caused to flow in intermittent surges down one and then down the other of said surfaces.

5. In a refrigerator, a non-freezing food storage space, an ice maker having parts exposed to the air in said space, an evaporator including a substantially vertical surface forming a part of said ice maker and disposed to form ice, said evaporator also acting to cool air in said space, means for circulating water into and out of heat exchange with said evaporator surface while ice is forming, control means for regulating the release of ice from said surface to be stored in an ice bin and for terminating water circulation to allow water to drain from said surface, a second control means for starting and stopping the production of ice in response to changes in the quantity of ice in said ice bin, and a third control means responsive to temperature changes in said food storage

space, the last said means acting at times when production of ice by said ice maker is stopped by the second control means to cause said evaporator to be cooled without the water being circulated in heat exchange with it, whereby the air within said non-freezing food storage space is cooled by the ice maker evaporator while the ice maker is not producing ice.

6. In a refrigerator, a food storage compartment maintained within a range of non-freezing temperatures, an ice maker in said compartment having a plurality of surface areas on which ice may be formed, an ice storage bin associated with said ice maker, ice harvesting means for releasing ice from said areas and transferring it to the ice storage bin, an evaporator for cooling said surface areas of the ice maker and also serving to cool air in said food storage compartment, means for causing water to flow into and out of heat exchange with said surface areas while a portion of the water is frozen on said areas, control means for regulating the operation of said ice maker and for starting and stopping water flow whereby said areas are wetted to make ice and drained dry when no ice is being made, and control means for regulating the cooling of said food storage compartment, the last said control means being effective during idle periods of said ice maker when water has been drained from contact with said surface areas, thus causing said evaporator to be cooled for the purpose of cooling the air in said food storage compartment while said areas are free of both ice and water.

7. In a refrigerator, a non-freezing food storage compartment, a freezer compartment for the storage of frozen foods, an ice maker in the first said compartment, a cooling element serving to cool ice-forming areas of said ice maker and also to cool air in said non-freezing compartment, an ice storage bin, ice harvesting means associated with said ice maker to release ice and transfer it to said bin, water supply means arranged to circulate water into and out of heat transfer with ice-forming areas cooled by said cooling element for the purpose of making ice, said areas being arranged to drain free of water when water is not being circulated, an evaporator arranged to cool said freezer compartment, and control apparatus for regulating the operation of said cooling element and said water supply means, whereby the air within the compartment containing the ice maker is cooled by said cooling element during certain periods when no water is being circulated in heat exchange with said ice-forming areas, which consequently are dry and not active in the production of ice.

8. In a refrigerator, a food storage compartment to be maintained above 32° F., an ice maker of self-harvesting type in said compartment, an evaporator forming a part of said ice maker and arranged to cool multiple areas on which ice is formed, a storage compartment for ice, a control for said ice maker responsive to variations in the supply of ice in said ice storage compartment to start and stop the production of ice, said control also starting and stopping movement of water into and out of heat transfer with said ice-forming areas, said areas being arranged to drain free of water when water is not being circulated, and an additional control means responsive to temperature variations in said food storage compartment to cause said evaporator to be cooled during idle periods of the ice maker for the purpose of cooling the air in said food storage compartment while said ice-forming areas are free of ice and water.

9. In a refrigerator, an ice maker having multiple areas on which ice is formed, an evaporator associated with said ice maker and arranged to cool said areas, an ice storage compartment, means for harvesting ice from said ice maker and depositing it in said ice storage compartment, means for circulating water to and from heat transfer with said areas of the ice maker during the production of ice thereby, said areas being arranged to drain free of water when water is not being circulated, a first control

means for starting and stopping operation of said evaporator and the supply of water to said ice-making areas to control ice production in accordance with the amount of ice in said ice storage compartment, a food storage compartment, and a second control means responsive to temperature changes in said food storage compartment to cause said evaporator to cool the food storage compartment during some of the time that said areas of the ice maker are not contacted by either ice or water.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 2,866,322

December 30, 1958

Glenn Muffly

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 1, lines 44 and 45, for "S. N. 235,910, now Patent No. 2,644,760, filed July 10, 1951, Power-actuated double doors." read -- S. N. 235,920, filed July 10, 1951, Refrigerator doors and actuating mechanism, now abandoned in favor of continuation S. N. 705,157, filed December 26, 1957. --; column 13, lines 50 and 51, for "nonc-onductive" read -- non-conductive --; column 17, line 30, for "breaker" read -- maker --.

Signed and sealed this 16th day of August 1960.

(SEAL)

Attest:

KARL H. AXLINE
Attesting Officer

ROBERT C. WATSON
Commissioner of Patents