

Sept. 13, 1955

S. W. E. ANDERSSON

2,717,495

ICE MAKER

Filed Jan. 11, 1951

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Fig. 1.

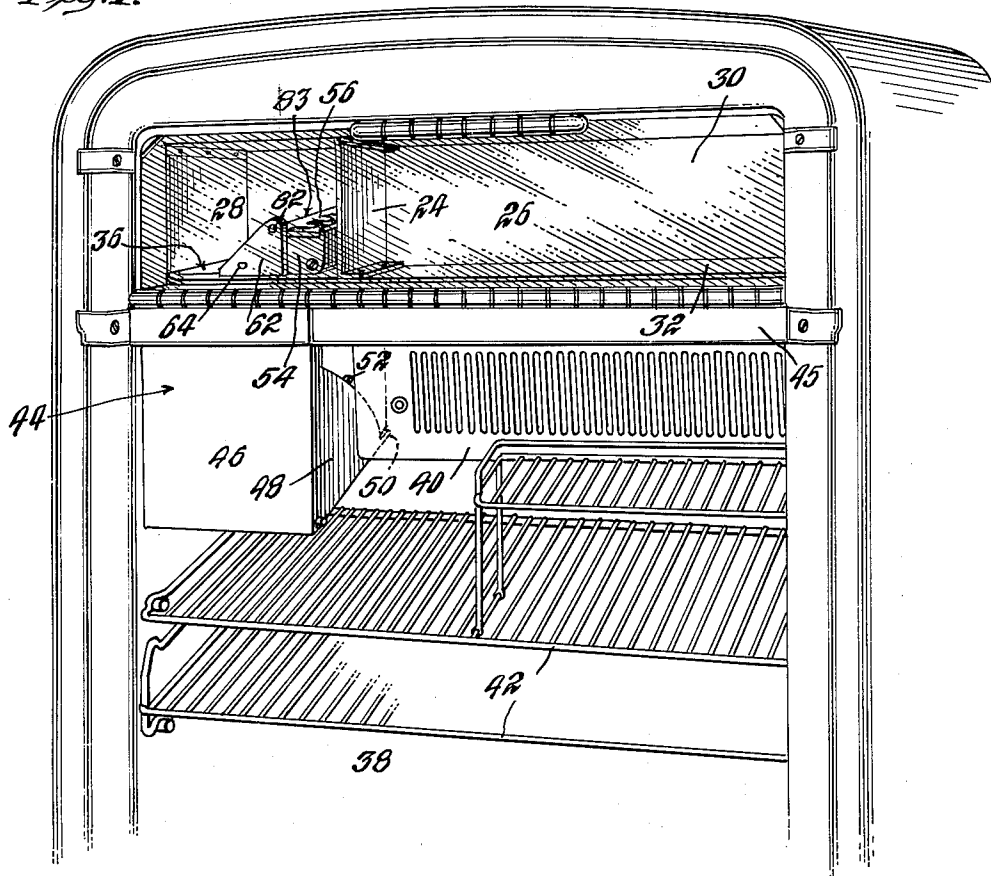


Fig. 1a.

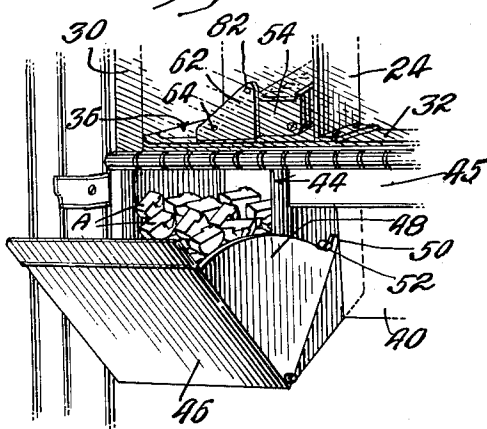
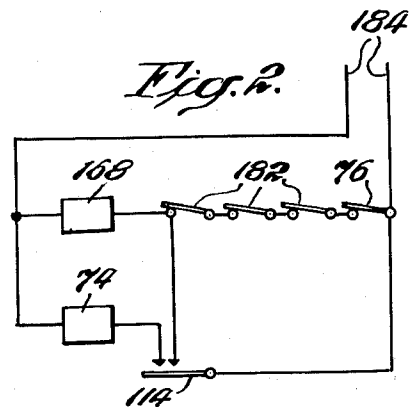


Fig. 2.



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Fig. 3.

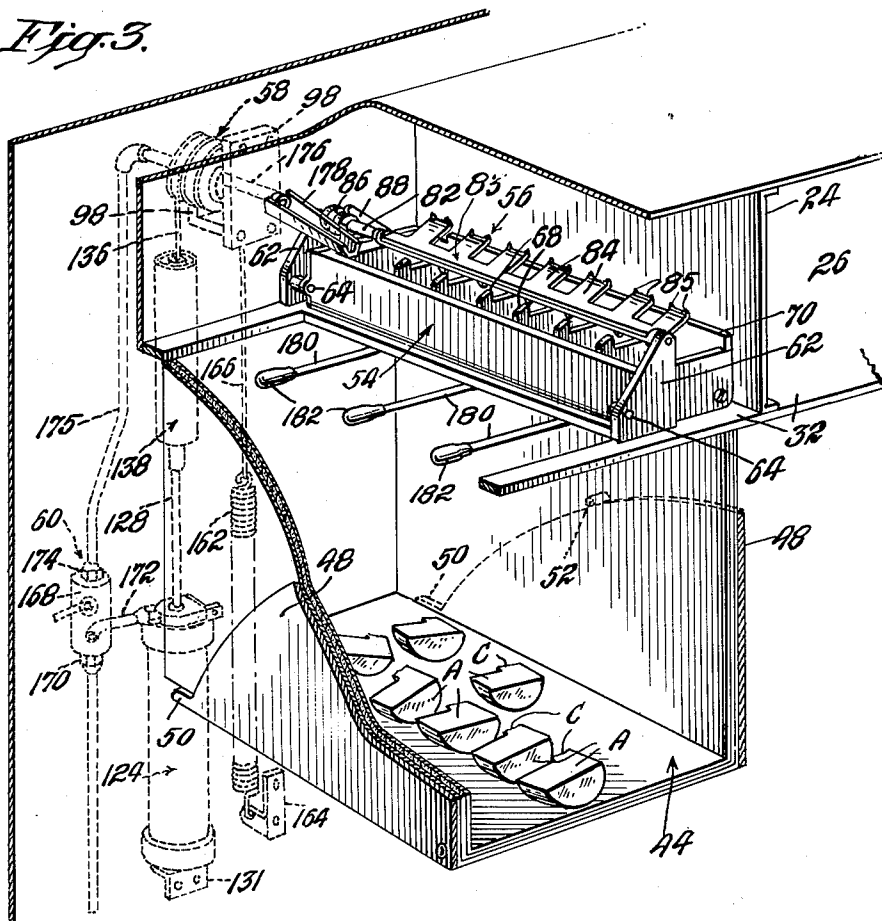
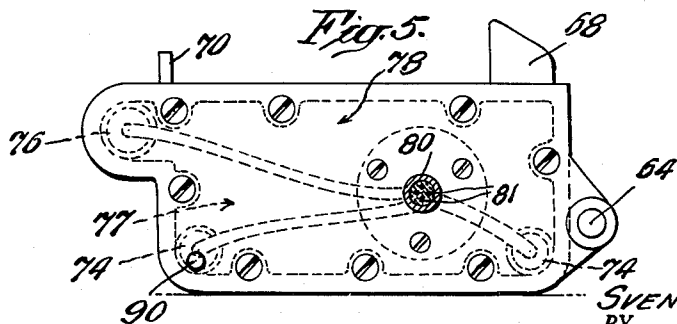


Fig. 4.



Fig. 5.



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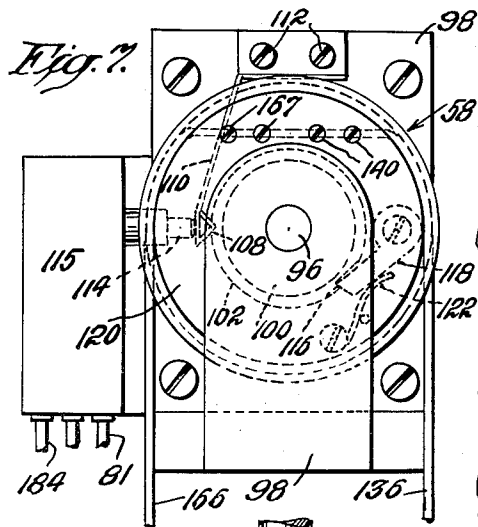
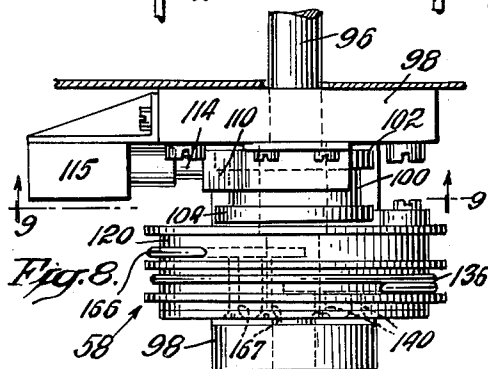
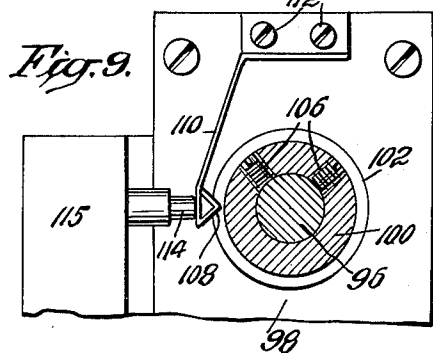
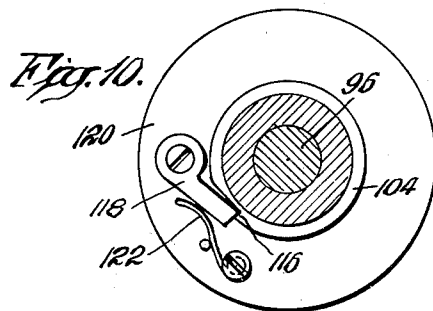
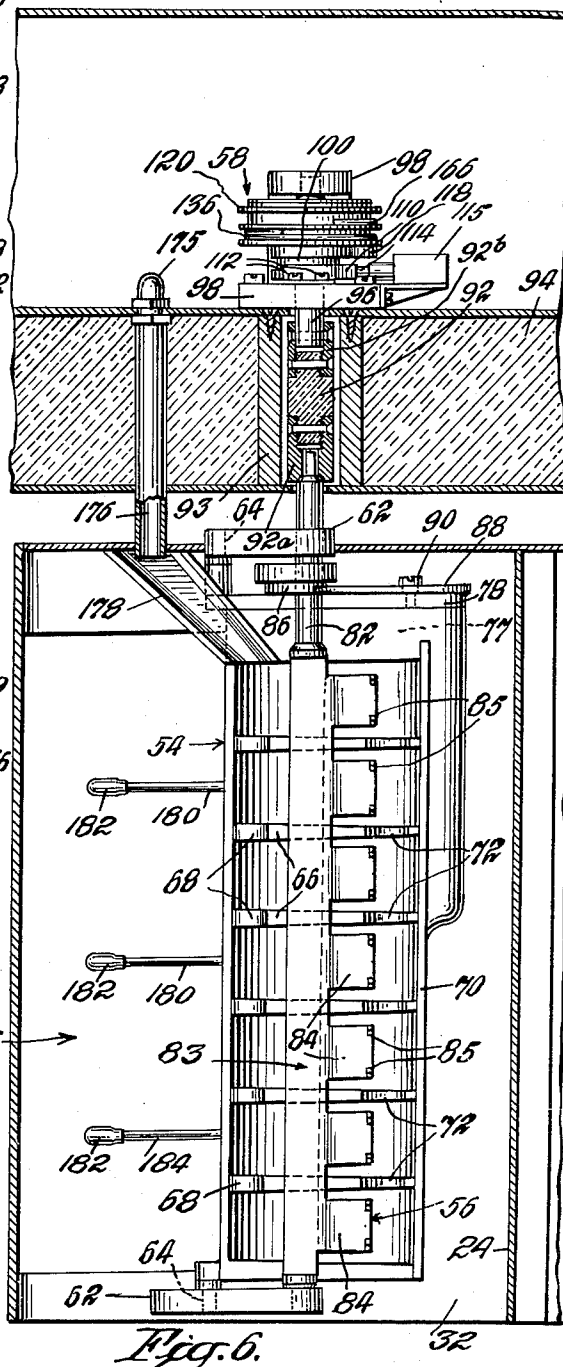
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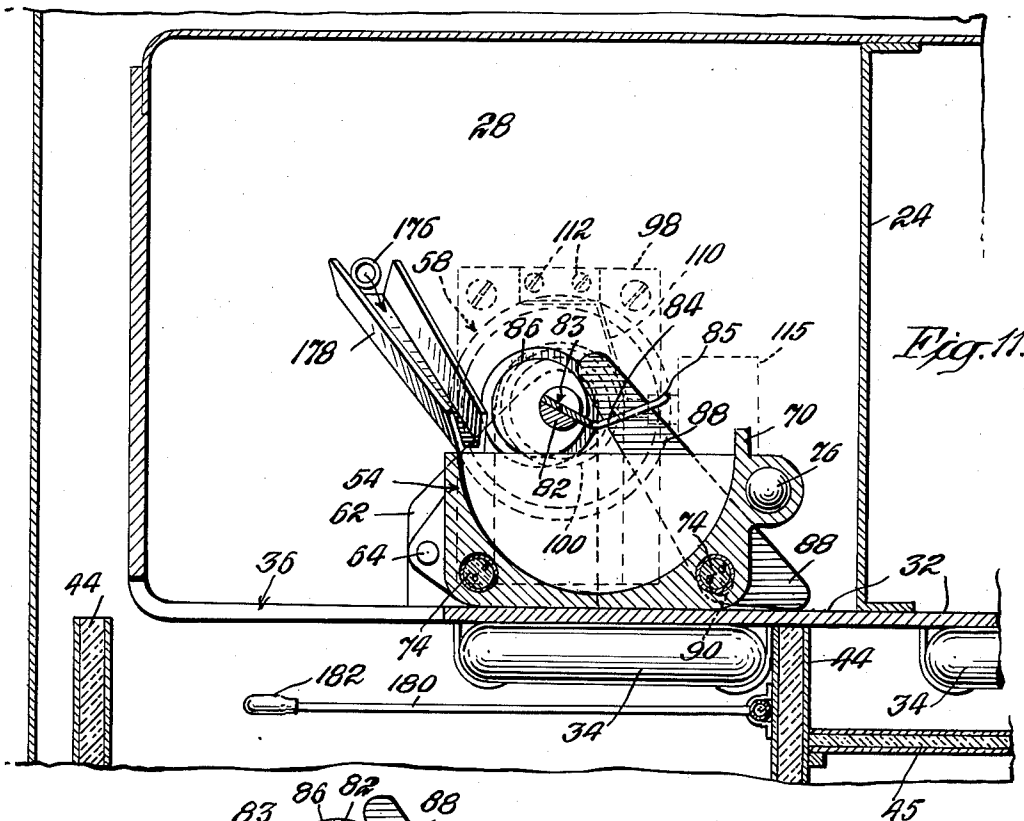
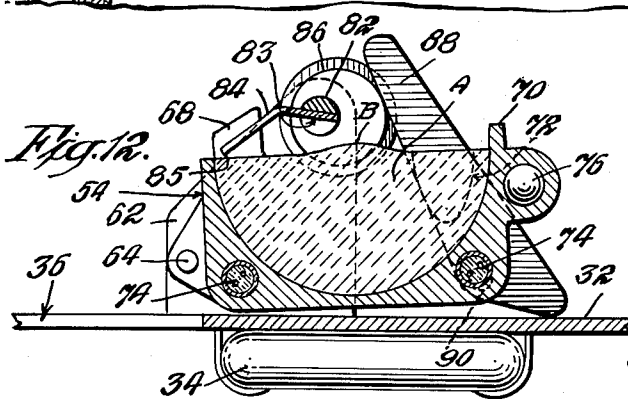
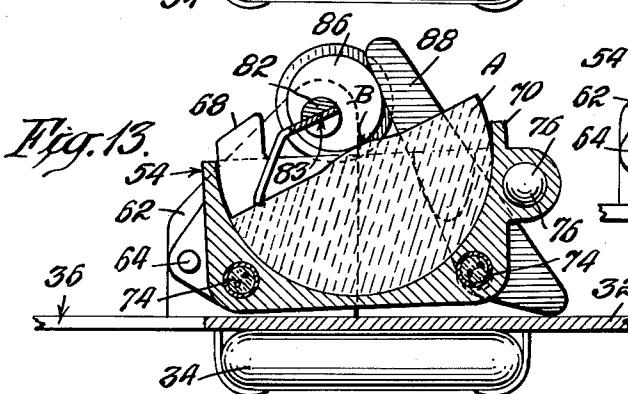
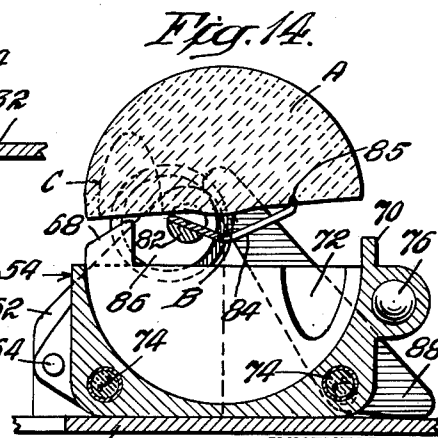
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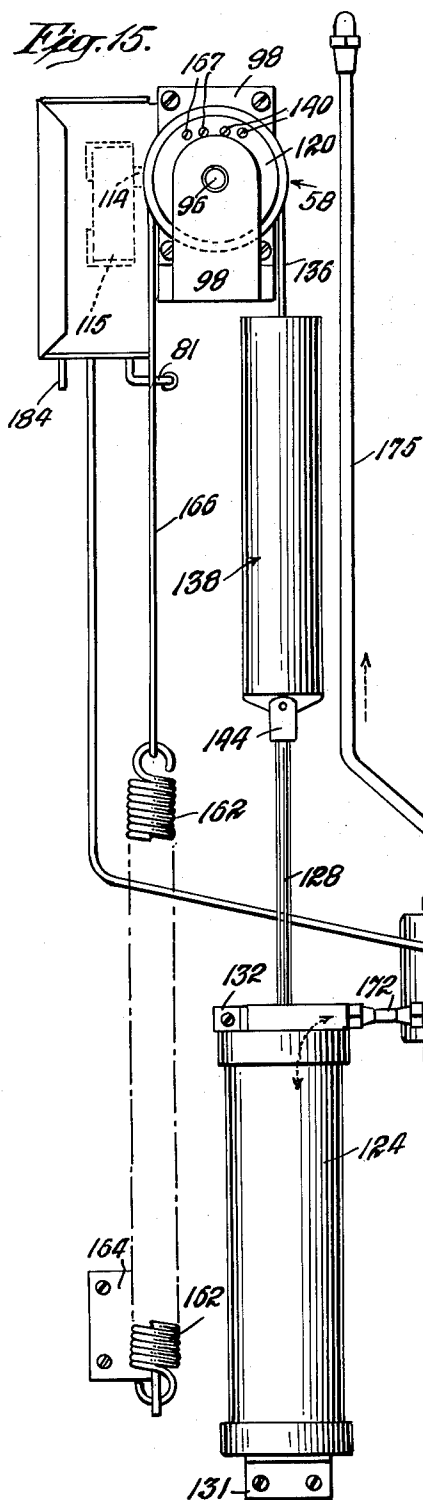
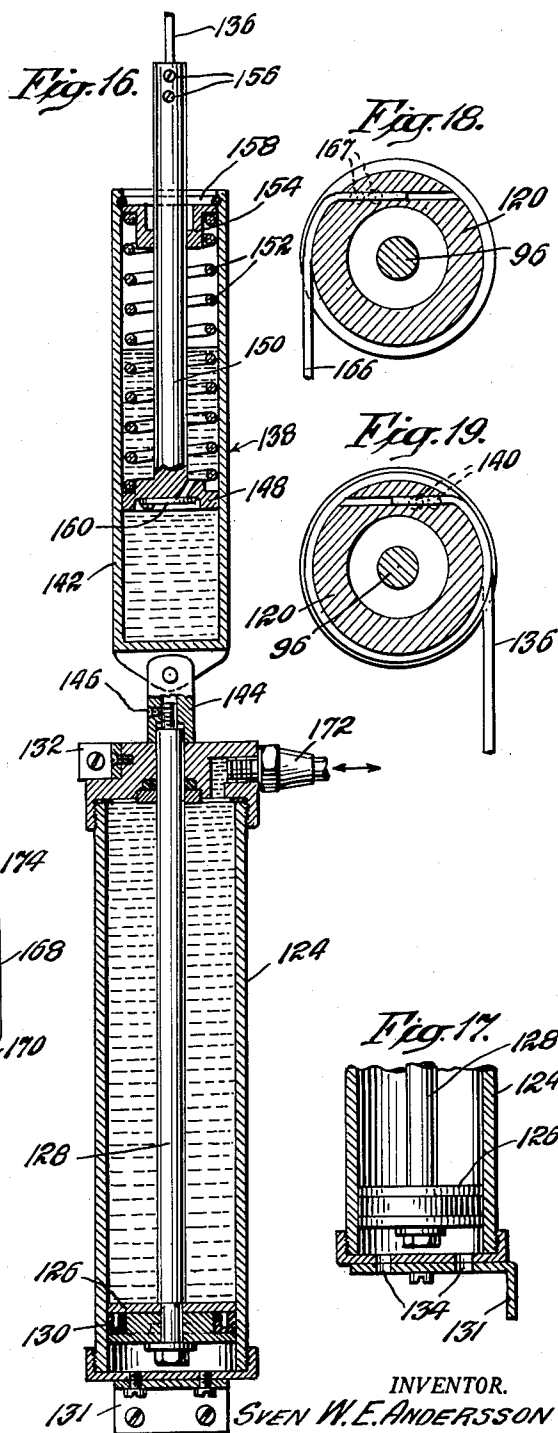
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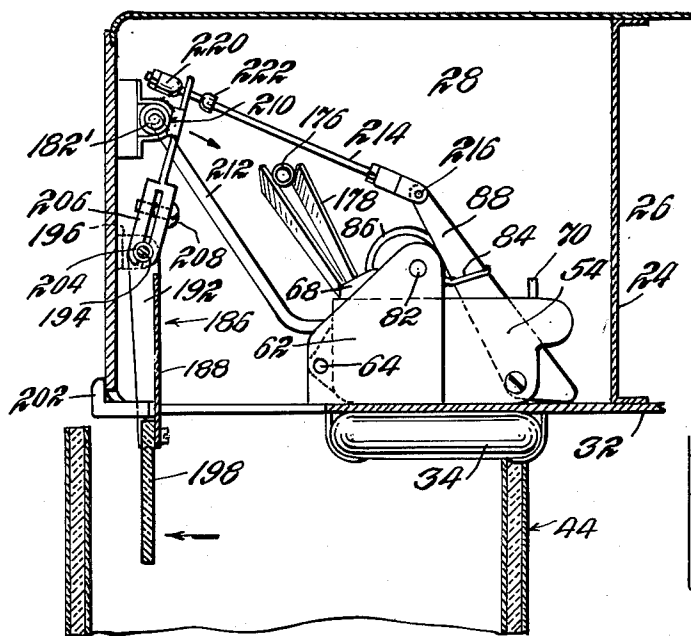
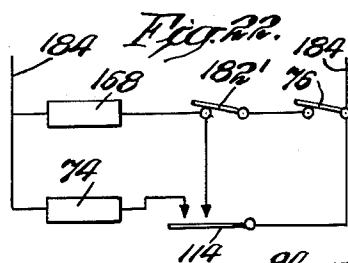
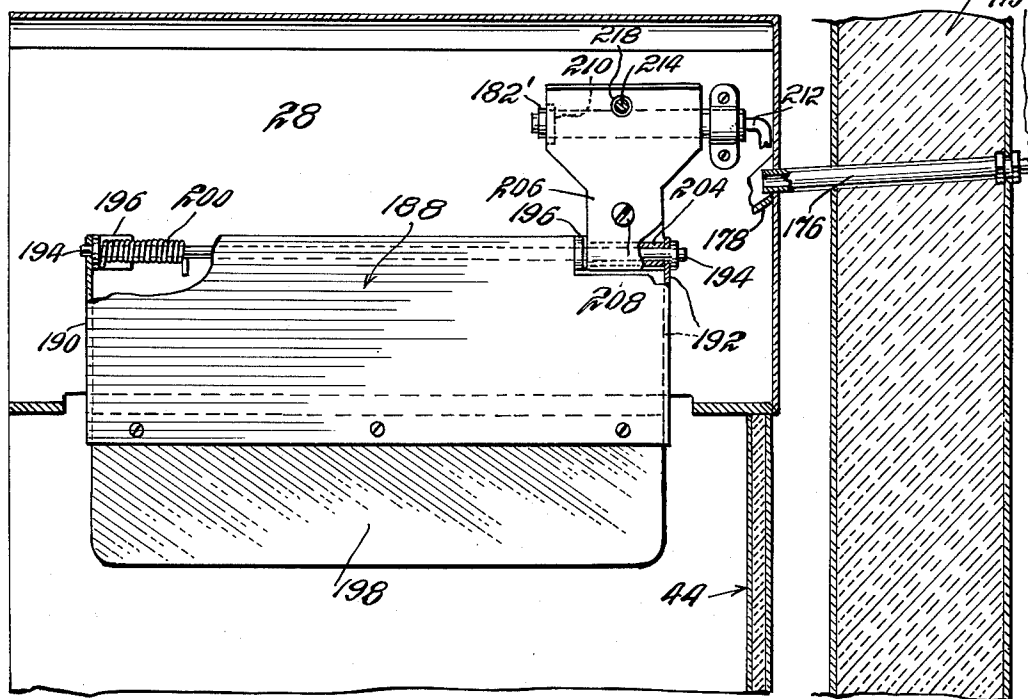
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6 Sheets-Sheet 6



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2,717,495

ICE MAKER

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Application January 11, 1951, Serial No. 205,519

43 Claims. (Cl. 62—4)

My invention relates to automatic making and harvesting of ice pieces generally called ice cubes.

In accordance with my invention, an ice forming mold has a generally arcuate contour so that a piece of ice may be readily turned or swept from the mold by relative turning movement between the mold and the ice piece. The ice removing action is automatic, as is filling of the mold, freezing, and loosening of the ice piece. The ice piece may be detained for thorough drying before discharge to storage. The automatic operation is stopped short of discharge of ice to storage, and remains suspended during the time that a desired quantity of ice pieces is in storage.

My invention, together with its objects and advantages, is more fully set forth in the following description and accompanying drawings, wherein:

Fig. 1 is a perspective of a portion of a domestic refrigerator incorporating my invention;

Fig. 1a is a perspective of a portion of the refrigerator shown in Fig. 1 with the storage bin door open;

Fig. 2 is a wiring diagram for the controls of my ice maker;

Fig. 3 is a perspective of the principal components of the ice maker;

Fig. 4 is an enlarged detail section of a mercury switch used in connection with my ice maker;

Fig. 5 is a rear elevation of the mold;

Fig. 6 is a top plan, partly in section, of the ice maker;

Fig. 7 is a rear elevation of a part of the operating mechanism;

Fig. 8 is a top plan of the mechanism shown in Fig. 7;

Fig. 9 is a detail section taken on line 9—9 of Fig. 8;

Fig. 10 is a detail section similar to Fig. 9, but looking in the direction opposite the arrows in Fig. 8;

Fig. 11 is a vertical section of my ice maker;

Figs. 12, 13, and 14 are detail sections similar to Fig. 11 but showing different stages in the process of conveying ice from the mold;

Fig. 15 is a rear elevation of the mechanism for operating the ice maker;

Fig. 16 is a vertical section of a portion of the mechanism shown in Fig. 15;

Fig. 17 is a detail section of the lower portion of the hydraulic cylinder shown in Fig. 16, but taken at an angle of 90° to Fig. 16;

Figs. 18 and 19 are detail sections of the pulley;

Fig. 20 is a view, similar to Fig. 11, but showing a modified form of a control for my ice maker;

Fig. 21 is a view like Fig. 20, but at right angles thereto; and

Fig. 22 is a wiring diagram for the control mechanism shown in Figs. 20 and 21.

General arrangement

As shown in Figs. 1, 3, and 11, I have incorporated my ice maker in a domestic refrigerator, the front door of which has been omitted for clarity of illustration. This refrigerator has a low temperature compartment divided

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by a vertical partition 24 into a frozen food storage section 26 and an ice making section 28, and closed by a glass door 30 pivotally mounted at its lower edge. If desired, the partition 24 may be omitted or provided with openings for circulation of air between the sections 26 and 28. A flat freezing plate or shelf 32, refrigerated by a flat evaporator coil 34, forms a bottom for the sections 26 and 28 and is provided with an opening 36 in the ice making section 28. Refrigerant may be supplied to the coil 34 by any suitable refrigerating system, not shown.

The refrigerator also has a food storage compartment 38 cooled by a suitable evaporator coil located behind a grille 40. The food storage compartment is provided with suitable shelves 42. An insulated ice storage bin 44 is located in the food storage compartment and is open at the top into the ice making compartment 28 through the opening 36 in the shelf 32. So that ice pieces stored in the bin 44 are kept at a temperature well below the freezing point, a portion of the evaporator coil 34 is located within the upper portion of the bin. An insulated partition 45 separates the frozen food section 26 from the food storage compartment 38.

The ice bin 44 is provided with a door 46 hinged at the bottom for convenient removal of ice as needed. To minimize loss of cold air from the bin, the access door 46 is provided with side shields 48 having projections 50 thereon which contact stop members 52 for limiting pivotal movement of the door to approximately 45°. The door 46 of the ice bin may be provided with springs, not shown, to keep the door tightly closed, and sealing gaskets, not shown, may be provided around the door. The bin should be maintained at temperatures always below the freezing point of water if the ice is to be stored dry. As described below, the ice is dry when dumped into the bin, so that if there is no subsequent melting and refreezing there will be no sticking of the ice pieces. The ice maker, shown particularly in Fig. 3, includes primarily an ice mold or heat exchange element 54, a conveyor mechanism 56, a ratchet and pulley mechanism 58, and an operating mechanism 60.

Ice mold

Referring now particularly to Figs. 6 and 11 to 14 inclusive, the ice mold or heat exchange element 54 comprises an aluminum die casting that is adapted to rest upon the evaporator shelf 32. The mold is pivotally mounted, as by pivot pins 64, at each end thereof upon a pair of brackets 62. Brackets 62 are secured in any suitable manner to the evaporator shelf 32. The interior of the mold is divided by integral partitions 66 into several compartments each having a generally arcuate contour like a segment of a disc. The partitions 66 are tapered from the left to the right side of the mold and are each provided with an upstanding projection 68 at the left side thereof. The ice mold is provided with an upwardly projecting edge 70 on its right side. So that water may flow from one compartment to another when filling the mold, the partitions 66 are each provided with a generally semi-elliptical slot or weir 72, as best shown in Fig. 14. The particular shape of the slots 72 is designed to allow the ice to be easily swept out of the compartments. Also, these slots provide means for connecting the individual ice pieces into a unit, as will be described below. The inside of the end walls of the mold slants outwardly from left to right.

As previously stated, the ice mold is produced as an aluminum die casting. In casting such a mold, some slant or draft in a vertical direction is necessary in the end walls as well as in the transverse partitions, which construction would tend to bind the ice pieces in the mold compartments. However, this vertical draft, not shown, in the end walls and transverse partitions is more than overcome by the horizontal taper of the partitions and by

the horizontal slant of the end walls. As shown, particularly in Fig. 6, the ice mold compartments are larger on the right side of the mold than the left side thereof. With this arrangement the ice pieces, once they have been freed from the partitions and mold surfaces, are readily turned in the mold. As will be described below, the ice is guided from the mold by the upwardly projecting edge 70; and the ice comes to rest on top of the conveyor blade. Later, the ice is guided into the bin by the upstanding projections 68 on the mold partitions.

The ice mold is provided with electric heating elements 74 located in holes along the bottom longitudinal edges thereof. Another hole is provided at the upper right hand side of the mold for the reception of a thermostat 76, which thermostat is set to close its contacts at about 12° F. During a freezing cycle the temperature of the mold at the location of the thermostat remains around 32° F., but the temperature drops promptly when the freezing is completed. The closing of the thermostat contacts is utilized for starting the ice conveyor mechanism. A compartment 77 is located in the rear of the ice mold casting and provides a space for the wiring connections of the heating elements 74 and of the thermostat 76. This compartment is closed by a cover 78, Fig. 5, provided with a water-tight bushing 80 which provides passage of a four-wire conductor cable 81 leading from the heating elements and the thermostat.

Conveyor mechanism

The conveyor mechanism 56 includes a shaft 82 that is milled flat on its upper side throughout a portion of its length, as viewed in Figs. 3, 11 and 14. This shaft is mounted for counterclockwise rotation in bearings on the brackets 62. A blade 83, provided with a plurality of resilient fingers 84, one for each ice mold compartment, is welded or otherwise secured to the flat portion of the shaft 82. In order that the ice may be turned out of the mold and on top of the blade 83, the shaft 82 is located off-center relative to the longitudinal axis of the mold.

In the production of ice in molds of the character described, the water in freezing from the sides and bottom toward the top center of the mold compartments produces ice pieces A with tips B projecting upwardly from the center of the top surface of such pieces. To accommodate these upwardly projecting tips on the ice pieces and, so that the ice pieces may come to rest on the blade 83, this blade is bent as shown in Figs. 3 and 11 to 14 inclusive and each of the fingers 84 is provided with a pair of teeth 85 at its outer edge, thereby forming only point and line contacts between the ice and the conveyor mechanism. As pointed out below, the teeth also aid in conveying the ice from the mold.

The shaft 82 is provided with a cam 86 on the rear portion thereof, which cam is adapted to operate a lever 88 pivotally mounted on the rear of the ice mold casting, as by a pivot pin 90. With this arrangement, when the shaft is rotated from the position shown in Fig. 14 to that shown in Fig. 12, the ice mold is pivoted about pivot pins 64 and is raised clear of the evaporator shelf 32, thereby substantially confining the heat liberated by the heating elements 74 to the mold. As the conveyor completes an ice transfer operation, the cam and lever will return the mold to the evaporator shelf.

Ratchet and pulley mechanism

The shaft 82 is extended, preferably by a suitable insulating coupling 92, through an insulated rear wall 94 of the refrigerator, and it is connected to a pulley shaft 96. As shown in Fig. 6, the insulating coupling 92 includes two ferrules 92^a and 92^b. The ferrule 92^a affords a slip connection between the end of the shaft 82 and the insulating coupling, whereas the ferrule 92^b is riveted to the shaft 96. The connection between the two shafts is quite loose, so that the coupling serves both to insulate the shafts and to compensate for any misalignment of

the shafts. The coupling is surrounded by a wooden block 93 which acts as a guide and support for the coupling if and when the shaft 82 is withdrawn, and the wooden block prevents the insulation in the rear wall of the refrigerator from interfering with the coupling.

The pulley shaft 96 is mounted in a U-shaped bracket 98 secured to the rear outer wall of the refrigerator. A ratchet wheel 100, provided with a front flange 102 and a rear flange 104, is secured by set screws 106 to shaft 96. In the front flange of the ratchet wheel there is a notch 108 generally in the shape of a check mark which is engaged by one end of a leaf spring 110, the other end of which leaf spring is secured by screws 112 to the U-shaped bracket 98. The primary purpose of the leaf spring is to hold the shaft 82 in its normal or inactive position, Fig. 14, following the discharge of ice from the mold. This leaf spring also operates a so-called split contact microswitch 114 which is so mounted adjacent the spring that the switch contacts are open when the lower or free end of the spring has slipped into the notch 108 on the ratchet wheel. When the lower end of the spring is out of the notch and rides on the flange 102 of the ratchet wheel, it actuates the switch 114 to close its contacts. The switch 114, the function of which will be described below, is contained in an electric junction box 115 mounted alongside the bracket 98.

A notch 116 generally in the shape of a check mark is provided on the rear flange 104 of the ratchet wheel 100. This notch 116 is adapted to be engaged by a pawl 118 pivotally mounted on a freewheeling pulley 120, which pulley is mounted for rotation on the shaft 96. The pawl 118 is urged into engagement with the notch 116 by a spring 122. The pulley 120 is rotated a trifle more than one revolution in a counter-clockwise direction, as viewed in Figs. 6 and 10, during each ice discharge operation. Rotation of the pulley is transmitted to the shaft 82 through the pawl 118, the ratchet wheel 100, the shaft 96 and the coupling 92. By rotating the pulley 120 a trifle more than one revolution, it is assured that upon reverse movement of the pulley following each ice transfer operation, to be described below, the pawl 118 will always pass past the notch 116 in the ratchet wheel, so that the pawl will be in position to engage the notch at the next operation. It is to be noted that the ratchet and pulley mechanism functions as a one-way clutch and converter for converting reciprocating motion of the operating mechanism to rotary motion for operating the conveyor mechanism.

Operating mechanism

The operating or driving mechanism for rotating the freewheeling pulley 120 is of an hydraulic type which is operated by city water. This mechanism includes an hydraulic cylinder 124 provided with a piston 126 and a piston rod 128. As shown in Fig. 16, the piston is made up of a plurality of parts and is provided with a packing ring 130. The cylinder 124 is attached to the rear outer wall of the refrigerator by brackets 131 and 132 or any other suitable means. The bracket 131 and the lower head of the hydraulic cylinder are each provided with registered openings 134 for flow of air into and from the cylinder. To prevent lint and dust from entering the cylinder, the openings 134 may be provided with a suitable fine mesh wire screen (not shown). The piston rod 128 is connected to one end of a flexible wire cable 136 by a torque reducing mechanism 138. The other end of the cable 136 is, in the position of the pulley shown in Figs. 15 and 19, wrapped around an outer groove in the pulley for about 1½ turns, and its extreme end is inserted into a hole bored in the pulley, and the wire is anchored in the pulley by two set screws 140.

The torque reducing mechanism 138 includes a cylinder 142 closed at its lower end and pivotally attached, as by a connector 144, to the piston rod 128 of the hy-

draulic cylinder. The connector 144 is screw-threaded onto the upper end of the piston rod and is securely held thereon by a set screw 146. This manner of connecting the piston rod 128 to the connector 144 affords a means for adjusting the stroke of piston 126 and the capacity of the hydraulic cylinder. A loose fitting piston 148, provided with a piston rod 150, is arranged in the cylinder 142. A compression spring 152 is located between the piston 148 and the top closure member 154 of cylinder 142. For a lower spring rate, additional springs may be added within the spring 152. The piston rod 150 is connected to the cable 136 by set screws 156. The closure member 154 of the cylinder 142 is held in place by a spring clip 158. The cylinder 142 is partly filled with oil and, so as to permit free movement of the cylinder relative to the piston 148, the piston is provided with a check valve 160.

A return spring 162, anchored at its lower end to a bracket 164, is connected by means of a second flexible wire cable 166 to an inner groove in the freewheeling pulley 120. In the position of the pulley 120 shown in Figs. 15 and 18, the cable 166 contacts the inner groove thereof through only about $\frac{1}{4}$ of a turn, and the extreme end of this cable is inserted into a second hole bored in the pulley and anchored therein by two set screws 167. For reasons described below, the compression spring 152 in the cylinder 142 is made slightly stronger than the return spring 162.

A three-way solenoid valve 168 controls the flow of water from any suitable source, as a city main, to and from the hydraulic cylinder 124. This three-way valve is provided with a normally closed inlet 170, a connector 172 and an exhaust 174. The connector 172 and exhaust 174 are normally in communication one with the other. The exhaust 174 is connected by a tube 175 to a conduit 176, Fig. 6. The conduit 176 passes through the rear wall 94 of the refrigerator and discharges into a trough 178, which trough in turn conveys the water to the ice mold 54. So that water will not be trapped in the conduit 176, be frozen therein and block passage therethrough, this conduit is made of Bakelite or other suitable heat insulating material. The conduit 176 slants downwardly from the rear and it is made larger than the tube 176.

Control mechanism

In the control mechanism, as shown in Figs. 3, 6, and 11, there are provided several resilient feelers 180 located in the path of ice pieces discharged from the conveyor blade 83 into the storage bin 44. These feelers are each provided in its outer end with a conventional mercury switch 182 which is closed when the feeler is in a horizontal position. One or more of the feelers may be deflected downward by ice falling into the storage bin, but they normally straighten out again to a more or less horizontal position when the ice has fallen clear. However, as the bin 44 becomes filled with ice, additional ice discharged thereinto will not be able to fall clear of the feelers, and one or more of them will be kept deflected downward, so that one or more of the switches 182 will be held open. When this occurs, as described below, no more ice will be discharged into the bin until some ice has been removed therefrom. The stop switches 182 are connected in series with the mold thermostat 76 and with the solenoid valve 168. The conductors for the heating elements 74, the mold thermostat 76, the switch 114, the solenoid valve 168 and the stop switches 182 are brought together in the electric junction box 115 and they are connected between a pair of supply wires 184 in the manner shown in Fig. 2.

Referring now to the wiring diagram in Fig. 2, when the mold thermostat 76 closes after an ice batch has been frozen, a circuit is established between the supply wires 184 through this thermostat, through the normally closed stop switches 182 and through the solenoid valve

168, which valve then opens. Shortly after the ice conveying operation has been started, the leaf spring 110 (Fig. 9) actuates the switch 114 and closes its double contacts whereby parallel circuits are established and the heating elements 74 are connected between the supply wires 184. When an ice batch slides from the top of the conveyor blade 83 and falls down into the bin, one or more of the resilient feelers 180 is deflected downward and thereby temporarily opens one or more of the stop switches 182. This, however, does not interrupt movement of the conveyor mechanism, because the solenoid valve 168 remains energized due to the parallel circuit formed by the earlier closing of the switch 114. The ice conveying procedure continues for the same reason even though the thermostat 76 opens due to the heat applied to the molds by the heating elements 74. The switch 114 opens, however, when the conveying operation has been completed which de-energizes both the solenoid valve 168 and the heating elements 74. The return movement of the pulley 120 and the filling of the ice mold then begins to complete an ice making cycle. In case the ice delivered to the bin 44 should hold one or more of the stop switches 182 open, due to the bin being filled with ice pieces, the transfer procedure is still completed so that a new batch of ice can be frozen in the mold, but it stays there, because now the closing of the thermostat 76 will not complete a circuit through the solenoid valve 168.

Operation

Assume that a batch of ice has been frozen in the mold, in other words, the temperature of the mold has been reduced to the point that the thermostat 76 closes the circuit to the solenoid valve 168. Energization of the solenoid valve 168 causes the inlet 170 to open and the exhaust 174 to close. With the valve in this position, water under pressure is supplied through the inlet 170, through the valve 168 and the connector 172 to the hydraulic cylinder 124. This water entering the cylinder 124 forces the piston 126 and the piston rod 128 downward from the position shown in Fig. 15 to that shown in Fig. 16. Downward movement of the piston rod 128 causes clockwise rotation (as viewed in Fig. 15) of the freewheeling pulley 120 through the torque reducing mechanism 138 and the flexible cable 136. Rotation of the freewheeling pulley causes rotation of the shaft 82 through the ratchet wheel 100. As the ratchet wheel 100 rotates, the end of the spring 110 leaves the notch 108 of the ratchet wheel and thereby closes the switch 114 which establishes parallel circuits through the heaters 74 and through the solenoid valve 168. Thus, the heating elements 74 are energized whereby heat is applied to the ice mold. Rotation of the shaft 82 brings the cam 86 thereon into engagement with the lever 88 and the ice mold is lifted from the position shown in Fig. 11 to that shown in Fig. 12, so that heat liberated by the heating elements is applied only to the ice mold. By this time the teeth 85 on the fingers 84 will have contacted the ice in the mold. However, the ice is still frozen to the mold and this temporarily prevents the conveyor mechanism from completing an ice transfer cycle pending the thawing of the ice bond by heat liberated by the heating elements 74.

The torque reducing mechanism 138 will, however, allow the piston 126 in the hydraulic cylinder 124 to complete its downward movement in one continuous operation and thus avoid a stalling of the hydraulic piston when the conveyor is stopped by the frozen ice. With this arrangement the conveyor shaft 82 is not subjected to excessive torque due to high water pressure. The torque applied to the conveyor shaft 82 is independent of water pressure in the hydraulic cylinder. This torque is determined solely by the difference in strength between the springs 152 and 162 and may consequently be limited to a suitable value.

As the piston 126 descends in the hydraulic cylinder 124 it draws the cylinder 142 downward relative to the piston 148 thereby compressing the spring 152 between the piston 148 and the top closure member 154. The spring 152 is made stronger than the return spring 162, so that when sufficient heat has been applied to the ice mold to free the ice therefrom, the compression spring 152 expands, thereby lowering the piston 148 and the piston rod 150. The freewheeling pulley 120, through the cable 136, completes a clockwise revolution (as viewed in Fig. 15) and in so doing rotates the conveyor shaft 82 and the attached fingers 84 which turn the ice out of the mold. Due to the braking action obtained from the oil in the cylinder 142, the turning of the pulley 120 takes place at a moderate speed and the rotated ice comes to rest on top of the conveyor blade, as shown in Fig. 14. Otherwise, the ice might be thrown off into the bin 44 before the wetted surface thereof has had a chance to be dried.

The cable 136 will continue to rotate the freewheeling pulley 120 in a clockwise direction until the spring 110 again slips into the notch 108 in the ratchet wheel 100. The switch 114 then opens and de-energizes the solenoid valve 168 to close the inlet 170 and open the exhaust 174. The return spring 162, through the cable 166, now reverses the motion of the freewheeling pulley 120 at which time the conveyor shaft 82 remains stationary. In reversing the motion of the freewheeling pulley 120 the piston of the hydraulic cylinder 124 is moved upward, discharging the water therein through the connector 172, the valve 168, the exhaust 174, the tube 175, the conduit 176 and the trough 178 into the ice mold 54. The hydraulic cylinder 124, in other words, not only furnishes the required power for driving the conveyor mechanism but it also measures the water for proper filling of the ice mold. In this way, need for a drain connection from the hydraulic cylinder is eliminated.

As shown in Fig. 14, an ice batch is held on the top of the conveyor blade for drying of the wet surfaces thereof while a new batch of ice is being frozen in the mold. When the conveyor again starts rotating at the next transfer cycle, the ice on top of the blade is dry and is first thrown off over the left side of the mold. The projections 68 on the mold partitions guide the ice as it leaves the conveyor so that it does not tumble end over end into the bin. The ice pieces fall into the bin where they are stored with previous batches. There may be some slight adhesion of ice to the conveyor blade, but, due to the line and point contact between the blade and the ice, and due to the fact that the fingers 84 are slightly resilient, the ice is readily freed therefrom.

In lieu of a guide to check any tendency of the ice to slide sideways on the conveyor blade just as it leaves the mold, the outer corners of each of the fingers 84 are peened up to form the sharp teeth 85. These teeth bite into the upper surface of the ice during a transfer cycle and thereby grip the ice and guide it from the mold onto the conveyor blade. Also, the upstanding edge 70 at the right side of the ice mold assists in guiding the ice from the mold and onto the top of the conveyor blade. The ice pieces A that make up an ice batch are usually connected together when they are removed from the mold and come to rest upon the top of the conveyor blade. This connection of the ice pieces assists in holding an ice batch on top of the conveyor blade in an orderly manner for drying of the wet surfaces thereof, and is brought about by the generally semi-elliptical weirs 72 in each of the ice mold partitions. These weirs cause generally semi-elliptical connecting portions C of ice to be formed between adjacent particles A, as shown in Fig. 14. The separation of an ice batch into individual pieces, shown at random in Figs. 1a and 3, is mainly due to the fall of the ice into the bin 44. In ice batches in which the pieces do not come completely apart they usually hang together only in pairs. The few pieces which happen not to be separated in

falling into the bin can most easily be cracked apart by merely pressing together the ends which are located opposite the connected sides of the pieces.

Modified control mechanism

Referring now to Figs. 20 to 22 inclusive wherein there is disclosed a modified control mechanism for stopping the action of the conveyor mechanism when the bin 44 becomes filled with ice, this mechanism, generally indicated by reference character 186, takes the place of the several resilient feelers 180 and the several stop switches 182, previously described.

As the ice receiving bin 44 is filled with ice and ice pieces collect to the right of a broad, movable vane 188, located in the upper left portion of the bin, the vane is deflected to the left as indicated by the arrow in Fig. 20. This movement will cause the opening of a switch, as described below. This switch, as in the case with the several switches 182, is wired in series with the mold thermostat 76 so as to prevent any more ice from being transferred once the bin is filled. In order to make this action more positive, the vane 188 is actually moved a small amount to the left each time the conveyor operates, and the stop switch will remain open if the vane encounters any resistance from ice collected in front of it when it tries to move back again as an ice transferring operation is completed.

As shown in Figs. 20 and 21, the control mechanism 186 specifically includes the vane 188, which is provided with a front flange 190 and a rear flange 192. The vane is pivoted on a small shaft 194, which shaft is supported on the left side of compartment 28 by a pair of brackets 196. So that any ice pieces lodged between the vane and the left wall of the ice receiving bin 44 may be easily discovered and removed, the lower portion of vane 188 is formed of a transparent plastic panel 198. Also, the use of plastic material at this point is desirable for easy removal of ice pieces in case there should be some adhesion of the ice to the vane upon prolonged storage of ice in the bin. The vane is urged or biased to the right by a torsion spring 200, and it is prevented from moving too far to the right by a stop 202 secured thereto. Rigidly attached to the rear flange 192 of the vane is a short cylindrical member 204. This cylindrical member is shown concentric with the shaft 194, although it is not attached to this shaft and may be attached to any suitable portion of the vane.

A friction clamp 206 is attached to the cylindrical piece 204 and held in frictional engagement therewith by a screw 208. The cylindrical piece 204 and the friction clamp 206 normally constitute a rigid extension of the vane. A relative movement between the clamp 206 on one hand and the cylindrical piece 204 and vane 188 on the other occurs only under special circumstances, as described below. The clamp 206 is provided with an ear 210, which ear is adapted to engage and hold closed a switch 182'. The switch 182' is mounted on the left side of the compartment 28 by a clamp. This switch 182', which takes the place of the several switches 182 shown in Figs. 3 and 4, may be of any suitable construction, so long as it is adapted to be held closed when engaged by the ear 210 of the friction clamp and remains open when not so engaged. A two-wire conductor cable 212 leads from the switch 182' and is connected in series with the cable that leads from the ice mold thermostat 76, as shown in the wiring diagram in Fig. 22. A link 214 is pivotally connected, as at 216, to the lever 88, which lever raises the ice mold 54 relative to the evaporator shelf, as previously described. The link 214 passes through an opening 218 in the upper portion of the friction clamp 206. A pair of adjustable stop members 220 and 222 are attached to the outer portion of the link on each side of the friction clamp.

Operation of modified control

The operation of the ice mold, the ice conveyor mechanism, the ratchet and pulley mechanism and the operating mechanism is the same with the modified control mechanism 186 as that previously described in connection with Figs. 1 to 19 inclusive. In the operation of the modified control, when an ice transfer movement takes place and the lever 88 is moved to the right by the cam 86, as viewed in Fig. 20, the link 214 is also moved to the right, whereupon the stop member 220 on the end of the link contacts and moves the friction clamp 206 to the right, which latter movement causes the vane 188 to move to the left. Movement of the friction clamp and the attached ear 210 out of contact with the switch 182' causes the switch to temporarily open. However, the transfer procedure continues because, as previously stated, the switch 114, Fig. 22 as in Fig. 2, will have previously been closed, thereby establishing parallel circuits through the solenoid valve 168 and through the heating elements 74; therefore, the solenoid valve 168 and heating elements 74 will remain energized. As the ice transfer procedure continues, the lever 88 will be returned to its normal position, whereupon movement of the link 214, the friction clamp 206 and the vane 188 will be reversed and these parts will be returned to their normal position shown in Fig. 20.

As the bin 44 fills with ice, the vane 188 will not be able to return to its normal position because of an accumulation of ice in front of it. Therefore, the stop switch 182' will remain open and the next ice batch cannot be transferred until some ice has been removed from the bin. Now, in case movement of the vane 188 be obstructed when a transfer takes place, as by ice pieces being lodged between the vane and the left wall of the bin, or by substantial adhesion of ice to the vane due to prolonged storage of ice in the bin, the friction clamp 206 will still move and pivot on the cylindrical member 204 on account of the frictional engagement at this point and it will not move back to its normal position, whereupon the switch 182' will remain open. Further ice production will, therefore, be prevented until the vane 188 is freed manually and pushed all the way to the left from its normal position. When this is done, the friction clamp 206 engages the stop member 222 on the link 214, which moves the clamp back to its regular position with respect to the vane 188. The friction arrangement also protects these parts from any undue strain that may be placed thereupon.

It is to be noted that the two different control means for the ice maker, that is the embodiment shown in Figs. 2 to 4 and the embodiment shown in Figs. 20 to 22, are quite similar in operation and they perform the same function. In the embodiment illustrated in Figs. 2 and 4, the stop switches 182 are moved to open or stopping position temporarily by the ice pieces as they fall into the bin, and these switches 182 are closed and are biased to closed or operating position by the resilient feelers as they return to their horizontal position after the ice pieces have fallen clear thereof. In the embodiment illustrated in Figs. 20 to 22, the stop switch 182' springs to open or stopping position when the ear 210 is moved out of contact therewith at the beginning of each ice delivery cycle, and this switch 182' is returned to closed or operating position by the ear 210 at the end of each ice delivery cycle. The switch 182' is biased to closed or operating position by the torsion spring 200.

One or more of the switches 182 in the embodiment illustrated in Figs. 2 to 4 and the switch 182' in the embodiment illustrated in Figs. 20 to 22 are held in open or stopping position by the accumulation of ice when the storage bin is full. Furthermore, as illustrated in the wiring diagrams in Fig. 2 and in Fig. 22, when the switch 114 is closed three parallel circuits are established, at least temporarily, between the supply wires 184. During the operation of the ice maker, with reference to

the wiring diagram illustrated in Fig. 2, when the switch 114 is closed one or more of the switches 182 and/or the switch 76 may be open, and when the switches 182 and 76 are closed the switch 114 is open. Likewise, with reference to the wiring diagram illustrated in Fig. 22, when the switch 114 is closed, the switches 182' and/or 76 may be open and when the switches 182' and 76 are closed the switch 114 is open.

The foregoing description and accompanying drawings disclose preferred embodiments of my invention, but it will be understood that this specific disclosure is merely illustrative and that the invention may take other forms and be variously applied within the scope of the following claims.

I claim:

1. An ice maker comprising an ice mold having an arcuate contour, a freezer for congealing water in the mold, power mechanism operative to cause relative turning movement between the mold and an ice piece formed therein to remove the ice piece from the mold, and a control device operative responsive to the formation of the ice piece to instigate operation of the turning mechanism.

2. An ice maker as set forth in claim 1 in which the power of said mechanism is supplied by an hydraulic motor.

3. An ice maker as set forth in claim 1 in which said power mechanism includes a shaft rotatably mounted above said ice mold, and a finger mounted on the shaft for engaging and turning the ice piece from the mold when the shaft is rotated.

4. An ice maker as set forth in claim 1 which also comprises means for loosening an ice piece formed in the mold, said control device being also operative responsive to the formation of the ice piece to instigate operation of the loosening means.

5. An ice maker as set forth in claim 1 in which said control device includes a thermostat subjected to the temperature of the ice mold.

6. An ice maker as set forth in claim 1 in which said control device is electrically operated and includes a first switch operative responsive to the temperature of the mold to initiate operation of the turning mechanism, and a second switch operated by movement of the turning mechanism for terminating operation of the latter.

7. An ice maker as set forth in claim 1 which also comprises an electric heater for loosening an ice piece formed in the mold, and said control device is electrically operated and includes a first switch for initiating operation of the turning mechanism, and a second switch for energizing the heater.

8. An ice maker as set forth in claim 1 which also comprises a device for filling the mold with water, and a control operative to instigate operation of the filling device upon removal of the ice piece from the mold.

9. An ice maker as set forth in claim 1 in which said mold has an aligned series of cells communicating at their upper edges by weirs which are also arcuate.

10. An ice maker comprising a mold having an arcuate contour, a freezer for congealing water in the mold, means for loosening an ice piece formed in the mold, a conveyor having a rotatable member movable through the mold for engaging and removing the ice piece from the mold, and means operative responsive to the formation of the ice piece to instigate operation of the loosening means and conveyor.

11. An ice maker comprising a freezer, a mold movable to and from thermal contact with the freezer, a heater for loosening ice formed in the mold, and ice removing mechanism including a control device operative responsive to the formation of an ice piece in the mold to move the mold from contact with the freezer and start the heater.

12. An ice maker comprising a mold, a freezer for congealing water in the mold, a device including a rotatable member movable through the mold for effecting

removal of ice from the mold, a reciprocating power element, and a converter so constructed and connected that the rotatable member is turned one revolution only by each power stroke of said element.

13. A refrigerator including an ice making compartment, a food storage compartment, an ice storage bin communicating with the ice making compartment, means for cooling said compartments and said bin, and an ice maker in said ice making compartment, said ice maker including an ice mold, a conveyor mechanism for engaging and removing ice from the mold and transferring it to the bin, and means in the conveyor mechanism for holding one batch of ice on said mechanism for drying wetted surfaces thereof during the freezing of a subsequent batch of ice in the ice mold.

14. A refrigerator as set forth in claim 13 wherein the conveyor mechanism includes a rotatable shaft mounted above the ice mold and a plurality of fingers mounted on the shaft for rotation thereby into and out of the ice mold.

15. In an ice maker, an ice mold having an arcuate contour, means for freezing water in said mold, and means mounted on the ice maker above said mold and rotatable therethrough for turning ice in the mold and removing it therefrom.

16. An ice maker as set forth in claim 15 wherein the means for removing ice from the mold includes a rotatable shaft mounted off center relative to the longitudinal axis of the mold, and means for rotating said shaft.

17. In an automatic ice maker, a cooling element, an ice mold movably mounted on said cooling element, means for filling said mold with water to be frozen, a conveyor mechanism for conveying the frozen contents from the mold, said conveyor mechanism including a rotatable shaft mounted above said mold and having members thereon movable into and out of the mold in one direction of movement, a fluid motor for rotating said shaft, means operable upon rotation of said rotatable shaft for raising the mold free of the cooling element, and control means for said conveyor mechanism, said control means including a first electric circuit having a first electric switch operable responsive to the temperature of said mold and an electrically operated valve for controlling the flow of fluid to and from said fluid motor, a second electric circuit including the electric valve and a second switch operable responsive to an initial movement of said conveyor mechanism for maintaining the electric valve energized during rotation of the shaft regardless of the position of the first switch and a third electric circuit including said second switch and heating means for heating said mold after the mold has been raised free of the cooling element.

18. An automatic ice maker as set forth in claim 17 which includes a storage bin for receiving ice discharged from the conveyor mechanism, and wherein the first electric circuit includes a cutout switch mechanism connected in series with the first switch and operable to open the first circuit upon the accumulation of a predetermined amount of ice in the storage bin.

19. An automatic ice maker as set forth in claim 18 wherein said cutout switch mechanism includes a plurality of resilient feelers each including a switch in a free end thereof, which switches are wired in series and which resilient feelers are adapted to be flexed downward by ice pieces falling from the conveyor mechanism into the storage bin to thereby open the first electric circuit.

20. An automatic ice maker as set forth in claim 18 wherein said cutout switch mechanism includes a movable vane adapted to open said first circuit upon the accumulation of a predetermined amount of ice in the storage bin, and means including a friction clutch for moving said vane.

21. An ice maker comprising a freezing section, an

ice storage bin, a heat exchange element in the freezing section on which liquid is frozen and from which ice is conveyed to the storage bin, means to cool said heat exchange element, and means for controlling the operation of said ice maker, said control means including a movable member biased to a position for operating the ice maker and movable to a position for stopping the ice maker and means for moving said movable member to stopping position during each delivery of ice to said storage bin and for returning said movable member to operating position after the delivery of ice to the storage bin provided the bin is not filled with ice, said movable member being detained in said stopping position by means including the ice when the storage bin is full.

22. An ice maker comprising a freezing section, an ice storage bin, a heat exchange element in the freezing section, apparatus for cooling the heat exchange element to freeze liquid thereon and for heating the element to release ice therefrom for delivery to the storage bin, and electric control means for controlling the ice maker to operate successively on liquid freezing and ice delivering cycles, said control means having parallel circuits with a switch in each circuit, operating means energized responsive to the freezing of water into ice on said heat exchange element for sequentially closing the switch in one circuit and opening the switch in the second circuit and vice versa during each ice delivering cycle, and said operating means including a movable member for actuating the switch in said second circuit and so positioned and arranged as to be held in open circuit position by the accumulation of ice when the storage bin is full.

23. A method of automatically producing pieces of ice which includes sequentially filling a multi-compartment mold with water, freezing said water, thereby forming a plurality of ice pieces, breaking the frozen bond between the compartments and the ice pieces, applying a force in a circular path simultaneously to the top surface of each of the ice pieces in a manner that the ice pieces are rotated and removed from the mold compartments, bringing the removed pieces of ice to rest in a freezing zone above the mold, and drying the removed pieces of ice in said freezing zone.

24. A method of producing individual pieces of ice which includes sequentially filling a multi-compartment mold with water, contacting the mold with a freezing surface until the water is frozen therein, heating the mold to free the ice therefrom responsive to the formation of ice in the mold, removing the ice from the mold as a batch of connected ice pieces, holding the batch of ice in a refrigerated zone for drying wetted surfaces thereof, and discharging the dried batch of ice into a storage zone in a manner that the batch is separated into individual pieces.

25. A method of producing individual pieces of ice which includes sequentially flowing water to each of a plurality of connected ice forming compartments, freezing said water, thereby forming a plurality of pieces of ice connected by bridge portions of ice, breaking the bond between the compartments and the ice pieces, removing the connected ice pieces as a unit from the compartments, drying the ice pieces by subjecting them to a freezing medium while simultaneously freezing an additional batch of ice in the compartments, breaking the connections between the dried pieces of ice by discharging the batch of ice into a storage zone, and discontinuing the production of ice upon the accumulation of a predetermined amount of ice in said storage zone.

26. An ice maker comprising a mold having a plurality of ice forming compartments, said compartments being so dimensioned as to form ice pieces that are of lesser thickness on one end at one side of the mold than on another end thereof, means for forming ice pieces in said compartments, and mechanism attached to the ice

maker for simultaneously removing the ice pieces from said compartments, said mechanism including means movable into contact with the ice pieces near the ends thereof of lesser thickness for moving the ice pieces from the mold with ends thereof reversed.

27. An ice maker comprising a mold having an ice forming compartment therein so dimensioned as to form an ice piece of unequal dimensions, means for forming an ice piece in said compartment, mechanism for removing the ice piece from said compartment, said mechanism including a member movable through the mold compartment in a manner to remove the ice piece from the compartment and bring the ice piece to rest in an inverted position thereon, means for drying the ice piece in said inverted position, and means for removing the dried ice piece from said member.

28. In an ice maker, a freezing element, a mold for holding water in thermal conductive relation with such freezing element, a sub-freezing storage compartment, means utilizing application of heat to the mold for releasing ice therefrom, and means for turning such ice upside down and holding it until dry before delivery thereof to said storage compartment.

29. An ice maker comprising a mold having a plurality of ice forming compartments, said compartments being tapered in a manner to form ice pieces of lesser thickness on one end than on an opposite end thereof, means for forming ice pieces in said compartments, and mechanism for removing the ice pieces from said compartments, said mechanism including members movable into contact with one end of said ice pieces in a manner to remove the ice pieces from the mold and bring such pieces to rest in an upside down position with the ends thereof occupying reversed positions relative to the mold compartments, and means for stripping the ice pieces from said movable members.

30. In an ice maker, a freezing mold, a sub-freezing storage compartment, an ice release utilizing a mold heater and a device to forceably engage ice in the mold, said device being also operative to first elevate the ice to a position above the mold for drying and then deliver the ice to said storage compartment, and a control to stop operation of said release with the ice in elevated position, and resume operation responsive to formation of ice in the mold.

31. An ice maker comprising a mold having an ice forming compartment therein, means forming an ice piece in said compartment, means for thawing the ice piece free of said compartment in a manner that one surface of the ice remains dry, and mechanism for removing the ice piece from said compartment, said mechanism including a member contacting the dry surface of said ice piece as the piece is removed from the mold, means for drying wetted surfaces of the ice piece while in contact with said member, and means for removing the dried ice piece from contact with said member to a place of storage.

32. An ice maker comprising a mold having an ice forming compartment therein, means forming an ice piece in said compartment, and mechanism for removing the formed ice piece therefrom, said mechanism including means for thawing the ice piece free of the compartment and a movable member held out of contact with the ice during the freezing thereof and movable into contact therewith for urging the ice from the compartment simultaneously with the operation of the thawing means whereby the ice is removed from the compartment coincident with the thawing thereof.

33. An ice maker comprising a mold having an ice forming compartment therein, means for forming an ice piece in said compartment, and mechanism for removing the ice piece from the compartment, said mechanism including a heating element for breaking the bond between the ice piece and the mold and a rotatable member for contacting and moving the ice relative to the mold, said rotatable member being so constructed and arranged

as to stall while energized upon contact with the ice frozen to the mold and to move the ice from the mold immediately the bond between the ice and the mold is broken.

34. In an ice maker, the combination with a mold, a drying station, a storage station, and refrigerating apparatus arranged to produce freezing temperatures at said mold and said stations, of a member so constructed and arranged as to move relative to the mold and engage ice while in the mold, mechanism arranged and connected to operate said member to contact and remove from the mold such ice, conduct it to the drying station and release it to the storage station, and a control to instigate operation of said mechanism operative responsive to change in a condition affected by freezing of water into ice in said mold.

35. In an ice maker, a mold, a drying station, refrigerating apparatus arranged to produce freezing temperatures at said mold and said station, a member so constructed and arranged as to move relative to said mold and engage ice while in the mold, mechanism arranged and connected to operate said member to contact and remove from the mold such ice and conduct it to the drying station, and a control operative responsive to change in a condition affected by freezing of water into ice in said mold to instigate operation of said mechanism, said member also being so constructed and arranged as to release ice from said drying station upon operation of said mechanism.

36. In an ice maker, a mold, a drying station, refrigerating apparatus arranged to produce freezing temperatures at said mold and said station, a member so constructed and arranged as to move relative to the mold and engage ice while in the mold, mechanism arranged and connected to operate said member to contact and remove from the mold such ice, conduct it to the drying station, and hold it at the drying station until dry, said member also being so constructed and arranged as to release the dried ice from said drying station upon operation of said mechanism, and a control operable to effect a repetition of the operation of said mechanism.

37. In an ice maker, the combination with a mold, a drying station, a storage station, and refrigerating apparatus arranged to produce freezing temperatures at said mold and said stations, of a member so constructed and arranged as to move relative to the mold and engage an ice piece while in the mold, mechanism arranged and connected to operate said member to transfer an ice piece from the drying station to the storage station and another ice piece from the mold to the drying station in one cycle of operation, a control initiated by change in a condition affected by freezing of water into ice on said mold to start operation of said mechanism and stop operation at the end of each cycle, and a device at said storage station constructed and arranged to prevent operation of said control while a desired quantity of ice is in said storage station.

38. The method of producing and storing ice which comprises sequentially congealing water into ice by contact with a freezing surface, loosening the ice from such surface by the application of heat, turning the ice upside down and holding it until dry, and then delivering the ice to sub-freezing storage.

39. The method of producing and storing ice which comprises congealing water into ice by contact with a freezing surface, freeing the ice from such surface by the simultaneous application of mechanical force on the ice and heat on the surface, holding the freed ice apart from such surface until the exterior of the ice is dry, and then delivering the ice to sub-freezing storage.

40. The method of producing and storing ice which comprises measuring a certain quantity of water, flowing the entire measured quantity of water into a freezing mold and there congealing all such water into ice, applying heat to loosen the ice from the mold, engaging the ice in the mold to remove the ice, holding the removed

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ice until dry, and then delivering the ice to sub-freezing storage.

41. A method of automatically producing and harvesting pieces of ice which comprises filling an open top mold with water, freezing the water into ice, thawing the ice free of the mold in a manner that one surface of such ice remains dry, removing the ice from the mold by a force applied to the dry surface thereof, supporting the ice by the dry surface in a freezing zone to thereby dry the remaining surfaces thereof, and conveying the dried ice to a place of dry storage.

42. A method of automatically producing and harvesting pieces of ice which comprises filling an open top mold with water, freezing the water into ice, thawing the ice free of the mold in a manner that one surface of such ice remains dry while simultaneously applying a force to the dry surface to thereby remove the ice from the mold, bringing the ice to rest in a freezing zone with the ice supported by the dry surface only to thereby dry the remaining surfaces of such ice, and conveying the dried ice to a place of dry storage.

43. A method of automatically producing and harvesting pieces of ice which comprises filling a multi-compartment mold with water, subjecting the water to a freezing temperature in a first freezing zone to thereby freeze a batch of ice pieces in the mold, thawing the ice pieces free of the mold in a manner that at least one surface of each of the ice pieces remains dry while the other surfaces thereof are wetted by the thawing action, removing the ice pieces from the mold by the application of force to the dry surfaces thereof, bringing the ice pieces to rest in a second freezing zone to thereby dry the wetted surfaces thereof while simultaneously freezing a second batch of the ice pieces in the mold, discharging the dried batch of ice into storage in a third freezing zone while removing the second batch of ice to the drying zone, and suspending the production of pieces of ice responsive to

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the accumulation of an optimum quantity of ice in the storage zone, with a batch of ice dried in the drying zone ready to be removed to the storage zone and a second batch of ice frozen in the mold, ready to be removed to the drying zone.

References Cited in the file of this patent

UNITED STATES PATENTS

10	1,868,503	Kennedy	July 26, 1932
	1,889,481	Kennedy	Nov. 29, 1932
	1,923,522	Whitehouse	Aug. 22, 1933
	2,026,227	Foraker	Dec. 31, 1935
	2,071,465	Huber	Feb. 23, 1937
15	2,077,820	Arp	Apr. 26, 1937
	2,150,792	Willat	Mar. 14, 1939
	2,161,321	Smith	June 6, 1939
	2,259,066	Gaston	Oct. 14, 1941
	2,269,642	Zerk	Jan. 13, 1942
20	2,334,941	Linden	Nov. 23, 1943
	2,364,559	Storer	Dec. 5, 1944
	2,407,058	Clum	Sept. 3, 1946
	2,429,851	Swann	Oct. 28, 1947
	2,429,882	Jennings	Oct. 28, 1947
25	2,431,278	Raver	Nov. 18, 1947
	2,431,916	Caesar	Dec. 2, 1947
	2,435,102	Rundell	Jan. 27, 1948
	2,435,802	Smith	Feb. 10, 1948
	2,449,132	Lucia	Sept. 14, 1948
30	2,526,262	Munshower	Oct. 17, 1950
	2,528,875	Embshoff	Nov. 7, 1950
	2,542,892	Bayston	Feb. 20, 1951
	2,575,892	Roberts	Nov. 20, 1951

FOREIGN PATENTS

35	898,171	France	Apr. 12, 1945
----	---------	--------	---------------