May 15, 1962 H. P. HARLE 3,034,312

AUTOMATIC ICE MAKER CONTROL MEANS

Filed Sept. 14, 1960 2 Sheets-Sheet 1

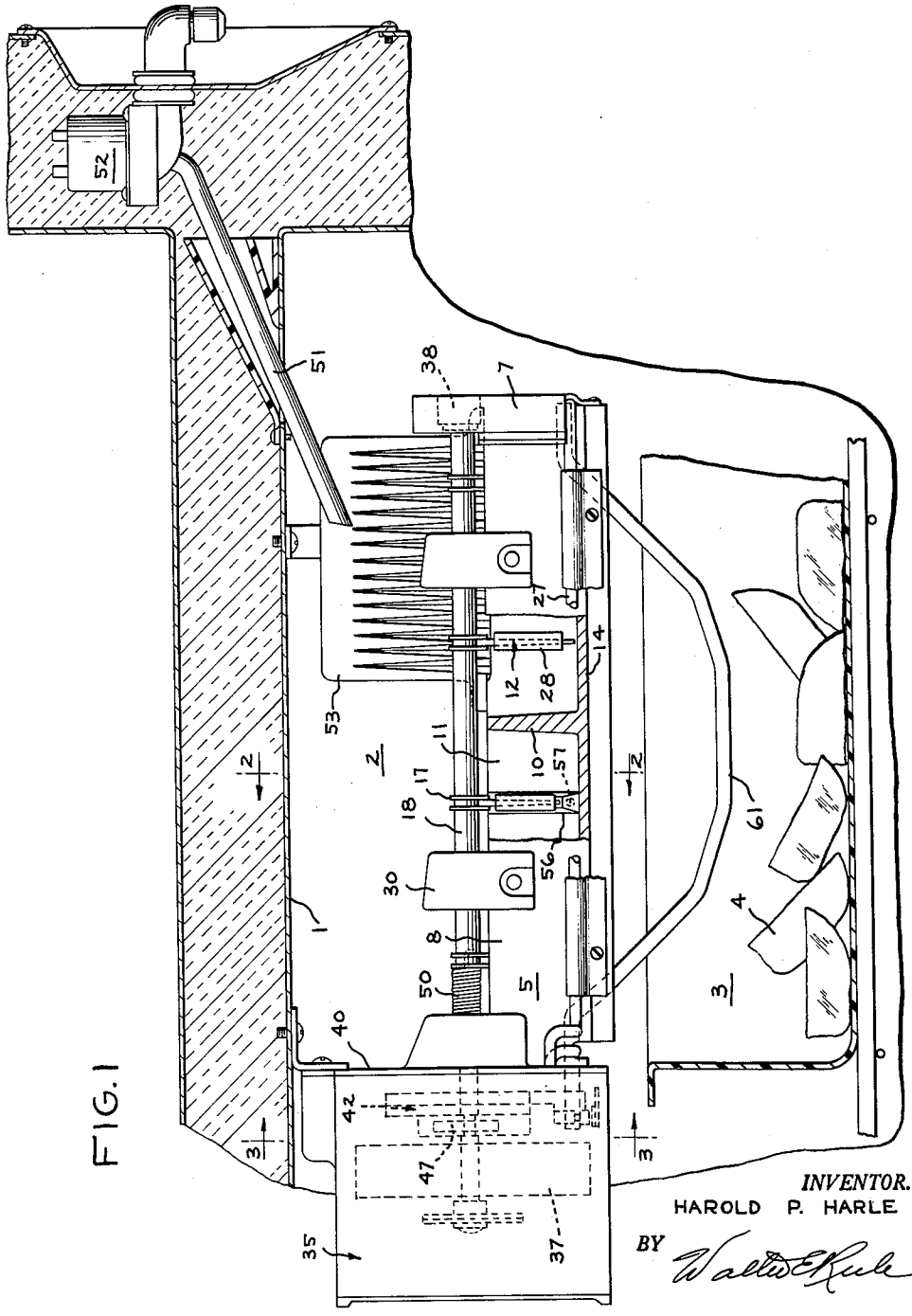


FIG. 1

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FIG. 3

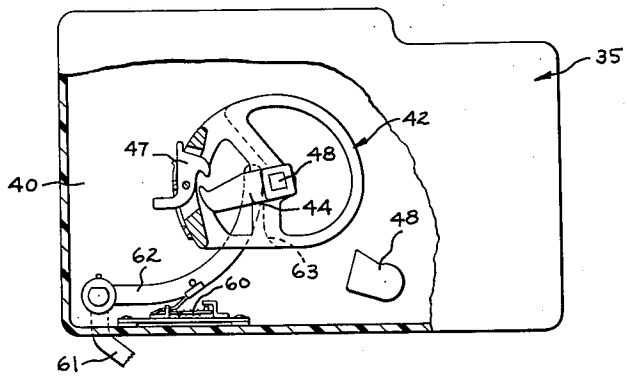
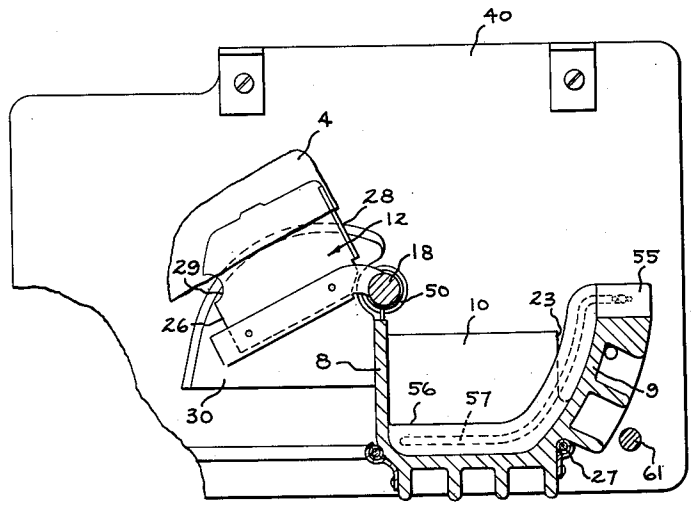


FIG. 2



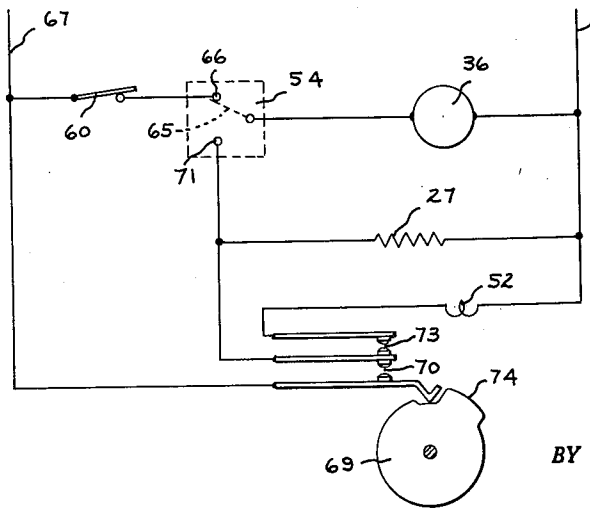


FIG. 4

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AUTOMATIC ICE MAKER CONTROL MEANS

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2 Claims. (Cl. 62—135)

The present invention relates to an automatic ice maker and is more particularly concerned with an improved control means for an ice maker adapted to be incorporated in a domestic or household refrigerator.

The invention relates particularly to the general type of ice maker including a mold in which a charge of water is frozen, means for removing ice pieces formed in the mold comprising one or more pivoting transfer elements which are frozen into engagement with the ice pieces during each freezing cycle and are movable from their normal positions within the mold to an ice piece discharge position outside the mold and water supply means for thereafter introducing another charge of water into the mold. An ice maker of this type in which movable dividers or partitions serve as transfer elements for harvesting the ice pieces is described and claimed in the copending application Serial No. 813,790 (now Patent 2,970,453) filed May 18, 1959 on the names of Harold P. Harle, Stephen Balogh and Henry J. Lowenthal and assigned to the same assignee as the present invention.

The present invention has as its principal object the provision of an improved low cost control means for an ice maker of this type.

Another and more specific object of the invention is to provide an automatic ice maker of this type including thermal switch control means responsive to the temperature of the mold for controlling the operation thereof, means for introducing a fresh charge of water into the freezing mold after each discharge of ice therefrom and means for controlling the automatic operation of the ice maker whereby a fresh charge of water cannot be introduced into the mold until the temperature of the mold is sufficiently high to assure that the control means is reset for a subsequent cycle.

Further objects and advantages of the invention will become apparent from the following description, reference being made to the accompanying drawing in which:

FIG. 1 is an elevational view partly in section, of an ice maker including an embodiment of the present invention;

FIG. 2 is a sectional view of the ice mold taken generally along line 2—2 of FIG. 1 but showing the movable dividers in a discharge position;

FIG. 3 is an operational view of the ice maker taken along line 3—3 of FIG. 1; and

FIG. 4 is a wiring diagram of the improved electrical control system employed for the automatic operation of the ice maker in accordance with the present invention.

With reference to FIG. 1 of the drawing, there is illustrated an ice maker designed to be suspended from the top wall 1 of the low temperature or freezing compartment 2 of a household refrigerator. The contents of the compartment 2 including the ice maker are maintained at the below freezing temperatures by air circulated over a low temperature evaporator (not shown) so that the ice maker can be mounted in the compartment out of direct contact with an evaporator unit. Also positioned within the compartment and below the ice maker is an ice receptacle or bin 3 in which ice pieces 4 discharged from the ice maker are stored at below freezing temperatures.

Referring now to FIGS. 1 and 2 of the drawing, the ice maker includes an elongated ice mold 5 comprising end walls 7 and side walls 8 and 9 forming a substantially rectangular mold cavity which is divided into a

plurality of sections by fixed, full width dividers or partitions 10 extending transversely of the mold cavity. Each of these sections is in turn divided into adjacent interconnected compartments 11 by movable dividers 12 arranged between the fixed dividers. The mold proper including the end walls 7, the side walls 8 and 9 and a bottom wall 14 are composed of metal and preferably comprise a unitary die cast structure.

The movable dividers 12 which function as transfer elements for removing ice pieces from the mold are composed of a low heat conducting flexible material such as a plastic material, thin stainless steel or the like and are each mounted on a shaft 18 rotatably supported above the vertical mold side wall 8. In order that the movable dividers 12 can pivot about the axis of the shaft 18 from a position within the mold as illustrated in FIG. 1 to a discharge position along one side of the mold as illustrated in FIG. 2, the mold side wall 9 opposite the shaft 18 slopes outwardly and is of a generally concave configuration while the cooperating side edge 22 of each of the movable dividers is similarly shaped. To provide for the flow of water from one compartment to another during filling of the mold cavity, each of the fixed dividers 10 includes a slot 23 adjacent the side wall 9 while the movable dividers 12 have their upper edge portions 26 terminating short of the side wall 9 to provide a channel or spacing similar to that provided by the slots 23.

In order to release ice pieces formed in the compartments 11 from the mold walls, there is provided an electric heating element 27 extending in the form of a loop around the bottom wall 14 below the side walls 8 and 9. When this heating element is energized, the mold, including its bottom wall 14, the end walls 6 and 7 and the side walls 8 and 9 as well as the fixed partitions 10, becomes sufficiently warm to melt the bond between the mold surfaces and the ice pieces. However, since the movable dividers 12 are composed of a material of lower heat conductivity than the mold, there is insufficient warming of these members to melt the ice bond. These movable dividers, upon rotation out of the mold, then serve as transfer elements by means of which ice pieces are removed from the mold.

While there is a natural tendency for the pieces to remain frozen to the low heat conductivity material for a longer period of time than the directly heated mold, in order to more positively assure transportation of the ice pieces from the mold and over the mold side wall 8 during piotal movement of the movable elements 12, these elements are preferably also provided with additional means for anchoring the ice pieces to the dividers. In the illustrated embodiment of the invention, the movable dividers 12 have fins 28 along both sides of the rear edges thereof, that is along the edges adjacent the shaft 18 and notches 29 in the opposite edges.

Once the bond between the ice mold proper and the ice pieces has been broken or thawed, the movable dividers 12 can be pivoted upwardly and outwardly from the mold by rotation of the shaft 18 to a discharge position as shown in FIG. 2 in which the ice pieces comes into contact with a plurality of spaced bumpers 30 suitably supported along the side wall 8 of the mold. As will be seen in FIG. 1 of the drawing these bumpers, which are opposite the fixed dividers 10, are wide enough to overlap the compartments 11 on each side of the fixed dividers. When the ice pieces contact the surfaces of bumpers 30, movement of the ice pieces is stopped and the continued movement of the dividers causes the ice pieces to peel away from the dividers and drop into the receptacle 3 provided below the mold.

Control and power mechanism for effecting and controlling the operation of the ice maker is generally housed

in a housing 35 secured to one end of the mold 5. The power mechanism includes a motor 36 diagrammatically illustrated in FIG. 4 of the drawing, the motor and a suitable speed reducing gear train forming a drive mechanism generally shown in broken lines and indicated by the numeral 37 in FIG. 1 of the drawing. The shaft 18 is rotatably mounted in a bearing 38 adjacent the mold end wall 7 and a bearing (not shown) in the front wall 40 of the housing 35. A pawl and cam assembly 42 shown in FIG. 3 is connected to the end of the shaft 18 extending into the housing 35 and an arm 44 connected to the drive shaft 45 forming part of the drive mechanism 37 provides means for connecting the motor to the shaft and rotating the shaft 18 upon operation of the motor 36. To this end, the arm 44 is adapted to engage the pawl 47 forming part of the pawl and cam assembly 42 during initial operation of the motor. The pawl 47 is pivotally supported on that assembly as illustrated in FIG. 2 of the drawing in such a position that after rotation of the cam assembly 42 through a predetermined number of degrees, a projection 48 on the wall 40 causes disengagement of the pawl from the arm and allows the motor to continue rotating in the same direction while a return spring 50 on shaft 18 causes the shaft to rotate in the opposite direction and return the dividers to the mold.

The illustrated water supply means, which is more fully described and claimed in my copending application S.N. 25,432, filed April 28, 1960, now Patent No. 3,012,417 and assigned to the same assignee as the present invention, includes a filler tube 51 connected through a normally closed solenoid valve 52 to a suitable source of water supply. When the solenoid valve is energized to open the valve, water is supplied to the mold from the outlet end of the tube 45, this charge of water flowing downwardly into the mold over a baffle 53 supported on the mold side wall 9. The water thus introduced into the mold flows from compartment-to-compartment through the slots 23 and around the dividers 12.

In order to initiate the ice harvesting cycle when the water introduced into the mold has frozen, there is provided a motor control circuit including a thermal actuated switch such as a bellows operated single pole double throw switch 54 diagrammatically illustrated in FIG. 4 and generally housed within the housing 35. The sensing bulb component 50 of the switch, in the form of a capillary tube extends through the housing wall 40, through a plastic housing 55 along one side of the mold and then downwardly into a plastic housing 56 below one of the movable dividers 12 which is shortened to provide space for housing. In this position of the end 57 of the capillary tube, the switch 54 is responsive to the temperature of the mold adjacent one of the movable dividers.

After a number of ice making cycles, the receptacle 3 becomes filled with ice pieces. In order to stop the ice making operation when this occurs, the control circuitry includes a normally closed switch 60 actuated by a U-shaped feeler arm 61 which is pivotally mounted at each end along the side 9 of the ice mold in such a position that it normally, hangs downwardly into the receptacle 3. In order that the feeler arm will measure the amount of ice stored in the receptacle 3, means are provided whereby it is raised out of the receptacle during each ice making cycle so that when it returns to its normal position within the receptacle, it will rest on top of the newly added ice if that ice has resulted in a substantial filling of the receptacle. To obtain this control, the feeler arm includes, within the housing 30, an extension or actuating arm 62 which rides on a cam surface 63 provided on the cam and pawl assembly 42. Upon rotation of the shaft 18, this cam surface raises the feeler arm out of the receptacle during the time that the dividers 12 are being pivotally moved upwardly and out of the mold. Switch 60 which, as is shown in FIG. 4 of the drawing, is normally held in a closed position by actuating arm 62, thereupon opens and remains open so long as the feeler arm 52 is held in a raised position either by the accumulation of ice in the receptacle 3 or by the cam surface 63.

In accordance with the present invention there is provided a simple low cost control circuitry for the automatic control of an ice maker of this type through a complete production cycle. This improved circuitry and control means will be described in connection with the following consideration of the ice maker operation.

During freezing of a charge of water in the mold 5, the temperature of the mold gradually decreases. When the temperature sensed by the sensing bulb 57 indicates the complete freezing of the water in the mold, as for example a temperature of 20–25° F., the switch arm 65 of the single pole double throw switch 54 moves into contact with the cold switch contact 66. This completes a motor energizing circuit between the supply conductors 67 and 68 through the normally closed feeler arm switch 60 and contact 66 of switch 54. A few degrees of rotation of the drive shaft 45 is permitted before the drive arm 44 carried by this shaft engages the pawl 47. Cam 69, also driven by the drive shaft 45, is so designed that before the arm 44 engages pawl 47, the cam 69 will close the normally open cam operated switch 70 to energize the heater 27 which then remains energized through the complete ice making cycle. Switch 70 also forms part of a second motor circuit which includes warm contact 71 of switch 54 and which functions to energize the motor 36 after switch 60 is opened.

As the movable dividers 12 are frozen into the ice in the mold, contact of arm 44 with pawl 47 causes the drive motor to stall until sufficient heat has been applied by the heater to melt the bond between the ice pieces and the mold. At this point the motor again operates to lift the dividers 12 upwardly and over the side of the mold so that the ice pieces 4 are broken free from the dividers by the bumpers 30 for discharge into receptacle 3. Stop 48 then trips the pawl 47 so that the power mechanism including the drive shaft 45 is disengaged from the shaft 18 and spring 50 will then return the dividers 12 to the mold.

During rotation of shaft 18 to a position in which the ice pieces 4 contact bumpers 30, the cam surface 63 raises the feeler arm 61 out of receptacle 3 so that when it thereafter returns to the receptacle as the dividers 12 are returned to the mold, it will measure the amount of ice accumulated in the receptacle. This movement of the feeler arm to an elevated position also opens switch 60 thus breaking the initial motor energizing circuit including this switch and stopping the motor 36. The motor 36 remains de-energized upon the opening of the switch 60 until the sensing element 57 of the switch 54 senses a predetermined mold temperature substantially above the cold trip temperature as for example a temperature of 30–35° F. Switch arm 65 then moves into contact with the warm contact 71 whereupon the motor is again energized through a circuit including the switch 70 and contact 71 of switch 54.

Movement of switch arm 54 from cold contact 66 to warm contact 71 occurs as soon as the sensing bulb portion 57 senses the warm trip temperature. Once the ice pieces have been pivoted out of contact with the mold walls so that they no longer have a cooling effect with respect to these walls, only a relatively short time is required for the heater to warm the mold to the temperature at which switch 54 trips to its warm position. If the mass of the mold and other conditions are such that this occurs before the feeler arm switch 60 opens, the motor 36 will be energized through the circuit including the warm switch contact 71 and the remaining portion of the ice harvesting cycle will be a continuous one. Otherwise, opening of the switch 60 as the feeler arm is raised will de-energize the motor until switch 54 trips to the warm position.

With the second motor energizing circuit including the

warm contact **71** completed, rotation of the cam **69** thereafter closes a second cam operated switch **73** to energize and open the solenoid valve **52**, the portion of the cam surface for this purpose being indicated by the numeral **74** and being designed to time the open period for the valve to introduce a controlled quantity of water into the mold.

As the cam **69** rotates through one revolution and returns to its original or starting position, switches **70** and **73** are reset to their normal or starting positions, the motor **31** being de-energized by the opening of switch **70**. The control and power mechanism is thereby set for the next operating cycle of the ice maker, which is initiated upon the decrease in the temperature of the mold to a point at which the arm **65** of the thermal control switch **54** again engages contact **66** unless the amount of ice collected in the receptacle **3** is sufficient to maintain the feeler arm **61** in an elevated position. In such a case, switch **60** will remain open so that the motor cannot be energized by the switch **54** until sufficient ice has been removed from the receptacle **3** to permit the feeler arm to drop to its normal position.

A particular advantage of the present control circuit is that the operation of the feeler arm or ice level switch **60**, which is opened by raising of the feeler arm **61**, provides means whereby the motor **36** cannot be energized after opening of the level switch unless the control switch **54** has tripped to its warm position thereby opening the circuit including cold contact **66** and conditioning the control circuitry for initiation of a subsequent cycle before a new charge of water is introduced into the mold.

This feature of the control circuit positively prevents repeated cycling of the ice maker if the control **54** due to any malfunction remains in its cold position.

While there has been shown and described a particular embodiment of the present invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention, and it is intended by the appended claims to cover all such changes and modifications that fall within the true spirit and scope of the invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. In an automatic ice maker comprising a mold in which water is frozen into ice, a storage receptacle, heating means for heating said mold to release the ice formed therein, transfer means for transferring the ice from said mold to said receptacle upon release of said ice from said mold, a motor for operating said transfer means, a feeler arm normally positioned within said receptacle for measuring the level of ice therein and movable to an elevated position above said receptacle, feeler arm actuating means operated by said motor for moving said arm to said elevated position during operation of said transfer means, electrical control means for controling the automatic operation of said ice maker through an ice making cycle including successive freezing, releasing and transferring steps and for stopping operation of said ice maker upon the accumulation of ice in said receptacle comprising a normally closed feeler arm operated switch, a control switch movable to a cold position in response to a freezing temperature of said mold and a warm position in response to an elevated temperature of said mold, and a normally open heater switch operated by said motor, said feeler arm switch and said control switch being series connected with said control switch is in its cold position to energize said motor when said mold attains a freezing temperature to first close said heater switch and thereafter raise said feeler arm to open said feeler arm switch and thereby de-energize said motor, said heater switch and said control switch in its warm position being series connected whereby movement of said control switch to its warm position energizes said motor when said mold attains an elevated temperature to complete the ice making cycle.

2. In an automatic ice maker comprising a mold in which water is frozen into ice, a storage receptacle, heating means for heating said mold to release the ice formed therein, transfer means for transferring the ice to said receptacle after release thereof from said mold, a rotor for operating said transfer means, water supply means including a solenoid valve for introducing a charge of water into said mold, a feeler arm normally positioned within said receptacle for measuring the level of ice therein and movable to an elevated position above said receptacle, feeler arm actuating means operated by said motor for moving said arm to said elevated position during operation of said transfer means, electrical control means for controlling the automatic operation of said ice maker through an ice making cycle including successive freezing, releasing, transferring and water charging steps and for stopping operation of said ice maker upon the accumulation of ice in said receptacle comprising a normally closed feeler arm operated switch, a control switch movable to a cold position in response to a freezing temperature of said mold and a warm position in response to an elevated temperature of said mold, a normally open heater switch operated by said motor, and a normally open valve switch operated by said motor, said feeler arm and control switch being series connected when said control switch is in its cold position to energize said motor when said mold attains a freezing temperature to first close said heater switch and thereafter raise said feeler arm to open said feeler arm switch and de-energize said motor, said heater switch and said control switch in its warm position being series connected to again energize said motor only when said mold attains an elevated temperature to close said valve switch to supply a fresh charge of water to said mold.

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