Sept. 22, 1964 E. B. ARCHER 3,149,473

AUTOMATIC ICE MAKING DEVICES

Filed April 22, 1959 4 Sheets-Sheet 1

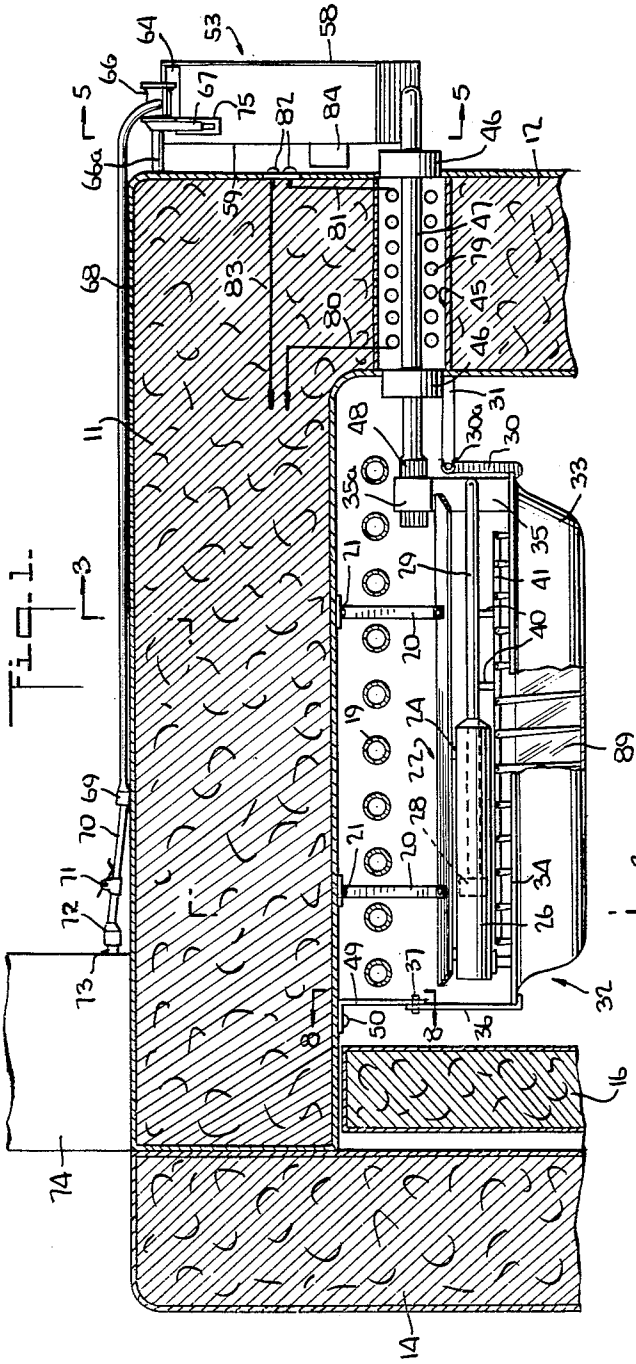


Fig. 1.

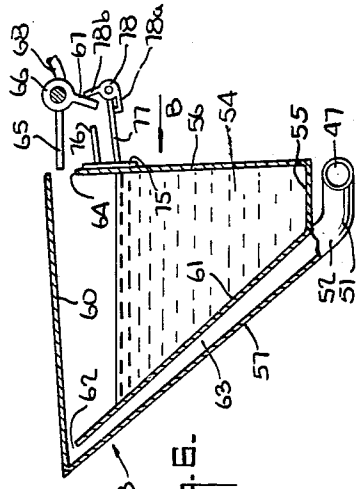


Fig. 6.

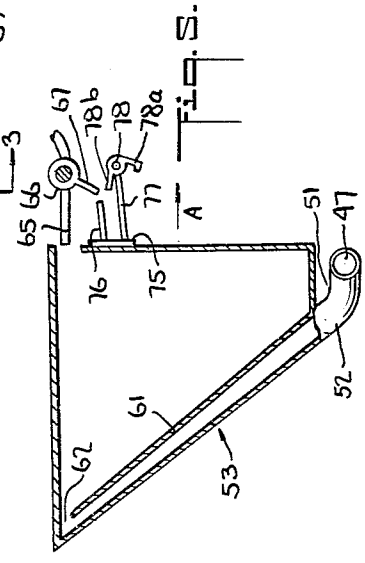


Fig. 5.

INVENTOR.
ERLING B. ARCHER

BY Norbert P. Holler

ATTORNEY

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AUTOMATIC ICE MAKING DEVICES

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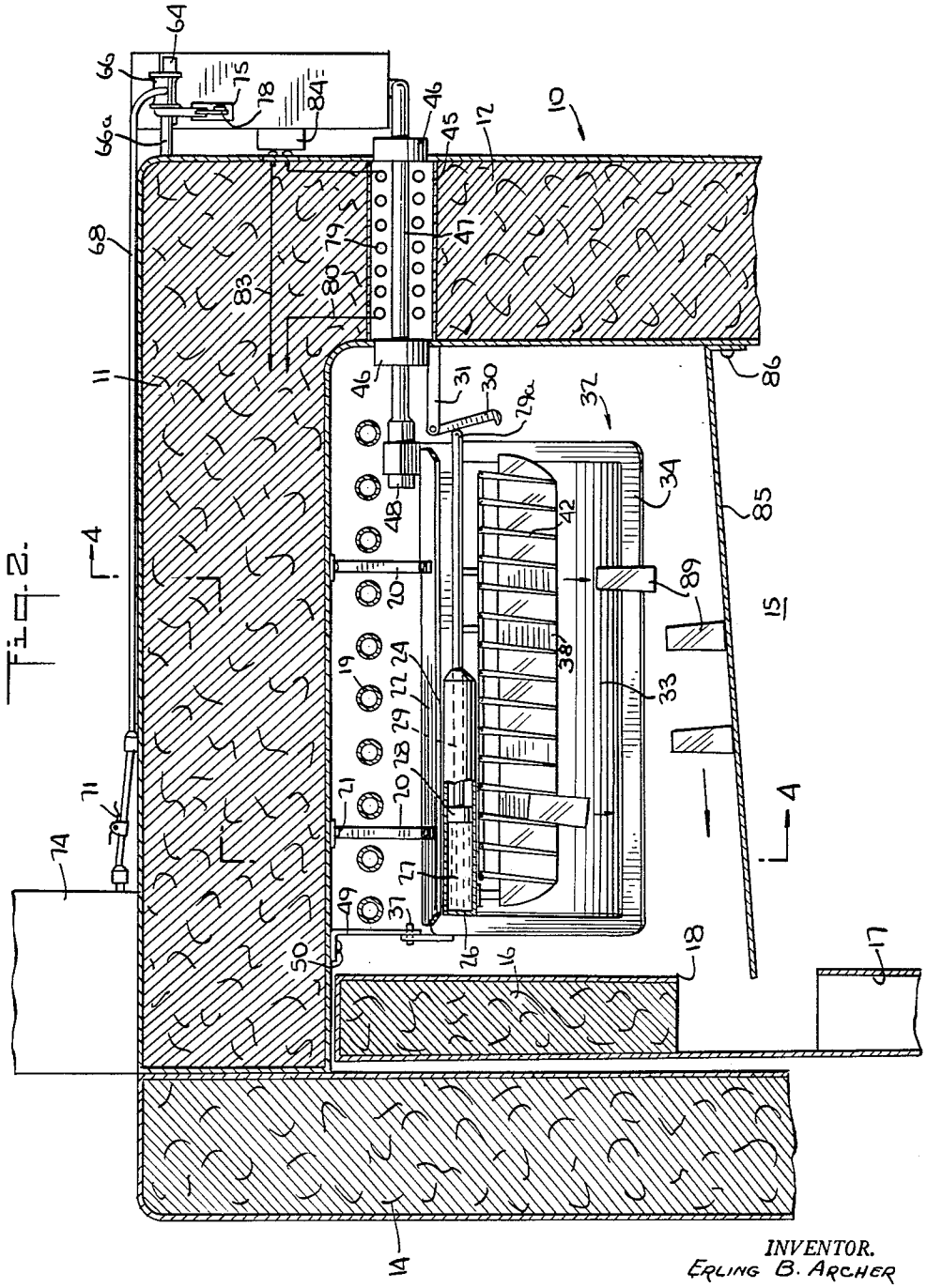


Fig. 2.

INVENTOR.
ERLING B. ARCHER

BY Norbert P. Holler

ATTORNEY.

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AUTOMATIC ICE MAKING DEVICES

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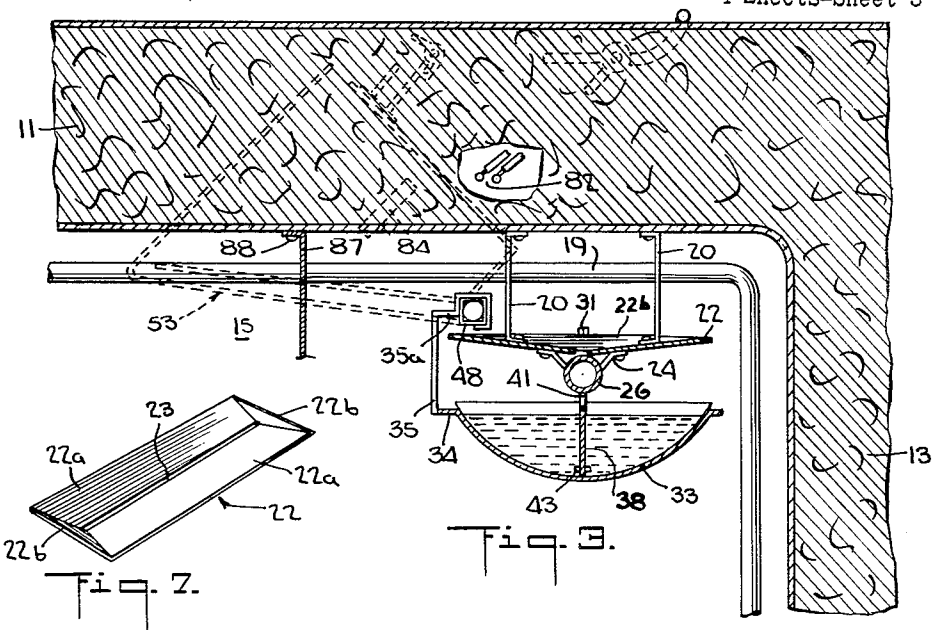


Fig. 3.

Fig. 7.

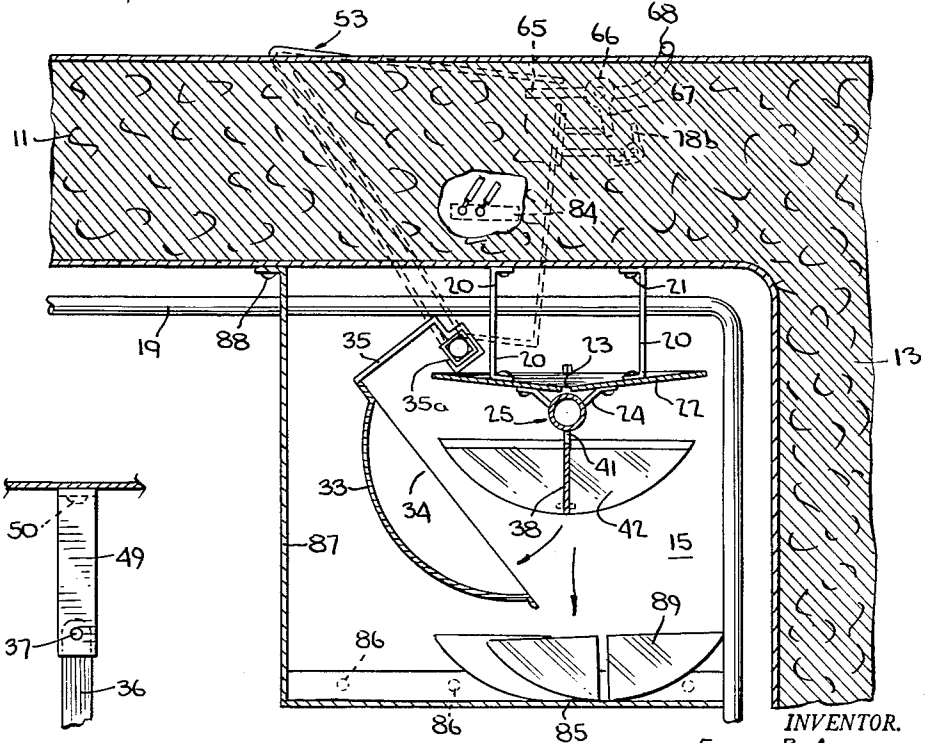


Fig. 4.

Fig. 8.

INVENTOR.
ERLING B. ARCHER
BY Norbert P. Holler
ATTORNEY

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AUTOMATIC ICE MAKING DEVICES

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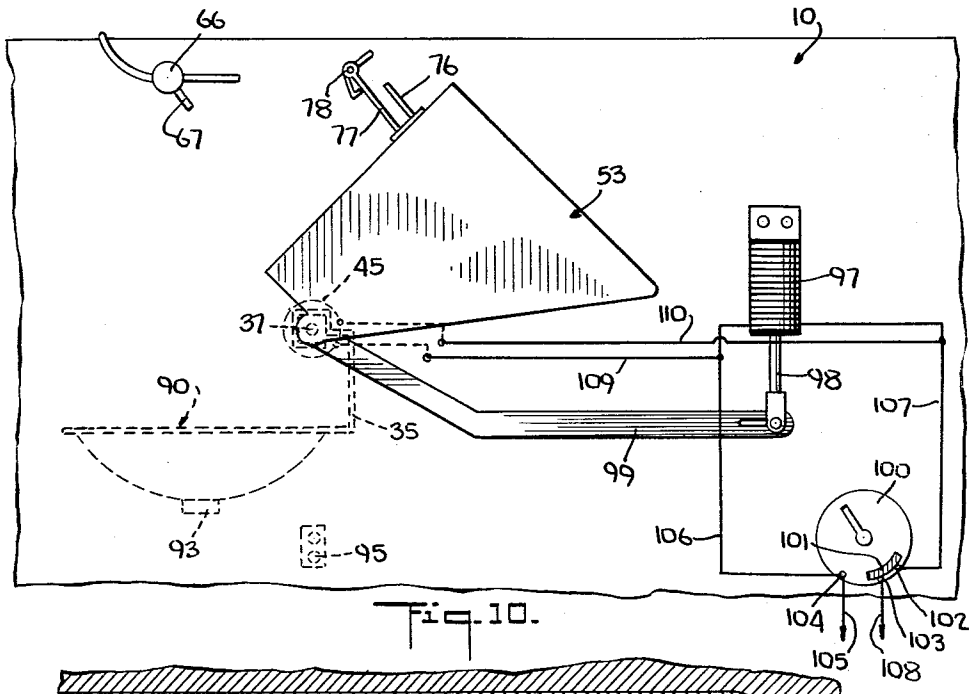


Fig. 10.

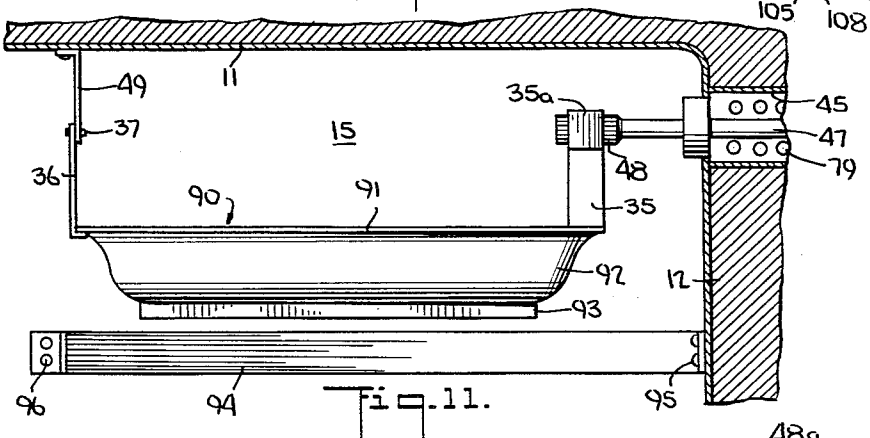


Fig. 11.

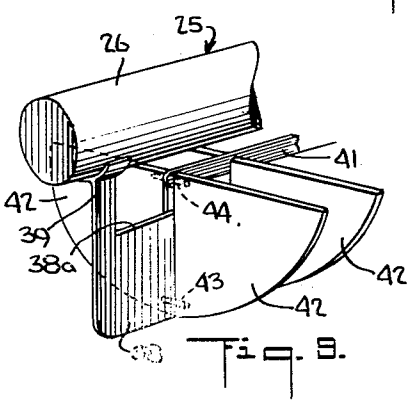


Fig. 8.

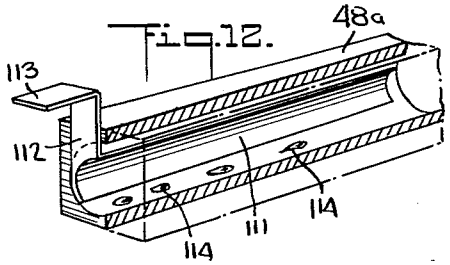


Fig. 12.

INVENTOR.
ERLING B. ARCHER

BY Norbert P. Holler

ATTORNEY

United States Patent Office 3,149,473 Patented Sept. 22, 1964

3,149,473

AUTOMATIC ICE MAKING DEVICES

Erling B. Archer, 33—74 191st St., Flushing 38, N.Y.

Filed Apr. 22, 1959, Ser. No. 808,054
14 Claims. (Cl. 62—135)

This invention relates to automatic ice-making devices, and in particular to apparatus for use in a standard refrigerator for the purpose of freezing and harvesting blocks of ice, commonly referred to as ice cubes.

The instant application is a continuation-in-part of my copending application Serial No. 725,159, filed March 31, 1958, now Patent No. 2,994,204.

As stated in the aforesaid copending application, there is available on the market at the present time, for use in household refrigerators, a number of ice cube making devices, some of which are fully automatic and provide a continuous supply of ice cubes, while others are semi-automatic or even non-automatic in that they require removal of a formed batch of cubes from the storage bin and/or manual emptying of the ice mold or tray prior to the formation of the next batch of ice cubes. Several of such ice makers further require thermostatically controlled heating means in cooperative relationship with the ice mold for loosening the ice cubes from the mold surfaces so as to enable associated gripper and/or conveyor means to remove the cubes from the mold. By their very nature, these ice makers still further entail the provision of means for drying the wet surfaces of the removed ice cubes prior to transfer of the latter to the storage bin. In addition, a permanent connection of the cube freezing apparatus to the water supply main of the house is necessary, which may entail having the refrigerator disposed in an undesirable location or the provision of extra piping and control valves if the refrigerator is not disposed immediately adjacent the main.

For the foregoing and a variety of other reasons, the known ice cube making devices or apparatus have failed to find full acceptance in the market. As will be readily appreciated, they are extremely expensive to produce and difficult to incorporate or install in commonly available refrigerators. Moreover, with respect to those devices which are less than fully automatic, proper functioning thereof depends on constant attention by the possessor of the refrigerator, and since freezing of a new batch of cubes in such non-automatic devices cannot be initiated until the preceding batch has been removed from the mold, the possibility of an insufficient supply of cubes in the event of a sudden, heavy demand therefor is always present. Still another problem which has not yet been satisfactorily resolved in such known ice cube making devices is that of the freezing of water in the mold feed pipe leading into the freezer compartment, which ultimately leads to the complete clogging of this pipe so as to render the entire device inoperative and requires defrosting of the refrigerator.

It is, therefore, an important object of the present invention to provide novel ice cube making devices which are substantially automatic in operation and free of the disadvantages and drawbacks inherent in known devices of this type.

Another object of the present invention is to provide automatic ice-making apparatus greatly simplified in construction and capable of being employed with all refrigerators having a freezer compartment normally maintained at a temperature below the freezing point of water.

It is also an object of the present invention to provide such apparatus in which water is periodically permitted to flow from a storage tank into a transfer tank rockably mounted exteriorly of the refrigerator and communicating with an ice mold or the like rockably mounted interiorly of the freezer compartment of the refrigerator in such a manner that the transfer tank is moved to a position for receiving water from the storage or reservoir tank during the ejection of a formed batch of ice cubes from the ice mold and is moved to a position for discharging this water into the ice mold subsequent to the termination of the ejection operation.

A related object of the present invention is the provision of means enabling the aforesaid cycle of filling and ejection operations to be carried out substantially without the aid of complicated valve arrangements of the type which have heretofore been indispensable in automatic ice-making devices of this type.

Still another object of the present invention is the provision of an ice-making apparatus of the aforesaid type in which the various operational cycles are effected as a function of a predetermined balance or weight distribution between the ice mold and the transfer tank.

In connection with this, it is a further object of the present invention to provide a transfer tank construction which permits tilting of the tank from its filling position to its discharging position only when the water level in the tank reaches a predetermined height, and in which this level is sufficiently far below the inlet end of the discharge conduit of the tank that the latter can move through an appreciable angle before the water discharge starts, whereby a valving action is effected without the use of any conventional valve elements.

Concurrently, it is an object of the present invention to provide means in such an ice-making device which ensure completion of the ice ejection operation prior to the return of the ice mold and the tank to the respective positions thereof in which refilling of the ice mold is permitted.

Still a further object of the present invention is the provision, in an ice cube making device as aforesaid, of an "ice motor" for initiating the ejection and refilling cycles through the use of the expansion characteristics of water at temperatures slightly above the freezing point thereof.

Yet a further object of the present invention is the provision of an ice cube making device which employs a tiltable transfer tank either in conjunction with a mold consisting of a rigid tray separable from the cube dividers or with a mold consisting of a deformable plastic tray and attached cube dividers.

It is still a further object of the present invention to provide means which will at all times inhibit the accumulation of such quantities of ice in the mold feed pipe as would tend to obstruct and clog the same and prevent proper functioning of the entire ice making apparatus.

The foregoing and other objects, characteristics and advantages of the present invention will be more fully understood from the following detailed description thereof when read in conjunction with the accompanying drawings, in which:

FIG. 1 is a fragmentary, partly sectional view of the freezer compartment of a refrigerator equipped with one embodiment of an ice-making device according to the present invention;

FIG. 2 is a view similar to FIG. 1 and shows the ice mold in its ice-ejecting position;

FIG. 3 is a sectional view taken along the line 3—3 in FIG. 1;

FIG. 4 is a sectional view taken along the line 4—4 in FIG. 2;

FIG. 5 is a sectional view taken along the line 5—5 in FIG. 1 and illustrates the transfer tank as the same is approaching the end of its movement into its water-receiving position;

FIG. 6 is a similar sectional view and illustrates the transfer tank just after the start of its movement away from the water-receiving position;

FIG. 7 is a perspective illustration of a splash plate associated with the ice-making apparatus according to the present invention;

FIG. 8 is a side view, taken along the line 8—8 in FIG. 1 of the means defining one of the support points for the rockable ice mold tray;

FIG. 9 is a fragmentary perspective view of a part of the ice motor and ice mold dividers associated therewith;

FIG. 10 is a fragmentary, schematic view of a modified form of the invention wherein a deformable ice mold or tray is used;

FIG. 11 is a fragmentary, partly sectional view of the ice mold and mounting therefor of the apparatus illustrated in FIG. 10 as seen from the left hand side of that figure; and

FIG. 12 is a partly sectional perspective view of a modified form of device for clearing ice out of the mold filling or feed pipe.

Referring now more particularly to FIGS. 1 to 4 of the drawings, a refrigerator **10** having an insulated top wall **11**, rear wall **12** and side walls **13** (only one side wall is shown in FIGS. 3 and 4) and an insulated front door **14** is shown as provided with a freezer compartment **15**, this compartment being defined by the top, side and rear walls of the refrigerator and by a bottom wall (not shown) extending across the interior of the refrigerator. The front of the compartment is provided with a door **16** which is hollowed out in its lower half, as shown at **17**, and is provided in its inner surface with an access opening **18** the purpose of which will become more clear hereinafter. Arranged within the freezer compartment **15** in any desired manner are the conventional refrigerating coils **19** through which any suitable refrigerant may be passed.

Suspended from the top wall **11** of the refrigerator by means of two pairs of brackets **20** affixed to the top wall **11** by rivets, bolts or like fasteners **21** is a plate **22** (see also FIG. 7) provided in its center with an elongated slot **23**, the lateral portions **22***a* of the plate **22** on either side of the slot **23** being arranged at a slight obtuse angle to one another and diverging from one another upwardly relative to the slot **23** and being connected to one another at their corresponding adjacent ends by slanted end plates **22***b*.

Affixed to the lower surface of the plate **22** by means of brackets **24** is a device **25** which will hereinafter be referred to as an "ice motor." As best shown in FIGS. 1 and 2, the ice motor **25** comprises a cylinder **26** one part of which is filled with an aqueous fluid **27** having a lower freezing point than water but nevertheless being possessed of the unique property of water of expanding while being cooled through a temperature range just above its freezing point. Slidably arranged within the cylinder **26** is a piston **28** between which and the rear wall of the cylinder the fluid **27** is confined. A piston rod **29** extends forwardly from the piston **28** and slidably through the front end of the cylinder **26**, the rod being of sufficient length to enable its leading end **29***a* to engage a latch **30** pivotally suspended from a bracket **31** affixed to the rear wall **12** of the refrigerator **10**.

The ice motor **25** according to this embodiment of the invention is associated with ice mold means **32** specially constructed therefor and differing from the ice mold means described in my aforesaid copending application. The ice mold means **32** comprises a tray or like container **33** which may have any desired cross-sectional shape but is shown in FIGS. 3 and 4 as being oval or arcuate in cross-section. The tray **33** is provided at its uppermost edge with a peripheral ledge or frame **34**. Attached to one of the corners of the ledge **34** is a suspension element or bracket **35** the uppermost end of which is bent as shown at **35***a* to provide a loop portion of substantially polygonal cross-section the purpose of which will be more fully explained hereinafter. Attached to the other corner of the tray ledge **34** on the same side as the bracket **35** is a further bracket or arm **36** which is provided at its uppermost end with a transverse pivot pin **37**.

The ice mold or tray **33** is associated with means adapted to define therein a plurality of chambers or spaces in which the ice cubes are to be formed. Such means comprise a longitudinal divider plate **38** arranged to extend longitudinally of the tray **33** and provided at one end with an arm **39** by means of which the plate is rigidly affixed to the ice motor cylinder **26** at the rear end thereof (see FIG. 9). Thus the upper edge **38***a* of the longitudinal divider plate **38** is spaced from the cylinder **26**.

Rigidly connected to and depending from the piston rod **29** projecting from the ice motor piston **28** are two small arms or lugs **40** to the lowermost ends of which is connected a transmission or connecting rod **41** extending longitudinally of the tray **33** from a point adjacent the free end **29***a* of the piston rod **29** to a point adjacent the rear end of the cylinder **26**. The connecting rod or bar **41** is located in the same plane as the divider plate **38** and extends into the space between the cylinder **26** and the edge **38***a* of this plate. A number of substantially sector-shaped transverse divider plates **42** are pivotally connected to and supported adjacent their lowermost edges by the longitudinal divider plate **38** through the intermediary of respective pivot pins **43**, the transverse divider plates **42** being pivotally connected adjacent their uppermost edges to the transmission rod or bar **41** by means of corresponding pivot pins **44**. Thus, each of the transverse divider plates **42** is mounted for rocking movement about a stationary axis. As best shown in FIGS. 1, 2 and 9, furthermore, each of the transverse divider plates **42** is wider at its upper edge than at its lower edge and thus has a substantially triangular cross-sectional shape, the purpose of which will be more fully explained presently.

The rear wall **12** of the refrigerator is provided, a short distance from the top thereof and along a line slightly below the top of the freezer compartment **15**, with a recess or bore **45** extending from the exterior of the refrigerator to the freezer compartment. Mounted in a fluid-tight and thermally insulated manner at the opposite ends of the recess **45** are two ball bearings or like bearing structures **46** which rotatably support a hollow elongated tube **47** one end of which projects into the freezer compartment and the other end of which projects to the outside of the refrigerator. That end of the tube **47** which is located within the confines of the freezer compartment **15** has a polygonal cross-sectional shape, as shown at **48**, the cross-section of the tube end **48** corresponding to that of the loop portion **35***a* on the bracket or arm **35** attached to the tray frame **34**.

As will be readily appreciated from FIGS. 1 to 4, the tube **47** functions in the manner of a rotatable shaft or axle, and its inner end **48** constitutes one of the support points for the ice cube tray **33**. The second support point for the tray **33** is defined by a bracket **49** affixed in any suitable manner, as by a rivet or bolt **50**, to the top wall **11** of the refrigerator and provided adjacent its lowermost end with an aperture adapted to receive the suspension pin **37** carried by the tray-supporting arm **36**. The axis of the aperture in the bracket **49** must, of course, be aligned with the axis of rotation of the axle tube **47** so as to permit an angular upward and downward movement of the tray **33** about this common axis. As will be more fully explained hereinafter, the tray **33** is normally held in its horizontal position by means of the latch **30** which is biased toward the tray by means of a torsion spring **30***a* which bears at one end against the latch and at the other end against the latch-supporting bracket **31**.

The second end of the axle tube **47** is provided a short distance from the outer roller bearing **46** with a right angle bend **51** which in turn is provided with a short upwardly slanted portion **52** to the uppermost end of which is connected a container or vessel **53** which will herein-

after be referred to as a transfer tank. The transfer tank consists of a hollow body or casing 54 which is substantially rectangular in vertical transverse cross-section (see FIG. 1) and substantially trapezoidal in vertical longitudinal cross-section (see FIGS. 5 and 6). The casing 54 is constructed with a relatively short bottom wall 55, a vertical end wall 56 and a slanted end wall 57, a pair of side walls 58 and 59, and a top wall 60 which extends substantially parallel to the bottom wall 55. Extending angularly upwardly from the bottom wall 55 and within the casing 54 is a partition plate 61 the uppermost edge of which terminates just short of the upper wall 60, thereby leaving a space 62 and establishing communication between the interior of the casing 54 and the space 63 defined between the partition 61 and the slanted casing end wall 57. The space 63, which narrows in the direction of its lowermost end, communicates at this lowermost end with the uppermost end of the pipe section 52.

Adjacent its uppermost end and immediately below the top wall 60 of the transfer tank, the vertical end wall 56 thereof is provided with an opening 64 (here shown as a rectangular slot but which may have any other desired shape). The opening 64 is adapted to receive, in one position of the tank 53, the outermost end of a short pipe or conduit 65 the other end of which communicates with the outlet port of and is controlled by a valve 66 of the open and shut type. This valve is mounted on an arm or bracket 66*a* affixed to and extending from the refrigerator, and is further provided with a handle or operating arm 67 by means of which it may be moved to its open and shut positions, respectively. Connected to the inlet port of the valve 66 is a hose or conduit 68 which extends along the top of the refrigerator and is provided at its remote end with a union or like connecting element 69. The union 69 is adapted to be connected with a short conduit 70 provided with a valve 71 and adapted to be connected at its other end by any suitable connector means 72 with the outlet nipple 73 of a storage or reservoir tank 74 removably positioned atop the refrigerator, preferably at the front thereof. The reservoir tank 74 is dimensioned to contain a predetermined quantity of water which is approximately enough to form a batch of ice cubes just sufficient to fill the space 17 defined in the lower part of the freezer compartment door 16, this space thus constituting a storage bin for the ice cubes.

Attached to the vertical end wall 56 of the transfer tank 53 is a small plate 75 from which extend two bars or rods 76 and 77 spaced vertically from one another, the bar 76 being shorter than the bar 77. Pivotally carried by the longer bar 77 at its outermost end is a small two-armed lever 78 having an arm 78*a* which extends normally from the pivot point toward the casing end wall 56, and an arm 78*b* which normally extends upwardly toward the valve 66. A small torsion spring (not shown) biases the lever 78 into this normal position thereof and in such a direction as to cause the arm 78*a* to engage the bar 77 from below (see FIG. 6). The operation of the bars 76 and 77 and the lever 78 will be more fully explained hereinafter.

Located within the recess 45 of the refrigerator rear wall 12 is a heating element 79, shown in the form of a coil of wire surrounding or wound about the axle tube 47. One end of the coil 79 is connected by a lead 80 to a source of electric power (not shown), while the other end of the coil is connected by a lead 81 to one of a pair of contacts 82 the other contact of which is connected by a lead 83 to the aforesaid source of electric power (which may be the power main for the refrigerator motor, for example). Carried by the transfer tank 53 on the side wall 59 thereof is a contact plate 84 which is so dimensioned as to be capable of bridging the gap between the contacts 82 and to close the electric circuit to the heating coil 79 for a predetermined interval of time during the movement of the transfer tank 53 from the position shown in FIG. 3 to the position shown in FIG. 4 and back, as will be more fully explained presently.

Referring particularly to FIGS. 2, 3 and 4, it will be seen that there is further provided in the freezer compartment 15 a slide plate or chute 85 which is attached at one end to the rear wall 12 of the refrigerator, as by means of rivets or bolts 86, and extends at a slight downward slant toward the front of the freezer compartment, terminating above the storage bin 17 and just inwardly of the opening 18 in the freezer compartment door 16. To provide additional support for the slide plate 85, as well as to enclose partially the cube-freezing space in the compartment 15, which tends to concentrate cold on the water in the tray so as to accelerate freezing thereof, there is provided a lateral vertical plate 87 connected at its lower end to the plate 85 and at its upper end to the top wall 11 of the refrigerator by bolt or rivet means 88.

The operation of this embodiment of the present invention is as follows:

It is first assumed that the various parts of the ice making device are in the position shown in FIGS. 1 and 3 and that a quantity of water is contained in the tray 33 and is in the process of being frozen into a batch of ice cubes. A certain amount of water is still contained within the storage tank 74 and the conduit 68, but the valve 66 is closed and thus no water can flow out of the conduit 65. This condition is absolutely essential since the tray 33 and transfer tank 53 are so connected with the axle tube 47 that the transfer tank is in the tilted position shown in FIG. 3 whenever the tray 33 is positioned about the divider plates 38 and 42. The transfer tank is completely empty at this time.

After a certain interval of time, the water in the tray 33 will have become frozen. It is, of course, a well known fact that water expands while being cooled through the last, relatively short temperature interval above its freezing point. With this fact kept in mind, it will be readily understood that the liquid 27 in the cylinder 26 of the ice motor 25, being aqueous in nature, will begin to expand as its temperature nears its freezing point which is somewhat below that of plain water. As the liquid 27 expands, it begins to force the piston 28 through the cylinder 26 so as to move the piston rod 29 axially of itself into engagement with the latch 30, and within a very short period of time this movement causes the latch 30 to be disengaged from beneath the tray frame 34.

Concurrently with the foregoing, the piston rod displaces the transmission bar 41 longitudinally through the intermediary of the brackets 40, and, since the upper portions of the transverse dividers 42 are pivotally connected to the transmission bar 41 while being rockably connected at their lower edges to the stationary longitudinal divider plate 38, the transverse divider plates are angularly displaced in a clockwise direction as seen in FIG. 1 about the axes of their respective pivot pins 43. This causes the various ice cubes 89 to be shifted slightly relative to the tray 33 (as well as relative to the transverse divider plates 42 and the main or longitudinal divider plate 38). The bond between the outer peripheral surfaces of the ice cubes and the inner surface of the tray 33 is thus broken, permitting the tray 33 to begin to swing downwardly about the axis of rotation thereof defined by the pivot pin 37 and the axle tube 47. At the same time the transfer tank 53 begins its upward swinging movement from the position shown in FIG. 3 by virtue of the fact that it is fixedly connected with the axle tube 47 which rotates in the ball bearings 46 due to the non-rotary connection between the axle tube end section 48 and the suspension loop 35*a* of the tray-supporting bracket 35. It is to be noted that the tray 33, being generally made of metal, is considerably heavier than the transfer tank 53, which is generally made of a suitable lightweight plastic material, whereby the conjoint angular movement of the tray and the transfer tank will be effected as a function of the moment arm of the tray about the axis 37–47.

As the transfer tank moves upwardly in the direction of the arrow A in FIG. 5, but before it reaches its final vertical position shown in FIG. 4, the contact plate 84 reaches the contacts 82 and closes the circuit to the heating coil 79 so as to cause a current to flow through the latter. This heats the axle tube 47 (which is the feed pipe for the ice mold) and ensures the melting of any particles of ice which may have formed therein from droplets of water which remained in the tube at the end of the preceding tray-filling operation. This principle of unblocking the axle tube by removal of ice therefrom prior to each tray-filling operation is one of the important features of the present invention, inasmuch as the problem of preventing the freezing up and complete blocking of the tray-filling tube or feed pipe has heretofore been one of the most difficult problems to solve in connection with automatic ice cube making devices. It will be noted that the heating element 79, which need not necessarily be constructed in the form of a coil, will remain energized for a considerable period of time during the upward movement of the transfer tank, while the transfer tank is being filled with fresh water, and during the initial part of the subsequent downward movement of the transfer tank (still to be described).

As the transfer tank approaches its erect position (see FIG. 5), the arm 78*b* of the pivoted lever 78 will be engaged by the tip of the operating arm 67 of the valve 66 which is still closed. Due to the manner in which the lever 78 is mounted on the bar 77, the lever 78 will be rocked about its pivot axis in a counterclockwise direction due to the force of the valve arm 67 which in effect constitutes at this time a stationary abutment. A short time thereafter, the tank will have moved upwardly sufficiently to have caused the free end of the lever arm 78*b* to pass the tip of the valve arm 67, at which time the torsion spring (not shown) acting on the lever 78 will cause the latter to rotate in a clockwise direction until the other lever arm 78*a* again engages the bar 77. Immediately after the arm 78*b* has been snapped back into its erect position, further upward movement of the tank 53 brings the shorter bar 76 into engagement with the valve arm 67 and shifts the latter in a counterclockwise direction from the position shown in FIGS. 3 and 5 to the position shown in FIG. 4.

The valve 66 is now open and water begins to flow from the storage tank 74 and conduit 68 into the transfer tank through the valve outlet conduit 65 the free end of which extends into the interior of the transfer tank casing 54. The cross-sectional width of the conduit 65 is made sufficiently small to restrict the flow of water therethrough to a predetermined rate which will ensure filling of the tank 53 in a period of about one half hour or approximately the period of time required for all of the quarter moon-shaped ice cubes 89 to drop downwardly onto the slide plate 85 from the spaces between the transverse divider plates 42. It will, of course, be understood that during the movement of the tray 33 to the position thereof shown in FIG. 4, the movement of the piston 28 and therewith of the transmission bar 41 to the right as shown in FIGS. 1 and 2 continues under the influence of the expanding ice motor liquid 27, this causing a further rocking of the divider plates 42 about their pivot pins 43 until all the bonds between the ice cubes and the divider plates are broken. The falling out and down of the ice cubes 89 is greatly facilitated by the fact that the divider plates 42 are substantially triangular in cross-section, which renders the spaces between the adjacent divider plates wider at the bottom than at the top, while concurrently the ice cubes are narrower at the top than at the bottom. The cubes 89 will slide along the chute 85 and into the bin. Moreover, since no heat is ever applied to the cubes to loosen them from the tray or the dividers, there is no danger that they will adhere to the chute or to one another in the bin.

Reverting again to the filling of the transfer tank 53, it will be noted that the latter is constructed somewhat eccentrically. The purpose of this construction of the tank 53 is to ensure that during the filling operation the center of gravity of the tank and of any water contained therein will remain to the right of a vertical plane passing through the axis of the axle tube 47 (as seen in FIG. 4). Consequently, even though a considerable amount of water may be accumulated in the tank to render the weight of the latter greater than that of the empty tray 33, no reverse angular movement of the tray and the transfer tank will take place until the level of the water in the tank rises to within a predetermined distance of the uppermost edge of the partition 61 within the tank casing 54. As stated hereinabove, the water in the transfer tank will not reach this level until about a half hour after the start of the ice cube ejecting operation.

When the water in the transfer tank 53 reaches the aforesaid predetermined level, the center of gravity of the tank is shifted to the left of a vertical plane passing through the axis of the axle tube (as seen in FIG. 4), whereupon the tank and the tray will begin to move angularly in a counterclockwise direction, as shown by the arrow B in FIG. 6, tending to bring the tray back to its horizontal position. Immediately after the start of this movement of the tank, the lever arm 78*b* engages the valve arm 67 and displaces it in a clockwise direction (see FIG. 6) until the valve 66 is again closed, the arrangement being such (for example through a resilient mounting of the valve arm 67) that the arm 78*b* can slip past the tip of the valve arm 67 when the latter is in its position shown in FIG. 3. Thus, by the time the conduit 65 has become completely separated from the opening 64 of the transfer tank 53, the flow of water from the conduit 68 has been completely interrupted, thereby making it impossible for any water to drip onto the floor behind the refrigerator 10.

As the tank continues to move downwardly, the level of the water therein approaches the upper edge of the partition 61. The construction of the tank is such that the initial water level at the start of the tank movement is sufficiently far below the upper partition edge as to prevent any flow of water through the space 62 and into the space 63 until the tray 33 has moved a substantial distance toward its horizontal position. The partition 61 and opening 62 thus serve the function of a valve without necessitating the provision of any complex valving structure and, in fact, without necessitating the provision of any movable valve elements at all.

When the tank reaches a tilted position somewhere intermediate those shown in FIGS. 3 and 4, the water will begin to flow through the opening 62 and space 63 into the pipe section 52–51 and thence into the tube 47, from which it flows rapidly through the tube end 48 onto the splash plate 22. As clearly shown in FIGS. 3 and 4, the open end of the feed tube or pipe 47–48 is located adjacent the outermost edge of one of the splash plate sections 22*a*. Thus, when the water first drops onto the plate 22, it will require a certain period of time to reach the slot 23. During this period, the tank 53 continues its downward movement, and therewith the mold tray 33 continues its upward swinging movement. This represents an additional safety factor in the invention, since the additional movement of the tray toward its horizontal position while the water flows over the splash plate section 22*a* further ensures that the possibility of any of the water dropping down onto the floor of the freezer compartment 15 is substantially eliminated, due to the fact that the tray is already sufficiently far advanced to receive some of the water without spilling the same.

The water coming from the transfer tank 53 is substantially at room temperature and thus, when it passes through the splash slot 23 and hits the cylinder 26 of the ice motor 25, will raise the temperature of the liquid 27 in the cylinder. The motor liquid 27 will, consequently,

begin to contract and the piston 28 will begin to move rearwardly through the cylinder (to the left as shown in FIGS. 1 and 2), preferably under the influence of a light compression spring (not shown) interposed between the piston 28 and the front end of the cylinder 26. In this manner, the piston rod end 29*a* is retracted from the latch 30, and the latter will, therefore, be biased by the torsion spring 30*a* into its operative position where it may again snap under the ledge 34 of the tray 33 when the latter reaches its ultimate horizontal position.

At a certain instant during the downward movement of the transfer tank 53, the contact plate 84 moves fully past and leaves the heating circuit contacts 82, thereby interrupting the flow of electric current to the heating element 79. It is understood, of course, that the heating of the tube or feed pipe 47 during the freezing of the ice cubes is not necessary, and that, should some drops of water remain in the tube and become frozen prior to the next ejection cycle, the subsequent reenergization of the heating coil during the associated upward movement of the transfer tank 53 will promptly cause these frozen ice drops to be melted. Accordingly, there will never be any substantial accumulation of ice in the feed pipe 47.

The entire system is now again in the position illustrated in FIGS. 1 and 3, and the aforesaid operational cycle will be repeated again at the termination of the freezing of the water just discharged into the ice mold. Moreover, this operational cycle will continue to be repeated as long as there is water in the storage tank 74. When this quantity of water has been exhausted and the last portion thereof frozen, a sufficient number of ice cubes will have been formed to substantially fill the storage bin 17 in the freezer compartment door 16. After the last ejection cycle, of course, the parts of the apparatus will remain in the position of FIG. 4, since no additional water is admitted into the transfer tank 53.

When the supply of these ice cubes in the storage bin 17 is almost exhausted or when it is desired to fill the bin anew, the possessor of the refrigerator need merely disconnect the conduit 70 from the inlet end 69 of the conduit 68 and close the valve 71. Thereafter the storage tank 74 can be bodily removed from the refrigerator, carried over to the sink and refilled with water. The filled tank, from which no water can escape due to the presence of the closed valve 71, is then returned to the top of the refrigerator and the conduit 70 reconnected to the conduit 68, whereupon opening of the valve 71 will again permit water to flow through the conduit 68 and the open valve 66 into the transfer tank 53.

The principles of the present invention, as hereinbefore set forth with respect to a rigid mold tray capable of being separated from the ice cube-forming divider plates, are equally applicable to a cube freezing system employing a deformable ice mold or tray with permanently attached divider plates of the type disclosed in my aforesaid copending application Serial No. 725,159.

Referring now to FIGS. 10 and 11, it will be seen that the ice mold 90 there employed comprises a metallic or otherwise rigid frame 91 to which is attached a tray body 92 made of any suitable low temperature-resistant, deformable, elastic, plastic material and provided at its lowermost part with a relatively thick and rigid reinforcing portion 93 which may be an independent element affixed to the tray body or a thickened part of the tray body itself. The mold 90 is rockably mounted in the freezer compartment 15 in the same manner as the tray 33, i.e., by means of brackets or arms 35 and 36 attached to the tray frame 91, the arm 35 being provided with a polygonal suspension element 35*a* non-rotatably engaging the similarly shaped section 48 of the axle tube 47, and the arm 36 being provided with a pivot pin 37 axially aligned with the tube 47 and extending through an aperture in a bracket 49 affixed to the top wall 11 of the refrigerator. Also arranged in the freezer compartment 15 is a horizontal bracket or abutment 94 affixed to the refrigerator walls 12 and 13 by means of bolts or rivets 95 and 96, respectively. As in the first described embodiment of the invention, the axle tube or feed pipe 47 carries on its outermost end a transfer tank 53 provided with valve actuating rods 76 and 77 and lever 78 for cooperation with the valve operating arm 67 of the valve 66.

In accordance with this embodiment of the invention, the ice motor 25 and its appurtenant elements, to wit the piston rod 29, brackets 40, transmission bar 41 and splash plate 22, as well as latch 30, are dispensed with. The ejection of ice cubes from the ice mold 90 is effected with the aid of a solenoid 97 mounted on the rear wall of the refrigerator 10 and provided with a plunger or armature 98 articulated at its outer end to one end of a link rod 99 the other end of which is connected to the axle tube 47. As will be readily understood from FIG. 10, when the armature 98, which is normally held in the illustrated position by means of a spring, a weight or like biasing means (not shown), is raised, the ice mold 90 will be swung downwardly and the transfer tank 53 upwardly about the axis of their support means 34–47 through the intermediary of the link rod 99. If this movement is sufficiently sudden or rapid, the rigid portion 93 of the tray 92 will be impacted against the bracket or abutment 94 so as to deform the tray 92 and eject the ice cubes therefrom onto the chute 85 (not shown in FIGS. 10 and 11) or directly into a storage bin.

Also mounted on the rear wall of the refrigerator 10 is an electric clock or like timer mechanism 100 provided with a rotating wiper element 101 and a plurality of spaced contacts 102, 103 and 104. The contact 104 is connected via a lead 105 to a suitable source of electric power, e.g. the power line of the refrigerator, and via a lead 106 to one terminal of the coil of the solenoid 97, the other terminal of this coil being connected by a lead 107 to the contact 102 of the timer mechanism 100. The contact 103 is connected by a lead 108 to the aforesaid source of electric power. The spacing of the contacts 102 and 103 from one another and the length of the wiper element 101 are so selected that the latter can bridge the gap between these contacts for a predetermined interval of time during its rotary travel. The contacts 103 and 104, of course, are spaced sufficiently far apart as never to be connected to one another by the wiper element 101. Connected to the leads 106 and 107 and across the power source are leads 109 and 110, respectively, these leads being connected to the heating element 79 disposed in the recess 45 of the rear wall 12 of the refrigerator.

The operation of this embodiment of the invention will be readily understood from the foregoing. Assuming a batch of ice cubes to be already frozen in the tray 92, with the latter being held in its horizontal position by the downwardly biased armature 98 of the solenoid 97, the operation of the timer mechanism 100 (which is continuous) will bring the wiper element 101 into the illustrated position where it bridges the gap between the contacts 102 and 103. This automatically completes the energization circuit for the solenoid 97 and causes the armature 98 of the latter to be drawn upwardly so as to move the ice mold 90 and transfer tank 53 jointly in a counterclockwise direction as seen in FIG. 10. Since this movement is quite rapid, the reinforcing member 93 of the tray 92 is impacted against the abutment 94, whereby the plastic tray 92 is deformed so as to eject the ice cubes therefrom.

At the same time, the transfer tank 53 is moved up to the valve 66 through which it is filled in the manner described hereinbefore with respect to the first embodiment of the present invention. The wiper element 101 is sufficiently long to engage the contacts 102 and 103 for a predetermined interval of time, during which the transfer tank 53 is filled. Concurrently therewith, the wiper element effects energization of the heating circuit for the

axle tube or feed pipe 47, to ensure melting of any ice which may have been formed therein. As soon as the trailing end of the wiper element 101 leaves one of the contacts 102 and 103, the solenoid becomes deenergized, permitting the armature to fall and the transfer tank and ice mold to move in a clockwise direction to the positions thereof illustrated in FIG. 10, during which time the water flows from the transfer tank 53 through the tube 47–48 into the ice mold in the same manner as described hereinabove with respect to FIGS. 1 to 9.

The present invention further contemplates the provision of a mechanical arrangement (as distinguished from an electric heating system) for preventing the accumulation of ice in the feed pipe. Such an arrangement is illustrated in FIG. 12. It is to be noted that all the component parts of the two embodiments of the invention remain the same except for the polygonally shaped end section 48 of the feed pipe or axle tube 47, which is replaced by a similarly constructed but relatively elongated section 48*a*. The suspension element 35*a* of the tray-supporting arm 35 is connected (this is not shown in FIG. 12) to the pipe section 48*a* adjacent the right hand end thereof as seen in FIG. 12. Extending into the pipe extension 48*a* from the discharge end thereof is a curved scraper element or blade 111 the outer end of which is connected with an arm 112 provided with a lug 113 by means of which it may be fixedly attached to the top wall 11 of the refrigerator.

It will be readily understood that should any ice be formed in the tube extension 48*a*, as indicated at 114, a subsequent rotation of the axle tube 47 and the extension 48*a* thereof will move the interior surface of the latter past the stationary scraper blade 111 and will cause the latter to break any ice particles off the said surface. These ice particles will then be flushed into the ice mold by the load of water discharged thereinto from the transfer tank.

From the foregoing it will be clear that the present invention provides a substantially automatic system for preparing and storing relatively large numbers of ice cubes in a standard household refrigerator which need be modified only to the extent of the provision of the recess or bore 45 in the rear wall of the refrigerator so as to define the mounting location for the axle tube or feed pipe 47 to which both the ice mold and the mold-filling water tank are connected for rotation therewith. According to one embodiment of the invention, the ice cube freezing system is a purely mechanical arrangement requiring no complicated valving or other control components, while in accordance with a second embodiment of the invention the ice cube freezing system is mainly mechanical except for the provision of a filling and ejection cycle-initiating solenoid operator and an electrical energization circuit therefor. Thus, the fundamental disadvantages and drawbacks of known ice cube freezing systems are effectively eliminated by the present invention.

The disclosed mechanisms are, of course, capable of being modified in a number of ways without any departure from the spirit of the present invention. For example, it is preferred that such structural elements as the tray 33 and the divider plates 38 and 42 be made of stainless steel or anodized aluminum, but these elements may naturally be made of any other rust or corrosion-resistant material (which need not necessarily be metallic). With respect to the embodiment of the invention shown in FIGS. 10 and 11, it is possible to provide the solenoid operator 97–98 with means for reducing the noise caused by the moving armature, and the tray body 92, although preferably made of polyethylene, may be made of any other suitable synthetic plastic material having the required thermal and mechanical properties.

It will furthermore be understood that the manner of mounting the tray 33 (or the ice mold 90) in the freezer compartment may be other than as illustrated in the drawings, the provision of the polygonally shaped suspension element 35*a* being merely one convenient way of accomplishing the desired result. The advantage of this particular mounting arrangement is the ease with which the tray can be placed in position or removed, this requiring merely that it be moved longitudinally of itself to slide the element 35*a* onto or off the feed pipe section 48 while sliding the pivot pin 37 into or out of the aperture in the bracket 49.

Having thus described my invention, what I claim and desire to secure by Letters Patent is:

1. In combination with a household refrigerator equipped with a freezer compartment; water-feeding conduit means rotatable about the axis thereof carried by said refrigerator and extending from the exterior of the latter to the interior of said freezer compartment, water-dispensing tank means disposed exteriorly of said refrigerator and in fluid flow communication with said conduit means, said tank means being connected with said conduit means for angular rotary movement therewith about said axis, and ice mold means disposed within said freezer compartment for receiving water from said conduit means, said ice mold means having at least a part thereof connected with said conduit means for angular rotary movement therewith about said axis.

2. The combination set forth in claim 1, said part of said ice mold means being movable between a water-receiving position and an ice-ejecting position, said tank means being movable between a water-dispensing position and a refilling position, the relative connections of said tank means and said part of said ice mold means with said conduit means being such that said tank means is in said water-dispensing position when said part of said ice mold means is in said water-receiving position, and that said tank means is in said refilling position when said part of said ice mold means is in said ice-ejecting position.

3. The combination set forth in claim 2, said tank means being provided in the interior thereof with partition means defining a water-containing chamber and an outlet passageway, said outlet passageway being in communication with said conduit means, said partition means being provided with an opening establishing communication between said chamber and said passageway, said opening being located a predetermined distance from the bottom of said tank means to ensure that no water can flow from said chamber into said passageway and thence to said conduit means and said ice mold means unless said tank means is substantially in said dispensing position thereof.

4. The combination set forth in claim 3, said partition means being slanted upwardly from the bottom of said tank means when the latter is in said refilling position thereof, said opening being located adjacent the uppermost edge of said partition means, and said tank means being constructed eccentrically with respect to the axis of rotation of said conduit means, whereby said tank means during filling thereof with water remains at said refilling position thereof until the level of the water approaches within a predetermined distance from said opening in said partition means, said tank means only then beginning its angular movement to said dispensing position thereof while said partition means and said opening serve as valve means tending to inhibit flow of water from said chamber into said passageway until said tank means has moved a considerable distance toward said dispensing position thereof.

5. The combination set forth in claim 2, further comprising means arranged in cooperative relationship with said conduit means for removing ice therefrom during each movement of said tank means to said refilling position thereof and concurrent movement of said ice mold means to said ejecting position thereof, to thereby prevent any accumulation of ice in said conduit means.

6. The combination set forth in claim 5, said ice-removing means comprising an electric heating element

positioned adjacent said conduit means, said tank means being provided with electrically conductive means adapted to close the circuit to said heating element upon movement of said tank means to said refilling position thereof.

7. The combination set forth in claim 5, said ice-removing means comprising a scraper blade fixedly mounted within said freezer compartment and projecting into said conduit means and having at least one edge in sliding contact with the interior surface of said conduit means.

8. The combination set forth in claim 2, further comprising water supply conduit means arranged on said refrigerator and adapted to communicate with said chamber in said tank means upon arrival of the latter in said refilling position thereof, valve means connected into said supply conduit means for controlling the flow of water therethrough, and actuating means carried by said tank means for opening said valve means upon arrival of said tank means at said refilling position thereof and for closing said valve means upon initiation of the movement of said tank means from said refilling position to said dispensing position thereof.

9. The combination set forth in claim 2, further comprising ice motor means mounted within said freezer compartment and operable a predetermined time interval subsequent to the completion of the freezing of water in said ice mold means for permitting the movement of at least said part of the latter to said ice-ejecting position thereof.

10. The combination set forth in claim 9, said ice mold means comprising separable tray means and divider plate means, said tray means being connected to said conduit means and movable away from said divider plate means, and said divider plate means being mounted for rocking movement relative to said tray means about respective stationary axes in response to operation of said ice motor means.

11. The combination set forth in claim 10, said ice motor means comprising a cylinder and a piston reciprocally arranged therein, said piston being provided with a piston rod extending slidably through one end of said cylinder, and the space between said piston and the other end of said cylinder being filled with an incompressible fluid having the property of expanding while being cooled through the temperature range immediately above the

freezing point thereof and having a freezing point lower than that of water, each of said divider plate means having one part thereof rockably connected with said cylinder and another part pivotally connected with said piston rod.

12. The combination set forth in claim 11, further comprising splash plate means positioned within said freezer compartment and interposed between said ice motor means and said conduit means, said splash plate means being provided with a slot overlying said cylinder, whereby water arriving from siad tank means through said conduit means must first flow over said splash plate means and said cylinder of said ice motor means before entering said ice mold means.

13. The combination set forth in claim 2, further comprising solenoid means operatively connected to said conduit means for rotating the same and for moving said tank means and said ice mold means to the respective positions thereof, and timing means for controlling the energization and deenergization of said solenoid means.

14. The combination set forth in claim 13, further comprising abutment means fixedly mounted within said freezer compartment, said ice mold means comprising a rigid frame connected to said conduit means, a deformable tray of elastic plastic material, and a relatively rigid reinforcing member affixed to the bottom of said tray and positioned for engagement with said abutment means upon energization of said solenoid means and consequent movement of said ice mold means to said ejecting position thereof.

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