Oct. 28, 1958 J. K. NELSON 2,857,748

ICE MAKER

Filed July 5, 1957 2 Sheets-Sheet 1

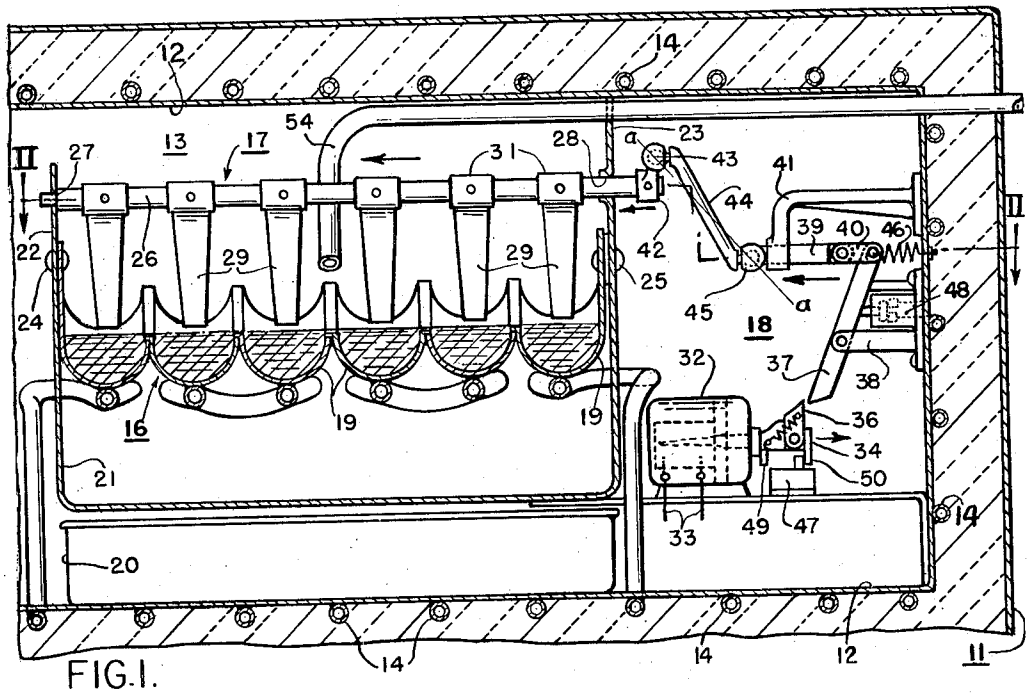

FIG. 1.

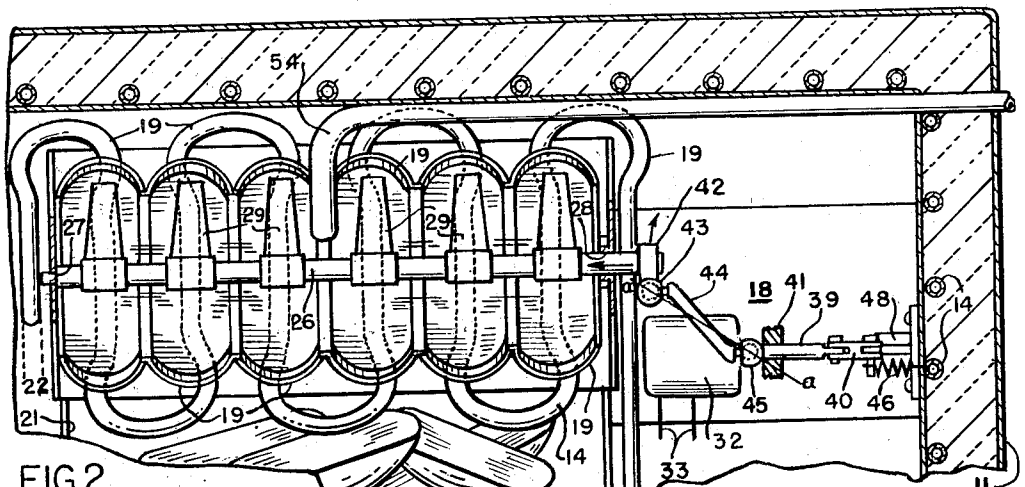

FIG. 2.

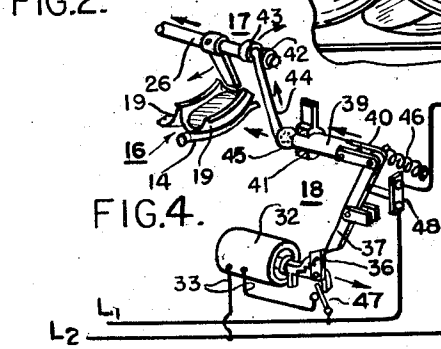

FIG. 4.

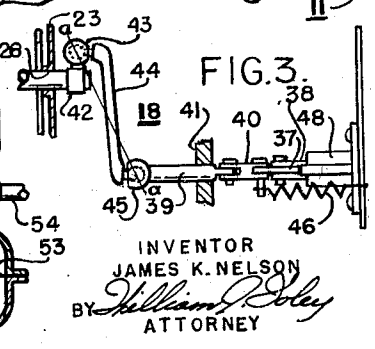

FIG. 3.

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ICE MAKER

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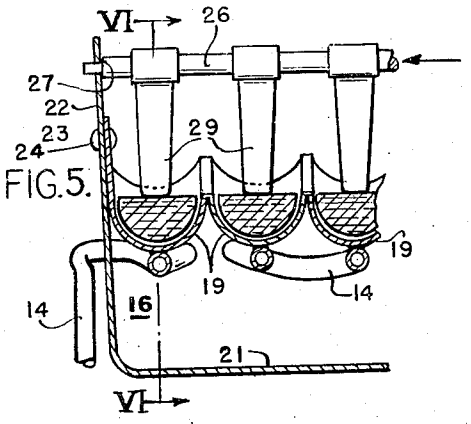

FIG.5.

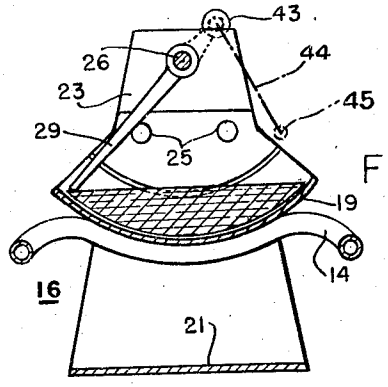

FIG.6.

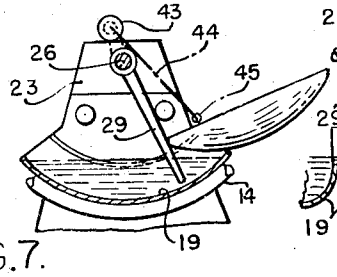

FIG.7.

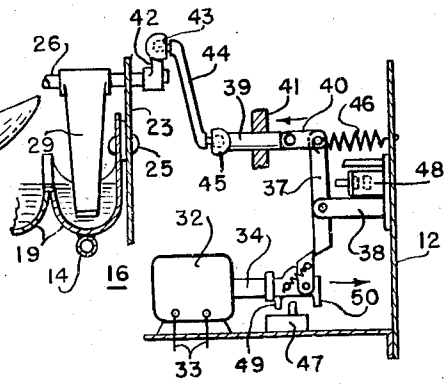

FIG.8.

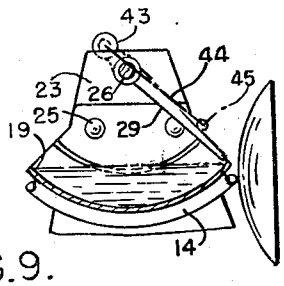

FIG.9.

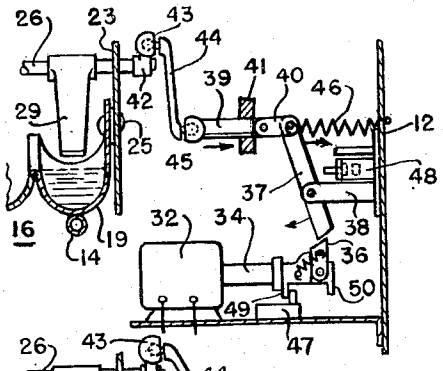

FIG.10.

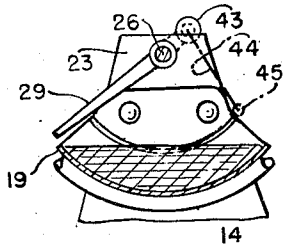

FIG.11.

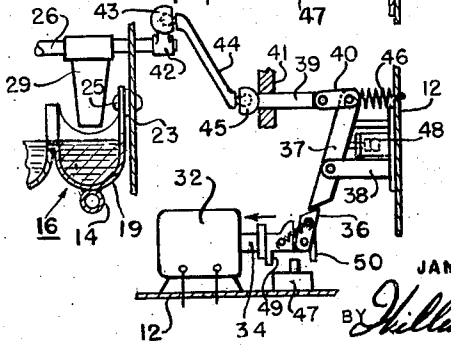

FIG.12.

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2,857,748

ICE MAKER

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Application July 5, 1957, Serial No. 670,013

9 Claims. (Cl. 62—354)

This invention relates to ice making apparatus and more particularly to an improved drive arrangement for ice makers of the type employed in a domestic refrigerator to produce small ice pieces for household use.

This invention is particularly applicable to, and will be described with reference to, the ice mold and ice removing mechanism disclosed and claimed in the copending application of Meigs W. Newberry, Serial No. 660,856, filed May 22, 1957, entitled Ice Maker and assigned to the assignee of the present application. In this ice maker a multi-pocket flexible ice mold is employed in conjunction with means for distorting the mold to loosen ice pieces formed in the ice pockets, and with a plurality of rotatable finger members which are moved into the ice pockets to remove the loosened ice from the pockets.

In accordance with the instant invention a shaft member is positioned adjacent the ice pockets, preferably directly above the pockets, and is mounted in such a manner as to permit it to undergo axially directed, linear motion, and rotary motion independent of the linear motion. Axial movement of the shaft is employed to spread the walls of the ice pockets to loosen ice therein. Rotary movement of the shaft is employed to swing the ice removing fingers into the ice pockets to push ice pieces therefrom.

The improved drive mechanism of this invention is capable of applying a rotating force and a linear force, simultaneously, to the shaft, to cause linear movement of the shaft for the purpose of loosening ice in the ice pockets, although rotary movement of the shaft may be arrested, or temporarily prevented, by virtue of the ice removing fingers encountering ice pieces which are frozen to the ice pockets.

The improved drive mechanism includes a force and motion transmitting linkage comprising a crank arm secured to the ice loosening and removing shaft, a motor driven reciprocating member, and a link that is universally connected at each end, respectively, to the crank arm and the reciprocating member. The special disposition of this link is such as to impart to the crank arm a rotating force and a linear force when linear force is applied to the reciprocating member. The drive mechanism is markedly useful in conjunction with a linear-movement motor, such as the self-controlling thermal motor described and claimed in my copending application Serial No. 643,193, filed February 28, 1957, entitled Ice Maker and assigned to the assignee of the present application, although other types of motors can be employed therewith.

Other features, objects and advantages of this invention will be apparent from the following detailed description, of which the accompanying drawings form a part and wherein:

Fig. 1 is an elevational view, partially in section, showing a refrigerated compartment embodying an ice maker constructed in accordance with this invention;

Fig. 2 is a plan view, partially in section, of the ice making apparatus illustrated in Fig. 1;

Fig. 3 is a fragmentary plan view showing the drive mechanism illustrated in Fig. 2 but with the elements in the positions they occupy when ejecting ice from the ice mold;

Fig. 4 is an electrical and water circuit diagram in which principal elements of the ice maker are shown in schematic perspective;

Fig. 5 is a fragmentary sectional view of the ice mold portion of the ice maker and illustrating the manner in which ice is loosened in the ice pockets of the mold;

Fig. 6 is another sectional view through the ice mold taken along the line VI—VI in Fig. 5; and,

Figs. 7 through 12 are schematic views illustrating the operation of the drive mechanism of this invention.

Referring specifically to Figs. 1 and 2, numeral 11 designates, generally, an insulated refrigerator cabinet having a freezing unit 12 enclosing a refrigerated chamber or compartment 13 in which the components of the ice maker are located. The freezing unit 12 includes a refrigerant conduit 14 through which refrigerant is circulated by suitable means, not shown, for maintaining the temperature of compartment 13 below the freezing point of water and, preferably, around 0° F.

The principal components of the ice maker are disposed within the refrigerating chamber 13 and include an ice mold, indicated generally at 16, an ice loosening and removing mechanism for the ice mold, which mechanism is identified generally by the numeral 17, a drive mechanism indicated generally at 18, and an ice storage container 20.

The ice mold 16 includes a plurality of flexible ice pockets 19, arcuate in configuration, and serially connected in a row. Adjacent pockets 19 are connected at the upper edges of their side walls (see Figs. 1 and 2). Each ice pocket 19 is refrigerated to freeze water therein by a segment of a serpentine extension of refrigerant conduit 14 bonded to the bottom thereof. The row of ice pockets 19 is supported and longitudinally clamped between the upstanding front and rear arms 22 and 23 of a U-shaped clamp 21, with the outermost side wall of each end ice pocket 19 secured, respectively, to one of the arms of the clamp, as indicated at 24 and 25. The rear arm 23 of the U-shaped clamp (the right hand arm as viewed in Figs. 1 and 2) is securied at its upper and lower ends to the freezing unit 14 in a manner to rigidly support the rear end of the mold 16. The forward arm 22 of the clamp 21 movably supports its end of the mold 16 through connection 24, and enables this end of the mold to be moved, to elongate the mold and distort, or flex, the side walls of the ice pockets 19 for the purpose of loosening ice pieces formed in the pockets.

Flexing of the mold 16 is accomplished by the application of a horizontal, linear force to the upper end of clamp arm 22 by a rotatable shaft member 26 forming a part of the ice loosening and removing mechanism 17. The shaft 26 is carried by the arms of clamp 21 and bearing connections between the shaft and the clamp arms, indicated respectively at 27 and 28, permit rotation of the shaft 26 about a longitudinal axis. The forward clamp arm 22 abuts a shoulder of the shaft 26 at bearing 27, and is moved when the shaft 26 is moved linearly in an axial direction, as is permitted by the rear bearing 28. This mounting arrangement for the shaft 26 permits the shaft to undergo independent rotary and linear movement.

The ice loosening and removing mechanism 17 also includes a plurality of ice removing fingers 29 which are disposed above the ice pockets 19 and are adapted to be swept through the ice pockets 19 for the purpose of removing loosened ice from the pockets. The fingers 29 are actuated by the shaft 26, and are preferably mounted directly on the shaft, as by means of hubs 31.

It will be noted that ice pieces formed in the icepockets of mold **16** are loosened and removed from the ice pockets by linear and rotative movement of the shaft **26** of the ice loosening and removing mechanism **17**. Linear motion of the shaft **26** is employed to elongate the mold **16** and open up the side walls of the mold pockets **19** to loosen the ice pieces, as illustrated in Fig. 5. Rotary movement of the shaft **26** is transmitted to the ice removing fingers **29** which enter the ice pockets **19** and sweep loosened ice pieces therefrom, as illustrated in Fig. 7.

The means for imparting the required movement to the shaft **26** is incorporated into the improved drive mechanism identified generally by the numeral **18**. This drive mechanism is motivated by a motor **32**. The motor **32** illustrated in the drawings, and deemed to be particularly appropriate for this application, is a so-called "thermal" or "heat" motor that converts electrical energy, supplied thereto by leads **33**, into usable, powered movement of a slide or plunger **34** associated therewith.

The motor **32** contains an electric heating element (not shown) which, when energized, raises the temperature of the thermal motor and causes an expansible-contractible substance or material therein (not shown) to expand and move the plunger **34** outwardly from the body of the motor. It will be noted that the motor **32** is disposed within the refrigerated chamber housing other components of the ice maker and is subjected to substantially the same refrigerating effect as is the ice mold **16**. The motor **32** is preferably constructed in such a manner that its cooling rate, following deenergization, is analogous to the cooling rate of the ice mold **16** and its contents, such that the same period of time is required for the motor **32** to be cooled from its maximum energized temperature to the temperature which causes full retraction of the plunger **34** as is required to freeze ice in the mold **16**. Since the movement of plunger **34** reflects the temperature of the thermal motor **32**, it also gives an analogous representation of the temperature, and state, of the contents of the ice mold. Thus, the movements of plunger **34** can be employed to control energization of the thermal motor **32** and thereby control initiation of ice removing operations of the ice maker.

The self-controlling thermal motor alluded to briefly above is described more fully and claimed in my aforementioned patent application Serial No. 643,193, filed February 28, 1957.

Motors of this type are available which are capable of producing forces of the order of several hundred pounds over a plunger range of movement of approximately one-half inch. To convert this short powerful movement of the plunger **34** into more pronounced motion usable by the ice loosening and removing mechanism **17**, the plunger **34** preferably drives, by means of a releasable latch including a spring biased dog **36**, one end of a first class lever **37** pivotally carried by a U-shaped support bracket **38** rigidly mounted on the freezing unit **12**. The other end of the lever **37** is connected to a reciprocating slide member **39** by means of a pivoted link **40**. The reciprocating slide **39** is supported by a bearing bracket **41**, also mounted on the freezing unit **12**, and guided for linear movement along a line generally parallel to the axis of rotation of shaft **26** in the ice loosening and removing mechanism **17** (see Figs. 1 and 2). The shaft **26** has a rearward extension upon which is mounted a crank arm **42** through which forces are transmitted to the shaft **26**. The outer end of crank arm **42** carries a universal pivotal connection **43** joining the crank arm **42** to one end of a force transmitting link **44**. The other end of link **44** is universally connected at **45** to one end of slide member **39**.

Figs. 1 and 2 illustrate the inactive or rest position of the components of the drive mechanism **18**. The lever **37** is biased to the position shown by a tension coil spring **46** connected between the upper end of lever **37** and a wall of freezing unit **12**. This is the position which the elements of mechanism **18** assume just prior to the completion of a freezing operation in the ice mold **16** and when no forces are being transmitted through the drive mechanism **18** to the ice loosening and removing mechanism **17**. It will be noted from these figures, that the path of movement of the reciprocating member **39** is parallel to but spaced from the axis of rotation of shaft **26** and that the relationship between the reciprocating member **39** of the crank arm **42** is such that an imaginary line (*a*—*a*) drawn through the pivotal connections **43** and **45** for the link **44** forms an acute angle with both a plane disposed normal to the axis of the rotation of shaft **26** (a plane defined by the path of movement of crank arm **42**) and another plane containing the axis of rotation of shaft **26** and the pivotal connection **43**. As thus arranged, linear forces and movements imparted to the reciprocating member **39** are imposed upon the crank arm **42** by the link **44** in such a manner as to tend to rotate crank arm **42**, and to tend to move crank arm **42** linearly, parallel to the axis of shaft **26**. For example, these elements are capable of movement to extreme positions illustrated in plan in Fig. 3 in which a force applied to the reciprocating member **39** has moved this member to the left as viewed in Figs. 1, 2 and 3, and this motion has been transmitted to link **44** and to the crank arm **42** to move the shaft **26** linearly to the left, and also to rotate the shaft **26** about its axis (counterclockwise as viewed from the front, see Fig. 6). The shaft **26** is thus movable axially in a direction to spread the walls of the mold pockets **19**, and also rotatably movable to bring the ice fingers **29** down into the ice pockets **19**.

Control of the ice maker is effected by a pair of switches **47** and **48**, the physical locations of which are shown in Fig. 1, and the electrical connections therefor being shown in Fig. 4. Switch **47** is positioned to be actuated by a pair of depending lugs **49** and **50** carried on the under surface of the reciprocating plunger **34** of the thermal motor **32**. The arrangement is such that the switch **47** is actuated to its closed position by lug **50** just as the plunger **34** is returned to its most retracted position by cooling of the thermal motor **32**. Lug **49** is adapted to open switch **47** when motor plunger **34** reaches its most extended position by virtue of the thermal motor **32** being energized and its contents heated. Switch **47** is electrically connected in series with the thermal motor **32** and controls energization and deenergization of a heater (not shown) in thermal motor **32**. The circuit for the thermal motor **32**, as shown in Fig. 4, extends from L_1 through switch **47**, leads **33** connected to the thermal motor **32**, and back to line L_2.

Switch **48** is positioned to be actuated to its closed position by lever **37** (see Fig. 1) and is adapted to be opened whenever lever **37** is moved away therefrom. The switch **48** controls energization of a solenoid valve **51** in the water filling circuit of the ice making apparatus. With switch **48** closed, solenoid valve **51** is energized from lines L_1 and L_2, and water is admitted from a supply conduit **52** into a water metering device **53** of the expansible-chamber type. With switch **48** open and solenoid valve **51** deenergized, a water circuit is established by valve **51** from the water metering device **53** to a fill pipe **54** which terminates above the middle of the ice mold **16** (see Figs. 1 and 2).

Operation

Assume the contents of the mold **16** have just become frozen. In refrigerating the ice pockets **19** to form ice in the mold **16**, the freezing unit **12** has also removed heat from, and cooled, the thermal motor **32** to the temperature at which the plunger **34** is fully retracted and the lug **50** on the plunger **34** actuates switch **47** to its closed position. Thermal motor **32** is thereby energized and, as it becomes heated, its plunger **34** is moved outwardly, to the right as it is shown in the drawings. Dog **36**, carried by the plunger **34**, engages the lower end of lever **37**, and the resulting counterclockwise movement of

the lever 37 is transmitted through link 40 to reciprocating member 39, and through link 44 to crank arm 42 secured to the end of shaft 26. Shaft 26 turns freely until the free end of one of the fingers 29 engages the surface of an ice piece in the ice pocket 19 into which it is moved (see Fig. 6); whereupon rotative movement of the shaft 26 is arrested temporarily by virtue of the bond between the ice piece and the walls of the ice pocket 19.

Upon initial movement of the lever 37 in a counterclockwise direction, switch 48 is closed, energizing solenoid valve 51 and admitting water from the supply conduit 52 into the water metering device 53. Water does not, at this time, enter the water fill conduit 54 or the ice mold 16.

Further movement of the thermal motor plunger 34 is transmitted by the aforementioned linkage chain to the shaft 26 for the purpose of moving the shaft axially to the left as shown in Fig. 1. Axial movement of the shaft 26 is transmitted through the forward arm 22 of the mold clamp 21 to lengthen and stretch the mold 16 and spread apart the walls of the ice pockets 19, loosening the ice in the pockets in the manner illustrated in Fig. 5. As the ice pieces in the ice pockets 19 are substantially freed from the walls of the pockets, the resistance to rotative movement of the shaft 26 becomes less than the rotative force applied thereto by the drive mechanism 18, and still further movement of the thermal motor plunger 34 results in the ice removing fingers 29 being swept through the ice pockets 16 as shown in Figs. 7 and 8. The loosened ice pieces are swept from the ice pockets 19 and fall into the storage container 20 positioned below the ice mold 16.

As shown most clearly in Figs. 9 and 10, the dog 36 on motor plunger 34 rides under the lower end of lever 37 as the plunger 34 nears its most extended position. This action releases lever 37 and permits it to swing clockwise, under the action of spring 46, and effect reverse rotation and reverse axial movement of the shaft 26 to the positions illustrated in Figs. 1, 2, 11 and 12. Engagement of switch 48 by lever 37 deenergizes solenoid valve 51 and permits a metered quantity of water, sufficient to fill mold 16, to flow from metering device 53, through fill conduit 54, and into the mold.

Upon the thermal motor plunger 34 becoming fully projected, lug 49 carried by plunger 34 engages and actuates switch 47 to its open position. This action is illustrated in Fig. 10 and effects deenergization of the thermal motor 32, which subsequently cools, under the effect of freezing unit 12, and retracts plunger 34 as illustrated in Fig. 12. Spring biased dog 36 tilts to an inactive position as it engages and passes under lever 37 on the return stroke of plunger 34. After moving past lever 37, dog 36 again assumes an upright position to engage lever 37 when the thermal motor 32 is thereafter energized.

The cooling rate of the thermal motor 32 is analogous to the rate at which heat is removed from the ice mold 16, and the plunger 34 of the thermal motor becomes fully retracted and switch 47 is again closed by lug 50 shortly after the contents of the mold 16 have become frozen.

From the foregoing it will be apparent this invention provides an improved drive mechanism for ice makers wherein ice is first loosened from the mold in which it is formed, and thereafter removed from the mold.

While the invention is shown in but one form, it will be obvious to those skilled in the art that it is not so limited, but is susceptible of various changes and modifications without departing from the spirit thereof.

What is claimed is:

1. In an icemaker, a mold including an ice pocket, a member disposed adjacent said pocket, means supporting said member for independent rotary and linear movement, means responsive to movement of said member for loosening and removing ice from said pocket, and means for imparting movement to said member, said last named means comprising a crank connected to said member, and

means including a second member universally connected to said crank and adapted to apply a force to said crank along a line forming an acute angle with both the plane of movement of said crank and a plane containing the axis of rotation of said crank and the connection between said second member and said crank.

2. In an ice maker, a mold including an ice pocket, a member disposed adjacent said pocket, means supporting said member for independent rotary and linear movement, means responsive to movement of said member for loosening and removing ice from said pocket, and means for imparting movement to said member, said last named means comprising a crank connected to said member, a reciprocating element adapted to move along a path substantially parallel to the path of linear movement of said member, and a rigid link universally connected to said crank and said reciprocating element, the construction and arrangement being such that an imaginary line drawn through the points of connection of said link is disposed at an acute angle with respect to both the plane of movement of said crank and a plane containing the axis of rotation of said member and the connection between said link and said crank.

3. In an ice maker, a mold including an ice pocket, a member disposed adjacent said pocket, means supporting said member for independent rotary and linear movement, means for transmitting linear movement of said member to said pocket to distort the walls of said pocket to loosen ice therein, a finger disposed adjacent said pocket, means responsive to rotary movement of said member for causing relative movement between said finger and said ice pocket whereby said finger removes an ice piece from said pocket, and means for imparting movement to said member, said last named means being constructed and adapted to impart a turning force and a linear force simultaneously to said member and being further adapted to produce linear movement of said member while rotary movement of the member is arrested by engagement of said finger with an ice piece in said pocket, whereby said last named means is effective to cause loosening of ice in said pocket prior to causing movement of said finger to remove ice from the pocket.

4. In an ice maker, a mold including an ice pocket, a member disposed adjacent said pocket, means supporting said member for independent rotary and linear movement, means for transmitting linear movement of said member to said pocket to distort the walls of said pocket to loosen ice therein, a finger movable into the space occupied by an ice piece formed in said pocket, said finger being adapted to remove an ice piece from said pocket, means for transmitting rotary movement of said member to said finger, and means for imparting movement to said member, said last named means being constructed and adapted to impart a turning force and a linear force simultaneously to said member and being further adapted to produce linear movement of said member while rotary movement of the member is arrested by engagement of said finger with an ice piece in said pocket, whereby said last named means is effective to cause loosening of ice in said pocket prior to causing movement of said finger to remove ice from the pocket.

5. In an ice maker, a mold including an ice pocket, a member disposed adjacent said pocket, means supporting said member for independent rotary and linear movement, means for transmitting linear movement of said member to said pocket to distort the walls of said pocket to loosen ice therein, a finger disposed adjacent said pocket, means responsive to rotary movement of said member for causing relative movement between said finger and said ice pocket whereby said finger removes an ice piece from said pocket, and means for imparting movement to said member, said last named means comprising a crank connected to said member, and means

including a second member universally connected to said crank and adapted to apply a force to said crank along a line forming an acute angle with both the plane of movement of said crank and a plane containing the axis of rotation of said crank and the connection between said second member and said crank.

6. In an ice maker, a mold including an ice pocket, a member disposed adjacent said pocket, means supporting said member for idependent rotary and linear movement, means for transmitting linear movement of said member to said pocket to distort the walls of said pocket to loosen ice therein, a finger movable into the space occupied by an ice piece formed in said pocket, said finger being adapted to remove an ice piece from said pocket, means for transmitting rotary movement of said member to said finger, and means for imparting movement to said member, said last named means comprising a crank connected to said member, and means including a second member universally connected to said crank and adapted to apply a force to said crank along a line forming an acute angle with both the plane of movement of said crank, and a plane containing the axis of rotation of said crank and the connection between said second member and said crank.

7. In an ice maker, a mold including an ice pocket, a member supported adjacent said pocket, means supporting said member for independent rotary and linear movement, means for transmitting linear movement of said member to said pocket to distort the walls of said pocket to loosen ice therein, a finger disposed adjacent said pocket, means responsive to rotary movement of said member for causing relative movement between said finger and said ice pocket whereby said finger removes an ice piece from said pocket, and means for imparting movement to said member, said last named means comprising a crank arm connected to said member, a reciprocating element adapted to move along a path substantially parallel to the path of linear movement of said member, and a rigid link, universally connected to said crank arm and said reciprocating element, the construction and arrangement being such that an imaginary line drawn through the points of connection of said link is disposed at an acute angle with respect to both the plane of movement of said crank arm and a plane containing the axis of rotation of said member and the connection between said link and said crank arm.

8. In an ice maker, a mold including an ice pocket, a member disposed adjacent said pocket, means supporting said member for independent rotary and linear movement, means for transmitting linear movement of said member to said pocket to distort the walls of said pocket to loosen ice therein, a finger movable into the space occupied by an ice piece formed in said pocket, said finger being adapted to remove an ice piece from said pocket, means for transmitting rotary movement of said member to said finger, and means for imparting movement to said member, said last named means comprising a crank arm connected to said member, a reciprocating element adapted to move along a path substantially parallel to the path of linear movement of said member, and a rigid link, universally connected to said crank arm and said reciprocating element, the construction and arrangement being such that an imaginary line drawn through the points of connection of said link is disposed at an acute angle with respect to both the plane of movement of said crank arm and a plane containing the axis of rotation of said crank arm and the connection between said link and said crank arm.

9. In an ice maker, a mold including an ice pocket, a shaft disposed above said pocket, means supporting said shaft for independent rotary and axial movement, means for transmitting axial movement of said shaft to said pocket to distort the walls of said pocket to loosen ice therein, a member carried by said shaft for rotation therewith and adapted to move into said pocket to eject ice from said pocket, and means for imparting movement to said shaft, said last named means comprising a crank arm connected to said shaft, a reciprocating member adapted to move along a path substantially parallel to the axis of said shaft, and a rigid link universally connected to said crank arm and to said reciprocating member, the construction and arrangement being such that an imaginary line drawn through the points of pivotal connection of said link is disposed at an acute angle with respect to both the plane of movement of said crank arm, and a plane containing the axis of rotation of said shaft and the point of pivotal connection between said link and said crank arm.

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