Jan. 24, 1961 L. K. WARRICK ET AL 2,968,935

ICE CUBE MAKING AND EJECTING APPARATUS

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FIG. 1

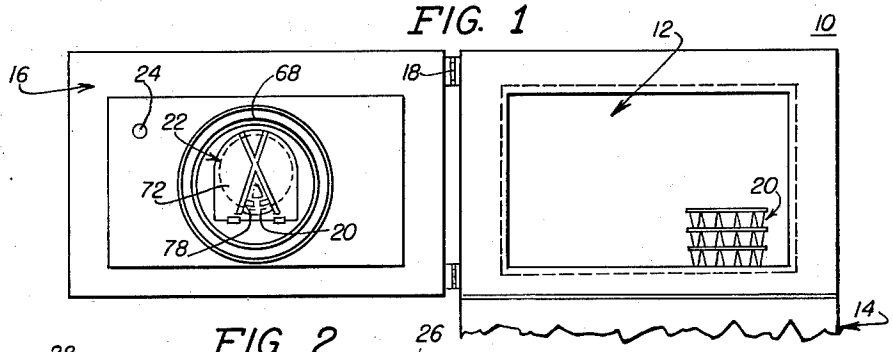


FIG. 2

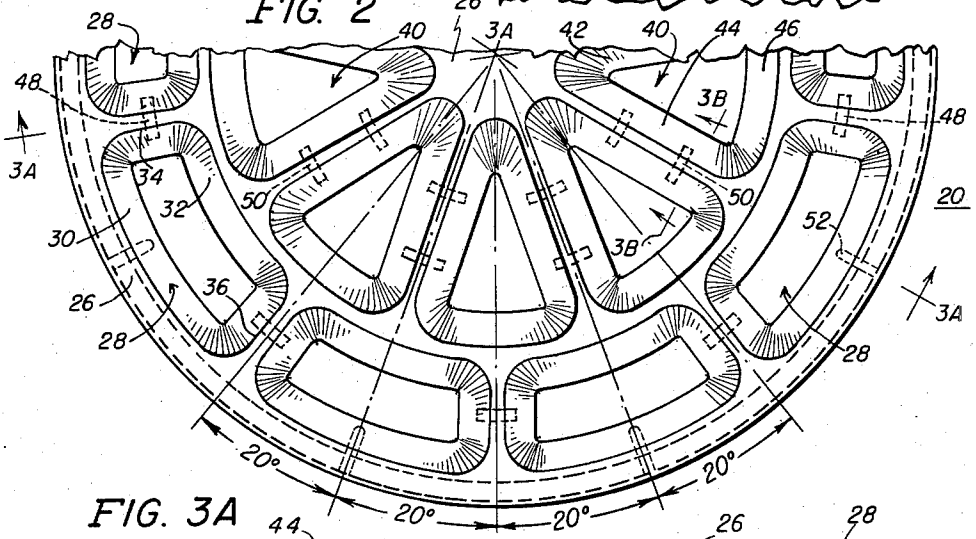


FIG. 3A

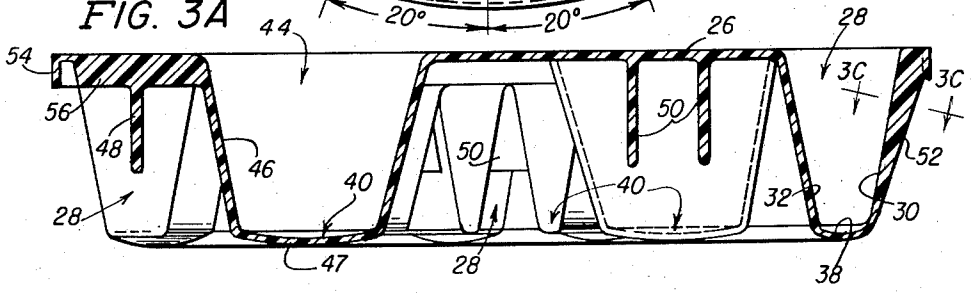


FIG. 3C

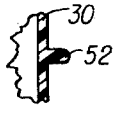
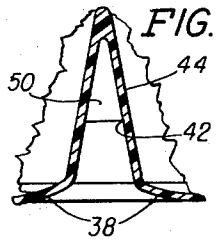


FIG. 3B



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FIG. 5

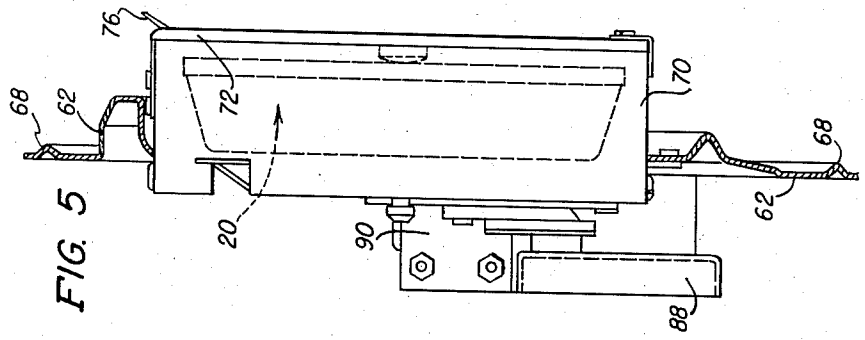
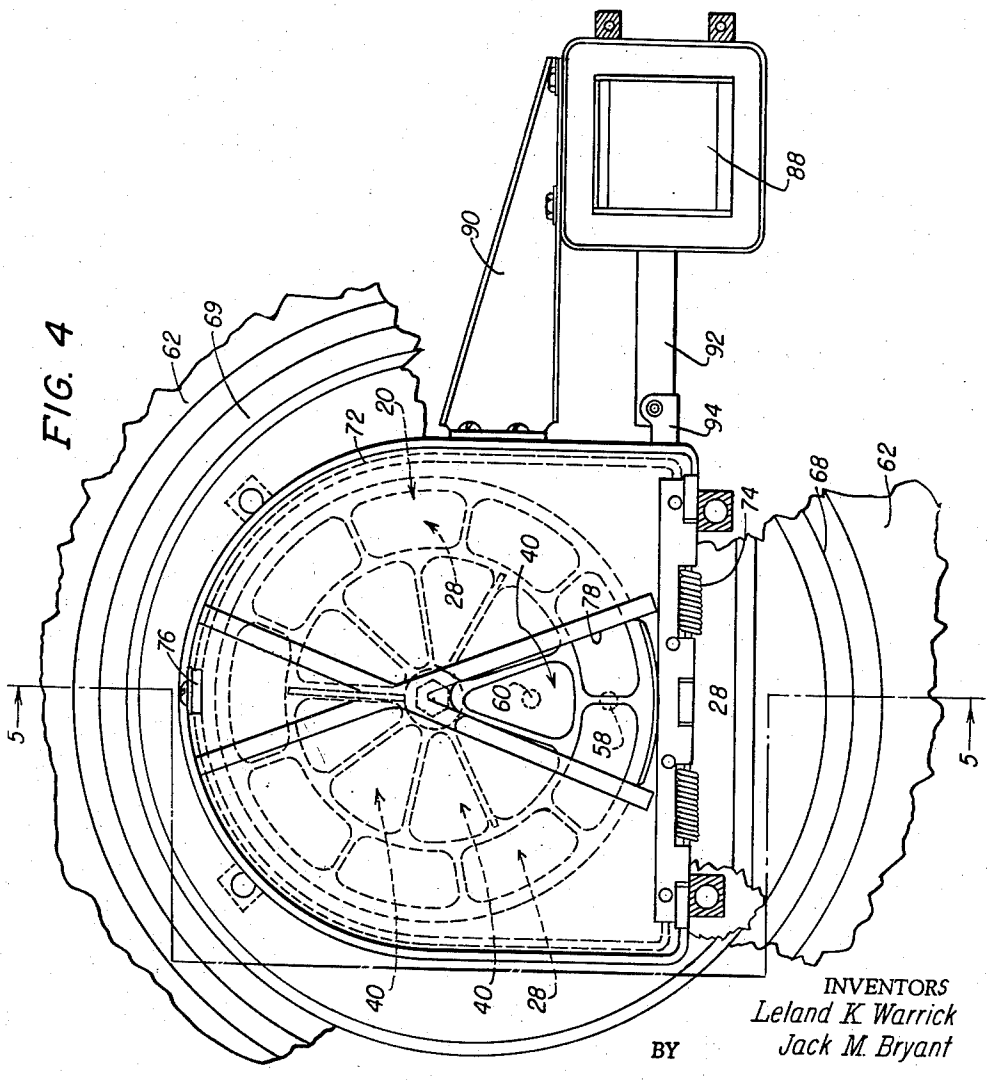


FIG. 4



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ICE CUBE MAKING AND EJECTING APPARATUS

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FIG. 6

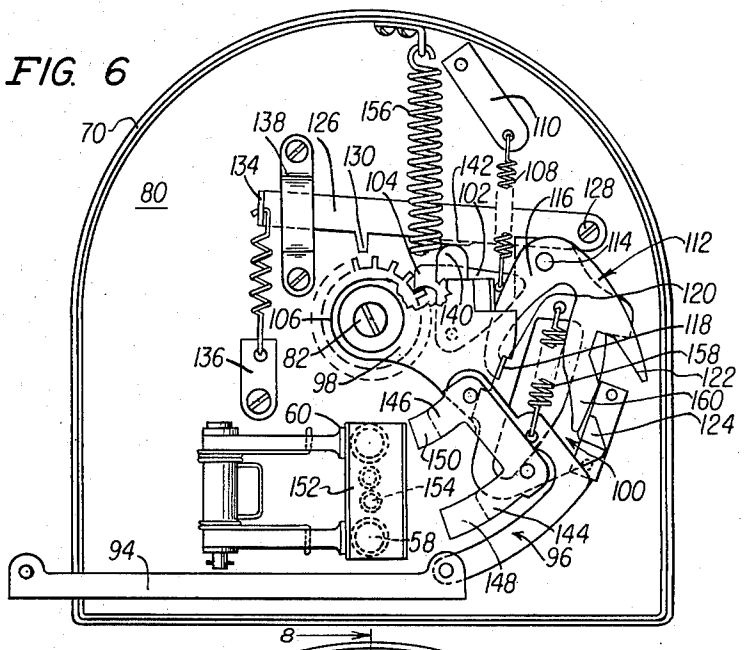
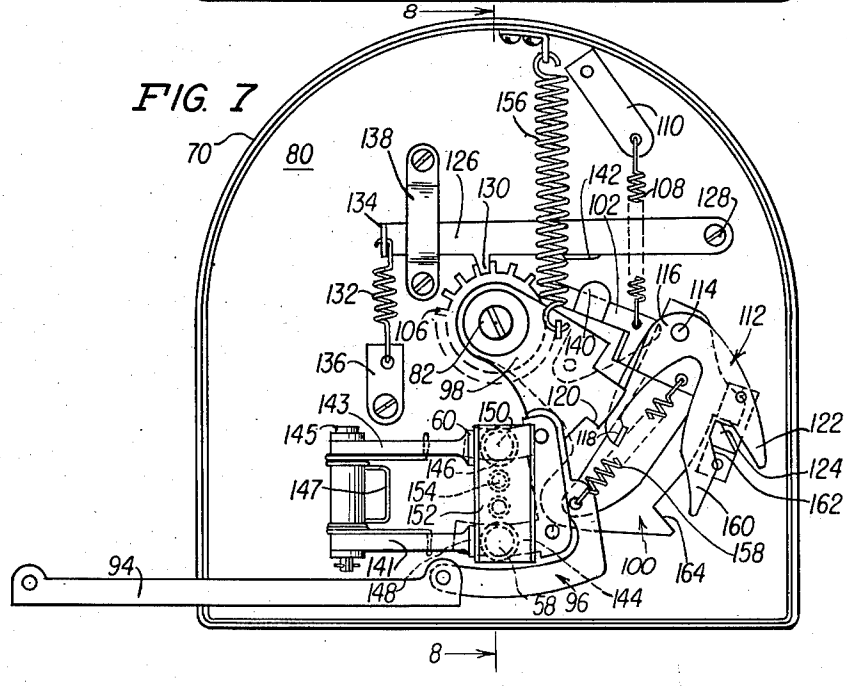


FIG. 7



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FIG. 8

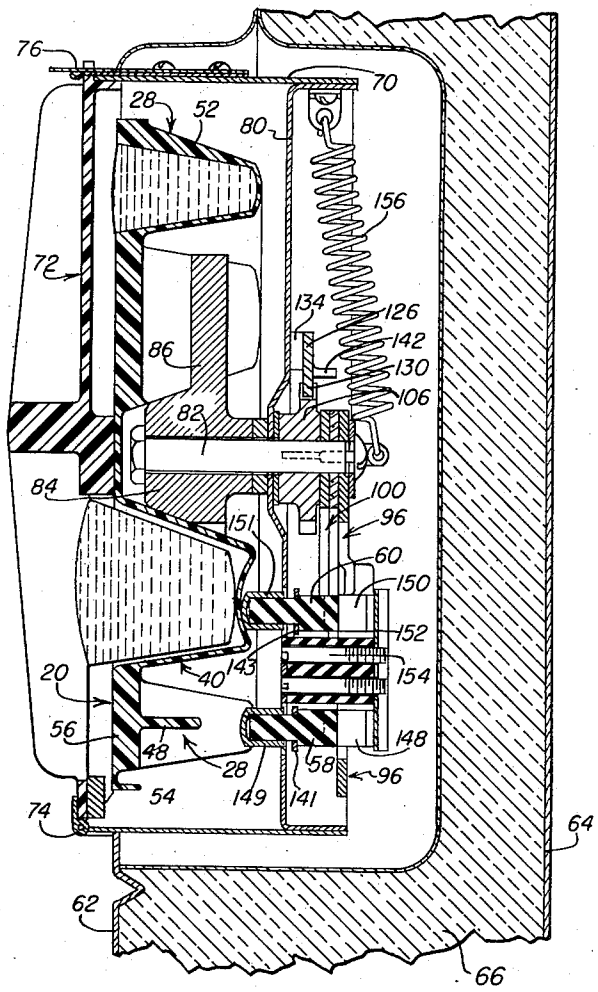
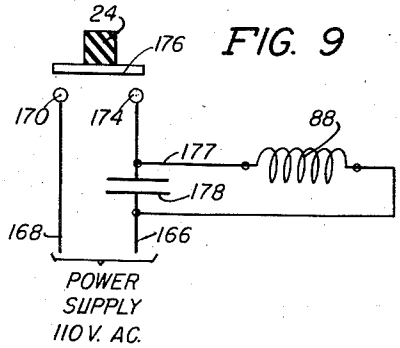


FIG. 9



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United States Patent Office 2,968,935 Patented Jan. 24, 1961

2,968,935

ICE CUBE MAKING AND EJECTING APPARATUS

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Filed Dec. 9, 1957, Ser. No. 701,463

13 Claims. (Cl. 62—353)

The present invention relates to ice cube making and ejecting apparatus for home refrigerators, or the like.

The present invention is particularly applicable to home refrigerators and especially to such refrigerators having separate refrigerating and freezing compartments. It is also desirable that the refrigerator be of the type in which separate doors are provided for each of the compartments. Since the invention has particular utility in such a refrigerator, it will be described in conjunction therewith, but it is to be understood that the present invention can be employed in other types of refrigerating apparatus.

Several systems have been utilized heretofore to provide ice cubes in home refrigerators. Certain of these prior systems utilized trays having mold cavities therein in which water can be frozen for the purpose of making ice cubes. The ice cubes are removed either by melting around the edges of the cubes whereby to release them from the mold cavities or manually operated mechanical looseners are used for this purpose. Such systems are disadvantageous because they require substantial manual manipulation and further because it is difficult to obtain only one or a few ice cubes at a time as desired. It usually is necessary to remove the entire load of ice cubes from a freezing tray in order to obtain even one ice cube.

In order to overcome the disadvantages of the system described, so-called automatic ice cube making apparatus has also been heretofore provided in home refrigerators. These automatic ice cube making mechanisms continuously freeze water to provide ice cubes and the cubes are then deposited in a container until needed. Such systems and mechanisms are relatively expensive to manufacture and to operate. In addition the manufactured ice cubes being stored will coalesce. This phenomenon occurs if the temperature of the storage compartment rises above freezing and even can occur due to the pressure or the weight of the ice cubes themselves against each other.

Accordingly, it is an object of the present invention to provide an improved ice cube making and ejecting mechanism, and particularly such mechanism for use in home refrigerators.

In conjunction with the foregoing object, it is another object of the invention to provide an ice cube making and ejecting mechanism which can be installed in the freezing compartment of an existing home refrigerator.

Another object of the invention is to provide an ice cube making and ejecting mechanism of the type set forth in which a large supply of ice cubes can be available at any time and in which a single ice cube can be obtained from a tray if desired without disturbing the other ice cubes in the tray.

A further object of the invention is to provide an improved ice cube ejector for use in the improved ice cube making mechanism of the present invention.

In connection with the foregoing object it is another object of the invention to provide an improved ice cube ejector which can remove ice cubes one at a time from a tray associated therewith, removal of one ice cube being achieved without disturbing the other ice cubes and while maintaining the other ice cubes separate in their individual mold cavities.

Yet another object of the invention is to provide an improved ice cube ejector which is electrically operated whereby an ice cube can be obtained by operating an electrical switch.

Yet another object of the invention is to provide an ice cube ejector of the type set forth which can be readily mounted in the door for the freezing compartment of a home refrigerator whereby to provide ready access for the user while obtaining an ice cube therefrom.

A further object of the invention is to provide an ice cube ejector of the type set forth in which the loaded ice cube trays can be readily mounted thereon and the emptied trays removed therefrom, the ejector and the tray being arranged so that the ice cubes can be readily removed from the trays by the ejector one at a time upon demand by the user.

These and other objects and advantages of the present invention will be better understood from the following description when taken in conjunction with the accompanying drawings, in which:

Figure 1 is a fragmentary front elevational view illustrating the freezing compartment of a home refrigerator, the compartment having positioned therein a plurality of ice cube trays that are suitable for use in the ice cube making and ejecting mechanism of the present invention, and the door of the compartment being shown also and having mounted thereon the ice cube ejector embodying the present invention;

Fig. 2 is an enlarged fragmentary plan view of an ice cube tray of a type suitable for use in the mechanism of the present invention;

Fig. 3A is a vertical sectional view of the ice cube tray, taken in the direction of the arrows along the line 3A—3A in Fig. 2;

Fig. 3B is a fragmentary sectional view of the ice cube tray, taken through the junction of two adjoining ice cube mold cavities in the tray in the direction of the arrows along the line 3B—3B in Fig. 2;

Fig. 3C is a fragmentary sectional view of the ice cube tray, taken through the outer wall of one of the mold cavities in the direction of the arrows along the line 3C—3C in Fig. 3A;

Fig. 4 is an enlarged fragmentary front elevational view, with certain portions broken away, of the ice cube ejector of Fig. 1;

Fig. 5 is a vertical sectional view of the ejector, taken in the direction of the arrows along the line 5—5 in Fig. 4;

Fig. 6 is a front elevational view of the operating mechanism of the ice cube ejector of the present invention, the parts being shown in the position assumed prior to the initiating of an ice cube ejecting cycle;

Fig. 7 is a view, similar to Fig. 6, showing the parts thereof in the position occupied immediately after ejection of an ice cube from an associated ice cube tray;

Fig. 8 is a vertical sectional view of the ice cube ejector, taken in the direction of the arrows along the line 8—8 in Fig. 7, and further illustrating the mounting of the ejector on the door of the freezing compartment of the home refrigerator; and

Fig. 9 is a schematic electrical diagram illustrating the operating circuit for the solenoid used to actuate the ejection mechanism.

Referring now to Fig. 1 of the drawings, there is shown a typical domestic or home refrigerator generally designated by the numeral 10 and including a heat-insulated freezing compartment 12 and the usual re-

frigerating compartment 14 (shown only partially). Means (not shown) is provided to cool the compartments. The freezing compartment 12 is provided with a door 16 secured to the refrigerator 10 by suitable hinges 18 and further provided with the usual seals and latch mechanism (not shown). The freezing compartment 12 is adapted to receive a plurality of ice cube trays generally designated by the numeral 20. Mounted upon the compartment door 16 is an ejector generally designated by the numeral 22 which is adapted to receive therein one of the trays 20 and to eject ice cubes therefrom one at a time upon demand. More specifically a push button 24 is provided on the inner side of the door 16. The push button 24 is accessible when the door 16 is open as illustrated and the push button 24 is further positioned adjacent to the ice cube ejector 22 so that while operating the push button 24 with one hand the operator can position a suitable receptacle for an ice cube beneath the ejector 22 to receive an ice cube through a delivery opening therein as will be described more fully hereafter.

Preferably, the ice cube trays 20 employed in the ice cube ejector 22 are of the construction and arrangement of that disclosed and claimed in the copending application of Orrin E. Wolf, Serial No. 701,401, filed Dec. 9, 1957; which ice cube tray 20 comprises, as more fully illustrated in Figs. 2, 3A, 3B and 3C of the drawings, a unitary structure of annular configuration. Specifically, the tray 20 includes a substantially circular top or support wall 26; and depending from the top wall 26 is a first set of ice cube mold cavities 28. The ice cube mold cavities 28 are positioned outwardly near the periphery of the top wall 26 and are arranged in an outer circular row. The longer sides 30 and 32 of the compartments 28 are curved and are joined by radially extending end walls 34 and 36. Referring to the right hand side of Fig. 3A it will be seen that the side walls 30 and 32 slope inwardly toward each other from the top wall 26, the walls preferably forming an angle of approximately 10° with respect to a line disposed perpendicular to the surface of the top wall 26. The walls 34 and 36 are similarly inclined. This construction of the walls of the mold cavity 28 facilitates ready ejection of an ice cube therefrom. More specifically, this formation of the side walls minimizes the possibility of ice cubes being "keyed" in the mold cavity due to the expansion of the water therein during freezing. Likewise, the tendency of the ice cube to be retained in the cavity 28 by action of atmospheric pressure because of the vacuum produced by removal of the ice cube from the compartment is minimized by such a wall formation. The bottom 38 of each compartment 28, as viewed in Fig. 3A, is curved downwardly away from the top wall 26 also to facilitate ejection of ice cubes from the compartment as will be explained more fully hereafter.

Disposed inwardly from the outer row of mold cavities 28 is a second set of mold cavities 40. The mold cavities 40 are generally triangular in shape and are provided with two substantially radially extending side walls 42 and 44 and a circumferentially extending end wall 46 joining the outer ends of the side walls 42 and 44. Each of these walls also preferably has an inclination of approximately 10° with respect to a line perpendicular to the top wall 26 to facilitate removal of ice cubes therefrom for the same reasons as has been explained above with respect to the mold cavities 28. The mold cavities 40 are provided with outwardly curved bottom walls 47, as may be best seen in Fig. 3A.

In order further to reinforce the walls of the mold cavities 28 and 40 against deformation during freezing certain reinforcing structures have been added. A first set of ribs 48 is provided between adjacent end walls 34 and 36 of the mold cavities 28. Each of the ribs 48 is disposed substantially centrally of the walls and extends downwardly from the top wall 26 a distance slightly greater than one half of the depth of the mold compartments 28 (see particularly Figs. 3A and 3B). Similar reinforcing ribs 50 are provided in pairs between the adjacent walls 42 and 44 of the mold cavities 40. These ribs 50 also extend slightly more than half the way from the top wall 26 to the bottom of the mold 40. Reinforcing ribs 52 are also provided at the centers of the outer walls 30 of the mold cavities 28, a typical cross section of a rib 52 being shown in Fig. 3C of the drawings. All of the reinforcing ribs 48, 50 and 52 serve to prevent the mold cavity side walls from bulging during the freezing of the water in the mold cavities to form ice. If the walls of the mold cavities should be deformed outwardly, there is a possibility that the maximum diameter of the resultant ice cube might be at some place other than the top of the mold cavity as viewed in Fig. 3A. As a result the ice cube so formed would be held or keyed in position and it would be difficult to remove it from the ice cube tray 20.

A structure is also provided on the ice cube tray 20 to provide necessary support therefor during use in the ejector 22. There is formed on the outer edge of the top wall 26 a depending flange 54 extending around the circumference thereof. The portions of the wall 26 between adjacent mold cavities 28 near the periphery of the top wall 26 are also thickened as at 56. The top wall 26 thus reinforced by the flange 54 and the thickened portions 56 can serve to hold the trays 20 in proper shape for use in the ejector 22.

Referring now particularly to Fig. 4 of the drawings, it will be seen that nine mold cavities have been provided in the outer row on the tray 20 and nine of the mold cavities 40 have been provided in the inner row. Furthermore the mold cavities in the inner row and the outer row are positioned so that a radius of the tray 20 extending along the center of a mold cavity 40 falls between adjacent mold cavities 28 and similarly a radius bisecting a mold cavity 28 lies between adjacent mold cavities 40. Since there are nine mold cavities 28 in the outer row, their centers are disposed 40° apart and the centers of the mold cavities 40 are similarly disposed 40° apart, since the mold cavities in each row are identical in shape and equally spaced apart on the circular tray 20. The radii bisecting adjacent mold cavities in the inner and outer rows are disposed 20° apart as is best illustrated in Fig. 2 of the drawings. The staggered arrangement of the outer and inner rows of the mold cavities 28 and 40 facilitates removal of ice cubes therefrom by the ejector 22.

Referring again to Fig. 4, the ejector includes a pair of ejector pins or hammers 58 and 60. The ejector pins 58 and 60 are disposed vertically above each other and along a radius of an ice cube tray 20 when it is in operative position within the ejector 22. As illustrated in Fig. 4, the pin 60 is positioned to contact the bottom of a mold cavity 40. With the parts in this position the ejector pin 58 falls between adjacent mold cavities 28. If the ice cube tray 20 is rotated 20°, then the pin 58 will be disposed in the center of the bottom of a mold cavity 28 and the pin 60 will be disposed between adjacent mold cavities 40.

The ice cube tray 20 is preferably formed of a readily deformable material so that the mold cavities can be deformed as illustrated in Fig. 8 of the drawings to eject ice cubes therefrom. A suitable type of material of construction is synthetic organic plastic material and particularly those plastic materials which are pliable or bendable. A preferred material of construction is polyethylene plastic.

The construction and operation of the ejector 20 will now be described in detail with particular reference to Figs. 4 through 8 of the drawings. The ejector 22 and the operating mechanism therefor is all mounted upon and within the door 16 as has been described above. The door 16 is provided with a pair of spaced apart metal walls or sheets 62 and 64 between which is disposed the usual

insulating material 66. An aperture is provided in the inner sheet 62 and receives therethrough the front wall of the ejector 22. For purposes of ornamentation and reinforcement, the sheet 62 may also be provided with circular embossments 68 as is best illustrated in Fig. 1 of the drawings. The ejector 22 includes an outer housing 70 which is suitably secured to the sheet 62. Hingedly connected on the housing 70 is a lid or cover 72 mounted thereon by a pair of hinges including springs 74 which normally bias the cover 72 toward the up or closed position. The housing 70 and the cover 72 cooperate to provide a chamber to receive an ice tray 20 therein. A latch 76 is provided positively to hold the cover 72 in the closed position. A delivery hole or opening 78 is provided in the cover 72 so that an ice cube in registry therewith can be ejected therethrough upon operation of the ejector 22.

Referring now to Fig. 8 of the drawings, it will be seen that the housing 70 is provided with a rear wall 80. Journaled in the rear wall 80 is a shaft 82 which extends substantially perpendicular thereto and is adapted to be disposed horizontally in use. Mounted on shaft 82 and keyed thereto is a mounting sprocket 84 having a plurality of radially extending arms 86, preferably three arms 86 being provided when an ice cube tray of the type illustrated in the drawings is used. The arms 86 are adapted to be disposed between adjacent mold cavities 40 and it will be understood that since there are three equally spaced arms 86 and nine equally spaced openings between the mold cavities 40 that there is a plurality of positions in which the ice cube tray 20 can be suitably positioned upon the mounting sprocket 84. Preferably the surfaces of the sprocket 84 disposed toward the ice cube tray are shaped to conform to the shape of the adjacent portions of the tray and the cover 72 serves to hold a tray 20 in operative position upon the sprocket 84.

Mechanism is provided on the rear of the wall 80 to actuate the pins 58 and 60 simultaneously whereby to eject an ice cube from the tray 20. Prior to actuation of the ejector pins 58—60, it is necessary to rotate or index the tray 20 through an angle of 20° to insure that a mold cavity having an ice cube therein is presented before one of the pins 58 or 60 and in registry with the delivery hole 78.

In the form of the invention illustrated in the drawings, the indexing of the ice cube tray through a 20° angle and the subsequent simultaneous actuation of the ejector pins 58—60 is accomplished by the user pushing the push button 24 (see Fig. 1) which serves to energize an electric motor which in turn drives mechanism suitable to cause proper operation of the various parts. More specifically, the electric motor illustrated in the drawings is a solenoid 88 which is mounted by means of a bracket 90 on the housing 70. The solenoid 88 is provided with an armature 92 which is pivotally connected to a link 94 which is in turn connected to an ejector plate or hammer plate generally designated by the numeral 96 (see Figs. 6, 7 and 8). The hammer plate 96 has a portion 98 which is journaled on the shaft 82 and is rotatable with respect thereto, the plate 96 being movable between the position illustrated in Figure 6 and that illustrated in Fig. 7 of the drawings. A ratchet plate generally designated by the numeral 100 is provided and is also journaled on the shaft 82 and is rotatable with respect thereto. Pivotally mounted on the ratchet plate 100 is a ratchet pawl 102 having a nose 104 normally in engagement between the teeth of a ratchet wheel 106. The ratchet wheel 106 is fixedly attached to the shaft 82 and accordingly, rotation of the ratchet wheel 106 will serve to rotate the shaft 82, the attached sprocket 84 and through the sprocket 84 the ice cube tray 20. A spring 108 has one end thereof connected to the ratchet pawl 102 and the other end thereof connected through a strap 110 to the wall 80. The spring 108 continuously urges the nose 104 of the pawl 102 into engagement with the ratchet wheel 106 as may be best seen in Fig. 6 of the drawings. In order to index or rotate the ice cube tray 20, it is necessary therefore only to interconnect the hammer plate 96 and the ratchet plate 100 and rotate them in a clockwise direction as viewed in Fig. 6 of the drawings, the power for rotating the pins being derived from the solenoid 88.

To this end a latch or dog generally designated by the numeral 112 has been provided. The latch 112 is pivoted to the ratchet plate 100 as at 114 and includes an arm 116 carrying a projection 118 engaging with a shoulder 120 on the hammer plate 96. Accordingly, if the solenoid 88 is energized when the parts are in the position illustrated in Fig. 6, the link 94 will be moved to the left as viewed therein and will proceed to rotate the hammer plate 96 in a clockwise direction. The hammer plate 96 through the latch 112 will carry the ratchet plate 100 therewith. Since the ratchet plate 100 has the pawl 102 mounted thereon and further since the spring 108 holds the nose 104 in engagement with the ratchet wheel 106, the ratchet wheel 106 will be turned therewith. Turning the ratchet wheel 106 will turn the shaft 82 which in turn will rotate the sprocket 84 and the ice cube tray 20 mounted thereon. After approximately 20° rotation of the parts in this manner, an arm 122 formed on the latch 112 will engage a stop 124 mounted on the wall 80. Engagement between the arm 122 and the stop 124 will cause the latch 112 to be rotated in a counterclockwise direction with respect to the ratchet plate 100. Such movement of the latch 112 will move the projection 118 out of engagement with the shoulder 120 and thus disconnect the hammer plate 96 from the ratchet plate 100.

Means is provided positively to stop rotation of the ratchet wheel 106 after 20° rotation thereof. To this end a wheel stop 126 is provided and is pivoted as at 128 to the wheel 80. A projection or lug 130 is provided on the stop 126 and is continually urged toward engagement with the ratchet wheel 106 by a spring 132. The spring 132 has one end thereof connected to a flange 134 on the free end of the wheel stop 126 and has the other end thereof connected by means of a strap 136 to the wall 80. A guide 138 is provided for the wheel stop 126.

At the beginning of rotation of the hammer plate 96 and the ratchet plate 100 therewith, a projection or tab 140 formed on the ratchet plate 100 is in engagement with an abutment 142 on the adjacent side of the wheel stop 126. Rotation of the ratchet plate 100 in a clockwise direction during the beginning of an ejection cycle will also move the projection 140 clockwise and downwardly whereby permitting the wheel stop 126 to be rotated in a counterclockwise direction under the urging of the spring 132 toward the ratchet wheel 106. The projection 130 first engages the addendum circle surface of a tooth of the ratchet wheel 106. The contacting surfaces remain in sliding contact until the ratchet wheel 106 has been turned by the pawl 102 a sufficient distance to permit the projection 130 to fall between two teeth of the ratchet wheel 106 as is illustrated in Fig. 7 of the drawings. The insertion of the projection 130 between adjacent teeth of the ratchet wheel 106 positively stops rotation thereof and rotation of the associated ice cube tray 20. The parts are so arranged and proportioned that this movement of the parts indexes or turns the ice cube tray exactly 20°. To this end the ratchet wheel 106 has been illustrated as being provided with eighteen teeth so that movement of one tooth past the rest position of the pawl 102 will give the necessary rotation of the shaft 82 and the ice cube tray 20 mounted thereon. The above described rotation of the wheel 106 and the associated parts is achieved during substantially the first 20° of rotation of the hammer 96 and the connected ratchet plate 100 from the position illustrated in Figure 6 toward that illustrated in Fig. 7.

Substantially simultaneously with the insertion of the projection 130 between the teeth of the ratchet wheel

106, it is desirable to disconnect the hammer plate 96 and the ratchet plate 100 as has been described above. The stop 124 acting against the arm 122 brings about this necessary unlatching action and the parts are positioned and dimensioned to insure release of the two plates 96 and 100 at the proper time.

Also mounted on the hammer plate 96 is a pair of ejector cams 144 and 146 having inclined cam surfaces 148 and 150, respectively. As may be best seen in Fig. 8 of the drawings, the cam surface 150 is adapted to contact a cooperating surface on the ejector pin 60 and the cam surface 148 is similarly adapted to engage the cooperating surface on the rear of the ejector pin 58. In order to guide the cams 144 and 146 a guide way including a plate 152 mounted by means of bolts 154 on the wall 80 has been provided. The continued movement of the hammer plate 96 after unlatching thereof from the ratchet plate 100 serves to bring the cams 144–146 into sharp striking relationship with the ejector pins 58 and 60, respectively. The contact between these parts is very quick and gives a rapping movement which "pops" the ice cube out of the mold cavity positioned in front of the ejector pin.

Means is provided to return the ejector pins 58 and 60 to the retracted position. More specifically a pair of bifurcated arms 141 and 143 has been provided for the pins 58 and 60, respectively, the arms engaging the pins as is best illustrated in Fig. 8 of the drawings. The bifuracted ends of the arms 141 and 143 bear against shoulders formed on the pins. The other ends of the arms 141 and 143 are pivoted on a shaft 145 and are urged in a direction to retract the pins 58 and 60 by means of a spring 147. Accordingly, as soon as the cams 144 and 146 have been retracted, the ejector pins 58 and 60 will be moved to the retracted position.

Preferably the bodies of the ejector pins 58 and 60 are made of plastic. The ends of the pins are provided with caps 149 and 151, respectively, which are formed of metal to provide the necessary rigidity and to prevent direct contact between two plastics.

After the ejection of an ice cube from the tray 20 and de-energization of the solenoid 88, the parts are returned from the position illustrated in Fig. 7 of the drawings to that illustrated in Fig. 6. For this purpose a spring 156 is connected at one end to the hammer plate 96 and at the other end to the housing 70. The spring 156 serves to rotate the hammer plate 96 in a counterclockwise direction from the position shown in Fig. 7 to that shown in Fig. 6. During the retrograde rotation of the hammer plate 96, it is also desired to reconnect the ratchet plate 100 thereto. Movement of the parts to a position in which the latch 112 can interconnect the plates 96 and 100 is facilitated by a spring 158 which interconnects the plates 96 and 100. Means is further provided to insure that the projection 118 of the latch 112 moves into engagement with the shoulder 120. More specifically an arm 160 is provided on the latch 112 having a cam surface 162 which engages the stop 124. The stop 124 acting against the cam surface 162 pivots the latch 112 in a clockwise direction with respect to the ratchet plate 100 whereby to move the projection 118 into engagement with the shoulder 120.

The nose 104 of the pawl 102 is so shaped as to permit it to ride over the teeth of the ratchet wheel 106 and permits the pawl 102 to be moved to a position such that it can initiate a subsequent rotation of the ratchet wheel 106. As the ratchet plate 100 moves toward the final rest position, the projection 140 thereon comes into contact with portion 142 of the wheel stop 126 and pivots the wheel stop 126 in a clockwise direction whereby to remove the projection 130 thereon out of engagement with the teeth of the ratchet wheel 106. The final rest position of the hammer plate 96 is determined by a cam surface 164 which comes to rest against the stop 124. The parts are then in a position to initiate a subsequent ice cube ejection cycle.

The electrical circuit for energizing the solenoid 88 is diagramatically illustrated in Fig. 9 of the drawings. A pair of lines 166 and 168 is connected to a suitable power supply such as the usual 110 volt A.C. line. The line 168 is connected directly to a switch contact 170. The line 166 is connected to one terminal of the solenoid 88 and the other terminal of the solenoid 88 is connected through a line 172 to a second switch contact 174. The push button 24 carries an electrical conducting plate 176 which is moved into engagement with the switch contacts 170 and 174 when the user operates the push button 24. Closing the switch contact by means of the plate 176 energizes the solenoid 88 and causes operation of the ejection mechanism as has been described above. A suitable condenser 178 is connected across the solenoid 88 between the lines 166 and 172 to suppress arcing across the switch contacts.

To utilize the ice cube making mechanism of the present invention, the user first fills the mold cavities in one or more of the ice cube trays 20 with water and places the trays in the freezing compartment 12 of the refrigerator 10. After a suitable time the water in the ice cube trays freezes to form individual ice cubes. When the user desires an ice cube, he takes one of the filled ice cube trays 20, opens the door of the ejector 22 by disengaging the latch 76 and places the tray 20 upon the sprocket 84. The sprocket 84 is shaped to receive the ice cube tray in a plurality of different adjusted positions and, accordingly, mounting of the tray 20 thereon is facilitated. The cover 72 is then moved upwardly and latched whereby firmly to mount the ice cube tray 20 on the sprocket 84.

The user then pushes the push button 24 whereby to energize the solenoid 88. This causes movement of the armature 92 to the right as viewed in Fig. 4 and thus moves the link 94 to the right, as viewed in Fig. 4 and to the left as viewed in Figs. 6 and 7. The hammer plate 96 is rotated through substantially 30° total rotation in a clockwise direction by the energization of the solenoid 88. During approximately the first 20° of rotation of the hammer plate 96, it has the ratchet plate 100 connected thereto by means of the latch 112. The pawl 102 which is carried by the ratchet plate 100 rotates the ratchet wheel 106 in a clockwise direction as viewed in Figure 6 (in a counterclockwise direction as viewed in Fig. 4) and moves the ice cube tray 20 therewith. The 20° rotation of the ratchet wheel 106 and the associated movement of the ice cube tray 20 places an ice cube mold cavity in position to be ejected from the tray through the opening 78 in the cover 72. When the tray 20 is in the proper position, the projection 130 on the wheel stop 126 has dropped between two teeth on the ratchet wheel 106 and the latch 112 has been moved to disengage the plates 96 and 100.

The next 10° rotation of the hammer plate 96 drives the cam plates 144—146 into engagement with the ejector pins 58 and 60 whereby partially to move the ejector pins toward the rear of the mounted ice cube tray. Because of the staggered arrangement of the outer and inner rows of the ice cube cavities 28 and 40, only one cavity will be in a position such that it will be contacted by an ejector pin. In the position illustrated in the drawings, an ice cube cavity 40 in the inner row is in position to be contacted by the ejector pin 60. Accordingly, the ejector pin 60 serves to push the ice cube from the cavity as is diagrammatically illustrated in Figure 8 of the drawings. More specifically the bottom of the mold cavity is deformed outwardly positively and rapidly whereby to eject the ice cube from the cavity.

The ejector pin 58 is directed toward a point on the ice cube tray positioned between two of the mold cavities 28 in the outer row. Accordingly, the ejector pin 58 in

this cycle of operation will be ineffective to eject an ice cube from the tray 20.

Upon de-energization of the solenoid 88, the parts are moved from the position illustrated in Fig. 7 to that illustrated in Fig. 6 of the drawings. This completes an ejection cycle. The user if he desires may now close the freezing compartment door 16. This will preserve the other ice cubes in the tray 20 mounted in the ejector 22 in their frozen condition.

Either immediately after the ejection cycle described above or after an extended period of time, the user will again press the push button 24 to initiate the next cycle of operation of the ejector 22. Pushing the button 24 will first rotate or index the ice cube tray 20 in a counterclockwise direction as viewed in Fig. 4 through an angle of 20°. This will place a mold cavity 28 in front of the ejector pin 58 and will simultaneously position the ejector pin 60 between two of the mold cavities 40. Continued movement of the ejector parts will cause the ejector pin 58 to engage and deform the bottom of the mold cavity 28 positioned in front thereof. Accordingly, an ice cube will be ejected from the mold cavity through the opening 78 of the cover 72 and deliver the ice cube to a receptacle held by the user. The ejection cycle can then be repeated and this can be done until the ice cubes are exhausted from the tray 20.

The user then removes the emptied ice cube tray 20 from the ejector 22 and places a filled tray therein. The ejector is immediately in condition to eject ice cubes therefrom. The emptied tray may then conveniently have the cavities thereof filled with water and the filled tray replaced in the freezing compartment 12 for freezing of the water therein.

In the foregoing description of the construction and arrangement of the tray 20 and the ejector 22, it was pointed out that nine inner cavities 40 were disposed in the interior row in the tray 20 and that nine outer cavities 28 were disposed in the exterior row in the tray 20; however, it will be understood that while this arrangement is very convenient to achieve a proper subdivision of the 360°, other arrangements may be employed. For example, with ten cavities in each row, the displacement angles involved would be respectively 36° and 18°, instead of 40° and 20°; and with twelve cavities in each row, the displacement angles involved would be respectively 30° and 15°, instead of those noted.

Also, in the foregoing description of the construction and arrangement of the ice cube tray 20, and the cooperating ejector 22, it was pointed out that in the ejector 22, the pins 58 and 60 were arranged in radial alignment with the centerline of the shaft 82, while the outer mold cavities 28 and the inner mold cavities 40 in the tray 20 were displaced with respect to each other by angles of 20°. However, it will be appreciated that all of the required angular displacement of 20° need not be incorporated in the tray 20. For example, if the angle of rearward displacement between the outer cavities 28 and the inner cavities 40 were reduced from 20° to 8°, then the outer pin 58 would be displaced angularly in a complementary manner 12° forwardly of the inner pin 60, so as to preserve the total required angle of 20°, corresponding to one step of the sprocket 84. Hence, it follows that if the angle of rearward displacement between the outer cavities 28 with respect to the inner cavities 40 were reduced to 0°, so that the outer cavities 28 were, in fact, in radial alignment with the inner cavities 40, then the outer pin 38 would be displaced angularly in a complementary manner 20° forwardly of the inner pin 60, so as to preserve the total required angle of 20°, corresponding to one step of the sprocket 84. Thus, it will be appreciated that all of the required angular displacement of 20° may be incorporated in the angular displacement between the outer mold cavities 28 and the inner mold cavities 40 in the tray 20, or all of the required angular displacement of 20° may be incorporated in the angular displacement between the outer pin 58 and the inner pin 60 in the ejector 22, or the required angular displacement of 20° may be divided between the angular displacement of the two groups of cavities in the tray 20 and the angular displacement between the two pins in the ejector 22.

In view of the foregoing, it is apparent that there has been provided an ice cube making and ejecting machine, which fulfills all of the objects and advantages set forth above; and while the machine has been disclosed as employing the ice cube tray of the copending application of Orrin E. Wolf, as previously explained, it will be understood that other suitable ice cube trays may be employed therein.

Although certain preferred forms of the invention have been described and shown for purposes of illustration, it is to be understood that various changes and modifications can be made therein without departing from the spirit and scope of the invention. Accordingly, the invention is to be limited only as set forth in the following claims.

What is claimed is:

1. In combination, a refrigerator including walls defining a heat-insulated freezing compartment having a front opening, means for cooling said freezing compartment to a temperature below 32° F., and a front door including inner and outer walls disposed in spaced-apart relation and a layer of heat insulation therebetween, said front door cooperating with said freezing compartment front opening and movable between open and closed positions with respect thereto; an ice cube ejector carried by said front door and movable therewith and arranged in a cavity provided in said layer of heat insulation, said ejector comprising structure defining a chamber having a front opening through said inner wall of said front door and adapted to receive an ice tray, a front cover cooperating with said chamber front opening and movable between open and closed positions with respect thereto, so as to accommodate placement and removal of an ice tray with respect to said chamber, an ice tray having a plurality of ice cube mold cavities therein and adapted to be placed in said freezing compartment for the purpose of producing the ice cubes in said mold cavities and adapted to be placed in said chamber for the purpose of supplying the ice cubes from said mold cavities, said front cover facing directly into said freezing compartment and subject to the low temperature therein when said front door occupies its closed position, so as to maintain in a frozen condition the ice cubes in said mold cavities in said ice tray when it is in said chamber, said front cover having a delivery hole therein, mechanism successively operative to index said ice tray when it is in said chamber to bring said mold cavities into successive registry with said delivery hole and then to eject successively the ice cubes from the successively registering mold cavities through said delivery hole, and means for successively operating said mechanism.

2. The combination set forth in claim 1, wherein said means is manually operable and is arranged so that it is accessible to the user only when said front door occupies its open position.

3. In combination, a refrgerator including walls defining a heat-insulated freezing compartment having a front opening, means for cooling said freezing compartment to a temperature below 32° F., and a front door including inner and outer walls disposed in spaced-apart relation and a layer of heat insulation therebetween, said front door cooperating with said freezing compartment front opening and movable between open and closed positions with respect thereto; an ice cube ejector carried by said front door and movable therewith and arranged in a cavity provided in said layer of heat insulation, said ejector comprising structure defining a chamber having a front opening through said inner wall of said front door and adapted to receive an ice tray, a front door cooperating

with said chamber front opening and movable between open and closed positions with respect thereto, so as to accommodate placement and removal of an ice tray with respect to said chamber, an ice tray having a plurality of ice cube mold cavities therein and adapted to be placed in said freezing compartment for the purpose of producing the ice cubes in said mold cavities and adapted to be placed in said chamber for the purpose of supplying the ice cubes from said mold cavities, said front cover facing directly into said freezing compartment and subject to the low temperature therein when said front door occupies its closed position, so as to maintain in a frozen condition the ice cubes in said mold cavities in said ice tray when it is in said chamber, said front cover having a delivery hole therein, mechanism successively operative to index said ice tray when it is in said chamber to bring said mold cavities into successive registry with said delivery hole and then to eject successively the ice cubes from the successively registering mold cavities through said delivery hole, an electric motor successively operative to effect successive operations of said mechanism, and a manually operable push button for effecting incident to each operation thereof one operation of said motor, whereby the ice cubes are delivered one by one to the user.

4. In combination, a refrigerator including walls defining a heat-insulated freezing compartment having a front opening, means for cooling said freezing compartment to a temperature below 32° F., and a front door including inner and outer walls disposed in spaced-apart relation and a layer of heat insulation therebetween, said front door cooperating with said freezing compartment front opening and movable between open and closed positions with respect thereto; an ice cube ejector carried by said front door and movable therewith and arranged in a cavity provided in said layer of heat insulation, said ejector comprising structure defining a chamber having a front opening through said inner wall of said front door and adapted to receive an ice tray, a front cover cooperating with said chamber front opening and movable between open and closed positions with respect thereto, so as to accommodate placement and removal of an ice tray with respect to said chamber, an ice tray having a plurality of ice cube mold cavities therein and adapted to be placed in said freezing compartment for the purpose of producing the ice cubes in said mold cavities and adapted to be placed in said chamber for the purpose of supplying the ice cubes from said mold cavities, said front cover facing directly into said freezing compartment and subject to the low temperature therein when said front door occupies its closed position, so as to maintain in a frozen condition the ice cubes in said mold cavities in said ice tray when it is in said chamber, said front cover having a delivery hole therein, said ice tray having deformable walls defining said mold cavities therein, first mechanism successively operative to index said ice tray when it is in said chamber to bring said mold cavities into successive registry with said delivery hole, second mechanism operative to deform the bottom wall of any one of said mold cavities registering with said delivery hole, so as to effect the ejection of the ice cube therefrom through said delivery hole, and means for successively operating said first mechanism and for repeatedly operating said second mechanism.

5. The combination set forth in claim 4, wherein the deformable walls of said ice tray are formed essentially of a molded plastic material.

6. The combination set forth in claim 4, wherein said second mechanism deforms the bottom wall of the one of said mold cavities registering with said delivery hole by striking the same a sharp blow.

7. An ice cube ejector comprising structure defining a chamber having a front opening and adapted to receive an ice tray, a front cover cooperating with said chamber front opening and movable between open and closed positions with respect thereto, so as to accommodate placement and removal of an ice tray with respect to said chamber, said front cover having a delivery hole therein, an ice tray having deformable walls defining first and second rows of ice cube mold cavities therein, said mold cavities in each of said rows being disposed in spaced-apart relation, first and second ejector pins both aligned with said delivery hole and respectively cooperating with said mold cavities in said first and second rows, means for indexing said ice tray step by step when it is in said chamber to bring said mold cavities into successive registry with said delivery hole and to bring said mold cavities into alternate cooperation with said ejector pins, said mold cavities in said first and second rows and said first and second ejector pins being arranged in staggered relation with respect to each other, so that in the odd steps of said ice tray said first ejector pin is disposed in alignment with corresponding ones of said mold cavities in said first row and said second ejector pin is disposed in alignment with corresponding spaces between said mold cavities in said second row and so that in the even steps of said ice tray said first ejector pin is disposed in alignment with corresponding spaces between said mold cavities in said first row and said second ejector pin is disposed in alignment with corresponding ones of said mold cavities in said second row, each of said ejector pins being operative from a retracted position into a projected position to effect deformation of the bottom wall of an aligned one of said cavity molds and the resulting ejection of the contained ice cube through said delivery hole, and means for operating substantially simultaneously said ejector pins.

8. The combination set forth in claim 7, wherein said ice tray is of substantially disk-like form and said first and second rows of mold cavities comprise respective inner and outer annular rows.

9. The combination set forth in claim 8, wherein the angle between the centerlines of adjacent ones of said cavity molds in each of said rows is substantially θ and the angle between the centerline of one of said cavity molds in one of said rows and the adjacent staggered one of said cavity molds in the other of said rows is substantially $\frac{1}{2}\theta$.

10. The combination set forth in claim 9, where θ is substantially 40°.

11. An ice cube ejector comprising structure defining a chamber having a front opening and adapted to receive an ice tray, a front cover cooperating with said chamber front opening and movable between open and closed positions with respect thereto, so as to accommodate placement and removal of an ice tray with respect to said chamber, said front cover having a delivery hole therein, an ice tray having deformable walls defining first and second rows of ice cube mold cavities therein, said mold cavities in each of said rows being disposed in spaced-apart relation, first and second ejector elements both aligned with said delivery hole and respectively cooperating with said mold cavities in said first and second rows, first mechanism operative to index said ice tray step by step when it is in said chamber to bring said mold cavities into successive registry with said delivery hole and to bring said mold cavities into alternate cooperation with said ejector elements, said mold cavities in said first and second rows and second first and second ejector elements being arranged in staggered relation with respect to each other, so that in the odd steps of said ice tray said first ejector element is disposed in alignment with corresponding ones of said mold cavities in said first row and said second ejector element is disposed in alignment with corresponding spaces between said mold cavities in said second row and so that in the even steps of said ice tray said first ejector element is disposed in alignment with corresponding spaces between said mold cavities in said first row and said second ejector element is disposed in alignment with corresponding ones of said mold cavities in said second row, each of said ejector elements being operative from a retracted position into a projected position to effect deformation of the bottom wall of an aligned one

of said cavity molds and the resulting ejection of the contained ice cube through said delivery hole, second mechanism operative to effect substantially simultaneous operation of said first and second ejector elements, and a device operative to effect sequential operation of said first and second mechanisms.

12. An ice cube ejector comprising structure defining a chamber having a front opening and adapted to receive an ice tray, a front cover cooperating with said chamber front opening and movable between open and closed positions with respect thereto, so as to accommodate placement and removal of an ice tray with respect to said chamber, said front cover having a delivery hole therein, an ice tray having deformable walls defining first and second rows of ice cube mold cavities therein, said mold cavities in each of said rows being disposed in spaced-apart relation, said mold cavities in said first row being staggered with respect to said mold cavities in said second row, first and second ejector elements both aligned with said delivery hole and respectively cooperating with said mold cavities in said first and second rows, means for indexing said ice tray step by step when it is in said chamber to bring said mold cavities into successive registry with said delivery hole and to bring said mold cavities into alternate cooperation with said ejector elements, so that in the odd steps of said ice tray said first ejector element is disposed in alignment with corresponding ones of said mold cavities in said first row and said second ejector element is disposed in alignment with corresponding spaces between said mold cavities in said second row and so that in the even steps of said ice tray said first ejector element is disposed in alignment with corresponding spaces between said mold cavities in said first row and said second ejector element is disposed in alignment with corresponding ones of said mold cavities in said second row, each of said ejector elements being operative from a retracted position into a projected position to effect deformation of the bottom wall of an aligned one of said cavity molds and the resulting ejection of the contained ice cube through said delivery hole, and means for operating substantially simultaneously said ejector elements.

13. An ice cube ejector comprising structure defining a chamber having a front opening and adapted to receive an ice tray, a front cover cooperating with said chamber front opening and movable between open and closed positions with respect thereto, so as to accommodate placement and removal of an ice tray with respect to said chamber, said front cover having a delivery hole therein, a support rotatably mounted in said chamber and adapted to carry an ice tray thereon for rotation therewith, indexing mechanism to rotate said support, a pair of ejector pins mounted adjacent said chamber and both alinged with said delivery hole, each of said pins being movable between a rest position and a work position to strike the bottom of a mold cavity in an ice tray carried by said support to eject an ice cube therefrom through said delivery hole, said pins being spaced apart and arranged so that they alternately engage the bottoms of mold cavities, a hammer plate mounted for movement between a rest position and a work position to engage said pins to move them from their rest positions into their work positions, latch mechanism to interconnect said indexing mechanism and said hammer plate to cause operation of said indexing mechanism during initial movement of said hammer plate to rotate said support, so as to position one of the mold cavities in an ice tray carried thereby into registry with said delivery hole and then to release said indexing mechanism from said hammer plate, said hammer plate thereafter striking said pins to cause ejection movements thereof, and means for successively moving said hammer plate between its rest and work positions.

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