This invention relates to ice makers and in particular to ice makers for use in refrigerators. In my copending application Serial No. 45,750, filed July 27, 1960, an improved ice body maker is disclosed, wherein a mold is selectively positioned in a generally horizontal freezing position and a generally vertical dumping position. The mold is arranged to utilize the forces of expansion of the ice body during the freezing thereof to free itself from the mold and permit delivery of the ice bodies from the mold by the simple expedient of positioning the mold in the vertical position. The present invention is concerned with such an ice body maker and comprehends a number of structural modifications thereof providing further additional desirable features.

Thus, a principal feature of the present invention is the provision of an improved ice body maker.

Another feature of the invention is the provision of such an ice body maker having an improved mold construction providing facilitated ice body removal.

A further feature of the invention is the provision of such a mold construction arranged to prevent undesirable ice connections between the individual ice bodies formed in the mold, thereby permitting each ice body to become free of the mold independently of the others.

A further feature of the invention is the provision of such an ice body maker having an improved readily removable mold construction.

Other features and advantages of the invention will be apparent from the following description thereof taken in conjunction with the accompanying drawings wherein:

FIGURE 1 is a fragmentary vertical section of a refrigerator provided with an ice body maker embodying the invention.

FIGURE 2 is a fragmentary horizontal section taken substantially along the line 2—2 of FIGURE 1.

FIGURE 3 is a transverse vertical section taken substantially along the line 3—3 of FIGURE 2.

FIGURE 4 is an enlarged longitudinal vertical section taken substantially along the line 4—4 of FIGURE 2.

FIGURE 5 is an enlarged longitudinal vertical section taken substantially along the line 5—5 of FIGURE 2.

FIGURE 6 is a transverse vertical section taken substantially along the line 6—6 of FIGURE 2.

FIGURE 7 is a transverse section generally similar to that of FIGURE 6 but illustrating the arrangement of the mold in an inclined reset position.

FIGURE 8 is a fragmentary vertical section taken substantially along the line 8—8 of FIGURE 2 and illustrating an improved mold connecting means.

FIGURE 9 is a transverse section taken substantially along the line 9—9 of FIGURE 8.

FIGURE 10 is a plan view of another form of mold embodying the invention.

FIGURE 11 is a transverse vertical section thereof taken substantially along the line 11—11 of FIGURE 10.

FIGURE 12 is a longitudinal vertical section thereof taken substantially along the line 12—12 of FIGURE 10.

FIGURE 13 is a fragmentary diametrical section of another form of mold embodying the invention.

FIGURE 14 is a fragmentary diametrical section of another form of mold embodying the invention.

FIGURE 15 is a fragmentary diametrical section of still another form of mold embodying the invention.

FIGURE 16 is a fragmentary diametrical section of yet another form of mold embodying the invention.

FIGURE 17 is a fragmentary diametrical section of the mold of FIGURE 15 illustrating the manner in which the ice body freezes therein.

In the exemplary embodiment of the invention as disclosed in FIGURES 1 through 9 of the drawings, an ice body maker generally designated 10 is shown installed in a refrigerator 11 having a front wall 12 and a rear wall 13 defining therebetween a space 14 refrigerated by means of cold air delivered thereto through a suitable inlet 15. Inlet 15 is arranged to direct the cold air downwardly onto a mold 16 in the space 14 to form ice bodies 17 in the mold. The mold is preferably formed of an insulating material, such as a plastic, and the cavities 18 thereof are arranged to permit freezing of the ice bodies downwardly therein. This functioning is brought out in more specific detail later in the specification.

A control generally designated 19, generally similar to the control of said application Serial No. 45,750, is provided rearwardly of wall 13 and includes a shaft 20 extending through the wall and having an inner end 21 carrying the mold 16 for selective positioning in a number of positions displaced angularly about the horizontal axis of the shaft. Illustratively, the mold is disposed by the control in a substantially horizontal freezing position, as shown in FIGURE 1, an inclined quick-change-over position, not shown, an inclined reset position, as shown in FIGURE 7, and a vertical dumping position, as shown in dotted lines in FIGURE 1. Control 19 is generally similar to the control disclosed in said copending application Serial No. 45,750 and reference may be had therefor for a full disclosure of the structure thereof.

The completion of the freezing of the ice bodies 17 is sensed by a suitable temperature sensing device 22 extending to adjacent one mold cavity 18a at the end 21 of shaft 20, causing control 19 automatically to turn the mold 16 from the horizontal freezing position of FIGURE 1 to the dumping position wherein the ice bodies fall from the mold into a suitable collecting bin 23 disposed in space 14 subjacent the mold. The control is arranged to cause the mold then to pivot in reverse direction to the quick change-over position, then back to the reset position of FIGURE 7, and subsequently to the horizontal freezing position of FIGURE 1.

Referring now more specifically to FIGURES 2 through 5 mold 16 comprises a thin walled member including a peripheral upper rim 25 from which depends a skirt 26. A transverse wall 27 extends inwardly from rim 25 below the upper edge thereof and is provided with a plurality of generally conical downwardly pointed portions 28 defining the mold cavities 18, herein seven such cavities are provided. As best seen in FIGURES 2 and 4, the cavities 18a, 18c, 18d and 18e of the right-hand row are interconnected by suitable channels 29, defined respectively by a weir 30 between cavities 18b and 18c, weir 31 between cavities 18c and 18d and weir 32 between cavities 18d and 18e. Weir 31 is slightly lower than weir 30 and weir 32 is slightly lower than weir 31. Thus, water may be delivered to cavity 18b from a suitable duct 33 associated with control 19 and, after cavity 18b is substantially filled, may flow through channel 29 over weir 30 into cavity 18c. Similarly, when cavity 18c is filled, water overflows therefrom through channel 29 defined by weir 31 into cavity 18d; and similarly when cavity 18d is filled, water flows therefrom over weir 32 into cavity 18e. The delivery of water from duct 33 is effected by control 19 with the mold in the inclined reset position of FIGURE 7. Thus, when cavity 18e is substantially filled, the water may then flow over a weir 34 into the forward cavity 18f of the left-hand row of cavities. The left-hand row of cavities comprising forward cavity 18f, mid-
dle cavity 18g and rear cavity 18a are connected by channels 35 defined by a weir 36 between cavities 18f and 18g and a weir 37 between cavities 18g and 18a. As best seen in FIGURE 5,Weirs 36 and 37 terminate upwardly in a plane. Thus, when cavity 18f becomes substantially filled, water flows therefrom over weir 36 into cavity 18g and when cavity 18g becomes substantially filled, water flows therefrom over weir 37 into cavity 18c. Control 19 includes a conventional slug water valve 38 which delivers an accurate quantity of water to the mold so that each of the cavities will thus be accurately filled.

Upon completion of the filling operation, control 19 effects a pivoting of the mold about the axis of the shaft 20 to the horizontal freezing position of FIGURE 6. In so pivoting the mold, the weirs 30, 31, 32 and 34 are raised relative to the level of water in each of the cavities 18b, 18c, 18d and 18e, thereby effectively separating the water in each cavity from the water in the other cavities and preventing the formation of ice connection in the channels 29 therebetween. Additionally, the water level in each cavity is lowered to below the weirs by virtue of the increased capacity thereof below the weirs when the mold is so pivoted. Thus, when the control 19 rotates the mold to the vertical dumping position the ice bodies freely fall from the cavities 18 into the bin 23.

Referring now more specifically to FIGURES 8 and 9, the mold 16 may be seen to be of a different cavity configuration such as mold 116 of FIGURE 18 having star-shaped cavities 118, the mold may be readily removed from the shaft end by simply urging it forwardly therefrom to clear the tip of the shaft end 21. As shown in FIGURE 8, shaft end 21 further tapers forwardly and is received in socket 42 in mold 16 for locking the mold to the shaft against rotation relative to the shaft. Clip 40 includes a downwardly projecting mid-portion 43 which engages the bottom wall surface of socket 42, and an upturned rear portion 44 received in a recess 45 extending from groove 41 toward the axis of the shaft wherein the clip is received to hold the mold 16 securely in place by friction and frictionally engages the socket wall surface to retain the mold readily releasable from the shaft end 21. However, when it is desired to remove mold 16, such as to gain freezer storage space, or for subsequent thereof by another mold having a different cavity configuration such as mold 116 of FIGURE 18 having star-shaped cavities 118, the mold may be readily removed from the shelf end by simply urging it forwardly therefrom to clear the tip of the shaft end 21.

The installation of the mold on the shaft end 21 is effected by a simple reverse operation wherein the mold is moved rearwardly out of the shaft end 21 to be received in socket 42 with spring clip 39 providing frictional retention of the mold against axial displacement.

Referring now to FIGURES 10-12 another form of mold generally designated 216 is shown to comprise a mold 216 of a suitable insulating material such as polyethylene plastic defining a plurality of cavities 218 separated by transverse walls 223. Transverse walls 229 effectively define weirs between the respective cavities for flow of water therefrom from one cavity to the next in a manner similar to that described relative to mold 16. The configuration of each cavity 218 provides improved self-leasing of the ice bodies from the mold walls defining the cavities. More specifically, the mold wall 228 defining each cavity 218 includes an upper frusto-conical, downwardly narrowing portion 258, a middle frusto-conical, downwardly narrowing portion 259 having an angle to the vertical axis of the cavity 218 greater than the angle of wall portion 258 thereto, and a lower frusto-conical, downwardly narrowing portion 260 having an angle to the axis of the cavity substantially greater than the angle of portion 259 thereto. The bottom of the cavity 218 is defined by the cavity 228 which is preferentially arcuate and is herein segmentally spherical. Illustratively, the height of wall portion 259 as measured parallel to the axis of the cavity may be approximately .37 inch and the height of the wall 260 may be approximately .46 inch where the overall height of the wall 228 is approximately 1.4 inches and the diameter of the cavity at the upper end of the wall is approximately 2.1 inches.

Tip portion 261 has a radius of approximately .25 inch. As shown in FIGURE 12, the wall portion 259 thickens downwardly whereas the thickness of wall portion 260 and tip portion 261 is substantially constant.

Thus, referring now to FIGURE 17, as the water in the cavity 218 freezes downwardly the ice body forms as a series of successively frozen layers. For example, the top portion of water freezes downwardly forming an incremental layer of ice whereupon the expansion forces caused by the freezing process cause a reactive hydraulic force within that body of water below this ice layer sufficient to force the ice layer upwardly and hence shear the adhering edge portion of the ice layer free from the mold wall. As all portions of the wall 228 widen upwardly, once the edge portion of the ice layer is sheared free, it is spaced from the wall preventing subsequent adhesion thereto. This seriatim incremental freezing and shearing continues downwardly until the entire body of water is frozen. It has been found, however, that the portion of the ice body 17 at wall tip portion 261 remains frozen thereto. However, as this ice portion is relatively small and the wall tip portion 261 is relatively rounded, the force imparted to the mold by the turning operation is normally sufficient to break the tip portion free from the mold for ejection with the remainder of the ice body.

Thus, the invention comprehends a mold cavity configuration which is relatively wide at the level thereof defining the upper surface of the ice body, as compared to the height of the cavity below this level. In the illustrated embodiment, this ratio is approximately 2 to 1. The desired ratio is partially determined by the insulating characteristics of the mold wall, as it is desirable to effect the freezing fully downwardly through the water before substantial amount of the water upwardly from the wall occurs. Thus, by providing a substantial ratio, the mold wall may be maintained relatively thin as the relatively shallow body of water may be frozen completely downwardly therethrough in a relatively short period of time.

As shown in FIGURE 13, the mold wall 328 may be provided which is thicker than the wall 228, thus further insulating the bottom portion of the water in the cavity and effectively precluding any upward freezing thereof. Such a wall configuration may be used to define a cavity 318 having a smaller width to depth ratio than that of cavity 218 while yet effective positive freeing of an ice body from the mold wall is assured.

Referring now to FIGURE 14, still another mold wall configuration 428 is shown wherein the wall portion 460 extends fully upwardly to the upper portion 458, the middle wall portion, such as middle wall portion 259 of wall 228, being omitted.

In FIGURE 15 still another form of wall configuration 528 is shown wherein the middle wall portion 559 is at an angle to the axis of the cavity 518 which is smaller than the angle of the wall portion 528 to the axis of cavity 218 but still sufficiently large to assure spacing of the ice layers from the wall as the subjacent layers are formed as discussed above.

As discussed above, the wall portions laterally of the ice body, in conformity with the invention, are inclined outwardly in an upward direction. In the above discussed embodiments, the walls are frusto-conical, thereby defin-
ing straight sectional configurations. It has been found that the upwardly widening walls function substantially similarly where they define slightly concave cross sectional configurations. Such a configuration is illustrated in FIGURE 16 wherein the lower wall portion 660 of the wall 625 is upwardly concave rather than frusto-conical.

As discussed above, the tip portion of the wall is preferably rounded. The radius of the tip portion is preferably small but sufficiently large to preclude the formation of a relatively pointed ice body tip which may remain lodged in the lower portion of the cavity. In the illustrated embodiment the tip portion has a radius of approximately one-quarter of an inch which assures relatively slow freezing of the water upwardly from the tip portion 261 of the mold wall and also assures that the tip will free itself from the mold wall with a small force such as provided in the mold tipping operation. Further, it is preferable that the lower portion of the cavity be relatively broad to preclude formation of a thick portion of ice by freezing upwardly from the tip of the wall. This is particularly desirable where, as in the present invention, the temperature of the water in the mold cavity is sensed by a device in the mold adjacent the lower portion of the cavity.

It will be observed in the drawings, notably FIGURES 2, 6, and 7. that the sensing device 22 is located adjacent the wall of cavity 18r and is laterally displaced from the vertical axis of the cavity. Because freezing occurs from top to bottom, it is desirable to sense the temperature at a point near the bottom of the cavity, although, as will now be discussed, the sensing point must be somewhat above the tip portion of the cavity. The sensing element has a certain amount of mass and hence is able to retain its cold condition for a period of time after the ice body has been removed from the cavity. Thus upon the addition of a new charge of water to the cavity, the cold mass of the sensing element draws heat from the water and causes freezing of water to occur in this area. If the sensing point were located at the tip portion of the cavity and in line with the vertical axis of the cavity, the amount of ice formed at the tip could in some instances be sufficient to prevent the incremental freezing described above from being totally effective and thereby interfere with the release of the resulting ice body from the mold cavity. However, by locating the sensing device 22 adjacent the side wall and laterally spaced from the tip portion of the cavity, the premature ice formed in the area of the sensing device will be sheared loose from the side wall of the cavity by the upward forces imparted to it by the freezing of that body of water which lies below the sensing point.

Thus, the invention comprehends an improved mold wall configuration wherein a width to depth ratio of the water holding portion of the mold is substantial, the mold wall is upwardly widening frusto-conical or concave, the lower tip portion is curved at a relatively small radius and the wall is formed of an insulating material. It has been found that such a mold wall provides improved, facilitated self-release of the ice body. The invention further comprehends providing such a mold wall which increases in thickness downwardly to provide greater insulation in the lower portion thereof and effectively preclude freezing of the ice body upwardly from the lower portion. Furthermore, the invention comprehends an arrangement of the sensing device relative to the cavity walls wherein malfunction caused by a failure of the ice body to release itself from the mold is effectively precluded.

Having described my invention as related to the embodiments shown in the accompanying drawings, it is my intention that the invention be not limited by any of the details of description, unless otherwise specified, but on the contrary, it is to be broadly construed in its spirit and scope as set out in the accompanying claims.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A mold for use in an ice body maker arranged for automatic freezing of the ice body from the mold upon completion of the freezing of an ice body therein, said mold comprising a wall of thermal insulating material defining a freezing cavity, said wall including an upper inwardly arcutely concave, downwardly narrowing annular portion, and a small central bottom arcutely concave tip portion having a radius of curvature substantially smaller than the radius of curvature of said upper portion.

2. A mold for use in an ice body maker arranged for automatic freezing of the ice body from the mold upon completion of the freezing of an ice body therein, said mold comprising a wall of thermal insulating material defining a freezing cavity, said wall including an upper frusto-conical, downwardly narrowing portion, an intermediate downwardly narrowing frusto-conical portion having a taper angle greater than that of said upper portion, and a small, central upwardly concave bottom tip portion, the ratio of the maximum width of said cavity to the height thereof being at least approximately 2 to 1.

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