

Oct. 2, 1962

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3,056,271

ICE MAKERS

Filed May 20, 1960

2 Sheets-Sheet 1

FIG. 1.

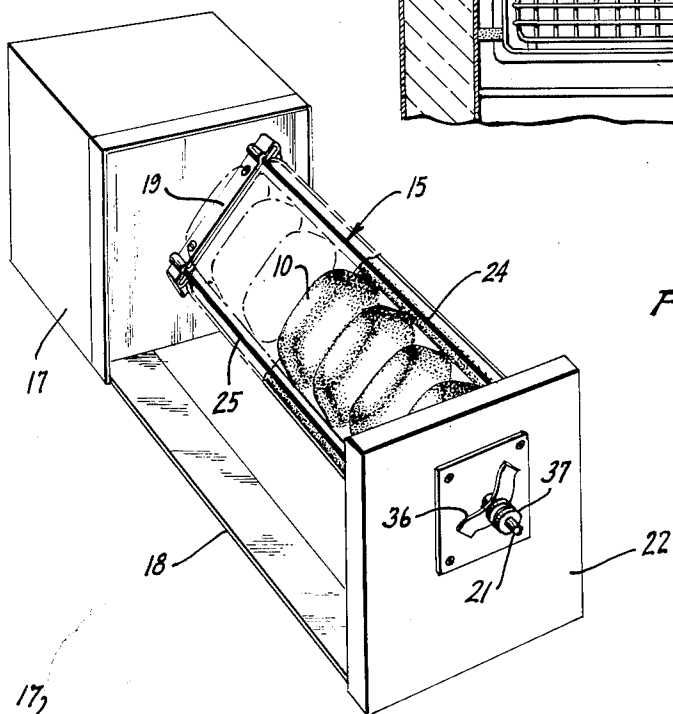
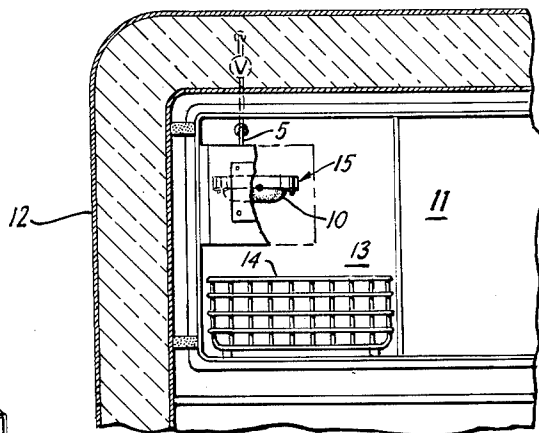


FIG. 2.

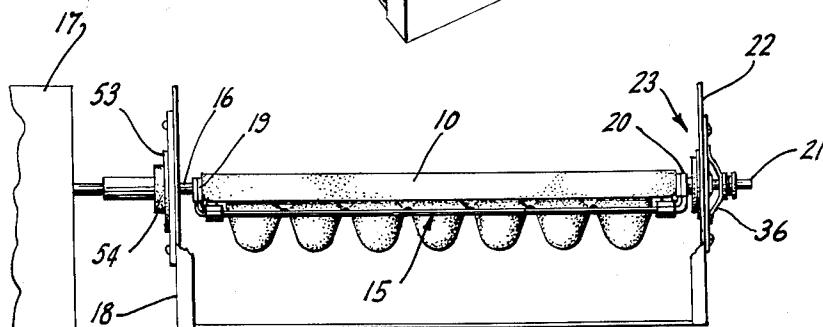


FIG. 3.

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2 Sheets-Sheet 2

FIG. 4.

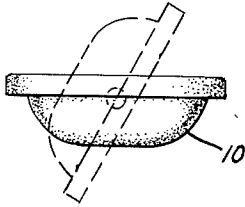


FIG. 5.

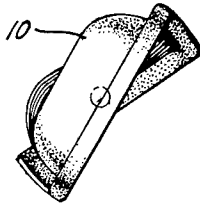


FIG. 6.

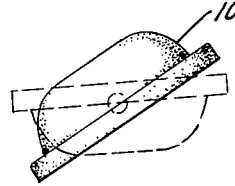


FIG. 7.

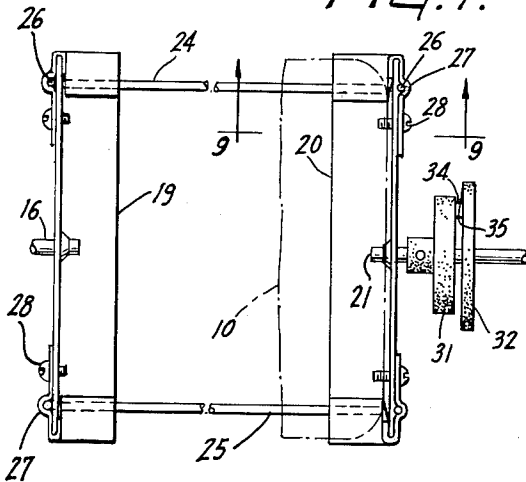


FIG. 8.

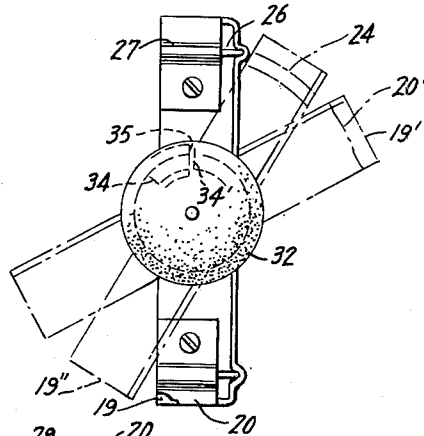


FIG. 10.

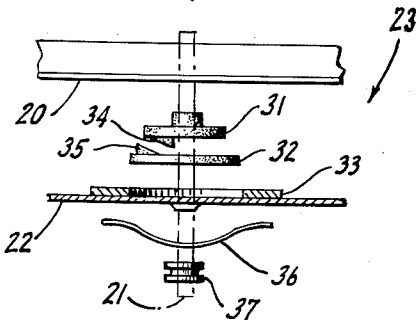


FIG. 9.

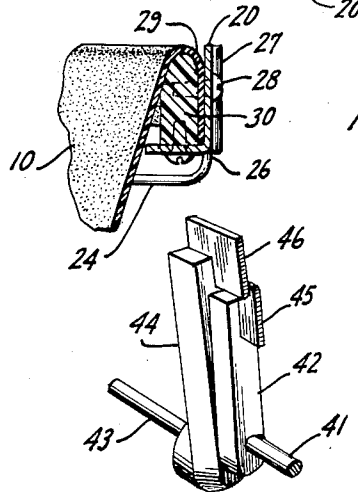


FIG. 11.

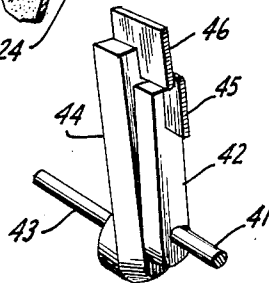
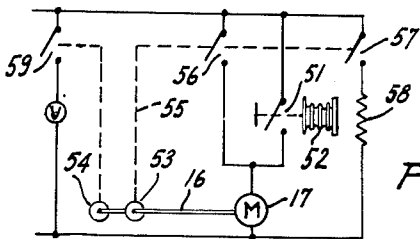


FIG. 12.



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1

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ICE MAKERS

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2 Claims. (Cl. 62—353)

This invention relates to ice making apparatus, in particular for domestic use. The invention is more specifically concerned with an ice maker wherein the so-called ice cubes are formed in flexible molds, being harvested by overturning such molds and by then flexing or twisting them.

A difficult problem has been encountered in connection with such flexing of flexible ice molds. It appears that pursuant to repeated twisting and untwisting operations, particularly when such operations are performed at very low temperatures, a flexible mold of suitable material is not entirely restored to its original and desired shape but that it gradually takes a permanent set in more or less twisted form, thereby interfering with subsequent filling operations, among other things. Such permanent deformation of a tray was not a matter of very serious concern so long as the trays were loosely stored in a refrigerator for manual use by the householder. It was then easy and not very expensive to replace a tray when it was either worn out or permanently deformed. The problem however became more bothersome as soon as attempts were made to provide automatic operation of flexible ice trays, as is desired for the purpose of minimizing the number of trays employed and for also minimizing the manual operations required, while providing for the production of substantial amounts of ice. Replacement of trays became much more difficult, in connection with automatic manipulators, while the difficulties of permanent deformation were by no means alleviated.

It is a primary object of this invention to overcome these problems and to provide apparatus which safely and effectively restores a suitable, twistable ice tray to its original shape after each twisting operation. A particular object is so to provide in connection with automatic ice making equipment.

One of the indicated problems of former automatic ice makers was that replacement of trays was almost as difficult as was the preservation of their proper undistorted shape; yet it was often desired for a variety of reasons to replace a tray in such a machine. Still other problems both technical and economical were connected with automatic mechanisms for the automatic filling, turning, twisting and other manipulation of a tray, as will best be explained hereinafter. In these connections it is a further object of the invention to provide an ice tray device of flexible type wherein the tray can readily be exchanged; and another object is to provide a tray operating mechanism of great simplicity and ruggedness and which requires only a minimum of electrical wiring, switching and control components. Still further objects and features of the invention will appear from consideration of the disclosure which follows.

The objects have been achieved by means of a new combination comprising a flexible non-resilient or low resiliency tray; a frame including resilient frame means secured to said tray; and a simple preferably mono-directional motor system for manipulating the frame and thereby the tray.

The construction of an ice maker system according to the invention will now be described.

In the drawing FIGURE 1 is a fragmentary front view of a refrigerator embodying a preferred embodiment of the invention and wherein the ice tray is shown in a nor-

2

mal operative position thereof. FIGURE 2 is a perspective view of the ice tray and its manipulating apparatus, wherein the ice tray is shown in a different operative position. FIGURE 3 is a side elevation of the apparatus of FIGURE 2, with the ice tray returned to the position of FIGURE 1.

FIGURES 4, 5 and 6 are front end views of the ice tray alone, in several of the operative positions thereof. FIGURE 7 is a plan view of the frame for the ice tray; FIGURE 8 is an end view thereof; and FIGURE 9 is a fragmentary sectional view, taken along line 9—9 in FIGURE 7. FIGURE 10 is an exploded plan view of a stop and release element, forming part of the apparatus, while FIGURE 11 perspective shows a modification thereof. FIGURE 12 is a schematic representation of electrical circuits used in the operation of the preferred, new mechanism.

Reference will initially be made to FIGURE 1, wherein ice tray 10 is shown as installed in the evaporator or freezer compartment 11 of a refrigerator 12, which for this purpose has an ice cube freezing chamber 13. Tray 10 is movably disposed in the upper portion of this ice cube freezing chamber, above a basket or other receptacle 14 which occupies the lower section of the chamber and serves to receive and store ice cubes which have been frozen in and then discharged from the tray.

Heretofore, designers of tray-type ice makers have often attempted to provide resilience in the flexible tray itself, yet they have achieved little success along that line of endeavor. This was so although the art of plastic compounds, potentially available for trays and the like, provided a great variety of materials having various combinations of flexibility and resilience. The truly resilient plastic materials were found by no means to be advantageous with regard to sustained resistance to subfreezing temperatures, sustained ability to release ice cubes by mechanical twisting and breaking out, and the like.

Attempts have therefore been made in the past to overcome the indicated problems in other ways. In particular apparatus has been developed which restores the tray to its original form by a succession of preflexing and reverse twisting operations. This however called for relatively complex and expensive motor equipment, whereas it is desired, as indicated above, to simplify such equipment.

It has occurred to me that instead of all these complications, a simple frame structure can be used which comprises resilient metal side members or the like and which is adapted to hold the tray for instance by rigid end members of the frame structure, secured to ends of the trays. Such a frame structure is able not only to restore the form of the tray after each flexing and ice cube harvesting operation; it also facilitates exchange of trays whenever such is still desired for any reason. Moreover the use of such frame structure has been found to simplify the entire ice maker system and thereby to make it more eligible, particularly for domestic use.

The new tray itself is accordingly made of a material, such as so-called "linear polyethylene," which merely has appreciable flexibility, mainly at temperatures below the freezing point of water, and which retains said flexibility for an appreciable time. The material is also able to release ice cubes properly; that is, the cubes frozen in and bonded to the tray are broken off from the surfaces of the tray, on application of a twisting effect, and incident to such breaking off, the surfaces of the ice cubes as well as those of the tray are kept substantially smooth and unimpaired.

While having these and other advantageous properties, the available plastic materials have little resilience. The tray can be flexed, in different ways and directions, but it does not automatically spring back to its original

form, at least not to the exact original form. Its failure to do so is probably due, in part, to the fact that the different operations are performed under different mechanical and thermal conditions, the ice cubes being in the tray during the twisting but being absent when the tray is untwisted. Nevertheless it is necessary to restore the tray to a precisely predetermined, original form, in order that filling and freezing may be repeated properly and safely.

The invention provides a metal frame structure 15 permanently gripping the tray as is best shown in FIGURE 2. This frame structure performs a number of functions, and it is one of the important functions thereof to provide resilience, for reasons which have generally been indicated, the exact mode of resilient motion being described hereinafter. It is a further function of the frame to support the tray and to facilitate exchange thereof, and it is still another function and advantage of the new tray and frame unit that it allows performance of a complete, satisfactory cycle of tray manipulating operations by an extremely simple motor and control system. In these respects, too, the details will now be described.

In the side view of FIGURE 3 and also in the full line showing of a front end view, given in FIGURE 4, the tray is shown in its normal or ice cube freezing position. Additionally shown in FIGURE 4, in broken lines, is a partly overturned position of the tray which is established before initiating the breaking loose of the ice cubes. It will be noted that clockwise rotation of the tray, as seen in FIGURE 4, establishes this broken line position, the indicated extent of such clockwise rotation from the full-line position to the broken-line position being approximately 120 degrees in the illustrated embodiment.

Such rotation is effected by means of a motor shaft 16, FIGURE 3, said shaft supporting one end of the tray frame 15. The shaft is driven by motor 17, is journaled in a support structure 18, and is secured to said one end (the motor end) of tray 10 by a rigid, structural element or bar 19 of frame 15. A similar element or bar 20, forming part of frame 15, secures the opposite end (the control end) of tray 10 to an idler shaft 21, aligned with drive shaft 16 and pivoted in a suitable portion 22 of support structure 18.

For the purpose of harvesting ice cubes motor 17 moves the motor end of the tray beyond the position shown in FIGURE 4, while idler shaft 21 on the control end of the tray is prevented from further similar rotation by means of a control mechanism 23, generally indicated in FIGURE 3 and which is more completely shown in FIGURE 10. As a result, the flexible tray is now flexed or twisted into the form illustrated in FIGURE 5, thereby breaking the formerly established bond between the ice cubes and the walls of the tray and thus preparing for the discharge of the ice cubes, or in some cases actually effecting such discharge.

The resilient frame 15, having end structures 19, 20 secured to the ends of the tray, is distorted with the tray into a position corresponding to that of FIGURE 5 and which is best shown in FIGURE 8. For this purpose the frame comprises a pair of torsion bars or rods 24, 25 (FIGURES 2, 7 and 8), interconnecting the rigid end structures 19, 20, these torsion bars being made of resilient material, such as spring-tempered steel. These resilient bars 24, 25 are secured to the rigid end structures 19, 20 for instance by hooks 26 forming integral end portions of the bars, said hooks being secured to the end structures by suitable holders 27. The end structures 19, 20 in turn are secured to the ends of the trays, as best shown in FIGURE 9, by fasteners 28, clamping a lip 29 of the tray between said end structures and underlying blocks 30.

The resilient force, stored in torsion bars 24, 25 in the position of FIGURE 8, is utilized with the aid of the aforementioned control mechanism 23 (FIGURE 3).

This mechanism is of a type adapted first to apply a stop or control action to the adjacent tray end structure and then to override or release this action. Exact details will be described hereinafter; at this point it suffices to say that rotation continues to be imparted to the motor end of the tray, which rotation is clockwise in the views of FIGURES 5 and 6, while a stop or control action is applied to the control end of the tray. In due course a stop or control overriding action or release of resilient force is automatically brought about by this continued rotation of the motor end. It is in the nature of a snap action. In other words, the stopped or retarded control end of the tray, which is visible at the front, in FIGURE 5, is suddenly released, whereupon it snaps into alignment with the rear end or motor end of the tray, also shown in FIGURE 5.

By this sudden release, the frame together with the tray snaps from the position or shape of FIGURES 5 and 8 into that indicated by full lines in FIGURE 6. This snap action returns the frame and, importantly, the flexible tray to the normal undistorted shape thereof.

The snap action of the tray also promotes and completes the release of ice cubes, by the vibration which it imparts to the tray.

The harvesting of the ice cubes in basket 14 (FIGURE 1) is further promoted by so arranging the operation of motor 17 and release mechanism 23 (FIGURE 3) as to effect the snap action when at least the leading portion or motor end of the tray has been rotated into a position which has a definite, downward component. However, the exact positions of the tray and of the elements thereof, illustrated in FIGURES 5 and 6, are of course shown only for purposes of illustration.

The illustrated mechanism is arranged so that the unidirectional rotation of the motor end, clockwise in FIGURE 6, continues during and after the snap action of the control end. When the tray has almost completed a cycle of 360 degrees but when it is still in slightly inclined position (broken lines in FIGURE 6), the refilling of the tray is preferably effected, by means of a spout S, FIGURE 1, which is controlled by a solenoid valve V, FIGURE 12. The normal freezing position is then reached again (full lines in FIGURE 4) and the operating cycle is terminated and restarted, as will be described hereinafter. It is one of the advantages of the invention that a single, complete cycle of unidirectional tray rotation thus provides for all of the required filling, freezing, breaking-out and cube-discharging operations.

The mechanism 23 for effecting the above-mentioned snap action of the tray (FIGURE 3) is more completely shown in the exploded view of FIGURE 10, which will best be considered together with FIGURE 8. In the latter figure the numerals 19', 20' indicate the normal position of the structure (which is here shown in turned position for greater convenience in showing other positions in this figure and in FIGURE 7). Numerals 19, 20 in FIGURE 8 indicate the form and position of the unit at the time when twisting starts and numerals 19'', 20 indicate the form and position of the twisted unit.

Idler shaft 21 is rigidly secured to control end structure 20 of the tray and also to a cam 31. An associated cam 32 is rigidly secured to the stationary pivot structure 22, for instance by welding it to a ring 33 which in turn is welded to said pivot structure. The two cams have, respectively, teeth 34, 35 thereon, said teeth having gradually inclined surfaces, one of which encounters the other in the normal rotation of the idler shaft 21.

FIGURE 8 shows the relative positions of teeth 34, 35 in the position 19, 20 of the structure wherein, pursuant to the rotation of cam 31, clockwise as seen from the front, tooth 34 is just about to encounter the stationary tooth 35. FIGURE 10 shows this position as seen at right angles to the front but shows it, as mentioned, in exploded form. Actually, either an end point

5

or an inclined surface of each tooth is always in contact with part of the other cam. When teeth 34, 35 have reached the position shown under these numbers in FIGURE 8 and when accordingly the inclined surfaces of the two teeth are in engagement, tooth 34 is thereby retarded, thus retarding cam 31, idler shaft 21, and control end frame structure 20. While not entirely prevented from further rotation, these parts are now prevented from continuing such rotation as the motor unit continues to apply to the motor end structure 19.

These conditions cause not only resilient distortion of torsion bars 24, 25, as described above, but also increased pressure between the inclined surfaces of teeth 34, 35, thereby tending to shift cam 31 toward the rear and cam 32 toward the front, as will be clear from consideration of FIGURES 8 and 10. Shifting of cam 32 is resisted by adequate rigidity of end structure 22, whereas cam 31, together with shaft 21, is allowed to move a slight amount rearwardly, through the bearing structure 22, against resilient resistance of a further spring element 36. This element is shown as a leaf spring (also see FIGURE 2) and is engaged by a collar 37 secured to the outer end portion of idler shaft 21.

This leaf spring and collar mechanism (FIGURE 10) normally holds cam 31 closely adjacent the stationary cam 32; but due to the rearward motion of shaft 21 and structures thereon, which has just been mentioned and which is allowed by provision of suitable axial play in the shaft structures, the two cams 31, 32 are slightly separated incident to the twisting of the tray. At the same time angular motion of tooth 34 is retarded, but not entirely stopped, and the inclined surface of this tooth slides gradually over that of the stationary tooth 35. This action continues during the twisting of the tray, until one tooth overrides the other (see 34' in FIGURE 8), at which time the inclined surfaces of the two teeth lose their engagement. When this occurs the retardation of angular motion of tooth 34 is thereby removed, the aforementioned snap action of the frame structure and of the tray takes place, and leaf spring 36 returns cam 31 to its normal position in close adjacency to cam 32.

The mechanism disclosed herein can be modified in many respects. For instance, a fragment of a modified control and release structure is shown in FIGURE 11. This modified structure is desirably installed at the motor end of a tray structure which may be similar to that of FIGURES 1 to 9. It comprises a motor output shaft 41 whereto a radial finger 42 is rigidly secured. A torsionally resilient shaft structure 43 is held in approximate alignment with shaft 41, by bearing structure not shown. This further shaft structure 43 has a radial finger 44 secured to one end thereof, while an end of the tray is secured to the other end of this shaft structure 43. The two fingers have, respectively, finger tip or tooth members 45, 46 secured thereto, said members being arranged so that on rotation of motor shaft 41 and finger 42, the first tooth member 45 normally is in engagement with the second tooth member 46, thereby causing rotation of finger 44 and torsion shaft 43. The opposite end of the tray is again retarded or stopped, at some suitable point of the rotation thereof, while the end of the tray secured to torsion shaft 43 continues to rotate. Thus it is again possible to twist the tray. When a certain degree of twisting has thus been applied, the tooth members of the finger mechanism lose contact, one with the other, as the shaft carrying one of the fingers is slightly eccentric to that carrying the other. As a result, the end of the tray connected to torsion shaft 43 snaps backwardly from its forwardly twisted position.

Although operating characteristics of the new ice maker have been described hereinabove, it may be well to review a complete operating cycle as follows.

It will be assumed that tray 10, initially and while in the position of FIGURE 1, is full of water, which is

6

being frozen into ice cubes due to the refrigerating effect of evaporator 11. During this freezing process the water is at freezing temperature but when the freezing has been completed, further heat is removed from the ice blocks and tray, it being assumed that the evaporator maintains a sub-freezing temperature in compartment 13. A switch 51 (FIGURE 12) is controlled by a thermostat bellows 52 which is in suitable contact with the tray and which contracts when the freezing of ice cubes has been completed and their temperature drops below the freezing point. The contracting bellows closes the switch, thereby starting motor 17. Motor shaft 16 then begins to rotate the motor end of the tray, as described above.

This shaft also has a pair of cams 53, 54 secured thereto. Shortly after its start of rotation, cam 53 by follower mechanism 55 closes a switch 56, which from then on keeps motor 17 energized. The same follower also closes a switch 57, thereby energizing a small heater 58 which now returns thermostat bulb 52 to the normal expanded position thereof, reopening the starting switch 51 and thus preparing the same for a future cycle of operations.

The continuing rotation of motor 17 causes twisting of the tray, snap-acting release, and further rotation, as described above. In due course the rotating tray approaches the normal horizontal orientation of FIGURE 1. The second cam 54 of FIGURE 12 then operates by a suitable follower to close a switch 59, thereby energizing the solenoid of the aforementioned fill valve V and refilling the tray. Finally, at or a few seconds before completion of 360 degrees rotation, cam 54 opens switch 59, thereby closing the filling valve, and the rotation of the tray then comes to an end when switch 56 is opened, with the tray returned to its normal, horizontal orientation.

Thus the tray has again been filled with water, as initially assumed. The evaporator again causes freezing of such water, and the thermostat is again ready to determine the moment when the formation of ice cubes has been completed and when accordingly a new cycle of turning, twisting, resilient untwisting and returning operations can be started. Such cycles can be repeated without interruption, although it may be preferred in some instances to interrupt them, for instance by means of well known sensing equipment (not shown) which determines whether ice cube storage basket 14 (FIGURE 1) is full.

During each cycle, the tray support or frame structure is twisted and then allowed resiliently to untwist, restoring itself and thereby the tray to the original form (see the full lines in FIGURES 6 and 8). It has been found that by virtue of this action, the tray is most effectively protected from such dangers as the gradual taking of a permanent set. At the same time, control equipment of utmost simplicity (FIGURE 12) is able, as shown, to operate the ice maker structure. Also, whenever it is necessary or desired to install a new tray, this can readily be done by loosening and subsequently reapplying fasteners 28 (FIGURE 9).

While only a single complete embodiment of the invention has been described, it should be understood that the details thereof are not to be construed as limitative of the invention, except insofar as in consistent with the scope of the following claims.

I claim:

1. An ice maker of the type wherein a flexible ice tray is flexed and unflexed by turning portions of the tray about an axis passing through first and second end members on the ends of the tray, the tray also having a pair of resilient sides interconnecting said end members, said ice maker comprising:

(1) motor means for effecting intermittently successive complete turning motions of the first end member in a single direction;

7

- (2) guide means for normally guiding the second end member in corresponding rotary motions applied thereto by said resilient sides; and
- (3) interengageable movable and stationary elements for temporarily delaying said rotary motion of the second end member during a certain portion of the turning motion of the first end member and for thus flexing the resilient sides and storing energy therein, the movable element being carried by the second end member and the interengageable elements being adapted pursuant to said flexing to terminate said delaying in such a way as to release said stored energy and to effect accelerated rotary motion of the second end member in said single direction, and thus to effect said unflexing of the tray by vibratory snap-acting motion.

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2. An ice maker as described in claim 1 wherein said interengageable movable and stationary elements (3) comprise: a first cam secured to said second end member to provide said movable element and a second cam rigidly mounted opposite said first cam to provide said stationary element, said two cams being interengageable by associated, variously projecting portions thereof.

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