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Bright

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[54] **HARVESTING MECHANISM FOR AUTOMATIC ICE MAKER**

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[73] Assignee: **General Motors Corporation,** Detroit, Mich.

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[52] **U.S. Cl.** **62/135,** 62/353
[51] **Int. Cl.** **F25c 1/10**
[58] **Field of Search** 62/135, 353

[56] **References Cited**

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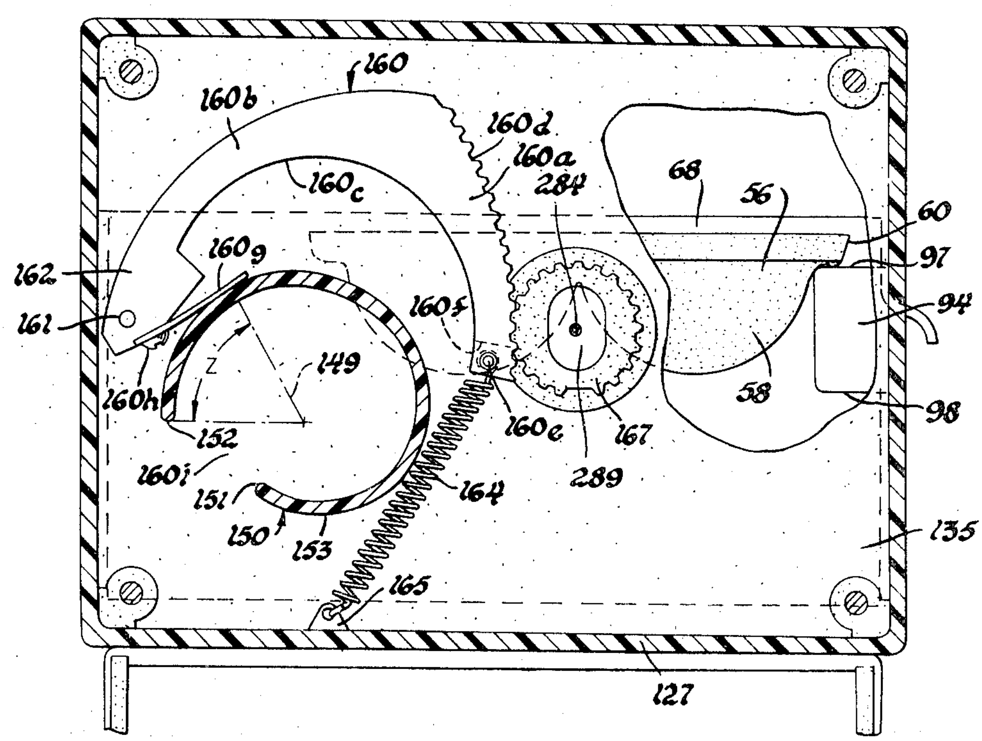
Primary Examiner—William E. Wayner
Attorney—William S. Pettigrew, Edward P. Barthel et al.

[57] **ABSTRACT**

The automatic ice maker mold is rotated in a first rotational direction from an inverted to an upright position by a motor driven cam gear having a spiral cam thereon engaging the resiliently flexible cam follower leaf member portion of a pivoted spring biased sector gear whereby the leaf member acts in resilient opposition to the rotation of the cam gear to rotate the mold from an inverted to an upright position and thereafter retaining the mold during water filling and freezing cycles. The ice harvesting cycle commences by reenergization of the motor to continue the rotation of the cam gear until the flexible leaf member drops-off the high portion of the spiral cam releasing the spring biased sector gear to transmit a driving force to the mold in a second rotational direction causing a sudden inverting and impacting of the mold against stop means to dislodge the ice pieces therefrom into an ice collection bin.

3 Claims, 6 Drawing Figures



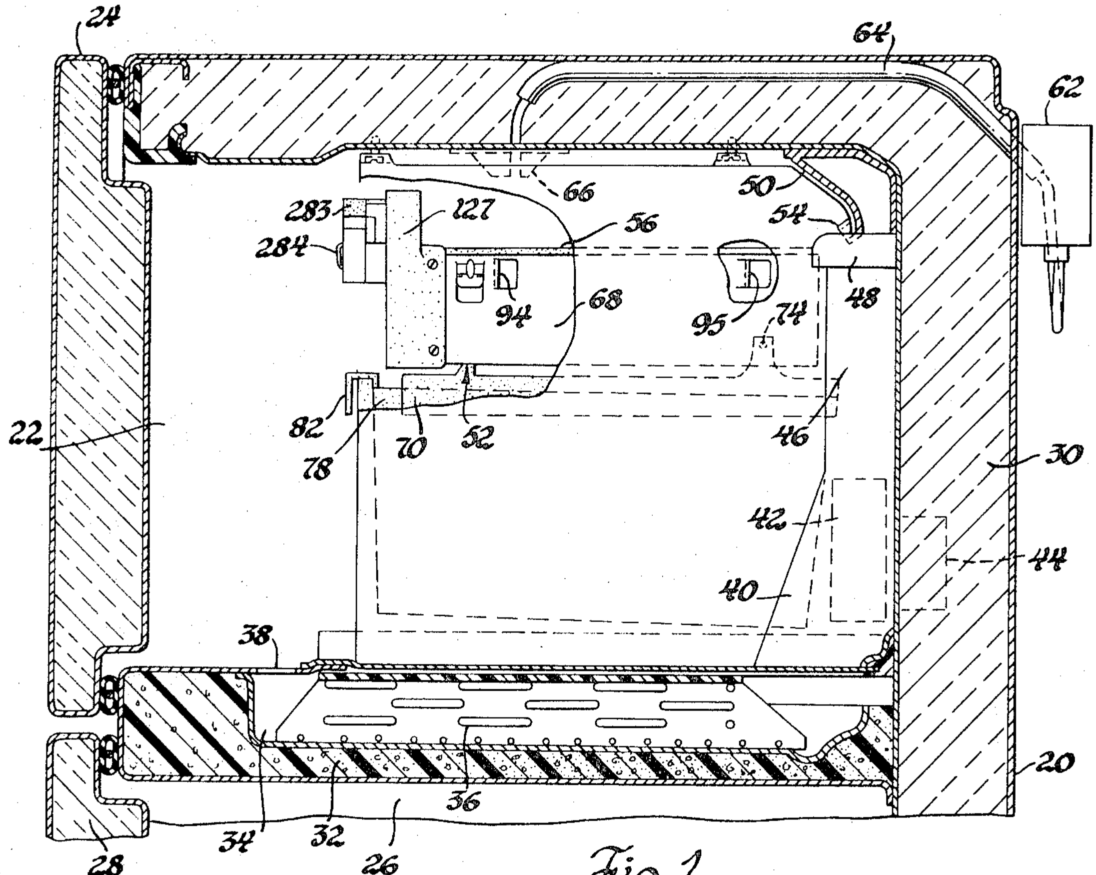

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Fig.1

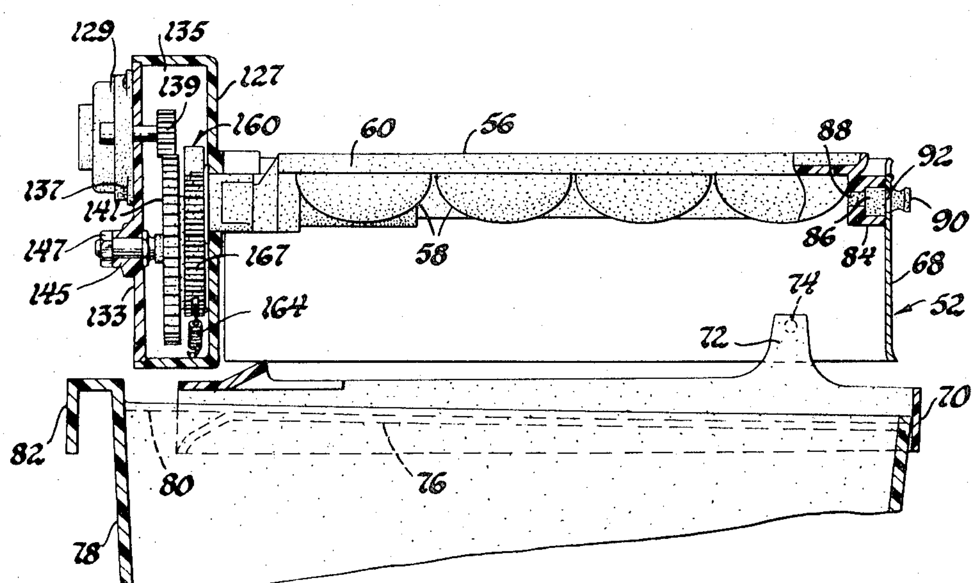
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Fig.2

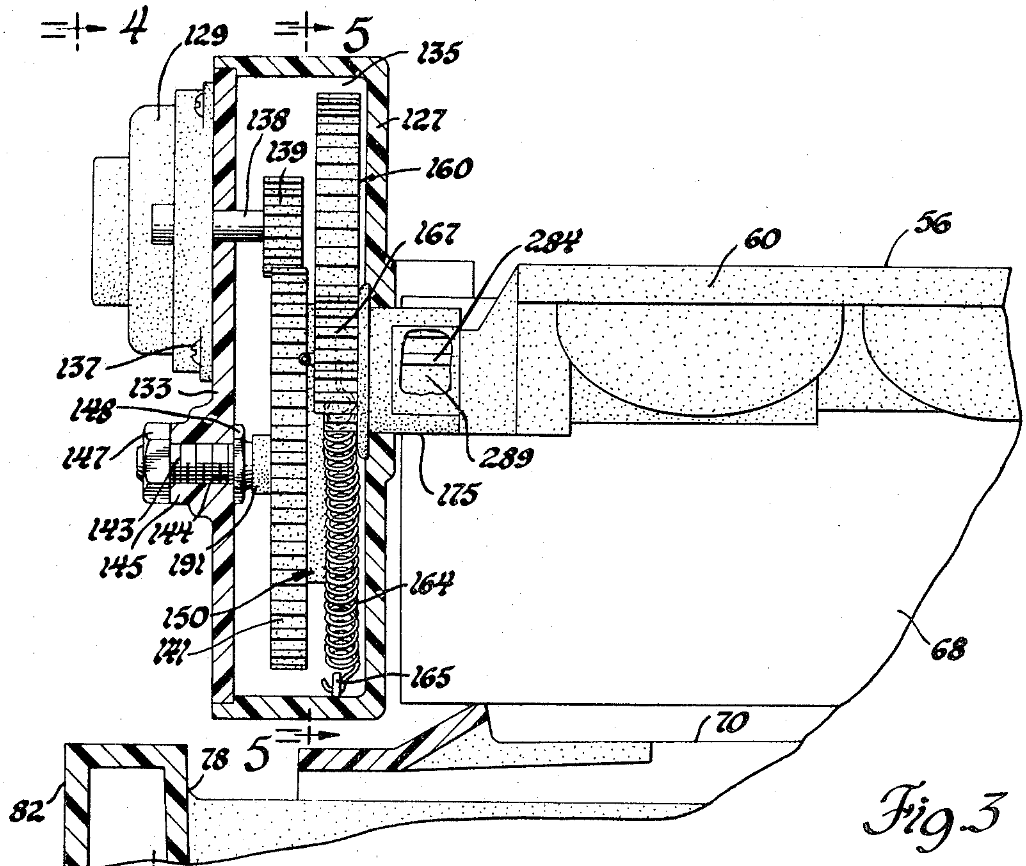
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Fig. 3

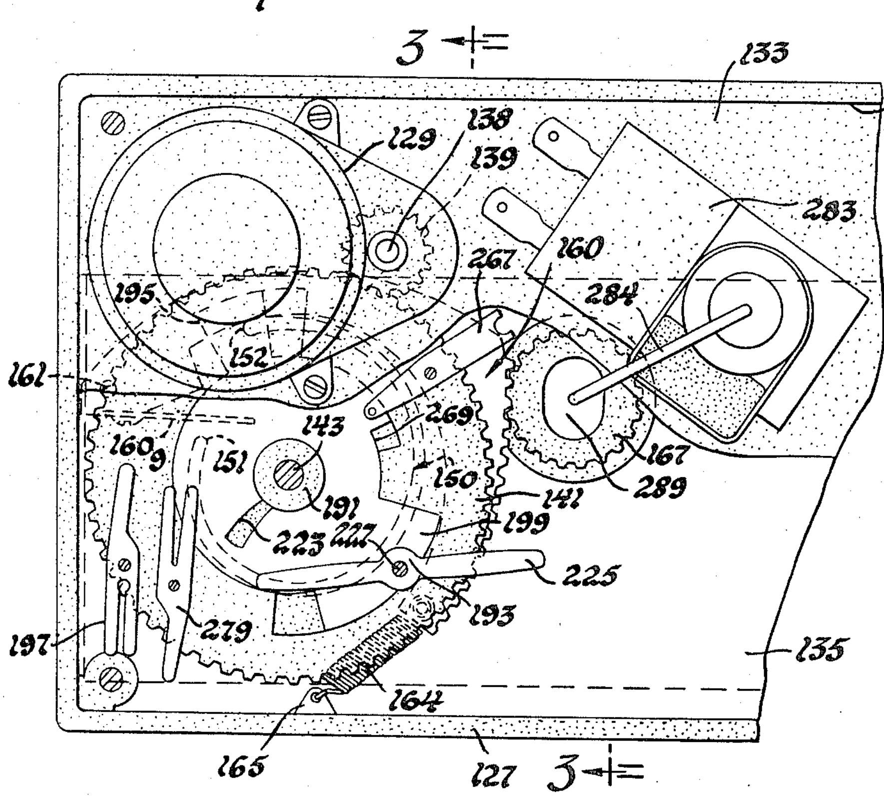
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Fig. 4

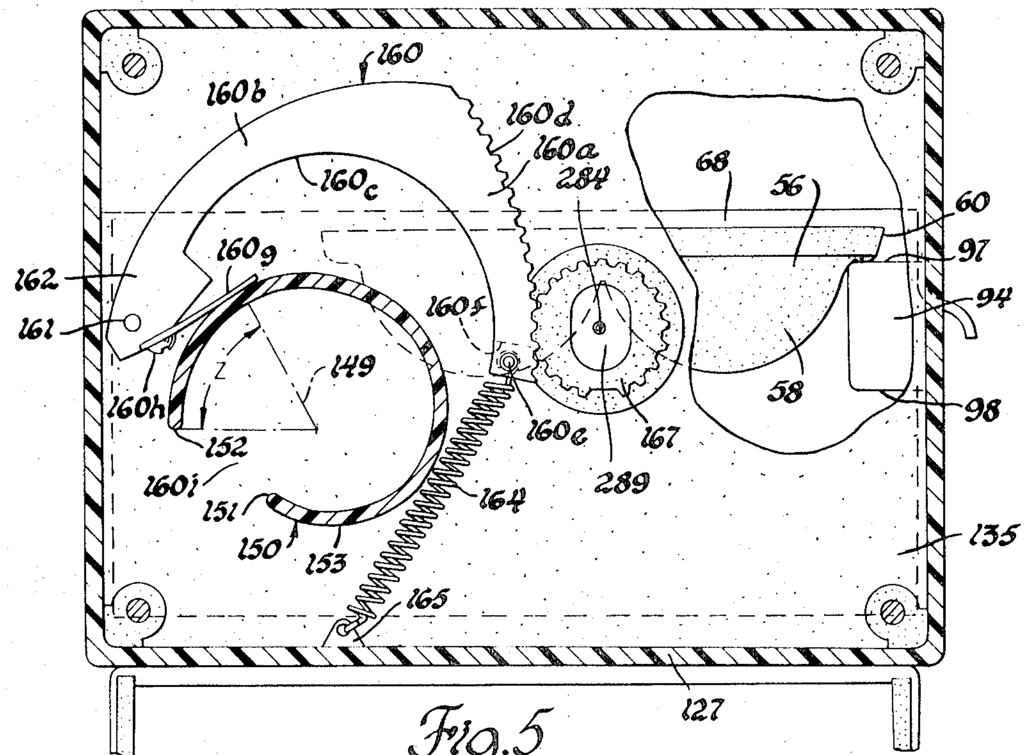
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Fig.5

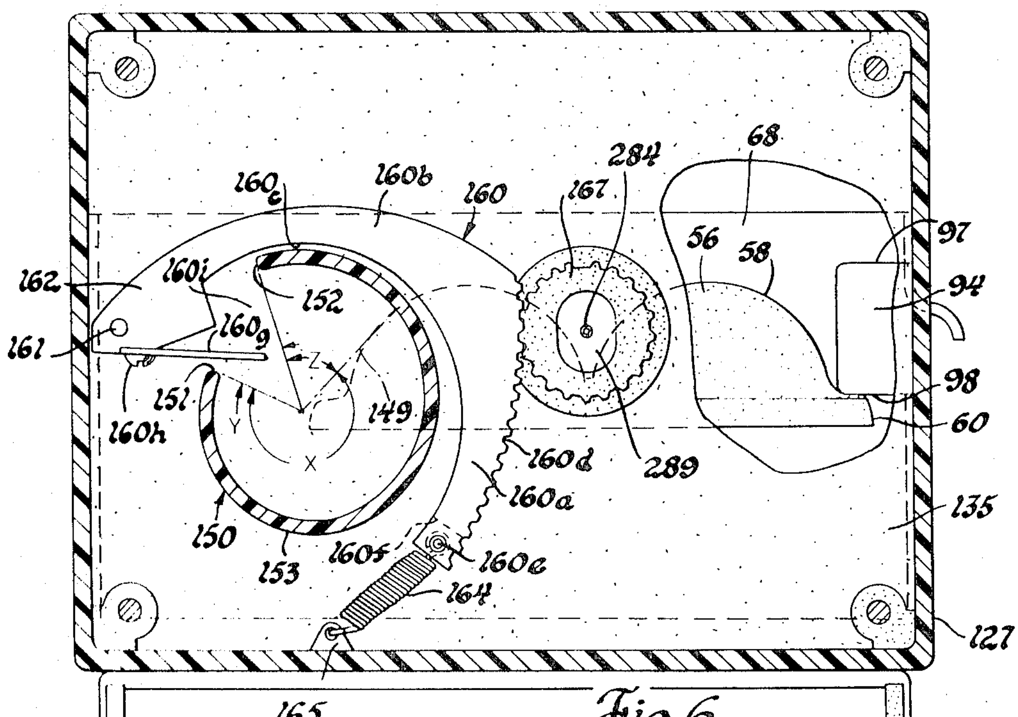
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Fig.6

HARVESTING MECHANISM FOR AUTOMATIC ICE MAKER

This invention relates to an automatic ice maker and more particularly to an apparatus for automatically harvesting ice masses for use in a household refrigerator.

Prior art icemakers exemplified by the automatic freezer described in U.S. Pat. No. 3,540,227 issued Nov. 17, 1970 to Eyman Jr., et al. and assigned to the same assignee as the instant application discloses a mechanism for automatically filling, freezing and harvesting ice pieces. The harvesting cycle includes an initial twisting of the flexible mold to dislodge the ice pieces. To further insure the complete ejection of all the frozen liquid from the mold a second twisting is imparted to the mold whereupon the mold is suddenly released under the resilient force provided by the twist to accelerate the tray into engagement with a stop. This imparts a jar and the resulting vibration forces eject any remaining frozen liquid from the mold. While the patented automatic ice maker has proved successful the object of the present invention is to provide an improved ejection system wherein the harvesting of ice pieces is accomplished by a sudden 180° rotation of the mold and impacting the mold against a stop such that the impact alone provides a more effective and reliable dislodgement of the ice pieces.

An object of the present invention is to provide an automatic ice maker mechanism for harvesting the ice pieces from a mold wherein the mold is rotated substantially 180° from an inverted position to an upright position for successive water fill and freeze cycles by means of motive means rotating a gear having a spiral cam on one face thereof in a first direction such that a sector gear resiliently biased in a second direction has a resiliently flexible cam follower leaf member engaged by the spiral cam which acts in resilient opposition to the rotation of the spiral cam thereby rotating the mold in the first direction from an inverted to an upright position and retaining the same during its fill and freezing cycle, whereupon re-energization of the motor initiates a harvest cycle by causing further rotation of the cam gear until the flexible leaf member drops-off the high portion of the spiral cam releasing the sector gear resulting in a sudden rotation of the mold in the second direction impacting the mold against stop means to dislodge the ice pieces therefrom solely by jarring the mold as a result of the impact.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings, wherein a preferred embodiment of the present invention is clearly shown.

In the drawings:

FIG. 1 is an irregular vertical sectional view through a refrigerator embodying an air cooled automatic freezer illustrating one form of the invention.

FIG. 2 is a vertical sectional view through the automatic freezer shown in FIG. 1.

FIG. 3 is an enlarged vertical sectional view taken along the lines 3—3 of FIG. 4 showing the drive and control mechanism.

FIG. 4 is a sectional view taken along the lines 4—4 of FIG. 3.

FIG. 5 is an irregular horizontal sectional view taken along the lines 5—5 of FIG. 3 showing the mold in its upright position during its fill and freezing cycles.

FIG. 6 is a view similar to FIG. 5 showing the mold in its inverted harvesting position.

Referring now to the drawings and more particularly to FIG. 1, there is shown the upper portion of a frost-free household refrigerator **20** with an upper below-freezing compartment **22** closed by an insulated door **24** and a lower above-freezing compartment **26** closed by a lower insulated door **28**. These compartments are surrounded by the insulated side, top, bottom and rear walls **30**, separated by a horizontal insulated wall **32** containing an evaporator compartment **34** provided with a finned evaporator **36** having vertical fins extending from the front to the rear of the compartment **34**. The evaporator compartment **34** is provided with an inlet **38** at the front communicating with the front of the below freezing compartment **22** and additional inlets (not shown) communicating with the top of the below-freezing compartment **26**. At the rear, the compartment **34** connects with a shroud **40** communicating with an entrance to a centrifugal fan **42** which is driven by an electric motor **44** housed in the rear wall **30** of the cabinet. The cooling arrangement for the compartments may be similar to that shown in U.S. Pat. Nos. 3,359,750 issued Dec. 26, 1967, or 3,310,957 issued Mar. 28, 1967 which may be referred to for details of construction of the refrigerator.

The fan **42** is provided with an upwardly extending discharge duct **46** having distributor **48** at the top which distributes the discharge of air through the below-freezing compartment **22**. The evaporator **36** is maintained at suitable below-freezing temperatures such as −5° to −15° F. to maintain the compartment **22** at the temperature of 0° F. or below.

For providing special cooling for the automatic freezer, the distributor **48** is provided with a laterally extending discharge duct **50** extending along the intersection of the rear and top walls. Behind liquid freezer **52** the laterally extending duct **50** is provided with wide discharge nozzle **54** which discharges cold air directly onto the top of the liquid freezer **52** and particularly onto the top of mold **56**.

As seen in FIGS. 2 and 5 the mold **56** is provided with two rows of pockets **58** containing four pockets in each row and has upwardly flanged longitudinal rim **60** extending around the short and long sides thereof. The mold **56** of the liquid freezer is supplied with water or any other liquid to be frozen from a pressure water system or other liquid under pressure to a solenoid control valve **62** which controls the water through a pipe **64**, extending through the insulation of the top wall to a suitable discharge device **66** in the top wall of the below- freezing compartment **22** above the front pockets **58** of the mold **56**. The freezer **52** is provided with a wide U-shaped frame **68** which surrounds the mold **56** and is fastened to the adjacent side wall of the freezing compartment **22** by suitable screws. Below the frame **68** is a rectangular bin carrier **70** having, adjacent the rear, upwardly extending pivoting projection **72** pivoted on the pivot pin **74** to the side walls of the frame **68**. The bin carrier **70** is provided with supporting ledges **76** on its inner sides for supporting the laterally extending flanges **80** of the box-shaped bin **78**. The bin **78** is provided with a double flange **82** at the front to serve as a handle.

At the rear, the mold **56** has an integrally molded boss **84** provided with a recess integrally receiving the flattened cylindrical portion **86** and a coaxial projecting pin **88** of the pivot pin **90** having a bearing portion **92** of reduced size fitting a bearing aperture within the rear wall of the frame **68.** The frame **68** has a pair of front and rear stop members **94** and **95** which are lanced and bent inwardly from the frame side wall so as to extend normal thereto into the path of movement of the adjacent front and rear underside portions of the mold rim **60** to stop the mold in its horizontal upright position on the stop upper edges **97** (FIG. **5**). As seen in FIG. **6** the stop lower edges **98** engage the forward upper portion of rim **60** while the rear stop (not shown) engages the rearward upper portion of rim **60** when the mold **56** is rotated into its upright horizontal position and thereby limit the travel of the mold to substantially 180°.

For accessibility all the mechanism and controls are located at the front of the freezer with the mold rotating an impacting mechanism and the control system being located in the housing **127** while the electric driving motor **129** and the wiring are located in the front face of wall **133.** Both the wall **133** and the housings **127** are formed of suitable plastic material. Substantially the entire operating and control mechanism are mounted upon the plastic upright cover or wall **133** which closes the housing **127** to form a compartment **135.** The front face of wall **133** has affixed thereto, such as by screws **137,** a drive motor **129** having its final drive shaft **138** extending through the dividing wall **133** and provided with a drive pinion **139** on the opposite side which continually meshes with large driven cam or commutator gear **141.** The cam gear **141** has an apertured hub **191** (FIG. 4) rotatably mounted in a removable manner by a suitable snap retainer (not shown) on the inner shaft end of hexagon collar bolt **143.** The outer threaded end of bolt **143** extends through opening **144** in boss **145** on the wall **133** and is fixedly secured thereto by lock nut **147** and its collar **148.**

The cam gear **141** is preferably molded of polycarbonate plastic or the like and has on its inner face integrally molded cam means **150** extending inwardly toward the mold **56.** As seen in FIG. **6** the cam means is preferably in the form of a modified Archimedes spiral whose center coincides with the center of the cam gear and extends through an angle X of approximately 255° from its leading or initial edge **151** to a point indicated by line **149,** and thence through circular arc Z of about 60°, its trailing edge **152** providing a drop-off gap indicated by angle Y of approximately 45°. Thus the spiral cam **150** outer surface **153** becomes progressively greater in radial extent from its initial edge **151** through angle X while remaining at a constant radial distance through angle Z to its trailing edge **152** for a reason to be explained.

As seen in FIGS. **2** and **5** a sector gear **160** is pivotably mounted on the rear wall **127** by means of a pivot stud **161.** The segment gear is C-shaped in configuration having an arcuate leg **160*a*** and a radial leg **160*b*** forming an inner semi-cylindrical surface **160*c*** with the stud **161** pivoting the segmental gear about its foot portion **162.** The sector gear has gear teeth **160*d*** on its arcuate leg **160*a*** extending through an arc of about 33° and is biased into engagement with spiral cam **150** by spring biasing means in the form of a spiral tension spring **164** which has one end secured by means of bracket **165** to the bottom flange of the housing and a loop or hook at the end of spring **164** extends through the bracket **165.** The opposite end of spring **164** is secured by a hook being engaged around a pin **160*e*** extending through the slotted free end **160*f*** of the sector gear **160** to normally bias the sector gear **160** in a first rotational direction which in the preferred form (FIG. **6**) is a clockwise rotational direction.

As seen in FIG. **5** the gear teeth **160*d*** adjacent the pin securing end **160*e*** of the tooth segment **162** are in mesh with the teeth of pinion gear **167** assuring that the mold is held in upright horizontal position during the water fill cycle. The sector gear contains just enough teeth **160*d*** to cause pinion gear **167** to make one-half of a revolution when the sector gear **160** is rotated approximately 27.5° to its upward counterclockwise position by cam **150** in a manner to be described. As seen in FIG. **6** the segmental gear has a resiliently flexible cam follower leaf member **160*g*** of longitudinal extent and being supported solely at one end such as by machine screw **160*h*** and is free to extend lengthwise in a resiliently non-flexed condition into a cam gap **160*i*** defined by the cam leading edge **151** and the trailing edge **152.** The flexible cam follower leaf member **160*g*** is biased into engagement with the cam member **150** so as to be in resilient opposition to rotation of the cam gear **141.** By this arrangement the mold **56** is rotated by the unidirectional drive mechanism **129** to its upright water fill cycle position shown in FIG. **5** with leaf member **160*g*** loaded to its maximum by engagement at the terminus **149** of the spiral arc X.

In considering the operation of the invention it will first be assumed that cam gear **141** is in its water fill cycle position with the mold **56** in its upright position. This is achieved by clockwise rotational movement of the cam gear **141** and spiral cam **150** by the energization of the drive mechanism **129** including pinion **139** in driving relationship with cam gear **141.** Upon the leading edge **151** of the spiral cam **150** engaging the underside of flexible leaf member **160*b*** the leaf member is placed in resilient opposition to the rotation of the cam **150** thereby continuously urging the leaf member against the outer cam surface **153** until the progressively higher surface overcomes the biasing effect of the tension spring **164** pivoting the sector gear **160** in a counterclockwise rotational direction driving the pinion gear **167** and mold into its horizontal position of FIG. **5** wherein mold lip **60** engages the stops **97.**

As seen in FIG. **4,** the cam member **150** is oriented with respect to the commutator **193** such that the trailing edge portion **152** of the spiral cam is located intermediate the boundaries of fill projection **195.** As described and shown in the above-mentioned U.S. Pat. No. 3,298,189 the energization of the fill valve **62** commences and continues as the cam gear **141** and its commutator **193** are rotated clockwise at a rate which is timed by the constant speed of the synchronous drive motor **129.** This provides a timed period of engagement of the upper end of spring contact **197** with the commutator fill projection **195** which moves upwardly at a constant speed until the projection **195** moves away from the rounded end of contact **197** to deenergize the solenoid fill valve **62.** The drive motor **129,** however, continues its operation through the contact of the rounded end of the spring holding contact **267** in engagement with the commutator **193.** This spring holding contact **267** engages the commutator **193** at all times except when the notch **269** is oriented below the contact **267** as explained in the U.S. Pat. No.

3,540,227. The clockwise rotation of the cam gear **141** and commutator **193** continues until the delay projection or segment **199** passes beneath the holding spring contact **267** and notch **269** begins to pass beneath contact **267**. Further clockwise movement of the cam gear **141** is under the control of the bellows operated double throw thermostatic switch **283** having its sensing tube **284** extending into coaxial cavity **289** in the mold boss **175**.

After the water fill is complete the water will be at an above freezing temperature and will warm the bellows thermostat switch **283** thereby establishing an alternative circuit which continues the operation of the drive motor **129** and the rotation of the cam gear **141** when the notch **269** passes beneath the holding contact **267**. The delay slot **223** is an open or dead spot in the commutator which prevents continuous operation of the motor **129** in the event no water has entered the mold. The open portion **223** cooperates with the adjacent end of pivoted contact member **225** pivoted on pin **227** whose diametrically opposite arm engages a segment contact member described in U.S. Pat. No. 3,540,227. The arcuate open portion **223** is laid out in a radius struck beneath the hub **191** by the end of the contact member **225** as it pivots on its pin **227**. When this end engages the open portion **223**, no current can flow through the contact member **225** to the commutator **193** to stop operation of the motor **129** after the fill period.

As explained in the aforementioned U.S. Pat. No. 3,540,227 the motor **129** will not restart until the thermostat sensing bulb **284** is cooled to a temperature of about 16° F. assuring the liquid in the mold **56** is completely frozen. The thermostatic switch completes the circuit from the drive motor to the supply which restarts the drive motor **129** causing continued clockwise rotation of the spiral cam **150** through arc Z without increasing the load on leaf member **160*g*** and thus preventing any possible distortion of the mold. At the precise time for the harvesting cycle of the ice cubes the leaf member **160*g*** will be released by being free to drop-off cam trailing edge **152** and move to its extended position in gap **160*i*** of the cam surface **153**, suddenly releasing the tension force of the fully extended biasing coil spring **164**. The tension spring **164** transmits a driving force to the sector gear **160** causing the mold member **56** to accelerate rapidly in a counterclockwise rotational direction through an angle of about 180° until its motion is suddenly arrested by having the underside of lip **60** impact on the upper edges **97** of the stop members **94** and **95** as shown in FIG. **6**. The resulting impacting of the tray will impart a jar and vibration to the mold **56** which acts to free the frozen liquid therefrom causing the ice pieces or "cubes" to fall by gravity into the bin **52** therebelow.

In this way applicant has achieved an improved harvesting mechanism for an automatic ice maker which materially reduces the amount of torque necessary to drive the mechanism as compared to an ice mold twisting arrangement such as disclosed in the above referenced U.S. Pat. No. 3,540,227, for example. The result is achieved because the energy to "flip" or invert the mold and impact it against the stop means **94, 95** is stored in the coil spring **164** over the entire ejection cycle (1 revolution of the cam gear). For example, it has been determined that the torque required of the motor **129** is reduced from about 100 ounce-inches for the icemaker of U.S. Pat. No. 3,540,227 to about 25 ounce-inches for applicant's instant invention.

It will be noted that in its biased position shown in FIG. **6** the sector gear **160** is positioned such that the center of its semi-cylindrical inner surface **160*c*** substantially coincides with the center of the circular cam gear **141** such that the sector gear partially envelops the modified cam surface **153** in a spaced non-contacting manner. In this way when the mold is rapidly accelerated to its inverted position the mold rim **60** will impact against the stops **94** and **95** without the possibility of sector gear **160** contacting the cam surface **153**. The construction line **149** denotes the transition point or zone between the first spiral portion and second circular portion of the modified cam surface which engages the leaf member **160*g*** during the water fill and freezing cycles of the icemaker.

While the embodiment of the present invention constitutes a preferred form, it is to be understood that other forms might be adopted.

I claim:

1. An automatic liquid freezer including a support for a mold having liquid holding pockets mounted for rotational movement on said support, means for supplying liquid to said mold, means for freezing liquid in said mold, a drive motor, means for ejecting frozen liquid from said mold, temperature responsive control means for said ejecting means, said ejecting means including a sector gear mounted for pivotal movement on said support, a pinion gear connected to and co-rotatable with said mold in mesh with said sector gear, biasing means resiliently biasing said sector gear in a first rotational direction whereby said mold is rotated to an inverted position engaged by stop means, said sector gear having a resiliently flexible cam follower leaf member supported on said sector gear solely at one end, a cam gear drivingly connected to said drive motor for rotation in the first rotational direction, said cam gear having a spiral cam surface thereon formed with a gap portion between leading and trailing edges of said spiral cam surface, said leaf member extending into said gap portion in resiliently non-flexed condition when said sector gear is rotated to said tray inverted position, said spiral cam surface upon rotation of said cam gear in a second rotational direction adapted to operatively engage said leaf spring cam follower in resilient opposition to the rotation of said cam gear, whereby said sector gear is pivoted in the second direction through an arc sufficient to rotate said mold to its upright liquid fill and freeze position, upon completion of the freezing of liquid in said mold said drive motor being energized to continue rotation of said cam gear until said leaf member drops-off the cam surface into said gap portion causing said resilient biasing means to transmit a sudden driving force to said mold for rotating said mold in the second direction substantially 180° to its inverted position resulting in an impact with said stop means of sufficient magnitude to jar the ice pieces loose from said mold and cause the ice pieces to fall from said mold into a storage bin therebelow.

2. An automatic liquid freezer including a support for a mold having liquid holding pockets mounted for rotational movement on said support, means for supplying liquid to said mold, means for freezing liquid in said mold, a drive motor, means for ejecting frozen liquid from said mold, temperature responsive control means for said ejecting means, said ejecting means including a mold driving sector gear mounted for pivotal movement on said support, a pinion gear connected to and co-rotatable with said mold in mesh with said sector gear, said sector gear resiliently biased in a first rotational direction whereby said mold is rotated in a second rotational direction to an inverted position engaged by stop means, said sector gear having a resiliently flexible cam follower leaf member of longitudinal extent supported on said sector gear solely at one end, a cam gear drivingly connected to said drive motor for rotation in the first rotational direction, said cam gear having a modified spiral cam surface thereon formed with a gap portion between leading and trailing edges of said spiral cam, said modified spiral cam surface having its center substantially coinciding with the center of said cam gear, said modified spiral cam surface extending from said leading edge through a first angular portion whereby said modified spiral cam surface becomes progressively greater in radial extent from its center and a second angular portion whereby said modified spiral cam surface remains at a constant radial distance from its center terminating at said trailing edge, said leaf member extending into said gap portion in resiliently non-flexed condition when said sector gear is rotated in said tray inverted position, said modified spiral cam surface upon being rotated by said drive motor in the first rotational direction causing said leading edge to operatively engage said leaf spring cam follower adjacent its free end in resilient opposition to the rotation of said cam gear, said sector gear being pivoted in response to the rotation of said cam gear in a second rotational direction against the biasing action thereon by said biasing means until said leaf spring cam follower moves to a transition zone on said cam surface between said first and second angular portions so as to rotate said mold in the first rotational direction to an upright position for commencement of a water fill cycle and a freeze cycle, means for deenergizing said drive motor for a predetermined interval until completion of the water fill and freeze cycles, means for energizing said drive motor to continue rotation of said cam gear without any additional resilient opposition being imparted to said leaf member by said cam second angular portion until said leaf member suddenly drops-off said cam surface trailing edge into said gap portion, said sector gear resilient biasing means being responsive to the release of said leaf member to transmit a sudden driving force to said mold thereby rotating said mold in the second direction substantially 180° to its inverted position resulting in an impact with said stop means of sufficient magnitude to jar all the ice pieces loose from said mold and cause the ice pieces to fall from said mold into a storage bin therebelow.

3. An automatic liquid freezer including a support for a mold having liquid holding pockets mounted for rotational movement on said support and within a freezing compartment, means for supplying liquid to said mold, a drive motor, a cam gear driven by said drive motor, means for freezing liquid in said mold, means for ejecting frozen liquid from said mold, said ejecting means including a mold driving C-shaped sector gear defining an inner semi-cylindrical surface, said C-shaped sector gear forming an arcuate leg and a radial leg, the free end of said radial leg connected for pivotal movement on said support, gear teeth formed in said sector gear arcuate leg through an arc of about 30°, a pinion gear connected to and co-rotatable with said mold in mesh with said sector gear teeth, spring biasing means connected between said support and the free end of said arcuate leg resiliently biasing said sector gear in a first clockwise direction whereby said mold is rotated in a counterclockwise direction to an inverted position engaged by stop means, said sector gear having a resiliently flexible cam follower leaf member of longitudinal extent supported on said sector gear solely at one end, said cam gear drivingly connected to said drive motor for rotation in a clockwise direction, said cam gear having a modified spiral cam surface thereon formed on one face thereof with a gap portion between leading and trailing edges of said spiral cam surface, said modified spiral cam surface having its center substantially coinciding with the center of said cam gear, said sector gear when in its biased position having the center of its inner cylindrical surface substantially coinciding with the center of said modified spiral cam such that said sector gear partially envelops said cam surface in a non-contacting manner, said modified spiral cam surface extending from said leading edge through a first angular portion of about 255° whereby said modified spiral cam surface becomes progressively greater in radial distance and a second angular portion of about 60° whereby said modified spiral cam surface remains at a constant radial distance from its center terminating at said trailing edge, said leaf member extending into said gap portion in resiliently non-flexed condition when said sector gear is rotated to said tray inverted position, said modified spiral cam surface upon being rotated by said drive motor in a clockwise direction causing said cam surface leading edge to operatively engage said leaf spring cam follower adjacent its free end in resilient opposition to the rotation of said cam gear, said sector gear being pivoted in response to the rotation of said cam gear in a counterclockwise direction against the biasing action thereon by said biasing means until said leaf spring cam follower moves to a transition zone on said cam surface between said first and second angular portions so as to rotate said mold in clockwise direction to an upright position for commencement of a water fill cycle and a freeze cycle, means for deenergizing said drive motor for a predetermined interval until completion of the water fill and freeze cycles, thermal switch means responsive to the freezing temperature of said frozen liquid energizing said drive motor to continue rotation of said cam gear without any additional resilient opposition being imparted to said leaf member by said cam second angular portion until said leaf member suddenly drops-off said cam surface trailing edge into said gap portion, said sector gear spring biasing means being effective to transmit a sudden driving force to said mold thereby rotating said mold in a counterclockwise direction substantially 180° to its inverted position resulting in an impact with said stop means of sufficient magnitude to jar all the ice pieces loose from said mold pockets and cause the ice pieces to fall from said mold into a storage bin therebelow.

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