March 21, 1967 J. J. O'CONNELL ETAL 3,309,892

FLEXIBLE BELT-TYPE ICE MAKER

Filed Dec. 28, 1964 4 Sheets-Sheet 1

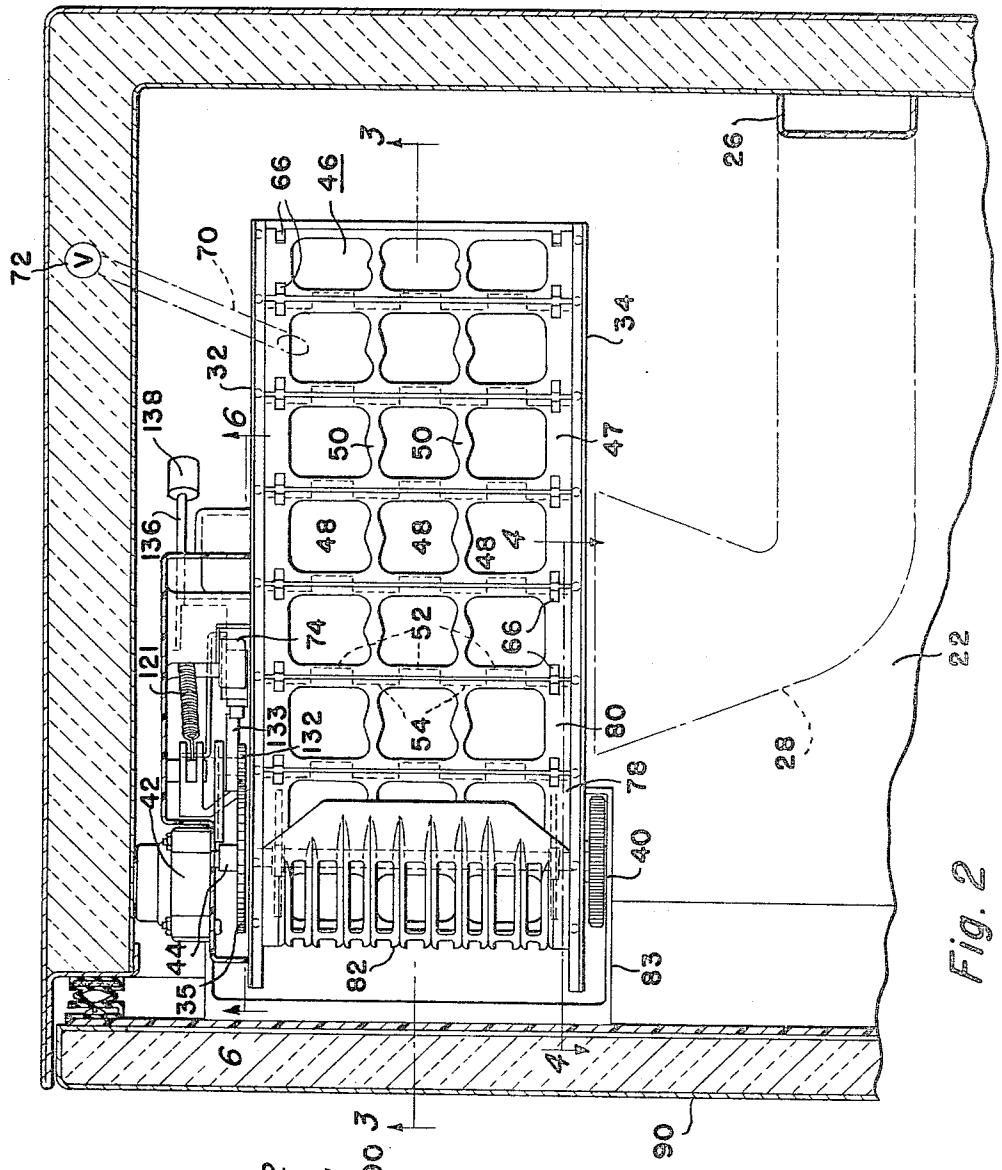

Fig. 2

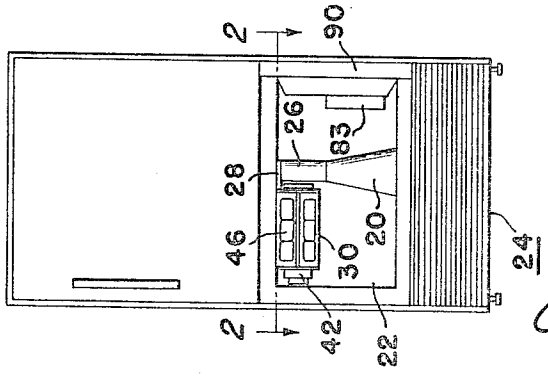

Fig. 1

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FLEXIBLE BELT-TYPE ICE MAKER

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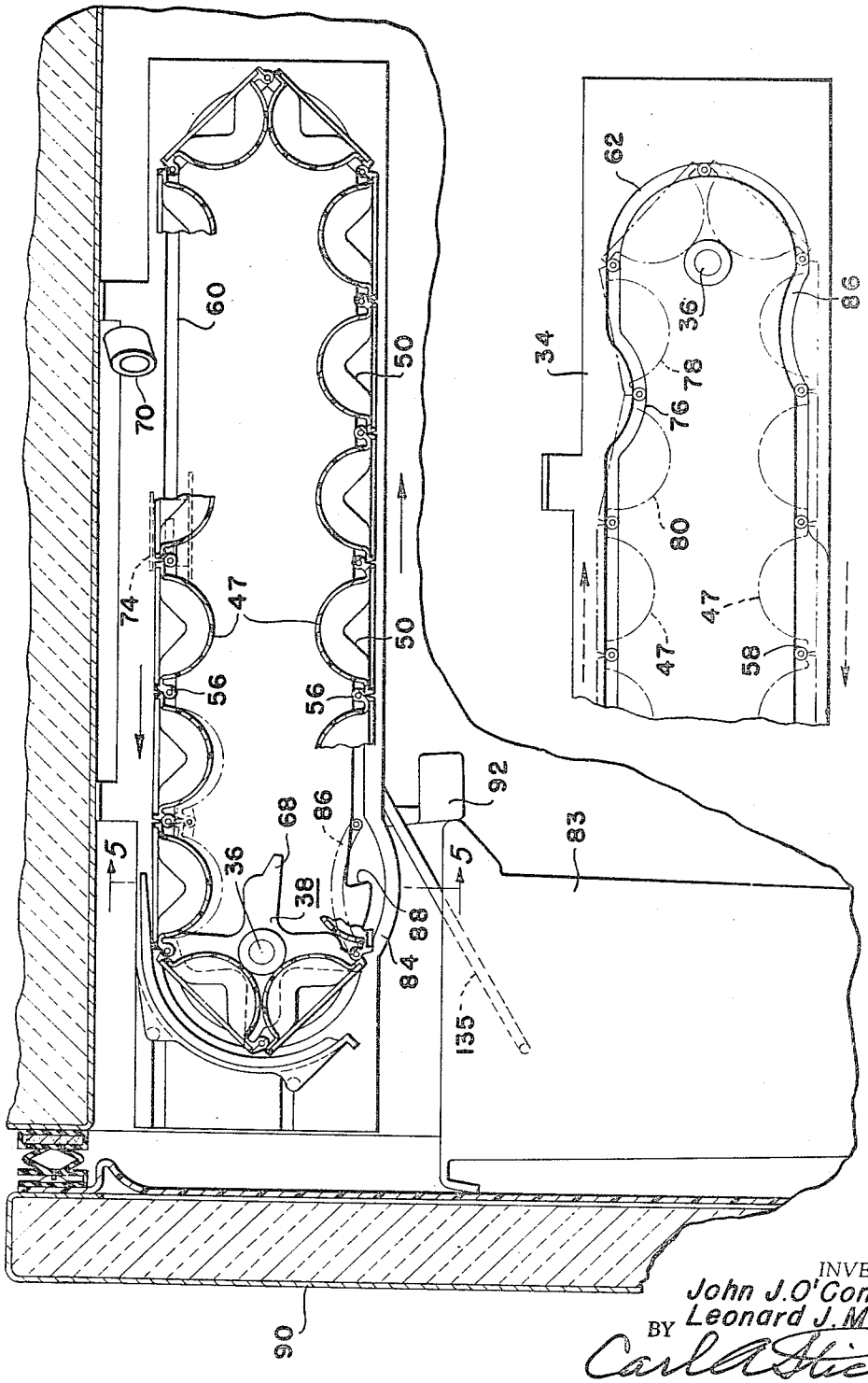

Fig. 4

Fig. 3

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FLEXIBLE BELT-TYPE ICE MAKER

Filed Dec. 28, 1964 4 Sheets-Sheet 3

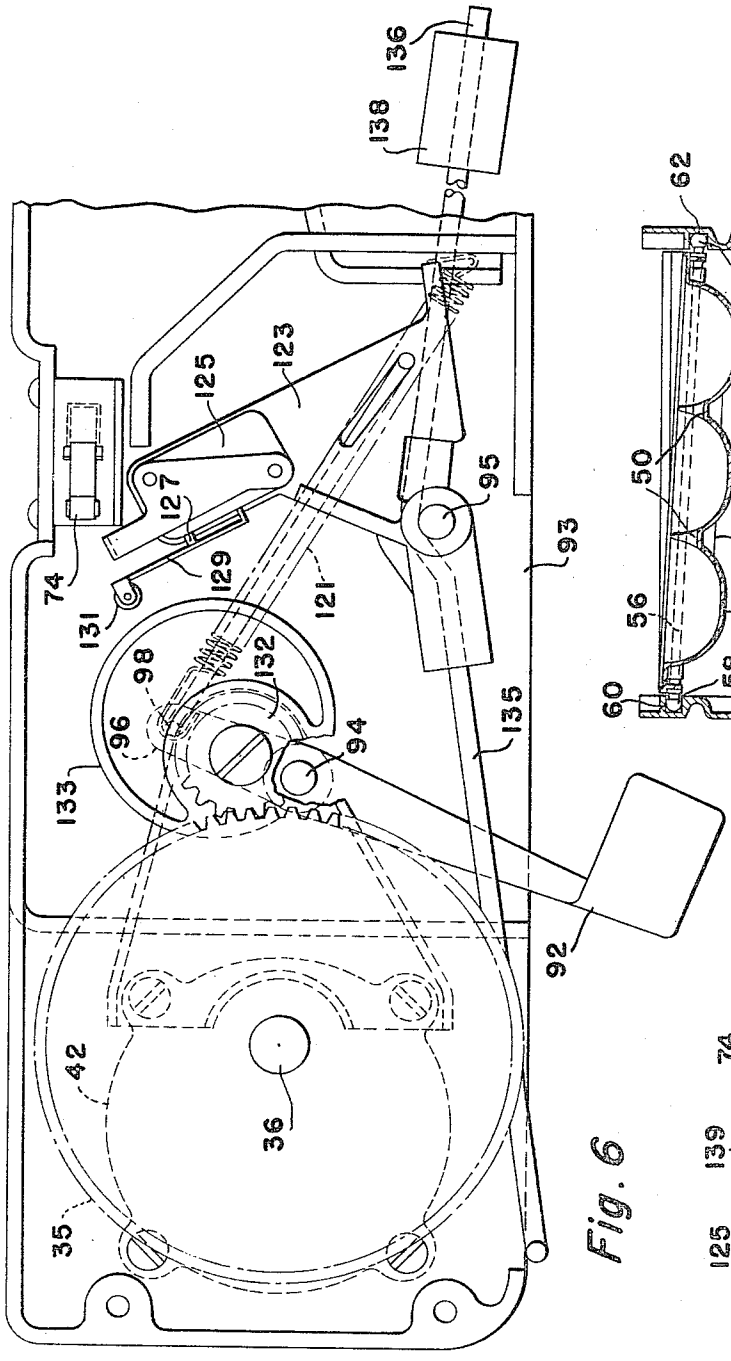

Fig. 6

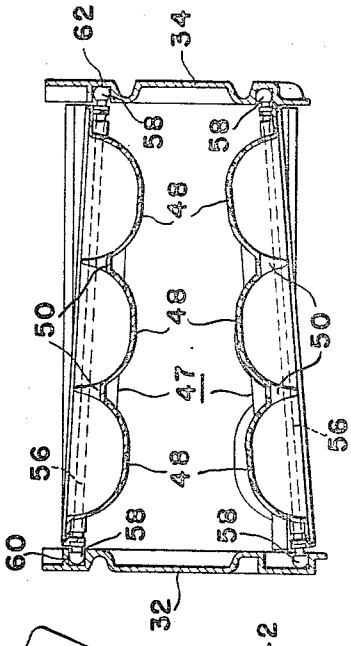

Fig. 5

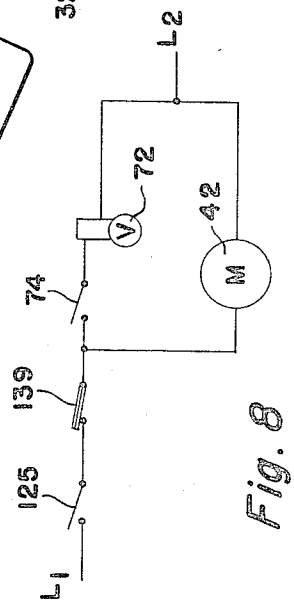

Fig. 8

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FLEXIBLE BELT-TYPE ICE MAKER

Filed Dec. 28, 1964 4 Sheets-Sheet 4

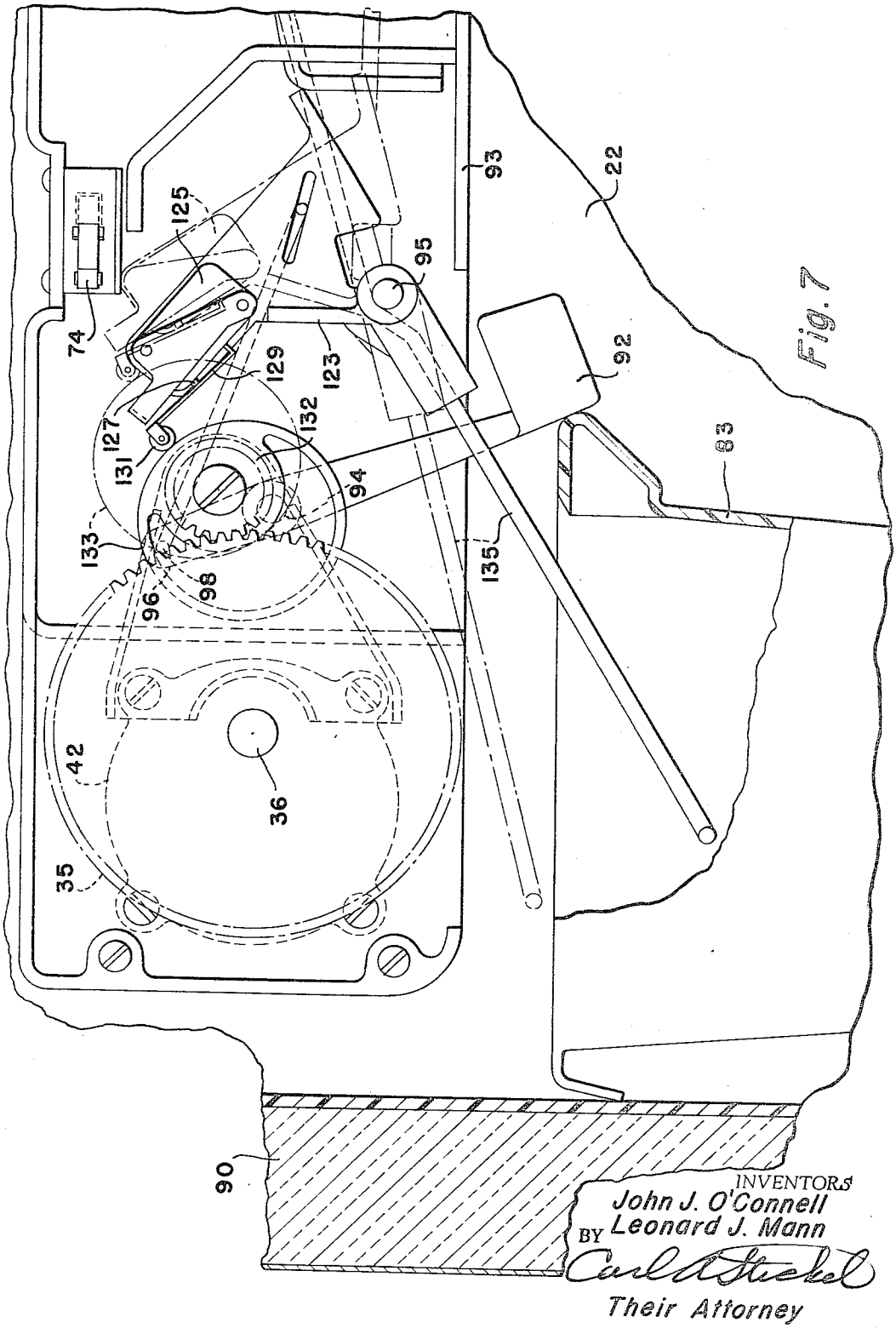

Fig. 7

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United States Patent Office 3,309,892
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3,309,892

FLEXIBLE BELT-TYPE ICE MAKER

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Filed Dec. 28, 1964, Ser. No. 421,405
10 Claims. (Cl. 62—345)

This invention pertains to refrigerating apparatus and more particularly to automatic liquid freezers for household refrigerators.

While many automatic liquid freezers have been devised throughout many years, only the commercial type has proved to be a significant commercial success. There is now increasing evidence that many potential customers are now interested in buying a household refrigerator with an automatic liquid freezer or ice cube maker. Various types have been tried for this purpose. It has been found that machines employing heat or releasing ice or frozen liquid from the freezing mold require more refrigeration than the standard household refrigerator has available for this purpose since the primary refrigerating requirements are needed to maintain the required refrigeration temperatures in all the storage compartments.

Although different types of automatic liquid freezers can be used in household refrigerators, the simplicity, high capacity, compactness and relative ease which it can be cooled by forced air circulation of cold air makes the belt-type automatic freezer advantageous for household refrigerators. However in many belt-type automatic freezers there has been encountered difficulties from belt stretching and breakage, failure to uniformly fill the compartments of the mold, failure to completely freeze the liquid, failure to eject all the cubes and failure to stop the making of ice or frozen liquid when the storage bin is full or is removed.

It is an object of this invention to provide a belt-type liquid freezer in which the belt is not susceptible to stretching or breakage and in which the freezing compartments are uniformly filled and the liquid is completely frozen before the frozen pellets are ejected from the belt.

It is another object of this invention to provide a belt-type liquid freezer in which the frozen liquid is loosened after being completely frozen and ejected uniformly at the proper place with a minimum of stress and distortion of the belt and a minimum of stress upon the drive mechanism.

It is another object of this invention to provide a removable frozen storage bin for a household refrigerator with a simple reliable control for stopping the liquid freezer when the bin is substantially filled or when it is removed.

These and other objects are attained in the form of automatic liquid freezer shown in the drawings in which the belt is of a link type having the links comprising three compartment molds connected together at their edges by hinged joints to form an endless belt. The ends of the hinge pins are provided with rollers which guide the belt through grooves in the support members located at the sides of the belt. A drive motor through a one-way clutch drives one end of the sprocket which drives the belt. The other end of the sprocket is provided with a knurled wheel for manual operation of the belt. A switch operated by the belt controls a solenoid valve to provide a measured fill for the compartments of the mold. The tracks at the sides of the belt are curved so as to provide a first twisting of the molds to loosen the frozen liquid and a second set of curves to provide a second twisting to eject all the frozen liquid from the belt. The two sets of curves are arranged so that the maximum twisting effort of each occurs at different times so as to minimize the power required for this purpose. A guard prevents premature ejection of the frozen liquid between the two sets of ejection curves.

A floating switch is provided for stopping the drive motor and the entire operation when the collecting bin is removed or is substantially filled with frozen liquid. The drive motor for the belt is provided with an eccentric which normally reciprocates a feeler arm into and out of the collecting bin. A second feeler member is engaged by the collecting bin when in the normal position. When the oscillation of the first feeler member is interferred with, the switch will open to stop the main drive motor and the entire ice freezing mechanism. Also if the collecting bin is removed, the second feeler member will allow the control switch to move to the open position to prevent the operation of the drive motor. In addition a normally closed thermostatic switch responsive to the temperature of the air is provided for stopping the drive motor in the event that the air is not sufficiently cold to complete the freezing of the liquid while it is being carried from the filling station to the ejection station.

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 a front view of a household refrigerator of the frost-free type with the freezing compartment door open showing a belt-type liquid freezer together with a portion of the cold air circulating system;

FIG. 2 is a horizontal sectional view taken along the line 2—2 of FIG. 1 showing a belt-type liquid freezer embodying one form of our invention;

FIG. 3 is a vertical sectional view through the liquid freezer taken along the line 3—3 of FIG. 2;

FIG. 4 is a fragmentary vertical sectional view taken along the line 4—4 of FIG. 2;

FIG. 5 is a transverse vertical sectional view taken substantially along the line 5—5 of FIG. 3;

FIG. 6 is a view in elevation and partly in vertical section taken substantially along the line 6—6 of FIG. 2;

FIG. 7 is a vertical sectional view similar to FIG. 6 showing the collecting bin in place and the control mechanism in position for normal operation; and

FIG. 8 is a simplified wiring diagram for the automatic freezer.

Referring now to the drawings and more particularly to FIG. 1 there is shown a household refrigerator of the frost-free type which is preferably similar to that shown in my patent 3,104,533 issued Sept. 24, 1963. As in said patent, cold air at temperatures of about −10° F. is delivered upwardly through the air duct **20** within the freezing compartment **22** of the household refrigerator **24**. This air duct **20** has an upwardly extending extension **26** provided with a curved discharge duct **28** for delivering this cold air to the belt-type automatic liquid freezer or ice maker **30** which is located at one side in the upper portion of the freezing compartment **22**. This belt-type ice maker **30** includes two spaced vertical sheet metal or die cast aluminum side frames **32** and **34**. Between these two frames and fixed to a drive shaft **36** is the four-bladed drive sprocket **38**. The sprocket **38** is located between the front ends of the two side frames **32** and **34**. On the outside of the frame **34** the drive shaft **36** is provided with a knurled wheel **40** by which the sprocket **38** may be manually rotated. The sprocket **38** is normally driven by a drive motor **42** through a one-way clutch **44** connecting with the drive shaft **36** adjacent the side frame **32**. The one-way clutch **44** assures normal driving of the sprocket **38** in the proper direction at all times

and yet allows the sprocket 38 to be turned manually by the wheel 40 in the same direction at any time.

The belt 46 is made up of a plurality of twistable, flexible semiresilient 3-compartment molds 47 which may be made of some suitable plastic resin such as polypropylene or polyethylene to which frozen liquid will not adhere tightly. Each of these molds include 3-compartments 48 which are aligned transversely across the belt and connected by weirs 50. The molds 47 may be stiffened for better ejection by integral webs between the compartments 48. Each of the molds include sets of complementary knuckles or eyelets 52 and 54 which are arranged on opposite sides of each of the molds. These knuckles or eyelets fit together and complement each other as in a piano type hinge and are each connected by long pins 56 extending through them and linking the molds 46 together to form an endless link type belt. Rotatably mounted and held on the ends of each of the pins 56 are ball shaped plastic rollers 58 which operate in the guide grooves or tracks 60 and 62 provided in the side frames 32 and 34. The belt 46 extends around the sprocket 38 and within the grooves 60 and 62 to provide a complete suspension system for the belt. The rollers 58 at the ends of the pins 56 reduce the friction with the grooves so that the drvie motor 42 may be kept relatively small. The molds 47 are each provided with adjacent notches 66 which are engaged consecutively by the four prongs 68 at the ends of the sprocket 38 which press against the adjacent portions of the pins 56 to drive the belt 48 at a relatively slow speed with the upper pass moving forwardly and the lower pass moving rearwardly. The belt 46 is filled at the rear from a fill spout 70 extending over the rear of the belt. This fill spout is supplied with the liquid to be frozen from a suitable supply source under the control of the solenoid valve 72. The solenoid valve 72 is controlled to open for a time period suffiiciently to properly fill the compartments 48 under the control of a suitable belt switch 74 which is responsive to a portion of the configuration of each of the molds 46 to supply sufficient liquid to properly fill each of the compartments 48 of each of the molds.

The cold air, delivered through the duct 26 and its extension 28 over and under the molds 46 of the belt, quickly cools the liquid below freezing temperatures. The side frames 32 and 34 may be provided with suitable ventilating apertures to increase the air circulation around the molds 47. The molds 47 are individually twisted to loosen the frozen liquid from the molds prior to reaching the sprocket 38. This is accomplished by having the guide groove 60 substantially straight while the guide groove 62 is provided with a downwardly curved section 76 as shown in FIG. 4 forming a first ejecting station. This will move the consecutive hinge pins 56 through acute angular position relative to the nearest adjacent hinge pin as shown in FIGURE 5 to impart a twisting movement in two directions relative to the horizontal at the end adjacent the groove 62 as illustrated in dot and dash lines for the molds 78 and 80. This will loosen substantially all of the frozen liquid consecutively in each of the molds as they move from the rear to the front prior to engaging the sprocket 38. Since only one end of each of the molds is twisted at a time, only a relatively light load is imposed on the drive motor 42. The frozen liquid or ice is therefore broken loose from the mold gradually by this arrangement.

To prevent the pellets or cubes from falling out of the belt prematurely and to hold them for additional freezing time, there is provided a plastic polyethylene guard 82 extending around the front periphery of the belt for holding the pellets or cubes in place until they are over the center of the collecting bin 83. The pellets or cubes do not readily adhere to the polyethylene material of the guard 82. It occasionally occurs that some of the pellets or cubes are not completely loosened by the initial twist produced by the curved portion 76 of the groove 62 at the first loosening or ejecting station. Therefore after the belt passes around the sprocket 38 there is provided a second loosening or ejecting station. This is provided by opposite curved sections 84, in the grove 60, and 86 in the groove 62. These downwardly and upwardly curved sections 84 and 86 are arranged relatively to the molds 47 in the belt 46 so that their maximum twist occurs at the time that there is a minimum twist produced by the curve 76 in the upper portion of the tract 62. This minimizes and distributes the peak load upon the drive motor 42. The curves 84 and 86, since they are positioned oppositely, provide substantially twice the change in relative angularity of the adjacent hinge pins to provide twice the amount of twist that the curve 76 alone provides. However the force required upon the drive motor during the twisting action provided by the curves 84 and 86 is not so great because substantially all of the pellets or cubes have been released in the initial twisting provided by the curve 76. In addition the groove 84 is provided with an extended enlarged step off portion 88 by which the twisting, when at a maximum, is suddenly released with a snap generating sufficient impact to jar loose any frozen pellets or cubes which may have a tendency to hold up due to a vacuum effect in the molds. The pellets or cubes will at the point directly above the bin 83 be ejected from the molds into the bin 83.

The bin 83 is removably supported upon the compartment door 90 for easy viewing and accessibility. It cooperates with a bin feeler arm 92 when the door 90 is closed. This feeler arm 92 is pivotally mounted to a drive frame 93 by the pin 94 and has an upwardly extending arm 96 having an anchoring pin 98 at its outer end to which is hooked the upper end of a tension type coil spring 121. Pivoted on a pin 95 is an assembly that includes a switch holder 123 upon which is mounted a rectangular switch 125 having an operating plunger 127. The switch 125 is also provided with a thin leaf spring arm 129 normally inherently sprung away from the switch 125 as shown in FIG. 6 to allow the plunger 127 to remain in its open circuit position. The spring arm 129 at its outer end is provided with a roller follower 131 which is adapted under normal operating conditions to ride upon the periphery of the eccentric 133 which is rotated by the drive motor 42 in synchronsim with the sprocket 38. A pinion 132 on the eccentric shaft drives a gear 35 on the shaft 36. The assembly 123 also includes the cube feeler arm 135 which is normally reciprocated by the eccentric 133 and the roller follower 131 between the full line position and the dot and dash line position illustrated in FIG. 7 along with the switch 125 and the spring arm 129 when the collecting bin 83 is in its normal receiving position. The opposite end of the feeler arm 135 is extended through the assembly 123 to provide an extension 136 on which there is a counterweight 138. The assembly 123 provides an anchor pin 137 for the lower end of the coil spring 121.

When the collecting bin 83 is properly mounted on the door 90 and the door 90 is closed, the rear edge of the collecting bin engages the feeler 92 to move it to the position illustrated in FIG. 7 to apply a tension to the spring 121 to lift the anchoring pin 137 and overcoming the force of the counterweight 138. This will pivot the switch mounting assembly 123 in a counterclockwise direction about the pivot pin 94 so that the roller follower 131 will be held against the periphery of the eccentric 133 at all times as long as the cube feeler arm 135 is free to move. The spring 121 when thus tensioned applies sufficient force to the assembly 123 to deflect the spring arm 129 sufficiently to depress the plunger 127 to move the switch to and hold the switch 125 in the closed position for normal operation of the ice maker. The continued operation of the eccentric 133 will reciprocate the cube feeler arm 135 into and out of the collecting bin 83. The frozen pellets or cubes will be ejected from the molds 47 in the belt 46 into the bin 83 and will accumulate therein.

When these cubes or pellets accumulate to an amount

above the normal path of movement of the feeler **135**, the oscillating movement of the cube feeler arm **135** will be obstructed. The obstruction of the feeler arm **135** will hold the assembly **123** and the switch **125** as well as the roller **131** from continuously following the movement of the eccentric **133**. When the assembly is so held, the eccentric **133** will move away from the roller follower **131** thereby allowing the tension of the spring arm **129** to move it away from the switch **125** to allow the switch plunger **127** to move outwardly to the open position so as to open the switch **125**. As shown in the wiring diagram of FIG. 8, switch **125** is connected in series with both the solenoid valve **72** and the drive motor **42** in between the supply conductors L1 and L2. Therefore this opening will immediately stop both the drive motor **42** and the solenoid valve **72** so that the automatic freezer will be stopped and no liquid to be frozen will be supplied to it.

Also connected in series with the switch **125** is a thermostatic switch **139** which is located in the below freezing compartment **22** and responsive to the temperature of the air therein. This switch **139** may be set to open at some suitable temperature such as 15° or 20° F. which will be at the point above which the cooling of the liquid to be frozen in the molds **46** is not sufficiently rapid to assure complete freezing before the pellets or cubes are ejected into the bin. Therefore under conditions of overloading due to the placing of large amounts of warm food into the refrigerator or excessively high room temperatures, the operation of the liquid freezer will be discontinued until refrigerating conditions improve.

I find that through this control arrangement adequate refrigeration of the refrigerator is provided at all times and the freezer is stopped whenever the collecting bin is removed or filled, or refrigeration is not available for satisfactory freezing. The molds and the belt are sufficiently strong and flexible that they will neither stretch nor break and through the first and second twisting action provided, the cubes are satisfactorily ejected at all times with a minimum of peak loading of the drive motor **42**. The ice maker or liquid freezer operates smoothly with a minimum of friction and uses only a relatively small amount of space available in the freezing compartment. The collecting bin is readily available for inspection at all times and is relatively free of possibility of accidents. The knurled wheel makes it possible for the user to test the operation at any time and to quickly obtain a few cubes whenever desired and also to clean the liquid freezer of cubes whenever desired.

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

We claim:

1. A liquid freezer including a belt having liquid holding compartments, means for filling the compartments with liquid to be frozen, means for freezing the liquid in said compartments, a rotatable means for driving said belt, a drive motor, a one way clutch operably connecting said drive motor and said rotatable means for driving said belt, said rotatable means being also provided with manually operable means for driving said belt.

2. A liquid freezer including a belt having liquid holding compartments, means for filling the compartments with liquid to be frozen, means for freezing the liquid in said compartments, a rotatable sprocket means for driving said belt, first means located on one side of the sprocket means cooperating with said belt prior to its engagement with the sprocket means for consecutively loosening the frozen liquid in said compartments, and second means located on the opposite side of the sprocket means cooperating with said belt after its engagement with the sprocket means for consecutively ejecting the frozen liquid from said compartments.

3. A liquid freezer including a plurality of twistable flexible molds having compartments for receiving liquid to be frozen, hinge means connecting said molds into an endless belt, means for moving said belt, means for supplying said compartments with liquid to be frozen, means for freezing the liquid in said compartments, and means for consecutively twisting said molds preponderantly upon axes transverse to the belt, and means for consecutively suddenly releasing the twisted molds to release the frozen liquid from said molds.

4. A liquid freezer including a plurality of twistable flexible molds having compartments for receiving liquid to be frozen, hinge means connecting said molds into an endless belt, means for moving said belt, means for supplying said compartments with liquid to be frozen, means for freezing the liquid in said compartments, guide track means on opposite sides of said belt, said hinge means comprising hinge pins connecting each adjacent mold, the ends of each of said hinge pins being provided with antifriction means cooperating with said guide track means to guide the belt, said guide track means being provided with cam surfaces cooperating with said antifriction means for twisting said molds.

5. A liquid freezer including a plurality of twistable flexible molds having compartments for receiving liquid to be frozen, hinge means connecting said molds into an endless belt, means for moving said belt, means for supplying said compartments with liquid to be frozen, means for freezing the liquid in said compartments, first means for consecutively twisting said molds for releasing the frozen liquid from said compartments, and second means for consecutively twisting said molds through a greater amplitude than said first means for assuring the complete release of the frozen liquid from said compartments.

6. A liquid freezer including a plurality of twistable flexible molds having compartments for receiving liquid to be frozen, hinge means connecting said molds into an endless belt, means for moving said belt, means for supplying said compartments with liquid to be frozen, means for freezing the liquid in said compartments, first means for consecutively twisting said molds for releasing the frozen liquid from said compartments, and second means for consecutively twisting said molds through a greater amplitude than said first means for assuring the complete release of the frozen liquid from said compartments, said first and second means comprising means for causing their alternate operation for causing the first and second twisting to take place alternately.

7. A liquid freezer including a plurality of twistable flexible molds having compartments for receiving liquid to be frozen, hinge means comprising hinge pins connecting said molds into an endless belt, means for moving said belt, means for supplying said compartments with liquid to be frozen, means for freezing the liquid in said compartments, first means for moving consecutive hinge pins through acute angular positions relative to the nearest adjacent hinge pins for consecutively twisting said molds preponderantly upon axes transverse to said belt for releasing the frozen liquid from said compartments, and second means for consecutively twisting said molds through a greater amplitude than said first means for assuring the complete release of the frozen liquid from said compartments, and a guard means located along the path of said molds between said first and second means for preventing the frozen liquid from escaping from said compartments between said first and second means.

8. A liquid freezer including a plurality of twistable flexible molds having compartments for receiving the liquid to be frozen, said molds having complementary knuckles adjacent their opposite edges, hinge pins extending through adjacent sets of complementary knuckles linking the molds into an endless belt, guide track means at the opposite ends of said hinge pins, said hinge pins extending into said guide track means for guiding said molds through a path, means for moving said molds through said path, means discharging liquid to be frozen into said compartments, and means for freezing said liquid in said

compartments, said guide track means in the portion of the track where the liquid in the molds is substantially completely frozen having one side deviating from a straight line for imparting a twist to each of the molds consecutively to loosen the frozen liquid from the molds.

9. A liquid freezer including a plurality of twistable flexible molds having compartments for receiving liquids to be frozen, hinge means connecting the adjacent edges of said molds to form an endless belt, said molds having side edges forming the side edge portions of the belt, means for supplying said compartments with liquid to be frozen, means for freezing the liquid in said compartments, and means for individually and consecutively twisting one of the side edges of each mold relative to the other side edge and out of alignment with the remainder of the belt to release the frozen liquid from the molds.

10. A liquid freezer including a plurality of twistable flexible molds having compartments for receiving liquids to be frozen, hinge means comprising hinge pins connecting the adjacent edges of said molds to form an endless belt, said molds having side edges forming the side edge portions of the belt, means for supplying said compartments with liquid to be frozen, means for freezing the liquid in said compartments, and means for moving consecutive hinge pins through acute angular positions relative to the nearest adjacent hinge pins for consecutively twisting one of the side edges of each mold relative to the other side edge and substantially out of alignment with the other side edges on the same side of the belt to release the frozen liquid from the molds.

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