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3,388,560

AUTOMATIC ICEMAKER

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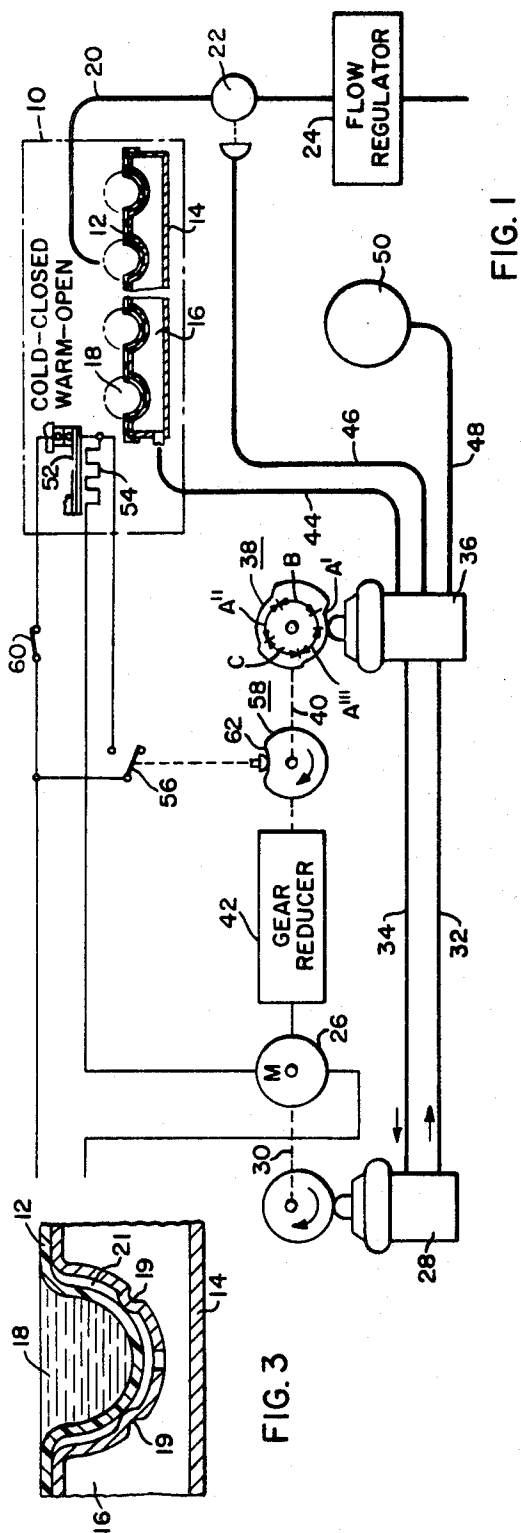
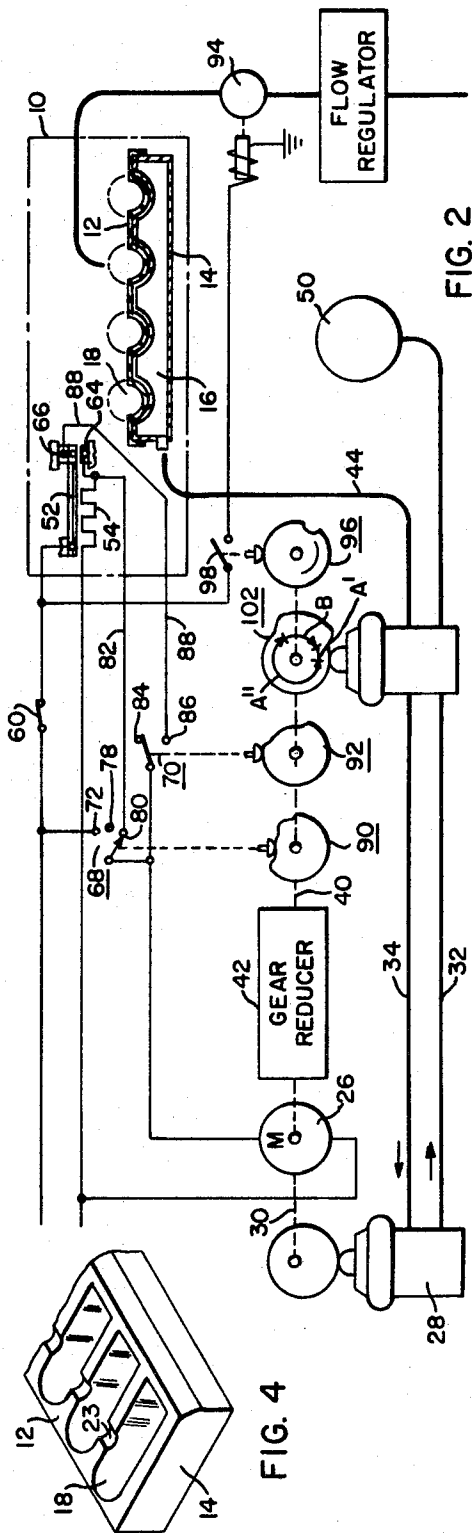


FIG. 3

FIG. 4

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AUTOMATIC ICEMAKER

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ABSTRACT OF THE DISCLOSURE

Ice cube making apparatus of the character in which ice cube pockets in a flexible wall liner are inverted by pressurizing the space underlying the liner to eject frozen cubes therefrom, and having a gas pumping system operable to obtain pre-release of the cubes from the pockets by drawing the pockets down out of adherence with the cubes prior to inversion of the pockets.

BACKGROUND OF THE INVENTION

Field of the invention

This invention relates to the art of ice cube making, and particularly to that category of the art dealing with apparatus in which a flexible wall, pocket-forming liner in which the cubes are frozen is associated with a system for inverting the pockets to eject the cubes, and returning the pockets to their water-receiving conditions.

DESCRIPTION OF THE PRIOR ART

Pressure actuated, invertible pocket, automatic icemakers are known in the patent art. Typically, so far as I know, the pressurizing fluid pumped into and out of the space formed between the liner and the underlying tray has been a liquid such as a solution of glycerine and water. In one arrangement of this general character, as exemplified by that taught in U.S. Patent No. 2,770,102, the solution is stored in a reservoir adjacent the ice tray (i.e. within the freezing zone) so that when it is pumped into the space between the liner and tray for inverting the liner its low temperature does not introduce undesirable heat into the system.

In another system, such as that exemplified by U.S. Patent 2,918,803, the ejecting liquid is stored in a region of substantially higher ambient temperature than the temperature within the freezing zone and the heat in the ejecting liquid is used to reset a thermal element to effect a next succeeding filling operation after the ejection.

In still other arrangements of the invertible pocket or mold type, and as exemplified by U.S. Patent 2,969,651, mechanical means is used to scavenge the cubes sticking to the inverted molds during the ejection operation.

Automatic icemakers of the invertible mold type have not reached commercial fruition so far as I know. Perhaps the complexities inherent in using a liquid system for controlling the condition of the flexible liner are a factor. Another factor may be the difficulties of insuring the release of the cubes from the pockets during ejection.

SUMMARY OF THE INVENTION

In accordance with my invention, a gas pumping system is preferably used and is employed to obtain a pre-release, to a degree at least, between the cubes and the pockets before the cubes are ejected by inversion of the pockets. This pre-release is believed to be more practically achieved with a gas system than with a liquid system,

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although the latter may be used within the scope of the invention. Additionally other problems inherent with a liquid system, such as close requirements of the volume of the ejecting charge, are substantially avoided. Other advantages of an arrangement according to my invention will be appreciated from the detailed description to follow.

DRAWING DESCRIPTION

FIGURE 1 is a schematic illustration of one automatic icemaker according to my invention;

FIG. 2 is a schematic illustration of a modified arrangement of an automatic icemaker according to the invention;

FIG. 3 is a fragmentary vertical sectional view through the tray structure for one pocket; and

FIG. 4 is a fragmentary isometric view of a tray and pocket structure of another character.

FIG. 1 embodiment

In the drawing, the freezer compartment of a domestic refrigerator, for example, is indicated by the dash-line outline 10. The flexible wall, pocket-forming liner 12 overlies the rigid tray 14 and is attached along its peripheral edges to the peripheral edges of the tray so that the space generally designated 16 between the liner and tray is sealed. The pockets 18 of the liner having a normal water-receiving condition in which they are generally concave in section as shown by the solid lines, and an inverted convex configuration as shown by the dash lines when the plenum space 16 is pressurized to push the pockets upwardly.

The water supply means for the tray includes a water line 20 having an on-off fill valve 22 and preferably a flow regulator 24 to compensate for pressure variations in the water supply source.

The gas pumping system is powered by an electric motor 26 which, as diagrammatically shown, drives a reciprocating diaphragm pump 28 through the motor shaft 30. The pump 28 may be of the well-known type in which a flexible diaphragm is flexed back and forth to produce volumetric changes in a chamber, with a check valve in each of the ports to which the pneumatic lines 32 (outlet) and 34 (inlet) are connected to the pump. It is here noted that while the preferred pumping system is characterized as a gas system, to distinguish it from a liquid system, the gas may be reasonably dry air.

The air lines 32 and 34 are connected to a three-position control valve 36 which is positioned in accordance with the actuating cam 38 mounted on shaft 40 of the gear reducer 42 which in turn is driven by the motor 26. The valve 36 may be of the character having an interior slide member provided with a number of passages for making selective connections between the various ports of the valve in accordance with the interior position of the slide controlled by the rotated position of cam 38. The various connections made during a cycle of the operation will be described in detail after the other components of the arrangement are identified.

The air line 44 connects the valve 36 to the space 16 between the liner and tray, the air line 46 connects the control valve to the water fill valve 22 to actuate it in accordance with the cycle stage, and the air line 48 connects the control valve to a flexible wall bladder 50 which serves as a variable volume reservoir for the air charge. The air lines and the components which they connect are sealed with respect to atmosphere.

The electrical component part of the arrangement includes a thermostatic switch 52 and a physically proximate resistance heater 54, a cycle switch 56 controlled by cam 58 on shaft 39 of the gear reducer, and a bucket switch 60 responsive to the quantity of ice produced and operative in known fashion to terminate further cycling of the icemaker when a predetermined quantity has been harvested. The thermostatic switch 52 and cycle switch 56 are in parallel as shown by the electrical diagram so that if either of the switches are closed the series connected heater 54 and motor 26 are energized if bucket switch 60 is closed.

The thermostatic switch 52 is operative to open in response to heat produced by the energized heater 54, and subsequently to close, with the heater off, in response to a cold condition corresponding to that indicating the cubes are solidly frozen. Thus, the switch 52 and heater 54 may be located in such a partly enclosed chamber within the freezing chamber 10 that there is a correlation between the rate at which the ice cubes freeze and the rate at which the switch cools, after being heated, for a given freezer space temperature. Alternatively, the switch and heater may be positioned in the space 16 between the liner and tray to provide a closer correlation of the freezing rate and the response rate of the switch.

The cycle is initiated, when the cubes are frozen, by thermostatic switch 52 closing. The cycle is terminated, after the cubes have been ejected and the liner 12 brought back to a water receiving condition and filled, by the opening of cycle switch 56 with the thermostatic switch 52 also being open from the heater 54 energization.

Before detailing a cycle of operation of the icemaker, the function of cam 58 controlling cycle switch 56, and cam 38 controlling valve 36 will be briefly described. The cam 58 has a segmental flat 62 which holds switch 56 open, and a uniform radius remainder surface which holds the switch closed. Both cams 38 and 58 make one revolution during the part of the cycle in which the cubes are ejected and the tray is again filled with water. As to cam 38, the segments marked A', A'', A''' are all of the same radius and hold the valve 36 in a position connecting those lines together to evacuate the space 16 between the liner and tray and direct the air into the bladder 50. The segment marked B reverses the valve and results in the air being pumped from the bladder into the space 16. The segment marked C corresponds to the A positions of the valve (evacuation of the space 16) but with the water fill valve 22 also having a vacuum imposed thereon so that it is opened for charging the tray with water.

The parts in the drawing are shown in their positions corresponding to the ice in the pockets 18 having been formed, and with the switch 52 having just closed in response to a temperature condition indicating that the ice cubes are solidly frozen and may be ejected. When the switch 52 closes, it completes the circuit energizing heater 54 and motor 26. The initial rotation of shaft 40 and cam 58 closes cycle switch 56 to insure that the motor will remain energized for a nearly full revolution of the cam even though thermostatic switch 52 opens.

During the initial rotation of the motor shaft 40 the control valve 36 is positioned in accordance with the A' segment of the cam 38. This connects the line 44 to the pump suction line 34 so that the pump 28 evacuates the air from the space 16 and pumps it through line 32 connected through the valve to line 48 and into the bladder 50. During this A' period the linear portions underlying the ice cubes are drawn down away from the surface of the ice cubes to obtain pre-release of the ice cubes. Pocket and tray structure for facilitating this pre-release is shown in FIGS. 3 and 4 and will be described later. As the cam 38 rotates past its initial A' position, the cam surface B positions the valve 36 to connect line 44 to pump discharge line 32, and to connect line 34 to line 48 leading to the bladder 50. Thus air is withdrawn from the bladder 50 and pumped into the space 16 underlying the liner to

invert the pockets to the dash-line positions and thus eject the ice cubes. Continued rotation of the cam 38 results in the cam surface A'' controlling the valve and again reverses the line positions so that the space 16 is evacuated with the air being pumped into the bladder 50. Thus the pockets 18 are brought back to a water receiving condition.

During the period that the cam surface C controls the valve 36, the connections through the reversing valve are essentially the same as in the A positions of the cam with the exception that the line 46 leading to the fill valve 22 is also connected to line 34 so that the vacuum produced in line 46 causes the valve 22 to open for a predetermined period to permit the water to be supplied to the pockets. Finally, the cam surface A''' controls the valve 36 position to continue the vacuum condition in the space 16 with the water valve closed. As the cam 38 approaches its stop position indicated, the cycle switch cam 58 flat 62 causes cycle switch 56 to open and terminate the cycle. The thermostatic switch 52 has of course also opened during the cycle in response to the heat from the heater 54.

Valve 36 may be of a character which permits leakage between the various ports. Thus, changes in atmospheric pressure result in leakage through the valve to or from the bladder 50 to compensate therefor without the changes substantially affecting the positioning of the liner 12. For example, a reduction of atmospheric pressure during the period the ice cubes are freezing does not result in the pockets moving up toward an ejecting position, but rather results in leakage through the valve 36 to cause the bladder 50 to expand instead.

FIG. 2 embodiment

In the arrangement of FIG. 2, the system is modified to avoid the dependence upon the time required for the thermostatic switch 52 to operate from a position closed against the cold contact to an open position. Where the parts of FIG. 2 are identical to those of FIG. 1, identical numerals are used.

The thermostatic switch 52 is provided with both a cold contact 64 and a back (warm) contact 66. The switch 52 may be of the snap-acting bimetal type.

Two cycle switches 68 and 70 are used instead of the single cycle switch of FIG. 1. Cycle switch 68 has a top contact 72 for connecting electrical line 74 to motor line 76 when the switch pole is in a top position, an intermediate contact position 78 in which the switch is open, and a lower contact position 80 which connects electrical line 82 (leading to cold contact 64 of switch 52) to motor line 76 when the pole is so positioned.

Cycle switch 70 has a top, open position contact 84 and a lower, closed position contact 86 which connects line 88 (leading to warm contact 66 of switch 52) to motor line 76 when the switch pole is in lower position.

Cycle switch 68 is controlled by cam 90 on gear reducer drive shaft 40. The surface of cam 90 has three levels as illustrated in the drawing with the outer radius surface holding the switch pole in the top contact 72 position, the middle radius surface dropping the switch pole to the intermediate contact 78 position, and the inner radius surface dropping the switch pole to the lower contact 80 position.

The second cycle switch 70 is controlled by cam 90 having one surface of greater radius holding the switch 70 pole in the top contact 84 position in which the switch is open, and another surface of lesser radius closing the switch to the bottom contact 86 position.

In the arrangement shown in FIG. 2 an electrically actuated fill valve 94 is used, instead of the pneumatically operated fill valve of FIG. 1. Accordingly, a cam 96 on shaft 40 is used to control a fill valve switch 98 which is held in a closed position for a predetermined period during the operating cycle to provide a timed water fill of the pockets 18.

The gas pumping system control valve 100 is simplified by elimination of the port required to connect the fill

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valve to a vacuum as in the case of FIG. 1, and the controll valve opening cam 102 has the C lobe omitted for the same reason.

The general cycle of operation of the FIG. 2 arrangement is similar to that of FIG. 1. When a charge of water in the ice tray pockets has frozen and the thermostatic switch 52 has cooled sufficiently, the switch 52 snaps from the warm contact 66 to the cold contact 64 to initiate a cycle of ejection and recharge. This energizes the motor 26 through line 82, switch 68 in its lower contact 80 position and motor line 76. Heater 54 is simultaneously energized. Switch 52 remains closed to the cold contact until the heater warms it sufficiently that it snaps to the warm contact. With the motor 66 energized, the cam 90 rotates to a position of large cam surface radius operating cycle switch 68 to the top contact 72 position which insures that the motor will remain energized when thermostatic switch 52 snaps to its warm contact position.

The control valve 100 controlled by cam 102 functions in substantially the same way as the valve of the FIG. 1 arrangement. The space 16 below the liner is evacuated during the A' segment of cam rotation to obtain pre-release of the ice cubes, then the liner 12 is inverted during the B segment, and the space 16 is then again evacuated to return the liner to the water-receiving condition during the A' segment.

After the tray has been evacuated and the pockets filled, cams 90 and 92 have rotated to positions in which second cycle switch 70 is closed to its lower contact 86 position, and first cycle switch 68 thereafter opens by dropping to its intermediate contacts 70 position. If the thermostatic switch 52 has not by this time snapped to its warm contact 66 position, the motor is deenergized until the switch closes to contact 66. If the switch has moved to the contact 66 position the motor is then energized through line 88, contact 86, and line 76. The motor then continues the remainder of its cycle until deenergized by cam 92 reaching its stop position and opening cycle switch 68. Simultaneously the pole of first cycle switch 68 drops its contact 80 position. The system is then in a condition to await cube freezing and the subsequent closing of thermostatic switch to cold contact 64 position to start another cycle.

It is noted with this arrangement the failure of the thermostatic switch 52 to move from its cold contact 64 to its warm contact 66 at the proper time does not restart the cycle, such as would occur if the thermostatic switch of FIG. 1 was still closed at the end of the cycle.

The showing of an electrically actuated water fill valve 94 with the cam operated actuating switch 98 (instead of the pneumatic fill valve of FIG. 1) is simply illustrative of a variation in the arrangement and has no direct functional relation to the dual cycle switches 68 and 70. Thus it will be appreciated that a pneumatically operated valve may be used in the FIG. 2 arrangement as conveniently as in the FIG. 1 arrangement.

In both arrangements the advantageous pre-release of the cubes before ejection is available and, in both, the preferred air system, as distinguished from a liquid system, may be used with the attendant advantages yielded thereby.

Pre-release of the cubes is promoted with a liner and tray arrangement including means for supporting cube portions against movement with the liner as the liner is being drawn away from the cubes. Two arrangements for giving this support are shown in FIGS. 3 and 4. In FIG. 3, the cavities of the tray 14 in which the liner pockets 18 loosely nest have a pair of upwardly directed dimples 19 on each lower side. The pocket in its unstressed, water receiving condition may rest on the crown of these dimples or be above the crowns. In either case an open space 21 exists between the major surface area of the cavity wall and facing pocket wall. When the pre-release suction is applied to the plenum space 16, this suction is communicated to the space 21 and the pocket

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wall is drawn into the space 21 starting near the upper periphery of the cube. The cube is supported by the dimples so that most of the pocket wall may be drawn away from the cube.

In the FIG. 4 arrangement, the liner 12 has channels 23 interconnecting adjacent pockets 18 molded therein. The tray 14 structure underlying the channels provides support for ice pieces formed in the channels, and thus for the cubes, when the pocket wall is drawn down away from the cube.

More detail as to the FIG. 4 arrangement structure may be found in Learn and Moreland commonly assigned U.S. patent application Ser. No. 652,866, entitled "Ice Cube Maker," filed simultaneously herewith, which also discloses additional information as to the type of material which may be used for the liner, and the order of pressures suitable for operation of a system according to my invention.

I claim as my invention:

1. An automatic icemaker comprising:

a tray;

a flexible mold liner having ice cube forming pockets therein overlying said tray to define an enclosed space between said liner and tray;

a pumping system connected to said enclosed space; means for filling said pockets with water to be frozen into ice cubes;

means for operating said pumping system to control pressure conditions in said space in a sequence of first exhausting from said space to place said liner in a water receiving condition and then, after said cubes are formed, exhausting from said space again to draw said liner away from the ice cubes formed in said pockets, and then pumping into said space to invert said pockets so that said cubes are ejected therefrom.

2. An icemaker according to claim 1 wherein:

said pumping system comprises a gas system closed to atmosphere and includes a variable volume storage bladder from which said gas may be drawn for inverting said liner and to which said gas may be pumped during the evacuation of said enclosed space between said liner and tray.

3. An icemaker according to claim 2 wherein:

said water fill means includes a water valve controlled in accordance with sequencing of said gas pumping system.

4. An icemaker according to claim 3 wherein:

said water valve comprises a gas pressure operated valve.

5. An icemaker according to claim 1 wherein:

said gas pumping system includes a single electric motor and a gas pump driven thereby when said motor is energized, cam means driven by said motor, and a three-position valve connected to said pump and to said enclosed space and controlled by said cam means, said three way valve having a first position for connecting said pump to said enclosed space to evacuate said enclosed space, a second position connecting said pump to said enclosed space for pressurizing said space, and a third position connecting said enclosed space to said pump for evacuation and simultaneously actuating said water fill means.

6. An automatic icemaker comprising:

a tray;

a flexible mold liner having ice cube forming pockets therein overlying said tray to define an enclosed space between said liner and tray;

a pumping system connected to said enclosed space;

means for filling said pockets with water to be frozen into ice cubes;

means for operating said pumping system to control pressure conditions in said space in a sequence of first exhausting from said space to place said liner in a water receiving condition and then, after said

cubes are formed, exhausting from said space again to draw at least portions of said liner away from the ice cubes formed in said pockets, and then pumping gas into said space to invert said pockets so that said cubes are ejected therefrom; and means for supporting at least selected portions of said cubes against movement with said liner as said liner is being drawn away from said cubes.

References Cited

UNITED STATES PATENTS

2,683,359	7/1954	Green	62—72	X
2,770,102	11/1956	Roedter	62—353	X

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