Aug. 11, 1964 E. T. MORTON ETAL 3,144,078

ICE CUBE MAKER AND STORAGE APPARATUS

Filed March 5, 1962 5 Sheets-Sheet 1

Fig. 1

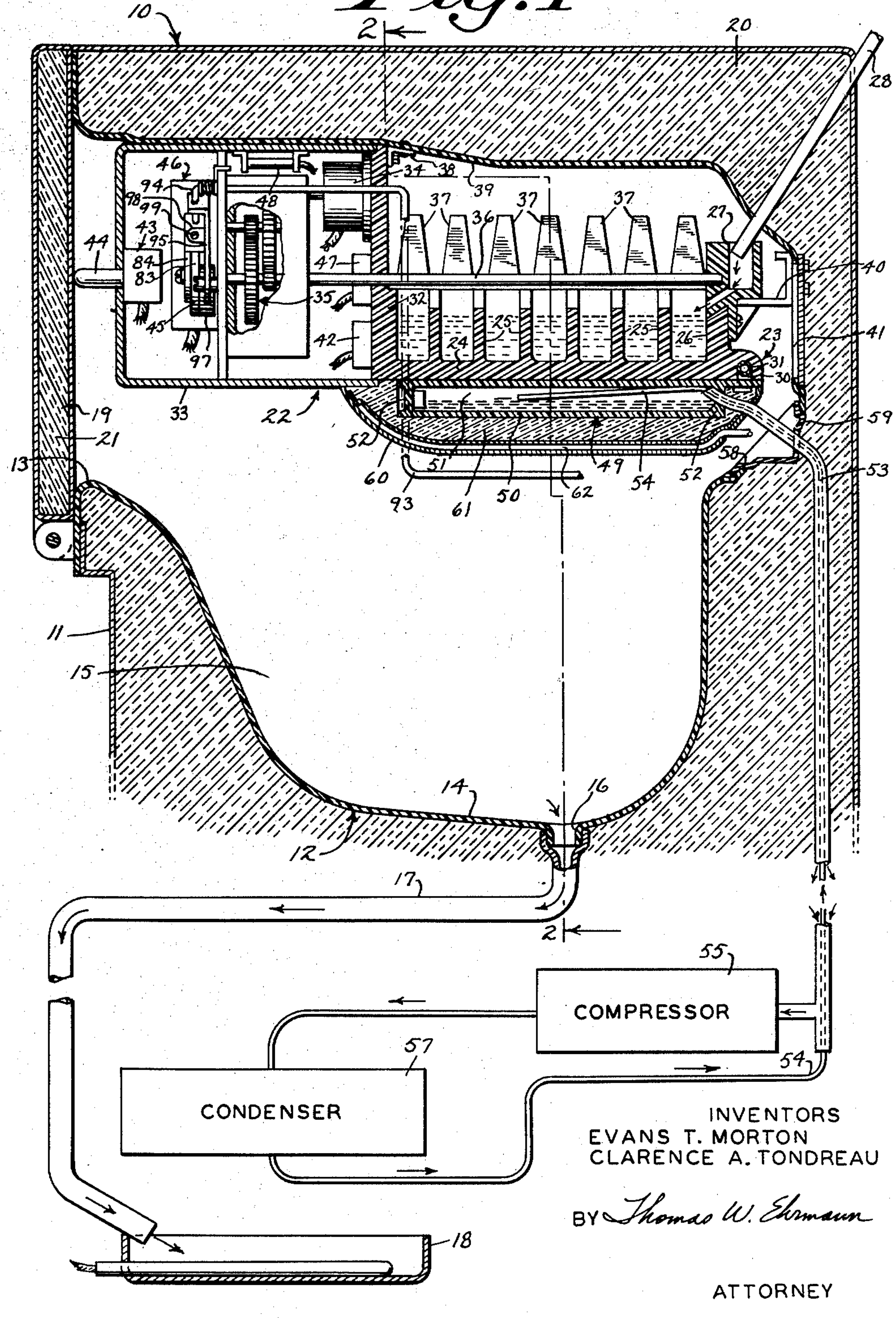

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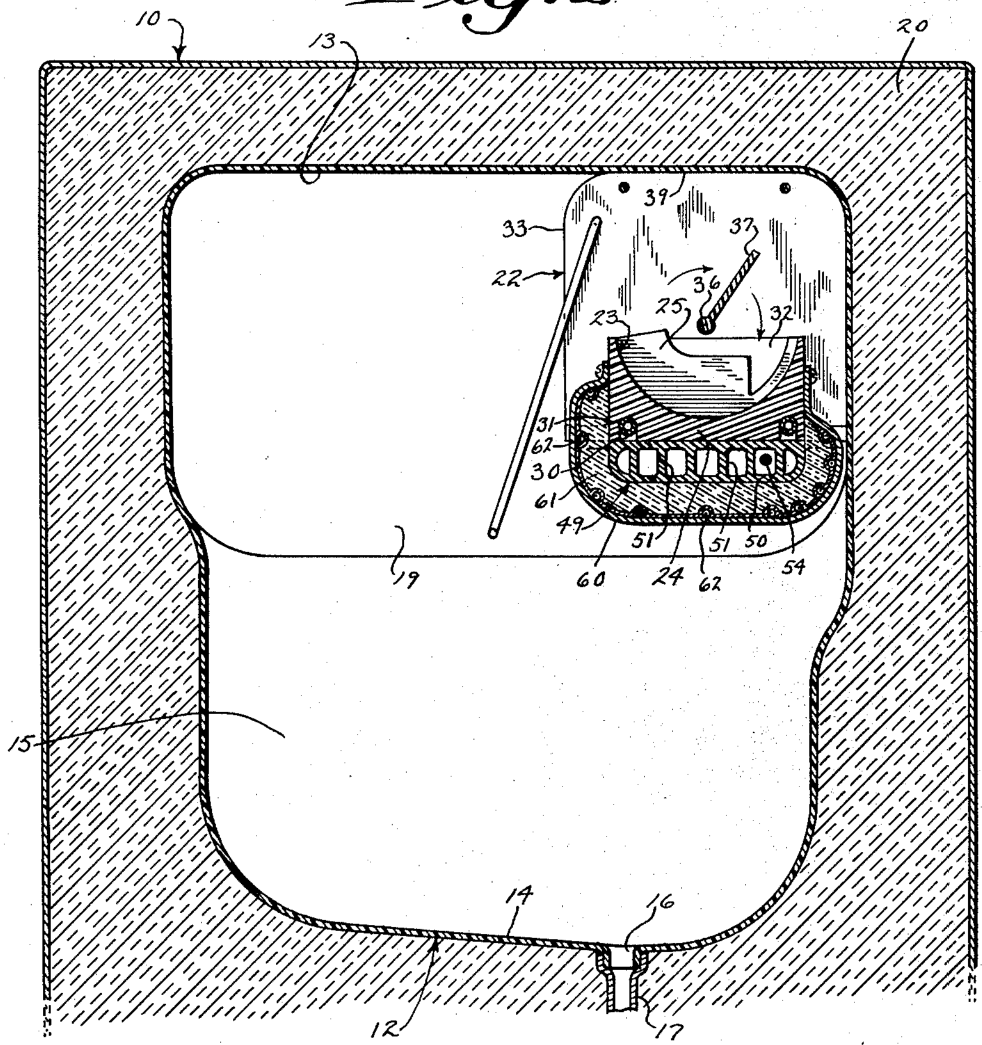
Fig. 2



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ICE CUBE MAKER AND STORAGE APPARATUS

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5 Sheets-Sheet 3

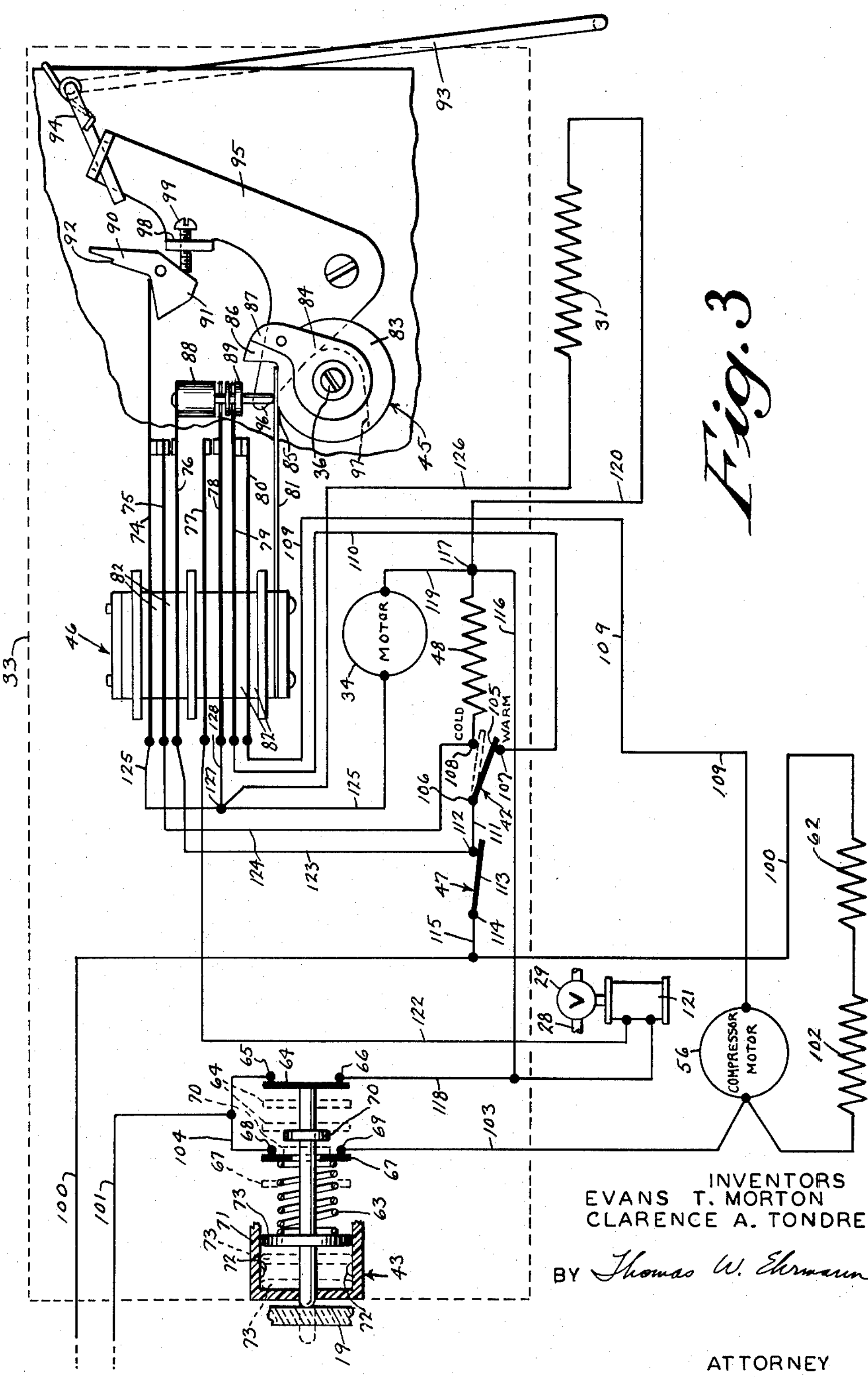

Fig. 3

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ICE CUBE MAKER AND STORAGE APPARATUS

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5 Sheets-Sheet 4

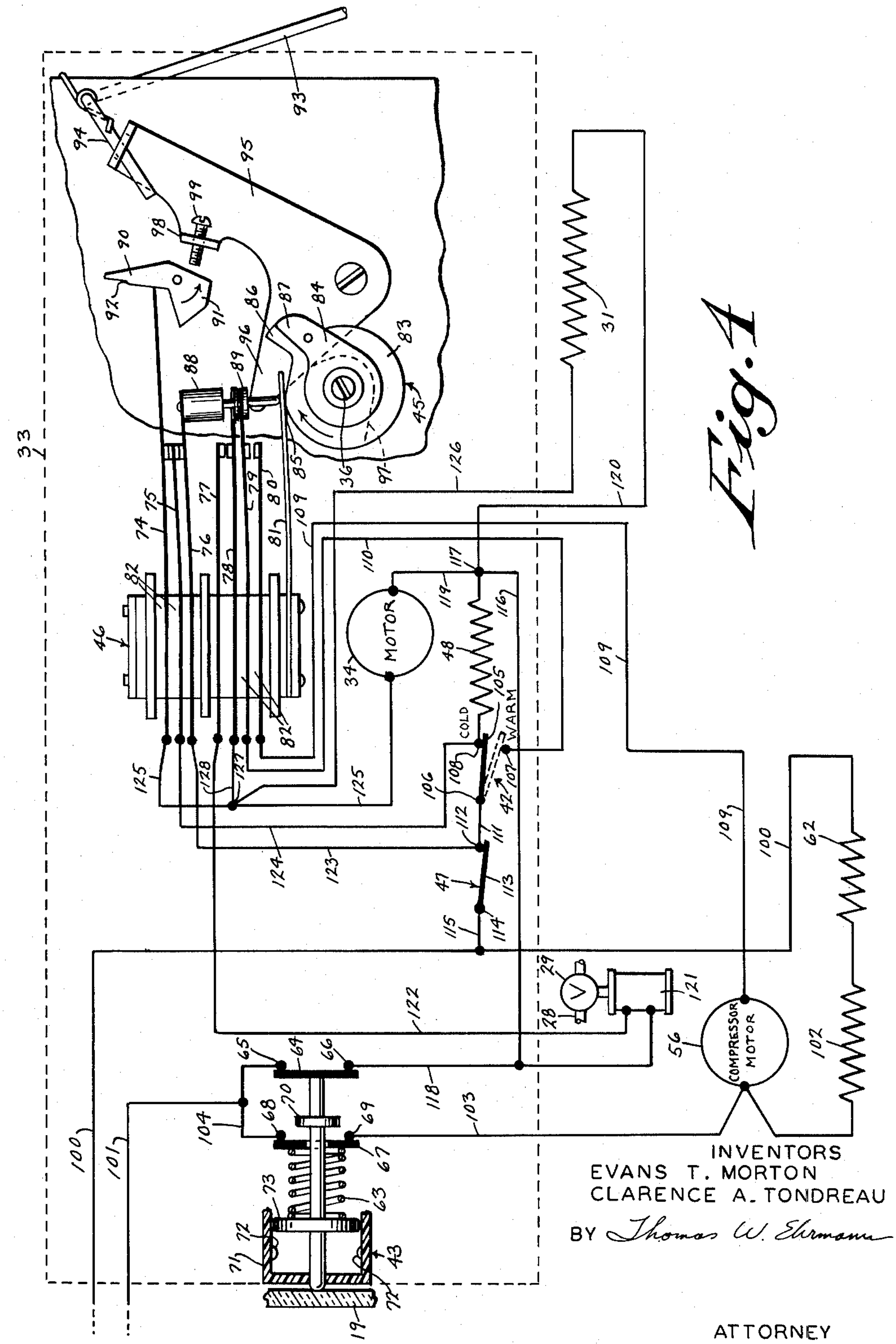

Fig. 4

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ICE CUBE MAKER AND STORAGE APPARATUS

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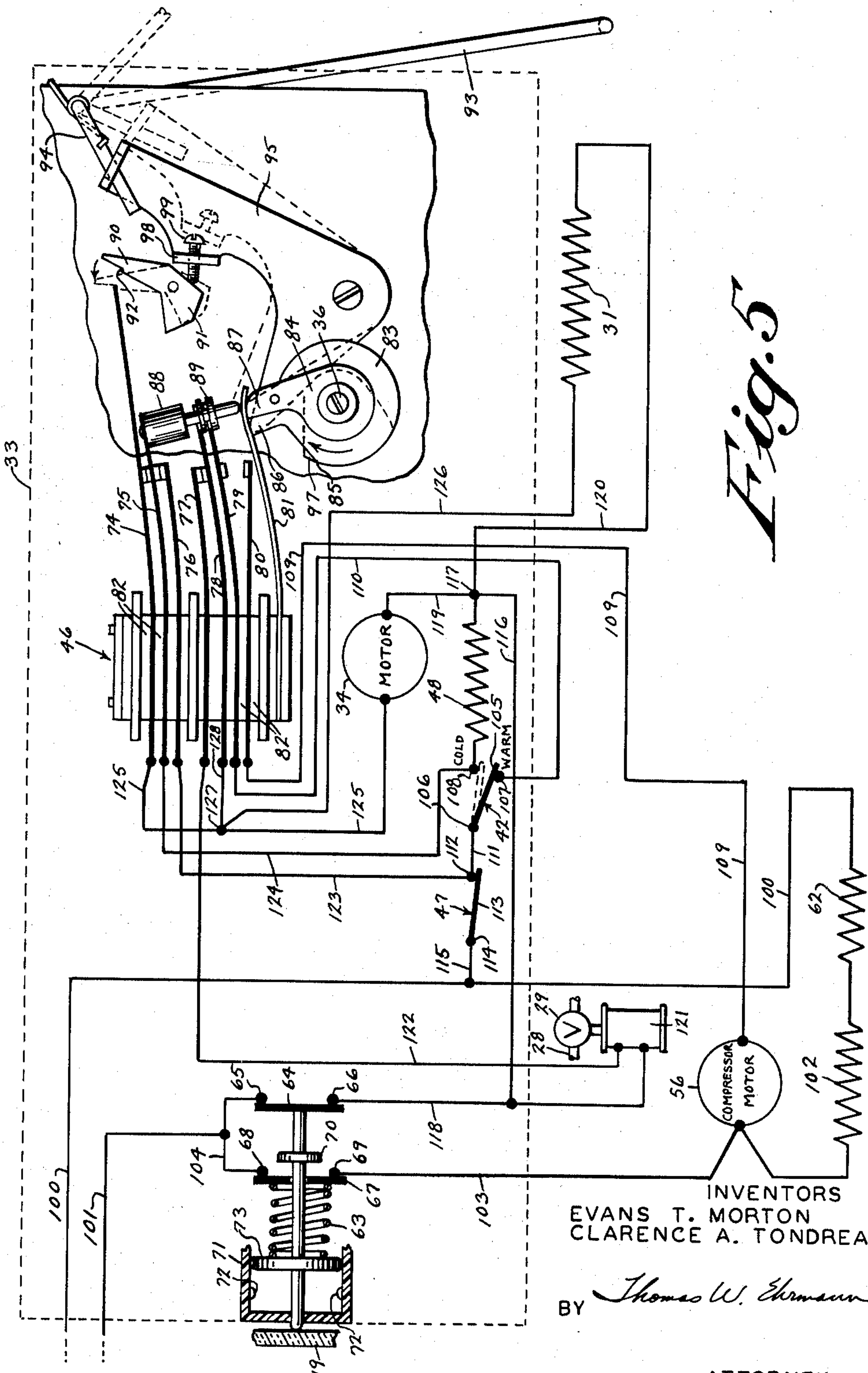

Fig. 5

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3,144,078
ICE CUBE MAKER AND STORAGE APPARATUS

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Filed Mar. 5, 1962, Ser. No. 177,532
5 Claims. (Cl. 165—30)

This invention relates to an ice cube maker and storage apparatus, and particularly to an apparatus having an enclosed, insulated tank including a storage area, an ice maker assembly disposed within said tank and which forms ice cubes and ejects the same into the storage area, and a refrigeration system for the ice maker assembly which is controlled by a single control means which also functions to control the temperature within the storage area.

Ice maker assemblies have been employed to produce a continuous supply of ice cubes in accordance with the demands of the consumer. The ice maker assemblies normally include an ice cube mold to which a metered water supply is connected for periodic filling of the mold. A refrigeration system is employed to lower the temperature of the water so introduced in to the mold and ultimately to freeze the same to form ice cubes. This is accomplished by attaching the evaporator of the refrigeration system to the ice cube mold. A mechanical ejector mechanism is also provided to harvest the formed ice cubes from the mold and to eject them to the exterior of the ice maker assembly. In order for the ejector mechanism to function easily without excessive strain being placed thereon, it is necessary to provide some means to loosen the ice cubes from the sides of the mold since the ice cubes at this stage are at a temperature substantially below the freezing point of water. This function of loosening the ice cubes is normally accomplished by heater means within the ice cube mold which, when energized, raises the temperature of the surface of the ice cubes to a level whereby there is a slight melting of the surfaces in contact with the mold, and this temperature is obviously at or near 32° F. This slight melting of the surface of the ice cubes within the mold permits easy removal of the ice cubes by the ejector mechanism.

Such ice maker assemblies have been employed within the freezer section of refrigerators. When so employed, the ice maker assembly acts as a parasite upon the freezer section since the ice maker assembly utilizes the refrigeration system for the freezer section to accomplish the necessary cooling of the ice cube mold. Generally, a control of such refrigeration system is provided for the freezer section to permit selection and maintenance of desired temperatures within the freezer section, and a separate control is provided for the ice maker assembly to control the cube forming and ejecting cycle. Ice cubes formed by the ice maker assembly are generally stored within an enclosure associated with the ice maker assembly and which is in reality a part of the freezer section. As has been noted above, the surfaces of the ice cubes, when ejected from the ice maker assembly, are at a temperature at or slightly above the freezing point and have melted slightly. When such ice cubes are introduced into the freezer section, which is at a temperature well below the freezing point of water, there is a tendency for the ice cubes to freeze to one another. The result is that instead of the desired ice cubes, a mass of ice is formed from which individual cubes must be forcibly removed. A further potential cause of freezing together of the ice cubes exists when the freezer section door is opened. The warm air which enters will produce condensation on the surfaces of the ice cubes stored within the freezer section and, after the door is closed,

the low temperature within the freezer section will freeze the water condensed on the ice cubes.

On the other hand, if the ice maker assembly is employed in an atmosphere of a temperature well above the freezing point of water, the ice cubes formed will melt excessively, although the problem of the ice cubes freezing to each other will have been minimized. Excessive melting of the formed ice cubes is as much to be discouraged as the tendency to freeze together, since this destroys the entire purpose of the ice maker assembly.

In comparison, the novel apparatus of this invention effectively eliminates the above problems by maintaining the temperature within a storage area for the ice cubes at a level equal to or slightly above the freezing point of water so that melting is minimal and there is little tendency for the ice cubes to freeze to one another. This is accomplished simply, efficiently and at a minor cost without recourse to multiple refrigeration systems or multiple temperature controls.

It is, therefore, a principal object of this invention to provide an ice cube making and storage apparatus which insures that ice cubes formed and thereafter stored within the apparatus will not freeze together, while at the same time minimizing melting of the ice cubes.

To accomplish the above object, the apparatus of this invention includes an insulated storage area which has no external source of cooling. The ice maker assembly is mounted within the insulated storage area and, therefore, the ice cube mold and the attached evaporator of a refrigeration system are disposed within the storage area. Ice cubes manufactured by the ice maker assembly and thereafter ejected into the storage area proper will be at a temperature approximately that of the freezing point of water due to the heater means provided in the ice cube mold; the surfaces of such cubes slightly above freezing and the centers of the cubes slightly below freezing. The ice cubes in the storage area will tend to keep the temperature within the storage area at or slightly above freezing, and thereby achieve the desired temperature conditions. However, it is obvious that it is impossible to perfectly insulate the storage area from its environment and, therefore, it is desirable to provide for cooling of the storage area when necessary to prevent excessive melting of the ice cubes. Such auxiliary cooling of the storage area is accomplished by the refrigeration system for the ice maker assembly through the medium of the ice cube mold and is controlled by the control for the refrigeration system within the ice maker assembly. Thus, a single refrigeration system is employed for cooling of the ice maker assembly and auxiliary cooling of the storage area and a single control of the refrigeration system is employed for both the ice maker assembly and the storage area.

Means are also provided to insure that the evaporator attached to the ice cube mold does not lower the temperature within the storage area to a level where freezing of the ice cubes to each other will occur. To this end the evaporator is insulated from the storage area and a heater means is provided at the exterior of such insulation adjacent the storage area to eliminate the cooling effect of the evaporator upon the storage area except as it may be transmitted to the storage area by the exposed surfaces of the ice cube mold.

Accordingly, it is another object of this invention to provide an ice maker and storage apparatus including a single refrigeration system having a single evaporator for forming the ice cubes and for auxiliary cooling of an enclosed, insulated storage area.

It is a further object of this invention to provide an ice maker and storage apparatus having a single control of a refrigerating system which controls both the ice cube forming temperature of an ice maker assembly and the temperature within an enclosed, insulated storage area as well as the ice maker ejection cycle.

The foregoing and other objects and advantages of this invention will appear in the description to follow. In the description, reference is made to the accompanying drawings which form a part hereof and in which there is shown by way of illustration a specific form in which this invention may be practiced. This form will be described in detail to enable those skilled in the art to practice this invention but it is to be understood that other embodiments of the invention may be used and that changes in the embodiment described may be made by those skilled in the art without departing from the true scope of the present invention. Consequently, the following detailed description is not to be taken in a limiting sense and the scope of the present invention is best defined by the appended claims.

In the drawings:

FIG. 1 is a partial view in vertical cross section of the ice cube maker and storage apparatus of this invention, with portions of said apparatus being shown diagrammatically;

FIG. 2 is a view in vertical cross section taken in the plane of the line **2—2** of FIG. 1;

FIG. 3 is a diagrammatic view of the circuits for an ice maker assembly and a refrigeration system, the view showing the position of controls when the ice cube mold is in a warm condition calling for refrigeration;

FIG. 4 is a view similar to that of FIG. 3, but showing position of controls after the ice cubes have been formed and are about to be ejected from the mold; and

FIG. 5 is a view similar to those of FIGS. 3 and 4, but showing the position of controls toward the end of a complete ice forming and ejecting cycle.

Referring to the drawings and particularly to FIGS. 1 and 2, the ice cube maker and storage apparatus of this invention may be mounted within a free standing enclosure **10** fabricated of steel and provided with a vinyl coating on its exterior surfaces. The upper portion of a front wall **11** of the enclosure **10** is open, and an inner tank **12** is disposed within the enclosure **10**. The front of the tank **12** is provided with an opening **13** which permits access to the interior of the tank and the opening **13** registers with the opening in the front wall **11** of the enclosure **10**. The tank **12** is preferably formed from a suitable plastic which may be readily cleaned and is preferably molded as an integral unit from a single sheet as by blow molding. The tank **12** is formed with a bottom wall **14** at an elevation substantially below the lower edge of the opening **13** to provide a depending bin portion **15** which constitutes a storage area. The bottom wall **14** of the inner tank **12** slopes gradually towards a drain outlet **16** to which is connected a drain pipe **17** which leads to an evaporation pan **18**. The opening **13** as well as the opening in the enclosure **10** is closed by a door **19** hinged upon the enclosure and which is urged normally into a closed position by a suitable spring assembly (not shown). Insulation **20** is packed about the inner tank **12** between the tank **12** and the enclosure **10**. The door **19** is likewise provided with insulation **21** in its interior cavity. Thus, in normal operation with the door **19** closed, the tank **12** functions as an enclosed insulated container.

An ice maker assembly designated generally by the reference numeral **22** is mounted within the insulated inner tank **12**. The general construction of the ice maker assembly is known in the art and includes a die cast ice cube mold **23** having a relatively thick bottom wall **24** and which is divided by partitions **25** to form independent cavities for the molding and freezing of ice cubes. A rear wall **26** of the ice cube mold **23** supports a trough **27** having water passages which open into the mold **23**. The open end of the water supply line **28** is received within the trough **27** so that water flowing through the line **28** will be introduced into the individual cavities within the mold **23**. Control of the flow through the water supply line **28** is provided by a solenoid operated valve **29** within the line **28** as shown in FIGS. 3–5. The bottom wall **24** of the mold **23** is provided with a U-shaped groove **30** which receives an electric mold heater **31** which, when energized, warms the mold to loosen the ice cubes formed therein.

A front wall **32** of the mold **23** supports a casing **33** in which is housed an electric motor **34** which functions as part of an ejector mechanism. The output shaft of the motor **34** is connected through reduction gearing **35** to an ejector shaft **36** which is journaled through the front wall **32** of the mold **23** and which is received within a bore provided in the trough **27** so that the shaft **36** extends over the length of the mold **23**. A series of spaced blades **37** are secured or formed upon the ejector shaft **36** and the blades **37** sweep through the individual cavities in the mold **23** during a revolution of the shaft **36** under the driving force of the motor **34**.

The ice maker assembly **22** is mounted within the tank **12** and to one side thereof by a mounting bracket **38** which is secured to a top wall **39** of the tank **12** and an extending portion of the trough **25** rests upon a second bracket **40** which is affixed to a rear wall **41** of the tank **12**. By mounting the ice maker assembly **21** in this manner it is possible to assemble the apparatus of this invention by sliding the ice maker assembly **22** into place within the tank **12**.

The ice maker assembly **22** also includes a thermostat operated switch **42** disposed within the casing **33** and attached to the front wall **32** of the mold **23** so that the switch **42** is responsive to the temperature of the mold **23**. A door controlled switch **43** is mounted on the front wall of the casing **33** and includes a plunger **44** which projects through the opening **13** where it is engaged by the door **19**. A cam assembly **45** is attached to the front end of the ejector shaft **36** exterior of the reduction gearing **35** and the cam assembly **45** functions to operate certain leaves of a combination leaf spring switch **46** also disposed within the casing **33**. A thermostat operated limit switch **47** is also mounted within the casing **33** to protect against overheating of the motor **34**, and a casing heater **48** is provided to prevent a build-up of moisture within the interior of the casing **33**.

A refrigeration system is provided for the apparatus, and the refrigeration system includes a novel combination evaporator-accumulator **49** which is attached directly to the bottom wall **24** of the mold **23**. The evaporator-accumulator **49** includes an outer housing **50** and a plurality of vertical partitions **51** which may be formed integral with the housing **50** by an extrusion process. Portions at each end of the partitions **51** are removed and front and rear closure plates **52** are secured within the outer housing **50** to completely enclose the evaporator-accumulator **49**. The removed portions of the partitions **51** form passageways between the individual cells formed by the partitions **51**. The open ends of a return suction line **53** and a capillary inlet line **54** extend within the evaporator-accumulator **49** through an opening in the rear closure plate **52** of the evaporator-accumulator **49**. For the sake of convenience and the saving of space, the capillary line **54** is carried within the return suction line **53**. The terminal locations of the lines **53** and **54** in the evaporator-accumulator **49** can be readily seen by reference to FIG. 1. The refrigeration system also includes a compressor **55** having a motor **56**, which may be mounted within the enclosure **10**. The suction line **53** communicates with the intake of the compressor **55** and the outlet of the compressor communicates with a condenser **57**, the outlet of which is the capillary line **54**.

The condenser **57** may take the form of a serpentine air-cooled tubing affixed to the exterior of the rear wall of the enclosure **10**. Variable load operation of the refrigeration system is achieved by on-off operation of the compressor **55**. This is, the greater the refrigeration load as determined by temperature requirements, the smaller will be the off intervals of time for the compressor motor 56.

The suction line 53 and capillary line 54 extend upward through the insulation 20 and through an opening 58 provided in the rear wall 41 of the tank 12. The opening 58 in the tank 12 is closed by a suitably conforming plate 59 of like material to that of the inner tank 12.

An evaporator insulation assembly which includes a thin plastic housing 60 completely surrounds the evaporator 49 and the housing 60 is secured to the mold 23. Insulation 61 is provided within the housing 60 in contact with the outer surfaces of the evaporator 49. A balancing heater 62 is disposed within the housing 60 along the inner surface thereof, and the purpose of such balancing heater 62 will become apparent hereafter.

Referring to FIGS. 3–5, the door controlled switch 43, as indicated, includes a longitudinally movable plunger 44 which is normally pressed outwardly by an expansion spring 63 coiled about the plunger 44. When the door 19 is in an open position, the plunger 44 is moved outward by the spring 63 and when the door 19 is closed the plunger 44 is moved inward by the pressure of the door 19 against the same. The extreme inner end of the plunger 44 is provided with a bridge disc 64 and when the plunger 44 is moved inward by the door 19 this disc 64 bridges a pair of spaced contacts 65 and 66. At a point spaced from the disc 64 is an annular bridge disc 67 which normally engages a second pair of spaced contacts 68 and 69 under the action of the spring 63. Rigidly secured to the plunger 44 between the discs 64 and 67 is an actuating head 70. The plunger 44 reciprocates within a guide housing 71 provided with stop lugs 72. Upon the opening of the door 19 the plunger 44 moves outwardly until the same is stopped by the engagement of a washer 73 with the lugs 72. At this time, the disc 64 is moved away from the contacts 65 and 66 and the actuating head just engages the annular disc 67 but does not break the connection with the contacts 68 and 69. However, the plunger 44, when the door 19 is opened, can be pulled manually outwardly to move the washer 73 past the lugs 72 and at this time the actuator head 70 will move the annular disc 67 away from the contacts 68 and 69 thereby breaking the connection thereacross.

It will be seen, therefore, that there are three possible positions for the door controlled switch 43. When the door 19 is closed, the pairs of contacts 65 and 66, and 68 and 69 are bridged. When the door is opened, the disc 64 is removed from engagement with the spaced contacts 65 and 66 and only the contacts 68 and 69 are bridged. Finally, when the plunger 44 is pulled outward the pairs of contacts 65 and 66, and 68 and 69 are both disconnected.

The combination switch 46 includes resilient switch leaves 74, 75, 76, 77, 78, 79 and 80 and a cam follower leaf 81. All of the leaves 74 through 80 are insulated one from the other and are mounted in superimposed relation between blocks or strips of insulation 82. As shown in FIG. 2, the leaves 74 and 75 are provided with normally closed contacts and the leaf 76 is provided with a contact normally opened with a second contact of the leaf 75. Similarly, the leaves 77 and 78 include normally opened contacts and the leaves 79 and 80 are provided with normally closed contacts. The cam assembly 45 operates to actuate certain leaves of the combination switch 46 and the cam assembly 45 includes a main cam 83 and a supplemental cam 84. The main cam 83 and supplemental cam 84 are secured to the ejector shaft 36 and the main cam 83 is provided with an actuator lobe 85 and an extreme high actuator lobe 86. The cam 84 is likewise provided with an extreme high actuator lobe 87 which functions as a continuation of the lobe 86 of the main cam 83. The supplemental cam 84 is pinned to the main cam 83 so that the two cams rotate as a unit. Since the supplemental cam 84 is pinned to the main cam 83 it may be adjusted within certain limits so as to lengthen or shorten the throw of the lobe 86.

The follower leaf 81 of the combination switch 46 extends over the periphery of the main cam 83 and is adapted to be actuated by the lobes 85 and 86 thereof as well as by the lobe 87 of the supplemental cam 84. The leaves 76, 78 and 79 of the combination switch 46 extend beyond the leaves 75, 77 and 80 and the leaf 76 carries an actuating rod 88 which slidably extends through the leaves 78 and 79. The actuating rod 88 is provided with a rigid lift 89 which is adapted to engage and raise the leaves 78 and 79 under certain conditions. The leaf 74 extends beyond all of the other leaves toward a pivoted catch 90. The pivoted catch 90 is provided with a weighted tail portion 91 and has a latch seat 92 formed adjacent its upper end. The catch 90 forms a part of a sensing mechanism for determining the height of formed ice cubes in the tank 12.

This sensing mechanism includes a pivoted arm 93 which sweeps the storage area of the tank 12 and is adapted to be restrained in its sweeping motion when the level of the ice cubes within the tank 12 reaches a height which interferes with its path. The upper end of the pivoted arm 93 is provided with a crank 94 which is operatively connected to a bell crank shaped lever 95 pivotally mounted at its bend to the housing for the reduction gearing. The lever 95 is provided with a tail portion 96 that rides on an actuator lobe 97 forming a part of the main cam 83. The upstanding arm of the lever 95 carries a lip 98 which is provided with an adjustable screw 99 for actuating the catch 90.

A pair of power lines 100 and 101 lead into the apparatus from any suitable source of electrical energy. The line 100 is connected to one side of the balancing heater 62 which in turn is connected serially with an electric heater 102 disposed within the pan 18 to evaporate water which drains into the pan 18. The other end of the electric heater 102 is connected to a return conductor 103 which connects to one terminal of the compressor motor 56 and thence to the contact 69. The second power lead 101 is connected to a bridging conductor 104 which is connected across the contacts 68 and 65 of the door controlled switch 43.

The thermostat operated switch 42 may be of any desired type or character and in the embodiment being described the switch 42 includes a bimetallic contact arm 105 provided with a terminal post 106, and the arm 105 is movable between a first contact 107 to a second contact 108 depending upon the temperature of the mold 23 to which the thermostat controlled switch 42 is attached. When the mold reaches a certain preselected high temperature, for example within the range of 21°–31° F., the arm 105 moves to the first contact 107 and this contact is designated as "warm." When the mold reaches a preselected low temperature, for example within the range of 9°–13° F., then the arm 105 moves to the second contact 108 and this contact is designated as the "cold" contact.

The second terminal of the compressor motor 56 is connected through a conductor 109 to the leaf 80 and through the leaf 79 to a conductor 110 which connects with the warm contact 107 of the thermostat controlled switch 42. The terminal post 106 on the movable arm 105 of the switch 42 is connected through a conductor 111 to one contact 112 of the limit switch 47. The limit switch 47 functions to operate only, should for some reason, the temperature in the casing 33 rises to an extreme undesirable limit, for example 135° F., indicating that there is a malfunction in the apparatus. The limit switch 47 is also of the thermostat controlled type and may include a bimetallic switch arm 113 movable to an off and an on position from the contact 112. One end of the arm 113 constitutes a contact or binding post 114 which is connected to the power line 100 through a conductor 115. One terminal of the casing heater 48 is connected to the cold contact 108 of the thermostat controlled switch 42. The opposite terminal of the casing heater 48 is connected to a conductor 116 at a junction point 117, and the conductor 116 connects to a conductor 118 which in turn is connected to the contact 66 of the door controlled switch 43. One terminal of the ejector mechanism motor 34 is connected to the conductor 116 at the junction point 117 by a conductor 119 and one terminal of the mold heater 31 is likewise connected to the conductor 116 at the junction point 117 through a conductor 120.

The terminals of a solenoid 121 for the solenoid operated water control valve 29 have connected thereto conductors 118 and 122. Conductor 122 is connected to the leaf 77 of the combination switch 46 and, as indicated above, the conductor 118 is connected to the contact 66.

A conductor 123 leads from the contact 112 of the limit switch 47 to the leaf 76 and the leaf 75 through a conductor 124 is connected to the cold contact 108 of the thermostat controlled switch 42. A second terminal of the ejector mechanism motor 34 is connected through a conductor 125 to the leaf 74. A second terminal of the mold heater 31 is likewise connected to the conductor 125 through a conductor 126 at a junction point 127 and the leaf 78 is connected to the conductors 125 and 126 by a conductor 128 at the junction point 127.

Let it be assumed that the door 19 is closed and the plunger 44 of the door controlled switch 43 is forced inwardly as shown in FIGS. 3, 4 and 5, and further that the ice cube mold 23 has been filled with water. The mold 23 will be warm because of the introduction of the water into the mold 23 and the arm 105 of the thermostatic controlled switch 42 will then engage the warm contact 107. As no abnormal high temperature is reached in the casing 33, the limit switch 47 is in its closed position. The freezing cycle for the water that is presently in the mold 23 may now begin.

With the door 19 closed, the contacts 65 and 66 and the contacts 68 and 69 of the switch 43 are bridged by the discs 64 and 67, respectively, thereby completing a circuit from the power line 101 to both the conductor 103 and the conductor 118. The compressor motor 56 under these conditions will be energized through a completed circuit which includes the power line 101, the switch 43, the conductor 103, the motor 56, the conductor 103, the closed contacts of the leaves 79 and 80, the conductor 110, the switch 42, the conductor 111, the limit switch 47, the conductor 115 and thence to the second power line 100. Since the compressor motor 56 has been energized, the refrigeration system may now function in its normal manner. That is, the compressor 55 withdraws the refrigerant vapor from the upper levels of the evaporator-accumulator 49 and draws such vapors through the suction line 53. The compressor 55 increases the pressure of the refrigerant vapor until at the discharge of the compressor 55 the refrigerant has a saturation temperature sufficiently high so that it may be condensed. This high pressure refrigerant vapor is then forced through the condenser 57 and the liquid refrigerant is then forced from the condenser 57 through the capillary line 54 into the evaporator 49 where it will be disposed in the lower portions of the evaporator 49. As is well known, in the evaporator 49 the liquid refrigerant absorbs the heat from the mold 23 as heat of vaporization thereby changing the liquid refrigerant to a vapor and cooling the mold 23. The novel evaporator-accumulator 49 of this invention functions not only as a normal evaporator but also as an accumulator to accommodate changing quantity demands of the refrigeration system. For example, it may require a greater amount of refrigerant in the evaporator 49 to produce freezing of the contents depending upon the temperature of the contents. The evaporator-accumulator 49 is designed to accommodate such varying amounts. In the above manner, the water within the individual cavities of the mold 23 is frozen to form ice cubes.

Simultaneously, the pan heater 102 and the balancing heater 62 are energized through a completed circuit which includes the power line 101, the switch 43, the conductor 103, and finally the second power line 100. Therefore, the pan heater 102 can evaporate any water in the pan 18 resulting from minor melting of the ice cubes in the tank 12. The function of the balancing heater 62 will be described hereafter. Since the thermostat controlled switch 42 is not in contact with the cold contact 108 at the initiation of the freezing cycle, current flow is prevented through the casing heater 48, the ejector mechanism motor 34, and the ice cube mold heater 31.

When the temperature of the ice cube mold 23 is reduced to a predetermined level indicating that the freezing cycle has been completed, such low temperature is sensed by the thermostat operated switch 47 and the switch arm 105 moves to the cold contact 108. This immediately opens the circuit through the compressor motor 56, and the compressor 55 can no longer function and the refrigeration system is dormant since it is no longer needed for the freezing of the water. However, the pan heater 102 and the evaporator heater 62 remain energized and continue performing their necessary functions. At the same time, the ejector mechanism motor 34 is energized through a closed circuit which includes the power line 101, the switch 43, the conductor 118, the conductor 116, the junction point 117, the conductor 115, the motor 34, the conductor 125, the normally closed contacts of the leaves 74 and 75, the conductor 124, the switch 42, the conductor 111, the limit switch 47, the conductor 115, to the second power line 100. The casing heater 48 is also energized since it is connected across the cold contact 108 of the switch 42 and the junction point 117, both of which points are in the previously described closed circuit for the motor 34. Likewise, the mold heater 31 is energized to loosen the ice cubes in the mold 23 since the heater 31 is connected across the junction point 117 and the conductor 25 at the junction point 127 and both of these junction points are in the closed circuit to the motor 34.

Once the ejector motor 34 has been energized, it will cause the ejector shaft 36 to rotate thereby carrying the blades 37 through the individual cavities of the mold 23 to eject the ice cubes from the mold 23 into the tank 12. If the blades 37 turn and reach the ice cubes and the ice cubes have not been sufficiently loosened from the mold 23 by the mold heater 31, the motor 34 will stall and the ejector shaft 36 will not rotate. However, the mold heater 31 will remain energized until the ice cubes are sufficiently loosened at which time the blades 37 can continue their rotation to eject the ice cubes. As the shaft 36 is rotating under the action of the motor 34, the cam assembly 45 will rotate. Initial rotation of the cam 83 will cause the follower leaf 81 to ride up upon the first lobe 85 thereby causing the actuator rod 88 to rise upward to complete a contact between the leaves 75 and 76 and at the same time to break the contact between the leaves 79 and 80. This has the effect of insuring that should the thermostat controlled switch 42 sense a high temperature in the mold 23 the movement of the switch arm 105 to the warm contact 107 will not cause the motor 34 to be deenergized, and furthermore will not reenergize the compressor motor 56 until an entire cycle has been completed. This is accomplished by removing the thermostat controlled switch 42 from the operative circuits in that closing of the contacts of leaves 75 and 76 bridges the thermostat controlled switch 42 and alternate closed circuits to the ejector mechanism motor 34, the casing heater 48 and the mold heater 31 are provided. At the same time, opening of the contacts of the leaves 79 and 80 causes an open circuit in the energizing circuit for the compressor motor 56 thus insuring that the refrigeration system will not be set in operation while the mold heater **31** is energized so as to prevent interference between the refrigeration system and the heater **31**.

As long as the ejector mechanism motor **34** is energized it will continue to rotate the shaft **36** and consequently the cam assembly **45** will also continue to rotate. When the extreme high lobes **86** and **87** of the cams **83** and **84**, respectively, ride under the actuator leaf **81** the leaves of the combination switch **46** are disposed as shown in FIG. 5. The leaf **74** is in its highest position and in a position to be engaged on the latch seat **92** of the catch **90** should the arm **93** be restrained by the ice cubes within the tank, as will be later set forth. The contacts of the leaves **77** and **78** will be closed and this completes a circuit through the solenoid **121** of the valve **29** so that the valve **29** is opened and water will flow into the ice cube mold **23**. The closed circuit through the solenoid **121** is as follows: power line **101**, switch **43**, conductor **118**, the solenoid **121**, conductor **122**, closed contacts of the leaves **77** and **78**, conductor **128**, conductor **125**, motor **34**, to the junction point **117** from which the circuit is closed to the second power line **100** either through the thermostat controlled switch **42** or by bridging the switch **42** as indicated above. The relative position of the high lobes **86** and **87** of the cams **83** and **84**, respectively, to one another controls the length of time the circuit is closed to the solenoid **121** and the cams **83** and **84** may be set relative to one another so that the exact desired amount of water can be delivered into the mold **23**.

The ejector mechanism motor **34** remains in operation until the high lobes **86** and **87** of the cam assembly **45** ride past the follower leaf **81**, at which time the follower leaf **81** returns to the lowest position on the cam **83** as shown in FIG. 2. At this time the contacts of the leaves **80** and **81** return to their normal closed position and the compressor motor **56** may be energized since the thermostat control switch **42** will have returned to its warm contact position due to the mold heater **31**. Furthermore, the motor **34**, the mold heater **31** and the casing heater **48** will no longer be deenergized.

The continuous cycle of filling with water, freezing and ejection continues until the ice cubes deposited within the tank **12** reach a level where they obstruct the normal sweeping motion of the arm **93**. As the cam assembly **45** rotates under the driving force of the ejector mechanism motor **34**, the lever **95** is caused to rotate clockwise initially thereby carrying the arm **93** upward. At the same time, the weight of the tail portion **91** of the catch **90** tends to swing the tail portion in the direction of the screw **99**. As the cam assembly **45** continues to rotate, the lever **95** will be caused to rotate counterclockwise thereby carrying the arm **93** downward. Should the level of ice cubes within the tank **12** be high enough to arrest the sweeping movement of the arm **93**, the lever **95** will be retained in a position in which the screw **99** does not contact the catch **90**. When the leaf **74** is lifted by the high lobes **86** and **87** raising the actuator rod **88**, the leaf **74** will be in position to be engaged by the latch seat **92** of the catch **90** and the catch **90** will not be pivoted to release the leaf **74** since the screw **99** of the lever **95** is prevented from contacting the catch **90**. When the arm **82** is raised the bell crank **84** is moved away from the weighted scale of the latch **78** and the latch swings on its pivot so that the seat moves under the leaf **60** as the motor continues its rotation to complete its cycle. Then, when the motor **34** is deenergized upon completion of the ejection cycle, it cannot thereafter be energized since the circuit to the motor **34** cannot be completed because of the open contacts of the leaves **74** and **75**. For the same reason the mold heater **31** cannot be energized. Thus, the supply of ice cubes will cease. However, the removal of ice cubes from the tank **12** as they are consumed will lower the level of the ice cubes and permit the arm **93** to return to a lowered position thereby causing the screw **99** to rotate the catch **90** and releasing the leaf **74** from the latch seat **92**.

In the event that the limit switch **47**, which is thermostatically controlled, is moved to an open position indicating an abnormally high temperature within the ice maker assembly **22**, the circuit to all elements is opened and only the circuit through the pan heater **102** and balancing heater **62** remain closed.

When the door **19** is opened, the disc **64** is moved away from contacts **65** and **66** thereby breaking the circuit to the conductor **118** and current flow to the motor **34**, the mold heater **31** and the casing heater **48** is shut off. Hence no injury can be caused to a person placing his hand in the tank **12** and in the path of the ejector blades **37**. However, the circuit through the compressor motor **56** will be maintained when the door **19** is opened and, therefore, the compressor motor **56** remains in operation and continues to effect cooling of the ice cube mold. By maintaining the compressor motor **56** in operation though the door **19** be open, not only is the refrigeration continued but constant starting and stopping of the compressor **55** is eliminated.

Now considering that it is desirable to clean out the ice compartment and to air the ice compartment with the door **19** open, the plunger **44** of the switch **43** may be pulled outward to move the disc **67** away from the contacts **68** and **69** thereby opening all circuits to the ice maker assembly **22** and to the refrigeration system. Thus, the interior of the tank **12** may be cleaned and aired.

The casing heater **48** functions to reduce the accumulation of moisture within the casing **33** which would have a very undesirable effect upon the mechanism contained within the casing **33**. As indicated above, the casing heater **48** is energized while the ejection of ice cubes from the mold **23** takes place. Furthermore, when the tank is filled with ice cubes thereby preventing energizing of the ejector motor **34** and the mold heater **31**, the casing heater **48** will continue to function whenever the thermostat controlled switch closes to the cold contact **108**. The heater **48** raises the temperature of the air within the casing **33** so that it can retain a larger amount of moisture than the cooler air outside of the casing **33**. Then, the flow of the warmed, saturated air from the interior to the exterior of the casing **33** due to the temperature differential results in a net reduction of moisture within the casing **33**.

The mold heater **31**, when energized, raises the temperature of the surface of the ice cubes within the individual cavities of the mold **23** to 32° F., or slightly higher so that there will be some slight melting of the surface of the ice cubes. This is necessary to sufficiently loosen the ice cubes from the mold **23**. At the same time, the temperature at the heart of the ice cubes may be somewhat below 32° F. Therefore, it will be seen that as the ice cubes are ejected from the mold **23**, they will be at a temperature approximately that of the freezing point of water. If the ice cubes were then placed in a perfectly insulated container which was not provided with an external cooling system, the ice cubes would maintain themselves in the environment of the container at a temperature of approximately 32° F. In such condition there would be minimum melting of the ice cubes and there would be little tendency for the ice cubes to freeze to one another and thereby create an unmanageable mass of ice. However, since it must be realized that it is impossible to provide complete insulation, when the ice cubes are ejected from the mold into the insulated inner tank **12**, provision must be made for insuring that the temperature within the tank **12** is maintained at or slightly above the freezing point of water. It is important that the inner tank be void of any source of external cooling so that the temperature within the inner tank does not fall below 32° F., which would result in freezing together of the ice cubes. On the other hand, the temperature within the tank 12 cannot be allowed to rise substantially above the freezing point of water or excessive melting will occur. The first of the above problems is effectively eliminated in the apparatus of this invention by the novel insulation of the evaporator-accumulator 49 from the interior of the tank 12 so that the evaporator-accumulator 49 functions only to cool the mold 23. In the apparatus of this invention, the balancing heater 62 provided about the exterior surface of the insulation 61 for the evaporator 49 prevents the cooling effect of the evaporator 49 from being directed to the interior of the tank 12 except through the mold 23, as will hereinafter be described. The balancing heater 62 is of a very low wattage, for example 2 to 3 watts, so that the surface of the housing 61 is held at approximately the freezing point of water.

The problem of excessive melting is not critical while there is a constant introduction of ice cubes into the interior of the tank 12. However, assuming that the tank 12 has been filled with ice cubes thereby causing the sweep arm 93 to be retained in an upper position which, as noted above, prevents energization of the ejection mechanism motor 34, the problem of melting will be critical if the full supply of ice cubes is stored within the apparatus for long periods of time. However, the apparatus of this invention will not permit the temperature within the tank 12 to rise much above the freezing point of water. If the temperature in the inner tank 12 rises, this will increase the temperature of the ice cube mold 23 and since the temperature of the ice cube mold 23 is sensed by the thermostat controlled switch 42 a rising temperature of the mold 23 will cause the switch 42 to complete its circuit to the warm contact 107 thereby energizing the compressor motor 56 which will set the refrigeration system in operation to cool the mold and thereby cool the interior of the tank 12. This will continue until the temperature of the mold 23 is lowered to the level where the switch 108 returns to its cold contact 108. Thus, the temperature within the inner tank is not permitted to rise substantially above 32° F., and control of this temperature is exercised by the identical control employed in the forming of the ice cubes.

Frost is not a problem in the apparatus of this invention. Frosting will occur upon the surfaces of the mold 23 which are open to the interior of the tank 12 and such frost will be removed by the operation of the mold heater 31. It has been found that the interior surfaces of the tank 12 are not subjected to frosting. Thus, the frost which does appear is confined to an area where it may be controlled by the mold heater 31.

While the ice cube maker and storage apparatus has been described as being enclosed within a free standing enclosure 10, the apparatus may be mounted within a wall with only the door 19 opening to the exterior of the wall. When so installed it would be necessary to provide a fan to assist the air cooled condenser.

It will be seen from the above description that the apparatus is particularly adaptable for home use or for installation in motel or hotel rooms. The ice cube maker and storage apparatus provides a constant supply of ice cubes for the consumer and permits long term storage of ice cubes without danger of freezing of the ice cubes to each other and with a minimum of melting. This is accomplished efficiently through the use of a single refrigeration system including a single evaporator and a single unitary control for the formation of ice cubes, to maintain the temperature of stored ice cubes at or slightly above freezing, and to control the ice cube ejection.

We claim:

1. An ice cube maker and storage apparatus comprising: an enclosed, insulated tank including a storage area, an ice maker assembly mounted within said tank and including an ice cube mold having surfaces exposed to the interior of said tank and means for ejecting formed ice cubes from said mold into said storage area, a refrigeration system including an evaporator within said tank and attached directly to said mold, said evaporator constituting the sole cooling element for the mold and the tank, means insulating said evaporator from the interior of said tank, said means comprising a housing surrounding the exposed surfaces of said evaporator and spaced therefrom, a temperature balancing heater disposed within said housing and along the inner surface of said housing, and insulation within said housing between said evaporator and said balancing heater, and unitary control means for said refrigeration system and said ice maker assembly, said control means responsive to the temperature of said mold to control the temperature of said mold and thereby maintain the temperature within said tank at substantially the freezeing point of water, said balancing heater adapted to maintain the surface of said tank at substantially the freezing point of water, whereby heat transfer from the interior of said tank to said evaporator will be directed through said mold.

2. An ice cube maker and storage apparatus comprising: an enclosed, insulated tank including a storage area, an ice maker assembly mounted within said tank and including an ice cube mold, a mold heater for loosening ice cubes formed in said mold, and means for ejecting loosened ice cubes from said mold into said storage area, sensing means adapted to sense the level of ice cubes accumulated in said storage area, a refrigeration system including an evaporator within said tank and attached directly to said mold and a compressor including a motor, said evaporator constituting the sole cooling element for the mold and the tank, means insulating said evaporator from the interior of said tank, and unitary control means for said refrigeration system and said ice maker assembly, said control means including thermostatic switch means responsive to the temperature of said mold and adapted to complete a circuit through said compressor motor when the temperature of said mold rises to a preselected level and adapted to complete a circuit through said ejector means and said mold heater and to open the circuit to said compressor motor when the temperature of said mold falls to a preselected level, said control means also including a normally closed switch in the circuit to said ejector means and said mold heater, which switch is responsive to said sensing means and is adapted to be opened when the ice cubes in said storage area have risen to a preselected level to thereby prevent the completion of the circuit to said ejector means and said mold heater.

3. An ice cube maker and storage apparatus comprising: an insulated tank having an opening to the interior thereof and including a storage area, a door normally closing said opening, an ice maker assembly mounted within said tank and including an ice cube mold having surfaces exposed to the interior of said tank, a mold heater for loosening ice cubes formed in said mold, and means for ejecting loosened ice cubes from said mold into said storage area, said ejecting means including a driving motor, a refrigeration system including an evaporator within said tank and attached directly to said mold and a compressor provided with a motor, said evaporator constituting the sole cooling element for said mold and said tank, means insulating said evaporator from the interior of said tank, said means comprising a housing surrounding the exposed surfaces of said evaporator and spaced therefrom, a temperature balancing heater disposed within said housing and along the inner surface thereof, and insulation within said housing between said evaporator and said balancing heater, and unitary control means for said refrigeration system and said ice maker assembly, said control means comprising a thermostat controlled switch responsive to the temperature of said mold and adapted to complete a circuit through said compressor motor when the temperature of said mold rises to a preselected level and adapted to complete a circuit

through said ejecting motor and said mold heater when the temperature of said mold falls to a preselected level, and switch means responsive to said ejecting motor and adapted to retain the completed circuit to said ejector motor until said ice cubes have been ejected from said mold.

4. An ice cube maker and storage apparatus in accordance with claim 3 further including switch means responsive to said ejecting motor and adapted to prevent the completion of the circuit to the compressor motor when the circuit is completed to said ejecting motor and said mold heater.

5. An ice cube maker and storage apparatus in accordance with claim 3 further including a door controlled switch adapted to open the circuit through said ejecting motor and said mold heater upon the opening of the door, said door controlled switch including a manually activated plunger adapted to open the circuit to the compressor motor when said plunger is activated.

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CERTIFICATE OF CORRECTION

Patent No. 3,144,078 August 11, 1964

Evans Thomas Morton et al.

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 1, line 24, for "in to" read -- into --; column 4, line 74, for "This" read -- That --; column 12, line 16, for "freezeing" read -- freezing --; line 18, for "tank" read -- housing --; same line 18, after "water", strike out the comma.

Signed and sealed this 1st day of December 1964.

(SEAL)
Attest:

ERNEST W. SWIDER
Attesting Officer

EDWARD J. BRENNER
Commissioner of Patents