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2,997,860

ICE MAKING AND REFRIGERATING SYSTEMS

Original Filed Aug. 12, 1949

3 Sheets-Sheet 1

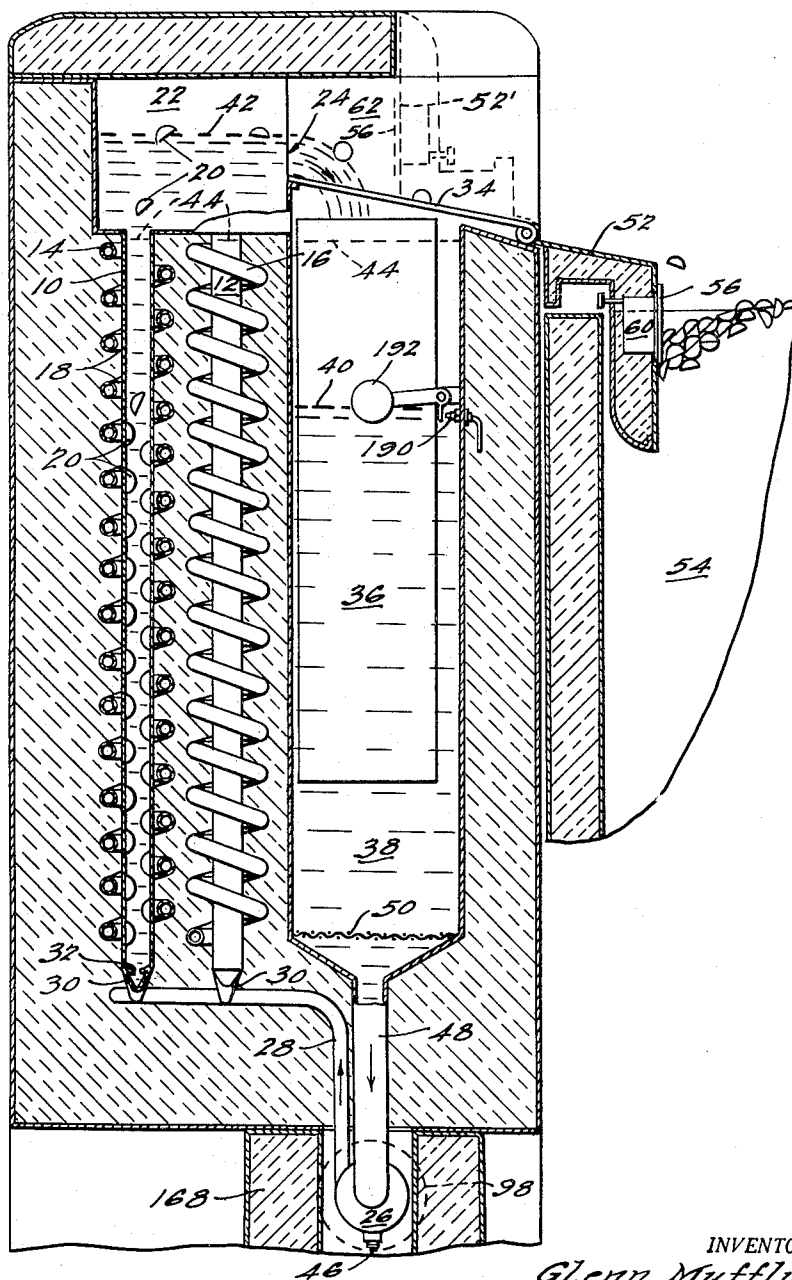


FIG. 1.

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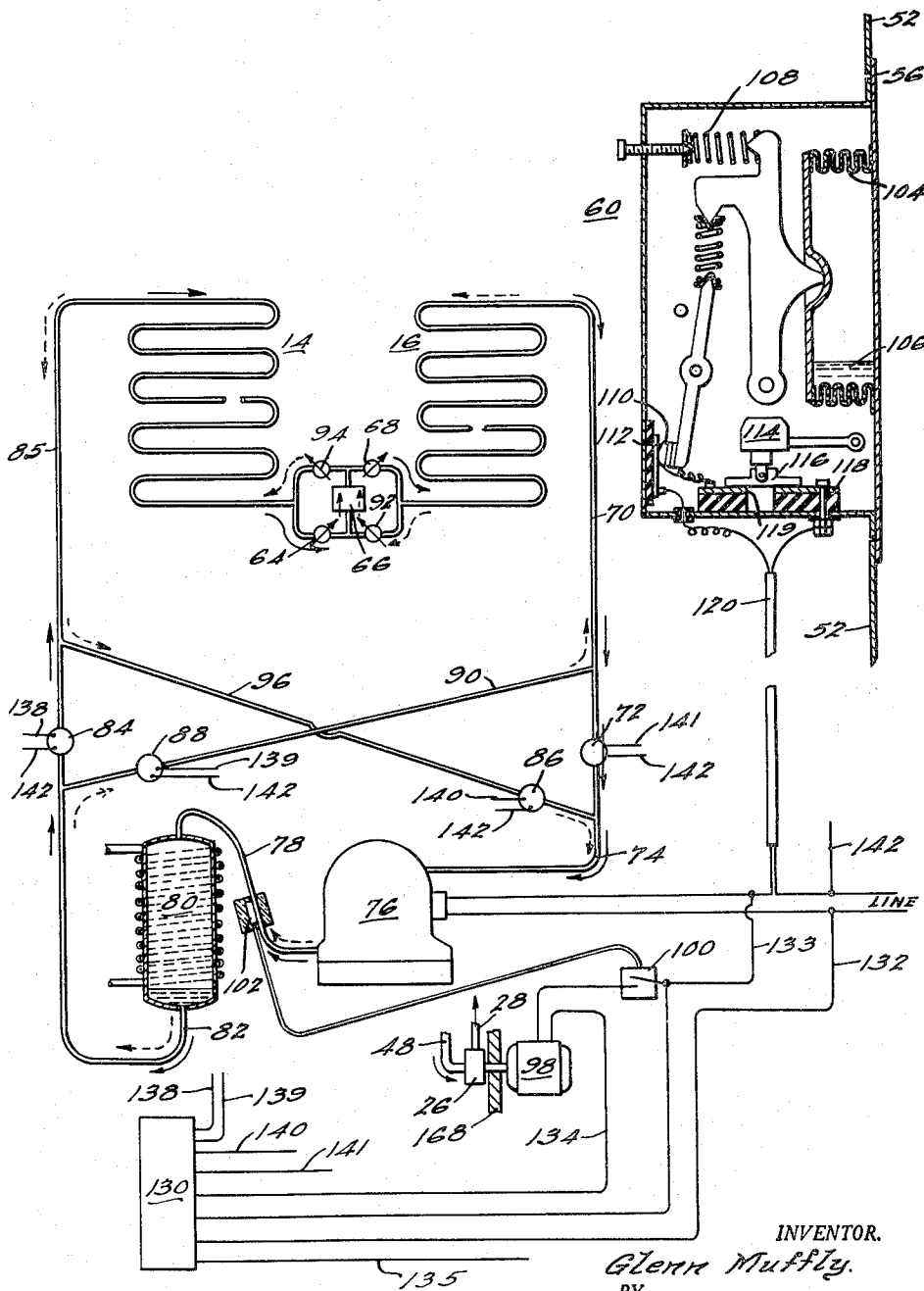


FIG. 2.

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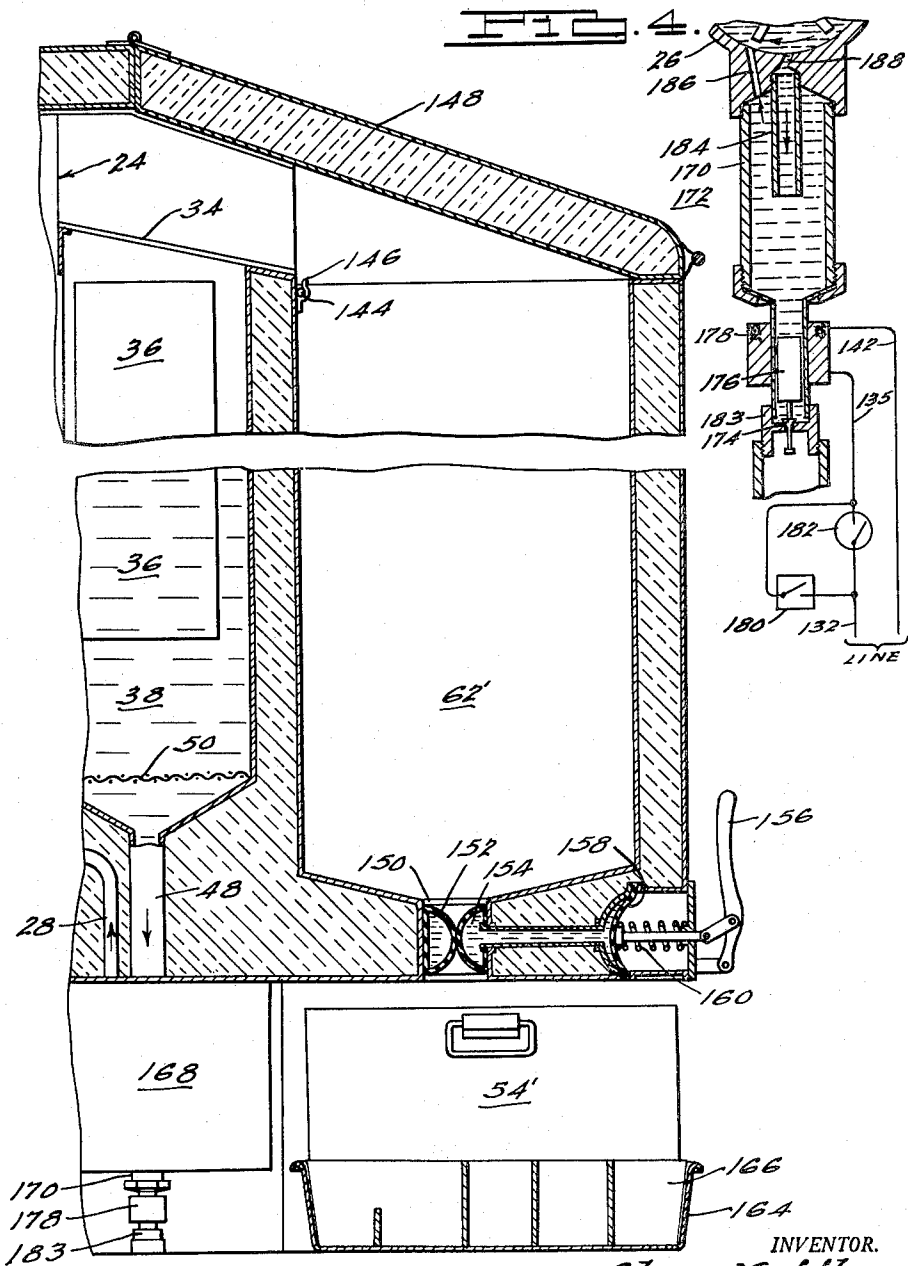


FIG. 3.

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2,997,860

ICE MAKING AND REFRIGERATING SYSTEMS

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Application Oct. 26, 1953, Ser. No. 388,361, now Patent No. 2,787,890, dated Apr. 9, 1957, which is a division of application Ser. No. 109,942, Aug. 12, 1949, now Patent No. 2,672,017, dated Mar. 16, 1954. Divided and this application Sept. 7, 1956, Ser. No. 608,599
5 Claims. (Cl. 62-344)

This application is a division of my copending application Serial Number 388,361, filed October 26, 1953, now Patent No. 2,787,890, issued April 9, 1957, which was divided from my application Serial Number 109,942, filed August 12, 1949, and now issued as U.S. Patent No. 2,672,017.

The present invention relates to automatic ice-making machines of the general type disclosed in my numerous issued patents and patent applications, being an improvement on the apparatus shown in my U.S. Patent No. 2,672,016, issued March 16, 1954, and in my Canadian application Serial Number 588,997, filed June 13, 1949.

One object of this invention is to provide for inclusion of a water softening device so arranged that recirculating water passes through the water treating material.

Another object is to provide for draining of water from the machine through one outlet.

An additional object is to provide for delivery of ice to a removable ice bunker and to control the machine so that ice production stops in response to the accumulation of ice in the bunker.

A further object is to provide a hinged ice chute extension for delivery of ice to a separate bunker with the ice quantity control located on this hinged extension.

An additional object is to arrange the hinged extension so that when lifted from the removable bunker it forms an insulated door closing the outlet of the ice chute portion located within the ice maker cabinet.

Another object is to provide control means associated with the hinged chute-door arranged to stop the ice-making machine in response to the lifting of the outside chute to the position in which it serves as a door.

An additional object is to provide an ice quantity control movable between two positions, in one of which it serves to stop the ice maker when a removable ice bunker is full of ice and in the other of which it serves to stop the production of ice upon accumulation of a predetermined quantity of ice within the ice maker cabinet itself.

An additional object is to so proportion the internal volumes of the ice maker tanks and the overflow tank that their water levels may be allowed to equalize when the machine is idle, thus eliminating the need for a check valve in the water circulating system.

Another object is to provide an ice maker including a storage bin for ice separate from the water circulating system and provided with means for filling separate ice containers from this storage bin by gravity under control of a gate valve.

An additional object is to provide a screen, grid or other reticulated member of large area through which recirculated water is required to pass on its way to the water pump, thus preventing accumulations of ice crystals which collect in the cold water from stopping the inlet to the pump.

A further object is to provide for centrifugal separation of minerals from the water by directing the denser portion of the water into a trap, preferably associated with the pump, so that the impure water may be drained from the machine without draining all of the water therefrom.

A further object is to provide a vertical ice-making tank having one horizontal dimension less than twice the thickness of ice which projects into the tank from an ice-making

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surface, thereby reducing the volume of water required to fill the machine and the rate at which water must be circulated to make clear ice.

Another object is to arrange ice-making surfaces on opposite sides of the flat tank in staggered relation so that full-sized pieces of ice attached to the tank walls may extend beyond the vertical middle plane of the tank and thus cause a greater agitation of water for a given rate of water flow.

Another object is to provide an ice quantity control operating thermostatically in response to the contact of loose pieces of ice with the flat cover plate of the control, thus eliminating the need for the usual bulb and capillary tube which are subject to damage, particularly when movably located as required for the dual control of ice quantity in a separate bunker and of ice quantity within the machine.

In the accompanying drawings:

FIGURE 1 is a vertical sectional view of the ice maker with the lower portion which contains the condensing unit and associated parts broken away;

FIGURE 2 is a diagram of the refrigerating system and controls employed in FIGURE 1;

FIGURE 3 is a sectional view showing an alternative design of cabinet to provide more ice storage space within the cabinet itself; and

FIGURE 4 is a partly sectional and partly diagrammatic view showing details of the device for draining water from the system and for centrifugally purifying the water as it recirculates in the system.

Referring now to FIGURE 1, we see two flat vertical tanks 10 and 12 which are identical in construction. The identical evaporator coils 14 and 16 are wrapped one about each of these tanks. The greater part of each of these coils comprises substantially horizontal legs adjacent the large flat sides of the tanks. Between these legs of the coils and the outside of the tanks, there are a large number of thermal contact buttons 18, preferably made of copper or other metal having a high thermal conductivity and soldered to both the tank and the coil. When the tank walls are flat as shown, one side of each button will be flat, but if the ice-making areas on the tank walls are formed by embossing outwardly, these contact surfaces of the buttons will be concave to fit the embossed portions of the tank wall. In any event, the opposite side of each button is preferably formed to provide an accurate fit and an increased area of contact with the evaporator tube. It is desirable that these buttons fit between the tank wall and the evaporator tube quite accurately so that all three parts may be sweated together with the minimum thickness of solder for maximum thermal conductivity from the tank wall to the tube.

It is also desirable that the flat tanks 10 and 12 be formed of relatively thin metal having a relatively low thermal conductivity. A suitable metal is stainless steel and a suitable thickness of the metal is about .020". The thickness of the buttons is preferably such as to hold the tubes 1/8" or more away from the tank wall and it is desirable that thermal insulation be provided between the tube and the tank wall in the spaces between the buttons.

FIGURE 1 shows only two of the tanks 10 and 12 and two of the evaporator coils 14 and 16, but it will be understood that any even number of these tanks and their corresponding evaporator coils may be employed. When four or more tanks are employed, one half of the evaporator coils will be arranged in parallel to be refrigerated at one time and the other half of the evaporator coils will be arranged in parallel and refrigerated while ice is being melted free from the walls of the tanks served by the first mentioned set of parallel evaporator coils.

It is desirable that the coils 14 and 16 be identical for

economy of manufacture and, as shown in FIGURE 1, this provides for the staggering of the positions of the horizontal legs of the two evaporator coils adjacent to each other, thus providing more space for insulation between the adjacent coils. This insulation need not be so thick between adjacent coils which are simultaneously refrigerated, but regardless of the number of tanks employed there will be a middle space between an active evaporator and an inactive evaporator where it is desirable to provide a thickness of insulation comparable to that shown between the two coils in FIGURE 1.

In FIGURE 1 it is assumed that the right-hand coil 16 is being refrigerated while the left-hand coil 14 is on its defrosting or ice-releasing portion of the cycle. We thus see a number of completed pellets 20 of ice attached to the inner walls of the tank 10 and a few of these pieces of ice floating upwardly to the upper tank 22 to be carried out of this tank through the notch 24 by the flow of water which is produced by the operation of the centrifugal pump 26. Ice is released first from the upper portion of the tank due to the fact that warm high pressure refrigerant liquid is introduced to the upper portion of the coil 14 and flows downwardly therein. This prevents the formation of an ice jam such as might result if the lowermost pellets of ice were released first.

The pump delivers water to the tube 28 which leads to manifolds 30, of which one is attached to the bottom of each of the ice-making tanks. Perforations 32 in the bottoms of the tanks provide for distribution of this water flow throughout the length of the tank. Water is delivered to all of the tanks constantly so that agitation is provided during the ice-making period and upward flow of water is provided in the tank or tanks where ice is being released. In a large machine having many tanks it may be desired to provide valve means for stopping the flow of water through the tanks not being refrigerated, as the ice will float upwardly when released without the aid of this water flow, but for simplicity such valve means is omitted in FIGURE 1 which illustrates a small capacity machine having only two ice-making tanks.

As the ice floats upwardly into the tank 22 with which all of the ice-making tanks are connected, the overflow of water through the narrow outlet gate 24 carries the ice onto the inclined chute 34 which is preferably formed of parallel wires located close enough together to prevent the passage of ice while allowing the overflow water to fall into the top of the water treating cartridge 36. This arrangement of the water treating cartridge is such that all or a substantial part of the circulating water flows through it each time it flows from the tank 22. This method of recirculating water through the cartridge of ion exchange resins, zeolite or other suitable water softening material solves the problem of preventing the water in the machine from gradually increasing in mineral content, as it would do if only the incoming water were passed through the water treating device. This effect of constantly increasing hardness of the unfrozen water results from the fact that the ice contains less mineral than the water from which it is formed wherever only a part of the water is frozen at each cycle. In my design, the unfrozen water is recirculated through the water softener to remove those minerals which are rejected by the ice and thus concentrated in the unfrozen water.

During operation, the water level in the overflow tank 33 will stand at approximately the level 40 surrounding the cartridge 36, but will be higher within the cartridge, this difference of level providing the head which causes flow of water through the cartridge. The water level 42 in the upper tank 22 is that prevailing during the operation of the machine, but when the machine including the pump 26 is stopped the water levels 40 and 42 are equalized at a common level indicated by the dotted line 44, due to the fact that water can flow in reverse through the pump while the pump is idle. Upon starting of the pump, the water level in the upper tank again assumes

the level 42 and the water level in the overflow tank 33 again drops to the operating level 40.

It will be noted that the manifolds 30, shown as formed of sheet metal welded or soldered to the bottoms of the ice-making tanks, are downwardly inclined at their bottoms toward the tube 28 with which they connect. This provides a taper which aids in distribution of water to the several outlet holes 32 and also provides for drainage of water from the ice maker tanks into the tube 28, which in turn drains back to the pump 26 when the plug 46 is removed. In place of this plug there may be a length of tubing provided with a suitable valve for draining water from the ice maker. Such a tube provides a trap in which a denser fraction of the circulated water is accumulated due to the centrifugal action of the pump. It is therefore possible by opening the valve to drain this trap and thus remove the denser portion of the water which carries the highest mineral concentration without draining the entire system. This is further explained in connection with FIGURE 4.

The water which is constantly being circulated over the newly formed ice during operation of the machine will fall to near its freezing point and portions of it may even become subcooled to a temperature below 32° F. Under this condition ice crystals may collect in the circulating water, hence provision is made to prevent the flow of such ice crystals into the suction tube 48 of the pump. It has been found that a screen of small area may be stopped by a mass of these floating ice crystals, hence I have provided a reticulated grid 50 of large area, preferably covering the entire bottom of the overflow tank 38. This large area insures against complete stoppage by ice crystals while the holes, or corresponding spaces between wires if 50 is a screen, prevent any accumulation of ice crystals large enough to interfere with operation of the pump from entering it.

As the ice pellets 20 leave the water and slide downwardly on the inclined chute 34, they drop onto the outside chute 52 and fall therefrom into a suitable container such as 54, which may be a large insulated box mounted on casters or a smaller container of the tote-box variety resting upon a suitable stand or shelf. As the ice falls into this container, it naturally builds up in the form of a central heap and slides toward all sides of the container, thus at the center of the box 54 ice may pile up above the side walls, but when leveled off the container will be something less than level full. As ice builds up to a high level near the center of the container, some of it will slide back against the plate 56 which is attached to the exposed vertical wall of the horizontally hinged outside chute assembly 52. The cover plate 56 forms the thermally responsive surface of thermostatic switch 60, as will be explained in connection with FIGURE 2. When ice accumulates to a level at which it covers a lower portion of the plate 56, the thermostatic switch opens to stop the machine. An attendant noting that the container 54 is full of ice, swings the hinged assembly 52 into the position 52' where it serves as an insulated door to close the ice outlet opening of the cabinet. If this is done while the machine is still running in order to move a partially filled container 54, ice will accumulate within the space 62 until it contacts what is then the lower portion of the plate 52 and this will likewise cause the thermostatic switch 60 to open, stopping the machine. While FIGURE 1 shows a very small compartment 62 in which ice may accumulate when the door 52' is closed, it will be understood that a much larger compartment may be provided so that the machine will operate for many hours with the door 52' in its closed position. Then when an attendant pushes an empty container 54 against the front of the machine and swings the door 52' down to the position 52, a large supply of ice will immediately flow into the container 54. If desired, the compartment 62 may be made of sufficient capacity to fill a number of portable containers 54.

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FIGURE 2 shows the refrigerating system of FIGURE 1 diagrammatically, indicating with solid arrows the path of refrigerant flow at the time in the cycle represented by FIGURE 1, that is, with the right-hand evaporator 16 active and the left-hand evaporator 14 being heated for the purpose of releasing ice by means of warm high pressure refrigerant liquid. This liquid leaving the lowermost leg of coil 14 flows past check valve 64 to the expansion valve 66 from which low pressure liquid refrigerant with less than the usual percentage of flash gas flows through the check valve 68 into the lowermost coil of evaporator 16. From the uppermost coil of this evaporator, vapor flows through the tube 70 and the open solenoid valve 72 to the suction tube 74 leading back to the inlet of the motor-compressing unit 76. Compressed refrigerant vapor flows through the tube 78 to the condenser 80 which also serves as a receiver. Liquid refrigerant leaves the condenser through the tube 82 and flows through the open solenoid valve 84 and the tube 85 to the uppermost leg of the left-hand evaporator 14, which is thus filled with liquid refrigerant, taking most of the liquid out of the condenser. It will be noted that there is no heat exchanger between the liquid line and the suction line as it is desired to retain the specific heat of the liquid for use in thawing off the finished pellets of ice in the left-hand tank 10.

The operation as just described continues until all of the ice pellets in tank 10 have melted free and floated out through the chute or are on their way to the chute. The solenoid valve 84 then closes to stop the flow of liquid refrigerant to the idle evaporator 14, but liquid continues to flow through the expansion valve to the active evaporator 16, since the liquid refrigerant in the idle evaporator 14 was under high pressure at the time that the valve 84 closed and this liquid will start evaporating as its pressure drops, due to the flow of liquid through the expansion valve. This continues until the upper portion (probably $\frac{2}{3}$) of the evaporator 14 is filled with vapor and the lower coils with liquid at a pressure somewhat higher than the normal evaporating pressure. During this period, liquid refrigerant collects in the condenser-receiver 80.

Next, the solenoid valve 72 closes, the solenoid valve 86 opens and the solenoid valve 88 opens, either simultaneously or in this sequence with a very short time interval between valve actuations. This starts flow of liquid refrigerant through the valve 88 and the tubes 90 and 70 to the uppermost coil of the evaporator 16 which is thereby filled with high pressure liquid refrigerant, the specific heat of which causes the newly formed ice pellets in the tank 12 to thaw free from its walls and float up into the upper tank 22 from which they are delivered to the ice bunker 54. Liquid refrigerant now flows through the check valve 92 to the expansion valve 66 and through it in the same direction as before, but thence through the check valve 94 (check valve 68 being now held closed by high pressure liquid in coil 16) to the lowermost coil of the evaporator 14, which now becomes active. Vapor flows from the uppermost coil of evaporator 14 through the tubes 85 and 96, the now open solenoid valve 86 and the tube 74 to the suction port of the sealed motor-compressor unit 76. This flow is indicated by broken line arrows in FIGURE 2.

It will be noted that the arrangement of check valves is such that liquid refrigerant flows through the expansion valve in the same direction when refrigerant flow is reversed through the evaporators. It will also be noted that the heat employed in melting the ice pellets free from tank walls is the specific heat of high pressure liquid refrigerant and not the latent heat of vapor as in the usual hot gas defrost method. This operation continues with reversal of flow after each ice-making cycle in one of the two tanks 10 or 12. Assuming a 20 minute period of ice-making and an 18 minute period of feeding hot

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liquid refrigerant to the idle evaporator for the purpose of releasing ice, we have a two minute period during which liquid refrigerant flow to the idle evaporator is stopped and a major portion of the liquid in the idle evaporator feeds into the active evaporator. This provides for partially emptying the evaporator which is about to become active of the liquid refrigerant which has filled it, thereby avoiding the flooding back of liquid refrigerant to the compressor when the previously idle evaporator becomes active. During this "pumping out" period liquid refrigerant accumulates in the condenser or receiver and is ready to flow into the evaporator which has just finished its ice-making period to start its ice releasing period. There is no thermal loss in using the specific heat of liquid to thaw ice off such as there would be if hot refrigerant vapor were used to thaw the ice off. By using the specific heat of the liquid we precool the liquid before it enters the expansion valve, thus minimizing the amount of flash gas at the inlet to the active evaporator.

It will also be noted that this method of introducing hot liquid refrigerant to the uppermost leg of the evaporator results in releasing ice at the top of the tank before ice is released from the ice-making areas nearer the bottom of the tank. This allows the use of a very narrow tank and makes the system more compact. The narrow tank requires less water flow to produce the desired agitation for making clear ice than would a wider tank. The ice making areas on the tank walls are staggered so that ice pellets forming on one side of the tank do not contact ice pellets forming on the opposite walls of the same tank, even though the ice pellets may grow to a horizontal dimension greater than half the thickness of the tank. This arrangement provides for making a very large number of ice pellets in a compact apparatus. This compactness becomes more evident when the number of ice-making tanks is increased, as the same dimensions may be retained for thickness of outer insulated walls and of the overflow tank 38. The machine can be doubled in capacity by adding about $\frac{1}{3}$ to the horizontal dimension of FIGURE 1. In this case, two of the evaporator coils will be connected in parallel and the two pairs of parallel coils connected just as the two single coils are in FIGURE 2. Two of the coils will be active making ice while the other two are heating the ice-making areas to release ice or are in the "pumping out" period of the cycle.

The motor 98 seen in FIGURE 2 is connected in parallel with the motor which operates the compressor and is controlled by a separate thermostatic switch 100, as previously disclosed in my U.S. Patent No. 2,672,016. After start of the system the tube 78 warms the bulb 102 to close the switch 100.

FIGURE 2 shows an enlarged sectional view of the thermostatic control 60 in FIGURE 1, the position shown being the same as that indicated by solid lines in FIGURE 1. The bellows or diaphragm 104 is of relatively large diameter and small length so that it covers a considerable area of the metal plate 56, to which it is soldered or brazed. This bellows is not provided with the usual capillary tube and bulb since it operates in response to temperature changes of the cover plate 56. In the position shown in FIGURE 3, there is a small amount of volatile liquid 106 in the lower portion of the space enclosed by the bellows 104 and plate 56. Ice accumulating in the bunker 54 and reaching the level of this liquid cools it so that some of the vapor above the liquid condenses, thereby allowing the bellows to contract under the pressure of the spring 108 and causing the contact member 110 to snap away from the fixed contact member 112, thus breaking the circuit of the motor which operates the compressor.

In series with the thermostatic switch above described and also seen in FIGURE 2, is a gravity switch operated by the weight 114. When the switch assembly is turned upside down as occurs when the outer chute 52 of FIGURE 1 is moved to the position 52' where it acts as a

door, this weight causes the contact 116 to leave the contacts 118 and 119, opening the circuit of the compressor motor even when the thermostatic switch is closed.

This gravity operated switch may be omitted, in which case the same thermostatic switch will operate to stop the motor-compressor unit when the outer chute is swung to its upper position to close the ice outlet. With this outlet closed, ice will accumulate in the chamber 62 until the uppermost pellets of ice contact the then lower portion of plate 56 and cool the liquid within the bellows 104, such liquid having moved to what is now the lower side of the bellows. This provides a single thermostatic switch entirely contained within the swinging outer chute and door assembly except for the plate 56 which serves as a flange for its attachment. The connection with the system is entirely by means of a two-wire cable 120 which is amply flexible for allowing the required movement. This may be preferred over the alternative of moving the bulb of a control, which involves bending a capillary tube.

The clock switch 130 seen in FIGURE 2 may be similar to the one shown diagrammatically in FIGURE 5 of my copending U.S. Patent No. 2,672,016, but is equipped with additional contacts for controlling the water pump motor 98 and a drain valve. The clock is preferably of the electric type driven by a motor connected with wires 132 and 133 so that it operates only when switch 60 is closed. One pair of added contacts connects wire 132 with wire 134 to control the pump motor 98 and the other pair connects wire 132 with wire 135 to actuate the drain valve described later herein. The pump motor may be controlled by a clock-operated switch in combination with or in place of the thermostatic switch 100. Where it is desired to circulate the water continuously during the freezing operation for the purpose of making clear ice, it is not necessary to connect the motor 98 with the clock switch, but in some cases it may not be considered important to make clear ice, in which event it is only necessary to operate the motor 98 during relatively short periods to float the ice from tank 22.

The wire 132, connected with one side of the line, also connects with switches controlling the various solenoids of valves 72, 84, 86 and 88. The other contact of each switch is connected with one of the solenoids, wire 138 being connected with the solenoid of valve 84, wire 139 with the solenoid of valve 88, wire 140 with the solenoid of valve 86 and wire 141 with the solenoid of valve 72. The connections 142 of the solenoids all lead back to the opposite side of the line. As shown in FIGURE 2, the thermostatic switch 100 will close soon after the system starts and thereafter the operation of pump motor 98 will be under control of the clock-operated switch.

The condenser-receiver 80 is shown as a plain cylinder cooled by a water coil wrapped around it instead of by the usual internal water coil employed in water cooled condensers. This modified form of water cooled condenser is designed to overcome objections which have been raised by health authorities in certain cities where it is felt that there should be two thicknesses of metal between the cooling water and the refrigerant to minimize the rather remote hazard of a leak which allows refrigerant to enter the water system.

FIGURE 3 shows a modification of FIGURE 1 in which the compartment 62 is greatly enlarged and identified by the numeral 62'. The hinged outside chute 52 is omitted and in place of the thermostat 60 a conventional thermostat is employed having a bulb 144 retained by the spring clip 146 in position to be affected by accumulation of ice in the compartment 62' up to this level. A door 148 covers the compartment 62' and closes the cabinet. This modification provides for storing a large quantity of ice within the cabinet itself and this ice is delivered by gravity through the opening 150, as required.

A special form of gate is provided for the opening 150

to overcome the difficulty experienced with sliding, swinging or rotating gate members, the operation of which may be blocked by pieces of ice caught in the opening as the gate is closed. The hollow annular member 152, formed of rubber or other flexible material, is expanded inwardly by the liquid 154 to close the opening. When it is desired to let ice flow into a portable container such as 54', the handle 156 is pulled outwardly, moving the diaphragm 158 against action of the spring 160, causing the liquid 154 to flow from the annular gate member through the tube 162. This causes the annular member 152 to collapse, leaving an opening through which the ice pellets flow into the tote box or other container 54'. When the handle 156 is released, the spring 160 actuates diaphragm 158 to force the liquid back into the member 152 and recloses the opening 150. In the event that a piece of ice is caught between opposed sides of the member 152 as the opening is closed, the spring 160 will maintain pressure on the liquid so that the opening is completely closed when this piece of ice melts away. Since the closure member 152 is flexible, no harm is done by any ice caught by it as it closes.

The contact surfaces of the member 152 need not be such as to form a water-tight closure. In fact these surfaces may be intentionally corrugated so that water will drain through the opening 150 when the flexible gate is closed. A drip pan 164, which may be movable for emptying or connected with the drain, serves to catch such water as drips through the opening when there is no ice container 54' in place. To provide for support of the container 54' and to minimize slopping of water if the pan 164 is movable, I have shown a grid member 166, similar to the solid grids formerly used in ice trays. This grid is flush with or extends slightly higher than the walls of the pan 164, thus providing a suitable support for the tote box 54'. It will be evident that the cabinet design may be varied at the designer's option to provide for filling very large containers 54 mounted upon wheels or to provide for filling smaller containers, even down to individual drinking glasses, without departing from the spirit of this invention.

FIGURE 3 also shows in elevation a portion of the insulated cover 168 of which a portion is seen in section in FIGURE 1. Extending downwardly from this cover is a drain tube 170 which takes the place of the plug 156 seen in FIGURE 1. The valve 172 connecting with this drain tube may be manually operated or arranged for automatic operation as described in connection with FIGURE 4.

In FIGURE 4, we see an enlarged section of the lower portion of the pump 26, the drain tube 170 and the drain valve 172 with electrical connections for operating the valve. The valve member 174 is lifted by the armature 176 of the solenoid 178 to allow water to drain from the tube 170 to a suitable receptacle or drain connection. The solenoid is actuated by manual closing of the switch 180 or by closing of the clock-actuated switch 182 which is contained within the assembly 130. Normally, the manual switch 180 is employed when it is desired to drain the apparatus completely, and the clock actuated switch 182 is employed during operation to dispose of that portion of the water contained within the tube 170. When desired to wash the system out and drain it more rapidly, the cap 183 which forms the seat for valve 174 may be removed, taking with it the valve and solenoid armature 176.

The impurities of water which interfere with making clear ice are mainly minerals which are more dense than the water and therefore increase the density of water in which they are dissolved. The pump 26, being of the centrifugal type, will tend to throw the harder fraction of the water against the periphery of the chamber, causing such water to flow downwardly through the tube 184. Gravity then aids in concentrating the mineral impurities in the lower portion of the tube 170 and within the space immediately above the valve 174. A small hole 186 is provided to allow limited circulation of water down-

wardly through the tube 184 and upwardly through the tube 170 to the pump. The hole 186 and the hole 188 may be oppositely inclined as shown to aid in the promotion of such circulation, which should be slow enough to allow a heavier fraction of the water to collect in the bottom of the tube 170, as above explained.

During regular operation of the system, once during each ice-making cycle or less frequently if the water supply is not too hard, the solenoid 178 is energized for a very short period to allow approximately the volume of water contained within the tube 170 and the valve chamber below it to escape. This removes the portion of the water containing the highest mineral concentration, thus offsetting the concentration of mineral within the unfrozen water which progresses with each ice-making cycle. This flushing method may be employed in combination with the demineralizer 36 or either one may be used alone, depending upon the hardness of the water supply, the desire for economy, and the importance placed upon the making of clear ice.

Water is admitted from the city water system to make up for the flushing to purify the water and for the ice removed from the circulating water. This is under control of the valve 190 operated by the float 192 seen in FIGURE 1, as explained in my U.S. Patent No. 2,672,016, wherein a similar float valve is disclosed. The float and valve are arranged to maintain approximately the level 40 within the overflow tank 48 during operation of the system. Naturally, the float valve cannot open while the water level is equalized at 44.

The method of introducing warm liquid refrigerant into an evaporator suddenly at the start of the defrosting period when there is very little cold liquid refrigerant in its aids in bringing warm liquid refrigerant into heat exchange with all ice-making areas sooner than would be the case if the warm liquid were introduced gradually or the evaporator were nearly full of cold liquid refrigerant when the defrosting period is started.

The buttons 18 are, as explained, preferably of round sections and might be machined by cutting from a round bar and milling out the recess to fit the tube with a milling cutter the diameter of the tube, but they are preferably made of copper, which is expensive and hard to machine, so I propose to make them by an upsetting operation. This could be called "forging," particularly if made from flat stock, or "die casting" if molten or semi-fluid copper is used. In any event the proposal is to form these buttons with a mold, die or upsetting tool rather than by machining, thus saving both labor and material.

While the drawings herewith show ice floated upwardly from the ice-making areas, it will be seen from my U.S. Patent No. 2,359,780, issued October 10, 1944, that I also have in mind dropping ice from the surfaces on which it is frozen. This requires very little change from the drawings of the present application. The tanks 10 and 12 would in that case have no bottoms and become vertical flues through which water trickles downwardly from the jets 32, which would then be located at the top. The chute 34 for separating ice from the water would be located below the vertical "tanks" or flues 10 and 12 and the tank 38 would be below the chute. This design would add something to the over-all height of the ice maker unless the condensing unit were then located at one side of instead of below the ice-making apparatus.

What is claimed is:

1. In an ice maker adapted to make small pieces of ice, a storage compartment for ice located with its bottom a distance above the floor on which the ice maker stands to allow space for a portable container, an ice passage from the bottom of said compartment for delivery of ice to such a container, a gate arranged to stop flow of ice through said passage by pressing a flexible wall against the ice in the passage to hold it there, yieldable means urging said wall in its ice-stopping direction to further restrict the passage as ice therein melts, and means for

opening said gate in opposition to said yieldable means.

2. In an ice-making apparatus, a storage compartment for small pieces of ice, a gravity chute for transferring ice from said compartment to a separate container, and control means for stopping the flow of ice through said chute, said control means including a flexible member arranged to stop ice movement by pressing against ice in the chute, energy storage means urging said member in its ice-stopping direction to prevent ice delivery from said compartment and to compensate for meltage of ice under pressure of said flexible member, and actuating means for moving said member in opposition to said urging means to open the chute for delivery of ice therethrough.

3. In an ice maker adapted to make small pieces of ice, a storage compartment for ice, an opening at a lower portion of said compartment for gravity delivery of ice therefrom, a gate arranged to control the delivery of ice through said opening by clamping ice in the opening and thus preventing its movement while allowing water of meltage to flow therethrough, said gate comprising a flexible wall adapted to be flexed in its closing direction by pressure of a constant-volume variable-pressure body of liquid, a second wall contacted by said body of liquid and movable to impose or to relieve pressure on the liquid for the purpose of stopping or starting the delivery of ice through said gate, energy storage means normally acting on said second wall to impose pressure on the liquid and thus stop ice movement through said opening, and means operable to move said second wall in opposition to said energy storage means for the purpose of opening the gate to deliver ice from said compartment.

4. An ice storage container for storing relatively small pieces of ice comprising a compartment having an outlet port arranged for gravity discharge of ice, and a gate for restricting said port to stop the flow of ice therethrough, said gate including a hollow member having a flexible distendable wall, said member being arranged to close said port to the passage of ice when said wall is distended to trap ice in the port by pressure of said wall, and yieldable fluid pressure means for yieldably urging said wall toward its distended position whereby any piece of ice caught in said port by said gate during closing thereof serves to aid in closing said port and as it melts away the flexible wall under urging of said fluid pressure means closes the port more fully as the ice caught in said gate is reduced in size by melting.

5. An ice storage container for storing relatively small pieces of ice comprising a compartment having an outlet port arranged for gravity discharge of ice from the container, and a gate for restricting said port to stop the flow of ice therethrough, said gate including a hollow member having a flexible distendable wall, said member being arranged to close said port to the passage of ice when said wall is fully distended, and fluid pressure means for yieldably urging said wall toward its fully distended position, said fluid pressure means being constituted by a closed fluid chamber partly defined by said hollow member and including a movable wall portion spaced from said flexible wall, a volume of liquid permanently sealed in said chamber, and yieldable means for urging said wall portion in a direction to decrease the volume of said chamber outside of said hollow member thereby to urge liquid into said hollow member.

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