April 17, 1951 M. G. LEESON 2,549,747

ICE-MAKING APPARATUS

Filed July 24, 1946 6 Sheets-Sheet 1

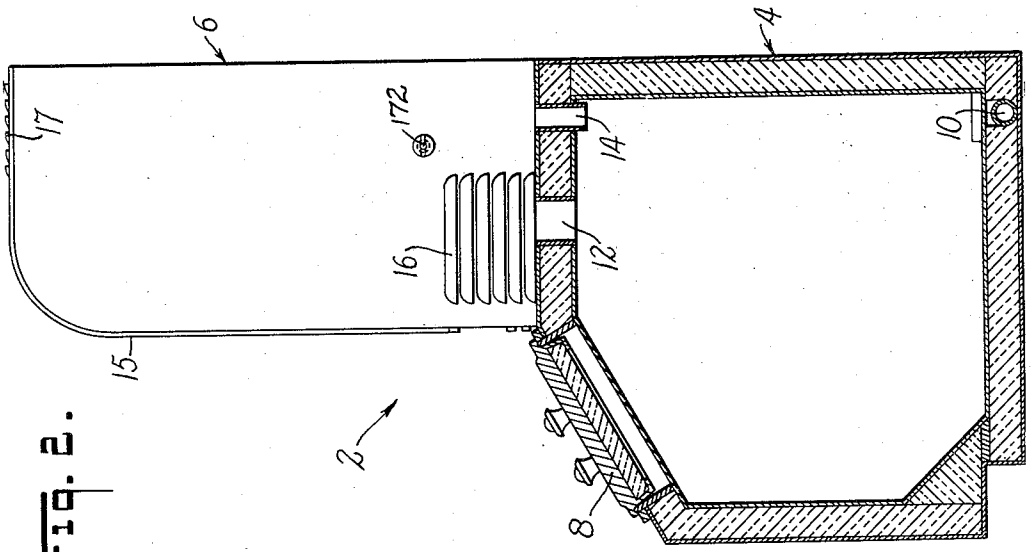


Fig. 2.

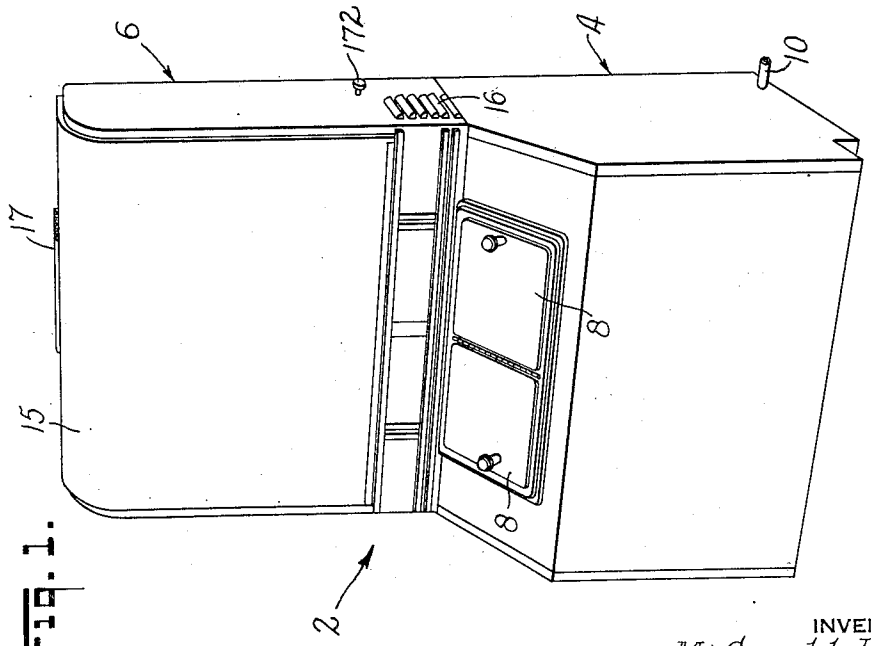


Fig. 1.

INVENTOR
M. Gerald Leeson
BY
Blair, Curtis & Hayward
ATTORNEYS

April 17, 1951 M. G. LEESON 2,549,747

ICE-MAKING APPARATUS

Filed July 24, 1946 6 Sheets-Sheet 2

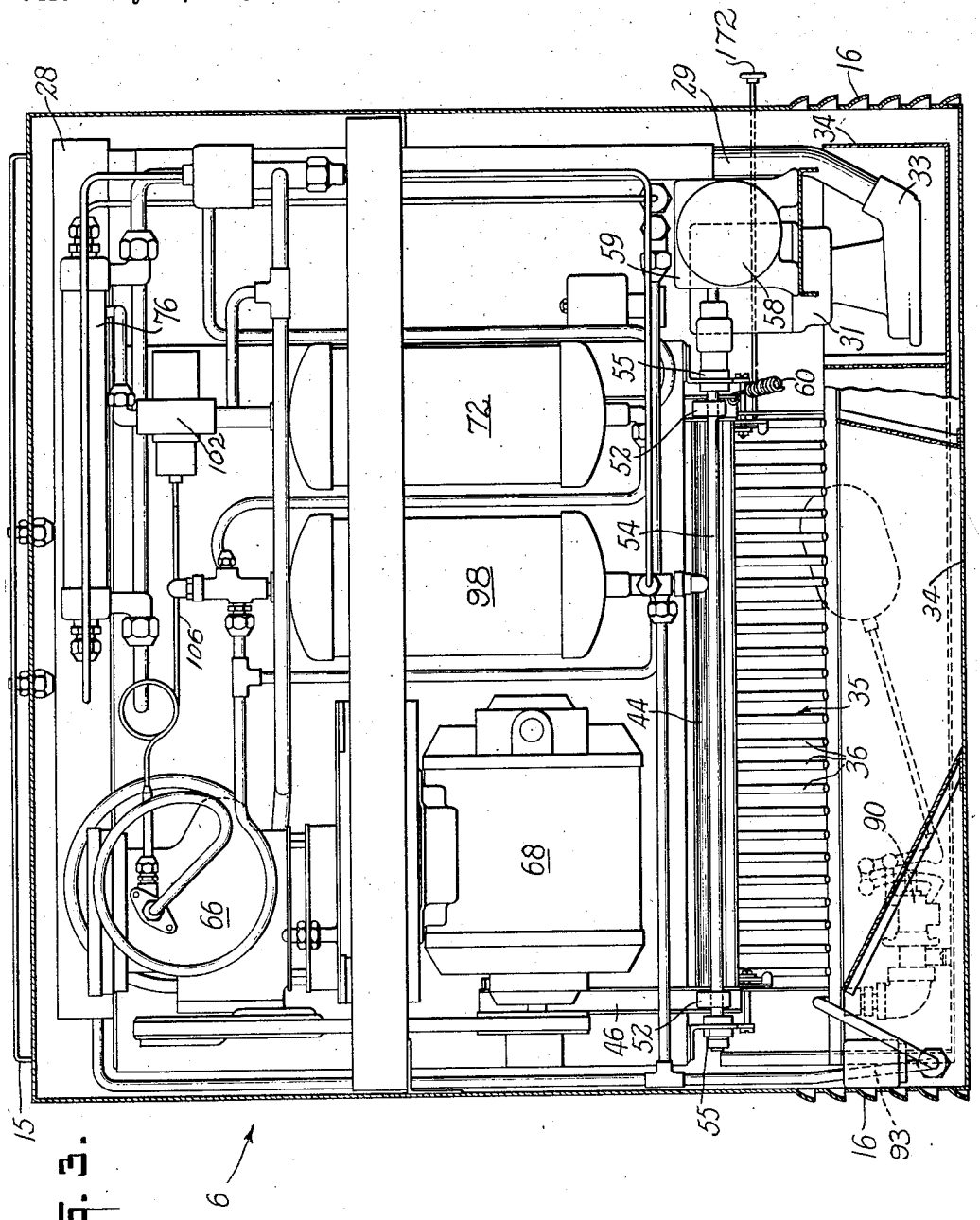


FIG. 5.

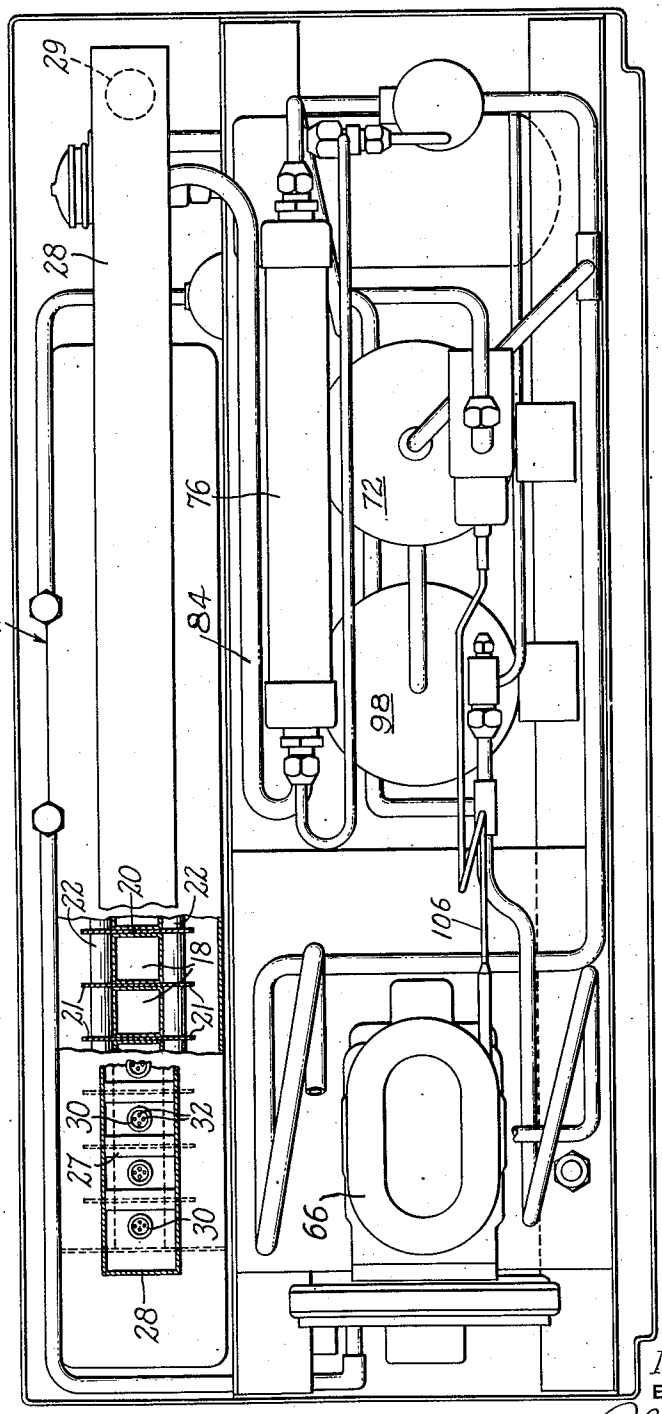
INVENTOR
M. Gerald Leeson
BY
Blair, Curtis & Hayward
ATTORNEYS

April 17, 1951 M. G. LEESON 2,549,747

ICE-MAKING APPARATUS

Filed July 24, 1946 6 Sheets-Sheet 3

FIG. 4.



INVENTOR
M. Gerald Leeson
BY
Blair, Curtis & Hayward
ATTORNEYS

April 17, 1951 M. G. LEESON 2,549,747

ICE-MAKING APPARATUS

Filed July 24, 1946 6 Sheets-Sheet 4

Fig. 5.

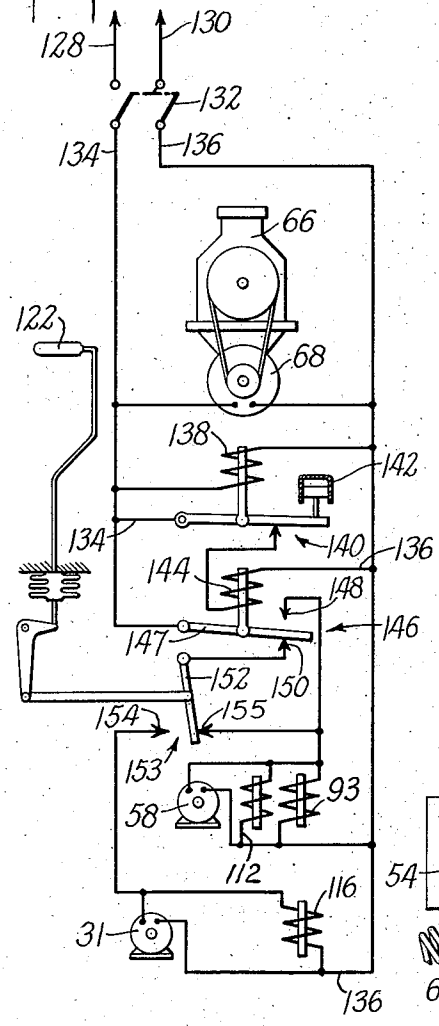
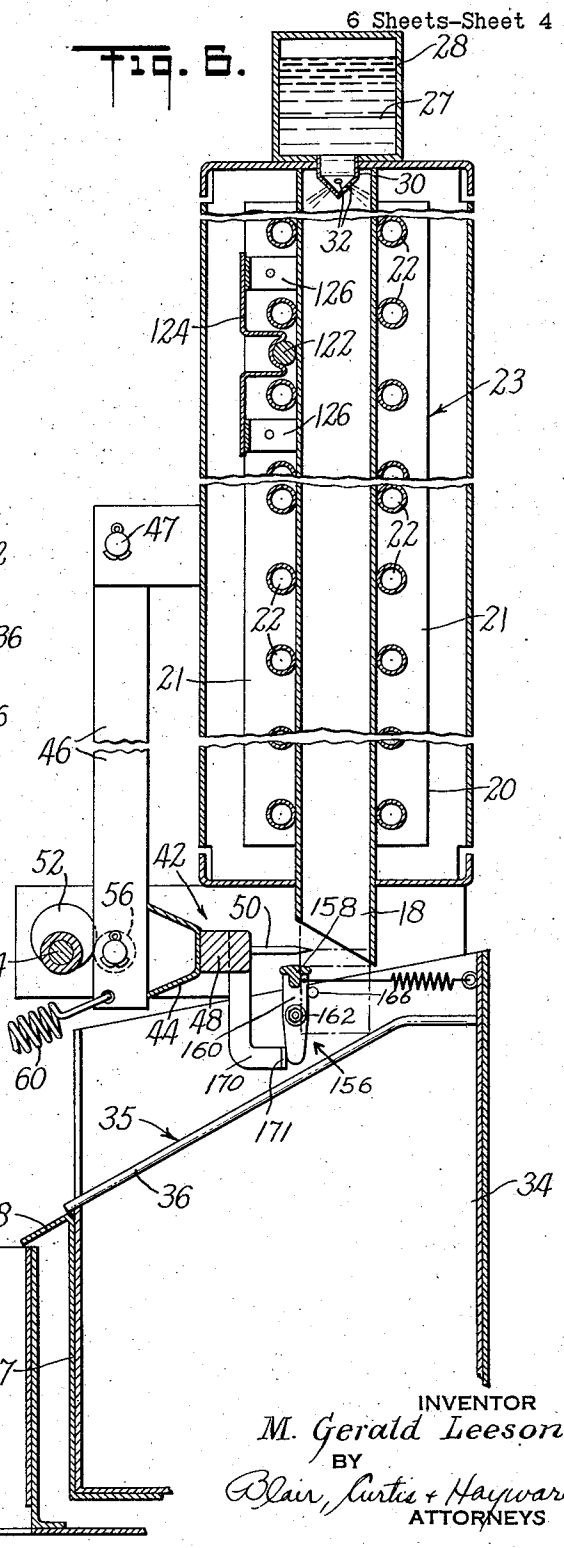


Fig. 6.



INVENTOR
M. Gerald Leeson
BY
Blair, Curtis & Hayward
ATTORNEYS

April 17, 1951 M. G. LEESON 2,549,747

ICE-MAKING APPARATUS

Filed July 24, 1946 6 Sheets-Sheet 5

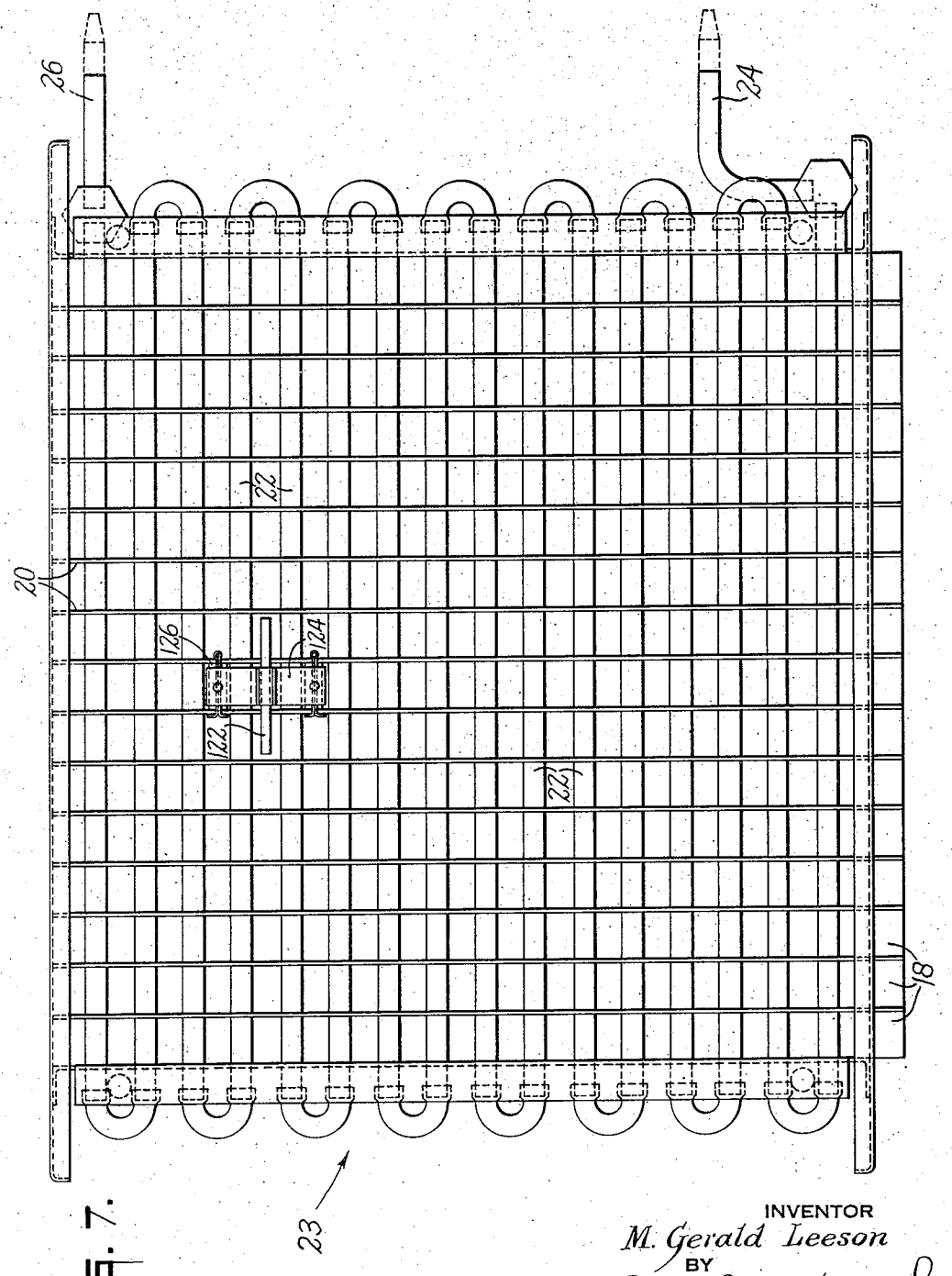


Fig. 7.

INVENTOR
M. Gerald Leeson
BY
Blair, Curtis + Hayward
ATTORNEYS

April 17, 1951 M. G. LEESON 2,549,747

ICE-MAKING APPARATUS

Filed July 24, 1946 6 Sheets-Sheet 6

Fig. 8.

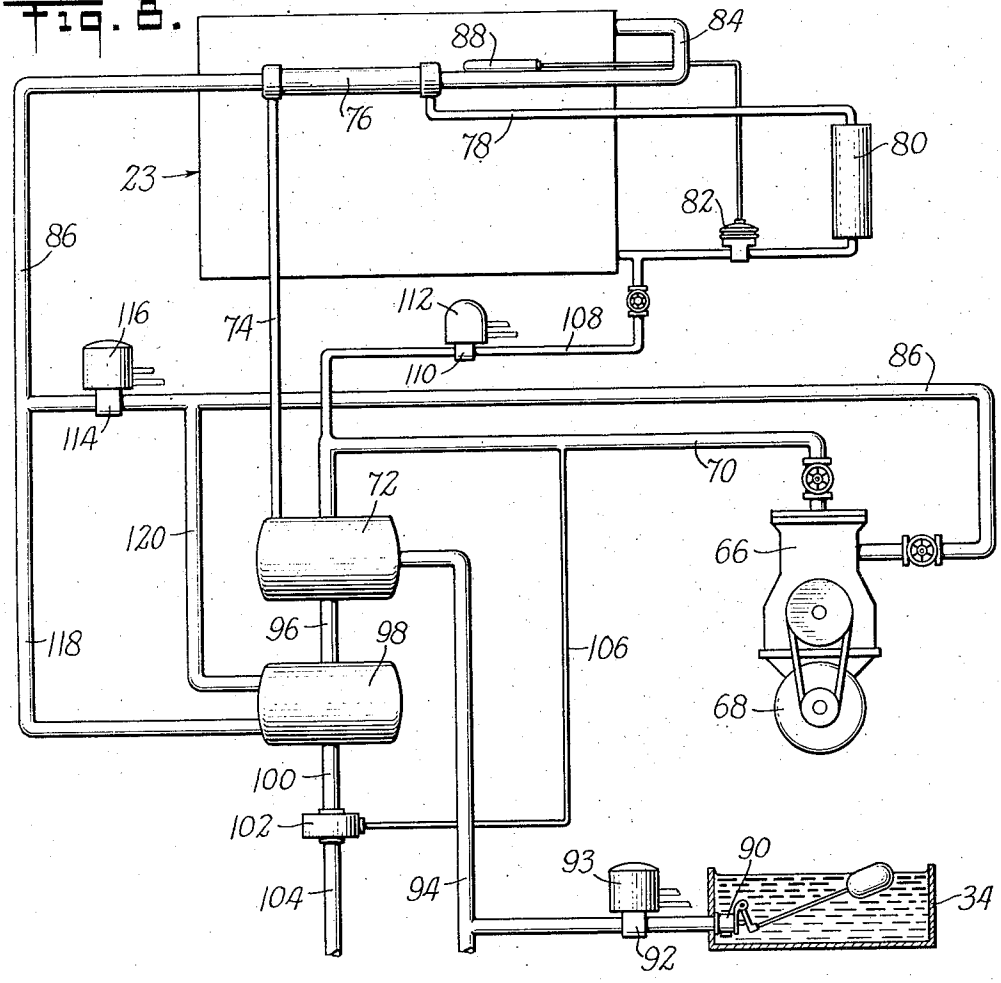
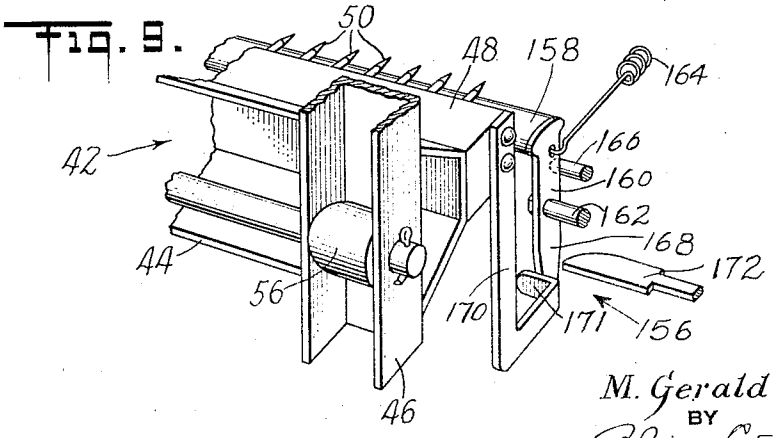


Fig. 9.



INVENTOR
M. Gerald Leeson
BY
Blair, Curtis + Hayward
ATTORNEYS

Patented Apr. 17, 1951 2,549,747

UNITED STATES PATENT OFFICE

2,549,747

ICE-MAKING APPARATUS

Meldon Gerald Leeson, York, Pa., assignor to Flakice Corporation, Brooklyn, N. Y., a corporation of Delaware

Application July 24, 1946, Serial No. 686,021

22 Claims. (Cl. 62—106)

1

This invention relates to refrigeration and, more in particular, to the manufacture of ice in the forms generally referred to as ice cubes and chipped ice. The present application is related to my copending application, Serial No. 573,939, filed January 22, 1945, which issued October 10, 1950, as Patent No. 2,524,815.

An object of my invention is to provide for the efficient and rapid manufacture of ice in the form of cubes and chips, in a thoroughly practical and dependable manner. A further object is to provide a compact unitary apparatus which will operate automatically to produce small particles of clear ice. A still further object is to provide apparatus for carrying out the above which is simple and sturdy in construction and which will meet the varying demands of commercial use. Another object of my invention is to use a simple thermostatic control for the freezing and thawing cycle in which the freezing time is determined by the thickness of the ice formed in the freezing tubes so as to produce ice of uniform thickness in each cycle of operation independently of other surrounding conditions. These and other objects will be in part obvious and in part pointed out below.

The invention accordingly consists in the features of construction, combinations of elements and arrangements of parts as will be exemplified in the structure to be hereinafter described, and the scope of the application of which will be indicated in the following claims.

In the drawings:

Figure 1 is a perspective view of one embodiment of the invention;

Figure 2 is a side elevation partly in section of the embodiment of Figure 1;

Figure 3 is an enlarged front elevation of the ice-making unit which is housed in the upper portion of the cabinet shown in Figures 1 and 2;

Figure 4 is a top plan view of the apparatus of Figure 3;

Figure 5 is a schematic diagram of the electrical circuit;

Figure 6 is a somewhat simplified sectional view showing the most important elements of the evaporator and ice-handling structure;

Figure 7 is a front elevation of the evaporator and freezing tube assembly;

Figure 8 is a schematic diagram of the refrigerant and water circuits; and,

Figure 9 is a view showing the structure of the mechanism which is used to make chips of ice.

In accordance with the invention disclosed in the above-identified application, long sticks of ice

2

are frozen in a bank of vertically positioned square tubes which are refrigerated by a direct expansion evaporator. The evaporator has two sections positioned on opposite sides of the square freezing tubes to give good heat-transfer. A continuous stream of water to be frozen is delivered to a header at the top of the tubes and flows down along the inner walls of the tubes at a rate sufficient to insure that the ice will be clear. The harvesting operation is performed by passing warm water along the sides of the freezing tubes so that the tubes are heated sufficiently to melt the sticks of ice free. The sticks fall from the bottoms of the tubes and are cut into predetermined lengths to form ice cubes.

In the illustrative embodiment of the present invention the operation is somewhat the same. However, the harvesting of the ice is performed by supplying hot refrigerant gas directly from the compressor to the evaporator; this warms the freezing surfaces at a rapid rate so as to free the ice sticks. The construction is simplified because it is unnecessary to provide a source of hot water for harvesting and a simplified control circuit is provided which makes it unnecessary to carry on a timed cycle of operations. Furthermore, there are simplifications and improvements in certain of the structures, and the arrangement is admirably suited for commercial production and use.

In the illustrative embodiment of the present invention the operator may produce cubes of ice or he may change the operation quite easily to produce chips of ice. During the freezing operation, water is circulated from a sump tank to a header at the top of the freezing tubes and it flows down through the freezing tubes at a very rapid rate with the result that its temperature may be reduced even below the normal freezing temperature of still water. As the operation continues an even sheet of clear ice begins to form on the inner walls of the tubes.

The tube walls are excellent heat conductors, whereas ice is a poor heat conductor, and, therefore, whereas the initial layer of ice forms very rapidly, thereafter the rate of ice formation diminishes rapidly. However, the interference of the layer of ice with the ready transfer of heat from the water to the refrigerant causes an increase in the temperature differential between the water being frozen and the refrigerant; and, the thermostatic expansion valve, which controls the flow of liquid refrigerant into the evaporator, maintains a constant temperature drop across the evaporator. This results in a steady decrease

in the temperature of the evaporator and the freezing tube walls as the layer of ice builds up. Therefore, if the layer of ice builds up unevenly, the reduced temperature of the tube walls tends to cause an accelerated freezing action where the ice layer is thin so that in practice the layer of ice is of fairly even thickness. With tubes of square cross-section there is a compensating freezing action at the corners of the tubes so that as the freezing operation is continued a small hole of circular cross-section remains through the center of the stick of ice. Illustratively, the freezing operation is discontinued when there is still this circular opening through the sticks and the sticks are then cut into lengths to produce cubes or chips as desired.

In accordance with the present invention, the starting and stopping of the freezing and harvesting operations are controlled by a simple single-pole double-throw thermostat which has its thermostatic bulb in direct contact with the walls of the freezing tubes. The temperature of the tube walls is a reliable indication of the conditions within the freezing tubes, not only during the freezing operation, but during the harvesting operation. Thus, when the temperature of these walls drops, for example, to 20° F. it is known that a layer of ice of a particular thickness has been formed on the inner walls of each of the freezing tubes. As the thickness of the layer of ice increases, the wall temperature drops in accordance with a known function. Thus, when the wall temperature has dropped, for example, to 12° F., the freezing operation is discontinued and hot refrigerant gas is supplied to the evaporator to melt the ice free. In the early stages of the harvesting operation the wall temperature rises slowly, but when the ice is freed from the walls, there is a sharp rise in the wall temperature. Therefore, the thermostat is set to discontinue the harvesting operation after this sharp rise in the wall temperature, for example, when the wall temperature reaches 40° F., and then the freezing operation is restarted immediately.

For any fixed set of conditions the time required for freezing and harvesting successive batches of ice is approximately constant, but the present arrangement does not depend upon a timed cycle for its control and therefore variations in the conditions are compensated for automatically. For example, if conditions are such that ice forms at a reduced rate, the temperature of the tube walls does not drop as rapidly and the freezing operation is continued for such time as is necessary to freeze the desired thickness of ice in the tubes. Or if the ice has not been released after the usual time required for harvesting, the tube wall temperature does not rise and the thermostat continues the harvesting operation for the necessary additional time. It is thus seen that the present system provides compensation for deviations from normal conditions and thus insures that the product is of uniform quality regardless of such deviations. Yet, this ideal mode of operation is provided by a control arrangement which is extremely simple in construction.

Referring particularly to Figures 1 and 2 of the drawings, the cabinet **2** is upright with a lower ice storage chest **4** and an upper casing **6** which encloses the refrigeration system and the ice-making equipment. Chest **4** has a pair of doors **8** which are hinged together so that they may be opened individually or may be removed to expose the entire opening. As shown at the lower right-hand portion of Figure 2, a drain **10** is provided through which water may flow to waste thus to maintain ice cubes or chips stored in the chest substantially free of water. At its top the chest is provided with an ice inlet opening **12** and an emergency drain opening **14** through which excess water from the ice-making unit may flow to the drain **10**. The front and top walls of casing **6** are formed by a panel **15** which is removable to give ready access to the interior of the casing. Casing **6** is provided on each of its side walls with a set of louvres **16** and at its top panel **15** has a similar set of louvres **17**; during operation these louvres permit warm air to escape at the top of casing **6** and cool air enter at the bottom.

Ice is frozen in the form of long square sticks having small circular center openings and these sticks are automatically cut into lengths thus to form cubes or ice chips. These sticks of ice are formed in square freezing tubes **18** shown, respectively, in horizontal and vertical section in Figures 4 and 6. In this embodiment there are sixteen freezing tubes positioned in parallel side-by-side relationship as shown in Figure 7. Between each freezing tube and the next adjacent freezing tube is a vertical separating plate or fin member **20**. Each of these fin members is much wider than the tubes so that the fin members project on the opposite sides of the tubes (see Figure 6) to provide fins **21**. Fins **21** are pierced at the surfaces of the freezing tubes and snugly receive evaporator tubes **22** which are thus held in engagement with the opposite sides of the freezing tubes. Evaporator tubes **22** are connected to form the two parallel evaporator sections of an evaporator **23**, and (Figure 7) the tubes are connected at the bottom by a liquid refrigerant inlet header **24** and at the top by a gas refrigerant outlet header **26**.

Water is delivered to each of the freezing tubes **18** during the freezing operation so as to provide for a steady flow of water down the entire inner wall of each of the tubes. Accordingly, at the top of the tubes (Figure 6) is mounted a water header **28** which has in its bottom wall sixteen nipples **30**, each of which is centered in the top of one of the tubes. Each nipple has a conical portion which has four holes **32** from which small streams of water are directed against the centers of the four walls of the tube. Water passes to these nipples from the right hand end (Figure 4) of header **28** and in order to confine the horizontal flow of the water to the upper portion of the header **28**, vertical baffles **27** are provided. These baffles are sheet metal and extend transversely of the length of the header in the bottom thereof (see Figure 6) and there is a baffle between each nipple and the ring. Thus, while the water flows horizontally in the upper portion of the header, there is no horizontal flow within the zones where the nipples are connected to the header. As indicated above, the water is supplied to the tubes in a continuous stream during the freezing operation and the water is sufficient in quantity to provide a rapid flow so that clear ice is produced. The water in excess of that which is frozen flows from the bottom of the tube into a sump tank **34** from which it is recirculated back to the tubes. Referring to Figure 3, positioned at the right-hand end of sump tank **34** is a pump **33** which is driven by a motor **31** and

which is connected through a pipe 29 to header 28.

Extending across the top of sump tank 34 is a grid 35 formed by a plurality of parallel bars 36. The central portion of the front wall 37 of the sump tank (at the left in Figure 6) is lower than the other walls, and grid 35 slopes as shown between the back wall and the front wall. The front wall also has a flange 38 at the left-hand edge of which is an ice chute 40 which (see Figure 2) is directly over the ice inlet opening 12 in the top of the ice storage chest. After tubes of ice have been formed in the freezing tubes, the tubes are heated so that the sticks of ice are melted free with the result that they slide down and rest upon grid 35 in the manner indicated in broken lines in Figure 6.

As shown at the left in Figure 6, swingably mounted along the front side of the evaporator assembly is an ice cutter assembly 42 which has a U-frame 44 carrying a horizontal cutter bar 48. Frame 44 is swingably mounted at its ends on a pair of fixed brackets 46 (only one of which is shown) on pins 47. Cutter bar 48 carries a large number of evenly spaced picks 40 which project toward the bottom ends of the freezing tubes. At the left (Figure 6) of the lower end of U-frame 44 is a cam shaft 54 which (see also Figure 3) is rotatably mounted at its ends in a pair of fixed bearings 55 and which carries near its ends a pair of cams 52. These cams engage a pair of cam follower rollers 56 (one of which is indicated in broken lines in Figure 6) rotatably mounted on the U-frame. During the harvesting operation shaft 54 is rotated at approximately fifty revolutions per minute by a motor 58 through a gear reduction mechanism 59 (Figure 3). U-frame 44 is urged away from the freezing tubes by a spring 60 so that when cam shaft 54 is rotated an oscillating movement is imparted to the cutter bar 48. That is, spring 60 holds the cam follower rollers 56 against the cams so that the rotation of the cams causes the U-frame to swing back and forth.

Thus, picks 50 are projected to the right from the position shown into the sides of the ice sticks which rest on grid 35 and sever the lower end of each stick and thereby form ice cubes. The cubes of ice slide to the left along the grid and fall through chute 40 into the ice storage chest. As the ice cubes slide down the grid the cutter bar is swung away from the sticks of ice with the result that the sticks of ice fall again with their lower ends again resting on the grid, and upon the next forward movement of the picks another cube is severed from each stick. This operation continues until all of the ice sticks are cut into ice cubes.

The refrigerant circuit by which refrigerant is supplied to the evaporator, and the water circuit by which water is supplied to sump tank 34, are shown schematically in Figure 8. As shown in the lower right-hand portion of the figure, a compressor 66 is driven by an electric motor 68 and delivers compressed refrigerant gas through a pipe 70 to a water-cooled condenser-receiver 72. The liquid refrigerant from condenser-receiver 72 passes through a liquid tube 74 to the outer shell of a heat-exchanger 76 and thence through a liquid tube 78 which is provided with a strainer 80 to an expansion valve 82. From the expansion valve the refrigerant passes to the two sections of the evaporator. Refrigerant gas passes from the top of

the evaporator through a pipe 84 to the heat-exchanger 76 and thence through a pipe 86 back to the compressor. Expansion valve 82 is controlled by a thermostat bulb 88 fixed to pipe 84 at the outlet of the evaporator so as to maintain a constant temperature drop across the evaporator.

Sump tank 34 is supplied with water under the control of a float valve 90 and a solenoid valve 92, having a solenoid 93, from a water supply pipe 94. Cooling water for the condenser-receiver 72 is also supplied through pipe 94 and is discharged from the condenser-receiver through pipe 96 into the water chamber of a hot water accumulator 98. The outlet from hot water accumulator is through a pipe 100 and a discharge-control valve 102 to a drain pipe 104. Water regulating valve 102 is controlled through a control line 106 which extends to the compressor discharge pipe 70 at the outlet of the compressor. The arrangement is such that valve 102 is spring-urged toward its closed position but it is opened gradually by a rise in the compressor outlet pressure in pipe 70. The pressure in pipe 70 is directly related to the quantity of water which valve 102 permits to flow through the condenser-receiver. It is desirable to maintain the condensing pressure constant and to supply only the amount of water to the condenser-receiver which is necessary to condense the refrigerant at that pressure and the pressure in pipe 70 is an indication of whether or not the proper amount of water is being supplied. Thus, by providing this controlled restriction on the water outlet, no more cooling water is used than is necessary to condense the refrigerant in the condenser-receiver; and, yet, if the temperature of the cooling water entering through pipe 94 should rise, or if there is an excessive load on the apparatus, there is a sufficient increase in the flow of water to insure proper operation. Furthermore, a body of hot water is provided in the hot water accumulator because the slow flow causes this body of water to be replaced slowly so that it is always hot.

As indicated above, the harvesting operation is performed by supplying hot gas from the compressor to the evaporator and for this purpose the high pressure gas pipe 70 is connected through a hot gas pipe 108 to the inlet of the evaporator. Pipe 108 has therein a normally-closed solenoid valve 110, having a solenoid 112, and during the harvesting operation solenoid 112 is energized thereby opening the valve and permitting the hot gas to flow to the evaporator. This melts the ice free so that it falls from the bottom of the tubes. The cooling of the hot gas in the evaporator causes some of the gas to be condensed and it is desirable to prevent the slugs of condensed refrigerant from passing to the compressor. Accordingly, the gas return pipe 86 which connects the evaporator to the inlet of the compressor has therein a solenoid valve 114, which has a solenoid 116, and at the left and right respectively of this valve are two pipes 118 and 120 which connect pipe 86 to the two sides of a heat-exchange coil in the hot water accumulator 98. During the freezing operation, solenoid 116 is energized so that valve 114 is open and the gas flows through pipe 86 directly to the compressor. However, during the harvesting operation solenoid 116 is deenergized and valve 114 is closed with the result that the gas and slugs of condensed refrigerant which pass from the evaporator are diverted by valve 114 down

pipe 118 to the hot water accumulator. Within the hot water accumulator the slugs of refrigerant are evaporated and the quantity of the hot water is sufficient to insure that only gas refrigerant passes back through pipes 120 and 86 to the compressor.

As indicated above, the initiating and terminating of the harvesting operation is automatic and the operation depends upon the temperature of the freezing tubes. Accordingly as shown best in Figure 6, mounted in contact with the left-hand side of the freezing tubes is a thermostatic bulb 122 (see also Figure 7) which is held in place by a bracket 124 which, in turn, is carried by a pair of U-brackets 126 mounted on the adjacent fins. These brackets are resilient and they hold the thermostatic bulb tightly against the adjacent freezing tubes thus to provide a good heat-exchange relationship.

The electrical circuit for the system is represented schematically in Figure 5. As indicated at the top of the figure, power is supplied through a pair of lines 128 and 130 and a switch 132 to a pair of lines 134 and 136. Motor 68 is connected directly across lines 134 and 136 so that when the switch is closed, the compressor is operated continuously. Also connected across lines 134 and 136 is a solenoid 138 of a normally-closed solenoid switch 140 which has a time-delay opening arrangement represented by a dashpot 142 so that upon the energization of solenoid 138 there is a two minute time delay after which switch 140 opens and the switch then stays open until the solenoid is deenergized.

Switch 140 is connected at one side to line 134 and at the other side to a solenoid 144 of a two-position solenoid switch 146 which has an armature 147. The other side of solenoid 144 is connected to line 136 so that when switch 140 is closed, solenoid 144 is energized and armature 147 engages the upper contact 148; whereas, when switch 140 is open, solenoid 144 is not energized and armature 147 engages the lower contact 150. Contact 150 is connected to the armature 152 of the thermostatic switch 153, the position of which is controlled by thermostatic bulb 122. When in the left-hand position, armature 152 engages a contact 154 which is connected to the water pump motor 31 and to solenoid 116 which controls valve 114 in pipe 86; when in the right-hand position, armature 152 engages a contact 155 which is connected to cam motor 58 and solenoids 112 and 93. The other side of each of solenoids 116, 112 and 93 and of motors 31 and 58 is connected to line 136.

Thus, the swinging of armature 152 to the left energizes motor 31 so as to circulate water through the freezing tubes, and it energizes solenoid 116 so as to open valve 114 and permit the refrigerant to return from the evaporator directly to the compressor. When armature 152 is swung to its right-hand position it closes a circuit to the cam motor 58 so as to start the oscillating movement of the ice cutter mechanism, it energizes solenoid 112 of the hot gas valve 110, and it also energizes solenoid 93 of the makeup water valve 92. The energizing of solenoid 93 opens valve 92 (see Figure 8) so that if float valve 90 is open, water flows into the sump tank 34. During the freezing operation, armature 152 is in the left-hand position and during the harvesting operation, this armature is in the right-hand position. Thus, water is supplied to the sump tank only during the harvesting operation and the freezing operation is not interfered with by the addition of warm water. However, the addition of warm water to the sump tank is still under the control of the float valve. During the harvesting operation solenoid 112 is energized so that valve 110 is opened with the result that hot gas is supplied to the evaporator thereby heating it to thaw the ice in the freezing tubes, and solenoid 116 is deenergized so that valve 114 is closed; thus, the gas returning from the evaporator to the compressor is diverted through pipe 118, the hot water accumulator 98 and pipe 120, and this insures the reevaporation of any refrigerant condensed in the evaporator.

During normal operation, armature 152 swings from the left-hand position to the right-hand position when the temperature of bulb 122 is reduced, for example, to 12° F. and the armature is then swung back to the left-hand position when the bulb temperature rises to 40° F. It has been found that with the apparatus of the illustrative embodiment ice cubes of uniform high quality are formed which are of clear ice. In practice the sticks of ice formed in the freezing tubes have small holes therein so that each cube has a hole through it. This has certain advantages from a commercial standpoint and the hole can be made large or small by varying the adjustment of thermostatic switch 153 controlled by bulb 122. For example, if this switch is adjusted to initiate the harvesting operation when the temperature of the freezing tubes falls to 20°, the holes through the ice sticks and therefore the hole through each ice cube is relatively large. However, for a given adjustment of the switch 153 these holes are relatively uniform even though there are variations in operating conditions.

During operation there may be a temporary power failure or switch 132 may be opened so that power is no longer supplied to lines 134 and 136 and the operation is temporarily stopped. In such event, solenoid 138 is deenergized so that switch 140 recloses. Thereafter, when power is again supplied to lines 134 and 136 switch 140 remains closed for two minutes and during this time, solenoid 144 is energized, armature 147 engages contact 148 and is held away from contact 150. The closing of the circuit through contact 148 connects line 134 directly to motor 58 and to solenoids 93 and 112, and the opening of the circuit through contact 150 prevents the supplying of power to motor 31 and solenoid 116 (even though armature 152 is in its left-hand position). Thus, upon the resumption of the supplying of power through lines 134 and 136 to the system, the harvesting operation is carried on for two minutes whereupon switch 140 is opened so that the circuit through contact 148 is opened and the circuit through contact 150 is closed, and the operations are then under the sole control of the thermostatically controlled switch 153.

By providing for this operation the difficulties are avoided which might otherwise result from a temporary power stoppage or by the opening of switch 132 for a short period of time; that is, if the power is cut off for a period of time sufficient to permit the sticks of ice to melt free and be lodged on grid 35, the restarting of the freezing operation might damage the apparatus. However, with this arrangement each time that the apparatus is turned on the ice tubes are freed of any ice which they may contain and after this initial harvesting operation the thermostat controls the operations.

Under some circumstances it is desirable to provide small cubes or chips of ice and with the apparatus of the illustrative embodiment of the invention this is possible. Accordingly, as shown in Figures 6 and 9, an auxiliary stop mechanism 156 is provided which stops the sticks of ice a short distance beneath the level of picks 50. When this auxiliary stop mechanism is operative a short length of each stick of ice (Figure 6) projects beneath picks 50, and therefore as the picks are projected into the ice sticks they cut off short flat lengths of the ice sticks so as to form chips and these chips slide down the grid and fall into chute 49. This stop mechanism is formed by a stop bar 158 which is swingably mounted at its ends on a pair of arms 160. Arms 160 are pivoted on a pair of pivot bolts 162 fixed to the casing frame and (see Figure 9) at one end of the bar is a tension spring 164 which is attached at one end to the bar and at the other end to the casing frame so as to urge the bar toward its position beneath the freezing tubes (Figure 6). A pin 166 rigidly mounted on the casing frame limits the movement of the bar so that it may move under the freezing tubes only a distance sufficient to be engaged by and thereby to stop all of the tubes of ice.

One of arms 160 has a downwardly projecting lever portion 168 and fixed to the adjacent end of cutter bar 48 is an operating bracket 170 which projects downwardly from the cutter bar and has a horizontally disposed toe 171 which is adapted to engage the lower end of arm 160. Thus, as the cutter bar oscillates the operating bracket moves with the cutter bar and its toe engages the lower end of arm 160 and swings the arm counter-clockwise. This counter-clockwise movement is sufficient to swing stop bar 158 out from under the freezing tubes and thus out from under the sticks of ice. Therefore, as the ice picks project into the sticks of ice and thus cut off a short length of each stick of ice in the form of chips, the stop bar is moved away with the result that the chips fall onto the grid and slide into bin 40. When the picks are cutting the ice they momentarily hold the sticks of ice from falling; but, as the picks are withdrawn, the operating bracket 170 is withdrawn from the arm 160 with the result that spring 164 pulls the stop bar back under the sticks of ice. Therefore, the sticks of ice are again held by the stop bar a short distance beneath the level of the picks so that upon the next forward movement of the picks another group of chips is cut free.

When it is desirable to render the stop bar inoperative and thus form cubes of ice (as explained above), a horizontal slide 172 is pushed in from the end wall of the casing and this has a cam on its forward end which engages the lower end of the arm 160 so as to swing the arm counter-clockwise. This moves the stop bar from beneath the freezing tubes in the same manner as does operating bracket 170. Therefore, upon each oscillation of the cutter bar, as the picks are withdrawn the ice sticks fall so as to rest on the grid, with the result that cubes are formed when the picks are again projected into the sticks.

As many possible embodiments may be made of the mechanical features of the above invention and as the art herein described might be varied in various parts, all without departing from the scope of the invention, it is to be understood that all matter hereinabove set forth, or shown in the accompanying drawings is to be interpreted as illustrative and not in a limiting sense.

I claim:

1. In ice-making apparatus, the combination of, a cabinet structure, a refrigeration system having an evaporator in said cabinet structure formed by a pair of parallel spaced evaporator sections having freezing zones therebetween, a bank of vertical freezing tubes which are square in cross-section and positioned parallel and side-by-side and occupying said freezing zone in heat-exchange relationship with each other and with said evaporator sections, an elongated water header positioned along the tops of said freezing tubes and having a plurality of water distrbuting nipples projecting respectively into the tops of said freezing tubes and having water outlet openings for directing water against the sides of each tube, water-supply means including a pump to supply water to said header whereby a steady stream of water flows down each tube during the freezing operation, means to initiate the supplying of heat to said tubes to melt ice formed therein whereby the ice falls from the bottom ends of the tubes, and means to sever the ice as it emerges including a horizontal cutter bar which is adapted to be swung to and from a position adjacent the lower ends of said tubes and a plurality of ice picks carried by said cutter bar and adapted to project into the ice as it emerges from the tubes.

2. Apparatus as described in claim 1 which includes, a spring urging said cutter bar away from the freezing tubes, and a cam assembly formed by a pair of cams fixed to a rotatable cam shaft and adapted upon rotation of the cam shaft to swing the cutter bar against the action of said spring.

3. Apparatus as described in claim 1 wherein said refrigeration system includes an expansion valve through which liquid flows to said evaporator and which maintains a substantially constant temperature drop across the evaporator during the freezing operation, and wherein the harvesting operation is controlled in accordance with the temperature of the freezing tubes.

4. Apparatus as described in claim 1 wherein said refrigeration system has a water-cooled condenser and wherein the harvesting operation is performed by means supplying hot refrigerant gas, a hot water accumulator to which hot water from the condenser is supplied during the freezing operation, and means to direct refrigerant flowing to the compressor during the harvesting operation into heat-exchange relationship with the water in said hot water accumulator.

5. Apparatus as described in claim 1 which includes a plurality of vertical fin members positioned respectively between the adjacent surfaces of the respective freezing tubes and having sufficient width to form fins on the opposite sides of the freezing tubes.

6. Apparatus as described in claim 1 wherein said header has a water inlet portion which projects horizontally beyond one end of the row of tubes and which has a transverse water inlet opening.

7. In ice-making apparatus, an evaporator and freezing tube assembly comprising, a bank of parallel square freezing tubes spaced in side-by-side relationship, a plurality of fin members of substantially greater width than the width of the freezing tubes and positioned respectively between adjacent surfaces of the respective freezing tubes with each fin having the opposite surfaces of its central portion abutting the side walls of the adjacent freezing tubes and with its marginal portions projecting beyond the sides of the tubes,

and a pair of evaporator sections positioned respectively on opposite sides of the freezing tubes and each formed by an evaporator tube having parallel runs which pierce the marginal portions of the fin members and which are in intimate heat-exchange relationship with the fin members and the tubes.

8. In ice-making apparatus, a water distributor header comprising, an elongated shell which is rectangular in cross-section and which is adapted to receive water delivered to it in a transverse direction at one of its ends, a plurality of nipples equally spaced along one wall of said shell and adapted to direct water in streams into the ends of freezing tubes, and a plurality of baffles positioned respectively between each two adjacent nipples and adapted to divert the water flowing along said header from the side thereof along which said nipples are positioned.

9. In ice-making apparatus, the combination of, a bank of vertical freezing tubes adapted to produce ice in the form of rods which emerge from the bottom ends of the tubes in side-by-side relationship, and an ice-cutter mounted to sever the sticks of ice into lengths as they emerge from the bottom ends of the tubes comprising a frame swingably mounted at its upper ends and a cutter bar assembly formed by a horizontal cutter bar fixed to the frame and positioned at the bottom ends of said freezing tubes and a plurality of picks mounted on the cutter bar and projecting toward the bottom ends of the tubes.

10. Apparatus as described in claim 9 which includes, a spring urging said cutter bar away from the tubes, and a cam assembly to project the cutter bar toward the tubes comprising a pair of cams mounted on a cam shaft and adapted upon rotation of the shaft to swing the frame toward the tubes against the tension of said spring.

11. In self-contained ice making apparatus, the combination of, a refrigerating system having an evaporator, a compressor and a condenser, a bank of vertical ice-freezing tubes positioned side-by-side in heat-exchange relation with each other and said evaporator, a water header positioned above the tops of said ice-freezing tubes having a plurality of openings registering with the tops of said ice-freezing tubes, water-supply means for supplying water to said header, means for supplying heat produced by said refrigerating system to said ice-freezing tubes to thaw the bond between the tubes and the ice formed therein whereby the ice protrudes from the lower ends of said tubes, and means for severing the ice as it emerges from said tubes including a horizontal cutter bar adapted to move horizontally and having mounted thereon a plurality of ice picks which project into the ice as it emerges from said tubes.

12. In ice making apparatus, a refrigerating system having an evaporator, a compressor and a condenser, vertical freezing tubes in contact with said evaporator, a pump for circulating water through said freezing tubes, said refrigerating system being adapted to evaporate refrigerant to cause ice to form in the tubes, a condenser to condense the refrigerant by passing it through the condenser in heat-exchange relationship with water which absorbs the heat of condensation, means for retaining a body of said water after passing through said condenser, means for thawing the ice from said tubes by passing hot refrigerant gas from said compressor into heat-exchange relationship with said tubes, and means for passing the refrigerant used to obtain the thawing action into heat-exchange with the body of retained condenser water for re-evaporating any condensed refrigerant before entering the compressor.

13. In ice making apparatus, a refrigerating system having an evaporator, a compressor and a condenser, vertical freezing tubes in contact with said evaporator, a pump for circulating water through said freezing tubes, said refrigerating system being adapted to evaporate refrigerant to cause ice to form in the tubes, a condenser to condense the refrigerant by passing it through the condenser in heat-exchange relationship with water which absorbs the heat of condensation, means for retaining a body of said water after passing through said condenser, means for thawing the ice from said tubes by passing hot refrigerant gas from said compressor into heat-exchange relationship with said tubes, means for passing the refrigerant used to obtain the thawing action into heat-exchange with the body of retained condenser water for re-evaporating any condensed refrigerant before entering the compressor, and means for severing the ice as it emerges from said tubes including a horizontal cutter bar adapted to move horizontally and having mounted thereon a plurality of ice picks which project into the ice as it emerges from said tubes.

14. In ice making apparatus, a plurality of vertical freezing tubes in side-by-side relation, an evaporator formed by a pair of parallel spaced evaporator sections in heat-exchange relation with said freezing tubes, and thermostatic means responsive to freezing tube temperature for controlling the operation of said evaporator to interrupt the freezing cycle and initiate the thawing cycle when the ice has reached a predetermined thickness in the freezing tubes.

15. In ice making apparatus, a control mechanism for carrying on successive ice making and ice harvesting operations comprising, means to control the temperature in the evaporator whereby a substantially constant temperature drop is mainained across the evaporator, means to initiate a harvesting operation when a predetermined quantity of ice has been frozen, means to supply hot refrigerant to the evaporator to melt the ice free from the freezing surfaces, and means responsive to a rise in temperature adjacent the freezing surfaces for restarting the freezing operation including means to prevent the restarting of the freezing operation without there being a time delay sufficient to permit the removal of ice from the freezing surfaces.

16. In ice-making apparatus, an evaporator and freezing tube assembly comprising, a bank of freezing tubes substantially abutting each other in side-by-side relationship, an evaporator assembly comprising means separate from said freezing tubes but in intimate heat exchange relationship therewith and forming refrigerant passageways within which liquid refrigerant is evaporated, and means rigidly attached to said bank of tubes holding said evaporator assembly in place.

17. In ice-making apparatus, a water distributor header comprising, a shell construction which is adapted to receive water delivered to it in a transverse direction, a plurality of nipples spaced along one wall of said shell and adapted to direct water in streams into the ends of adjacent freezing tubes, and a baffle assembly positioned along said wall and projecting transversely thereof

whereby water is diverted from flowing along said wall.

18. In ice-making apparatus of the type wherein elongated bodies of ice are formed, an ice cutter which is adapted to sever the elongated ice bodies into lengths to form cubes or the like comprising, a horizontal cutter bar having a plurality of spaced parallel pick elements projecting from one side thereof and adapted to engage and sever the ice, a supporting frame for said bar which supports said bar in such a manner that it may be oscillated to and from a position wherein it severs the ice, and operating means for said bar which is adapted to move the bar with a positive action to its position wherein it engages and severs the ice, said apparatus including means adapted to resiliently withdraw the bar from said position.

19. Apparatus as described in claim 18 wherein said frame comprises a pair of vertical swinging arms which are supported at their upper ends and which are fixed to said bar at their lower ends, means to hold the ice during the time that it is being severed, arresting means to hold the unsevered ice when the bar has been withdrawn thereby to permit the severed ice to move free, the means to render said arresting means ineffective immediately prior to the movement of the bar toward its position wherein it severs the ice.

20. In ice-making apparatus, an evaporator and freezing tube assembly comprising, a bank of parallel square freezing tubes positioned in side-by-side relationship and having opposite side faces which are positioned at two substantially parallel heat-transfer zones, a plurality of heat-transfer and evaporator-contacting members each extending between two adjacent tubes to provide an intimate heat-transfer relationship between the sides of the tubes and said members, and an evaporator assembly comprising a pair of evaporator sections formed by metal tubes with the sections being positioned respectively in said heat-transfer zones with there being straight tube portions extending transversely of the freezing tubes and each tube portion being physically attached to said members whereby a good heat-transfer relationship is provided between the tube portions and the freezing tubes through said members.

21. Apparatus as described in claim 20 which includes, a water distributor header comprising a shell construction which is adapted to receive water which is delivered to it in a transverse direction, and distributor means spaced along one wall of said shell construction and projecting respectively into said freezing tubes and each adapted to direct water against the adjacent tube walls in substantially even streams.

22. Apparatus as described in claim 21 which includes, means mounting said freezing tubes in vertical relationship, a sump tank positioned beneath the level of said tubes and adapted to have water flow therein from said tubes, a water pump to pump water from said sump tank into said header, an ice storage compartment positioned beneath the level of said sump tank and providing a base for the aforementioned apparatus, and means to direct the ice from said freezing tubes into said storage compartment.

MELDON GERALD LEESON.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,200,424	Kubaugh	May 14, 1940
2,220,001	Potter	Oct. 29, 1940
2,221,212	Wussow et al.	Nov. 12, 1940
2,221,694	Potter	Nov. 12, 1940
2,239,234	Kubaugh	Apr. 22, 1941
2,364,016	Wussow et al.	Nov. 28, 1944
2,387,899	Gruner	Oct. 30, 1945