

Jan. 27, 1959

M. W. GARLAND
ICE-MAKING APPARATUS

2,870,612

Filed Aug. 29, 1955

2 Sheets-Sheet 1

FIG. 1

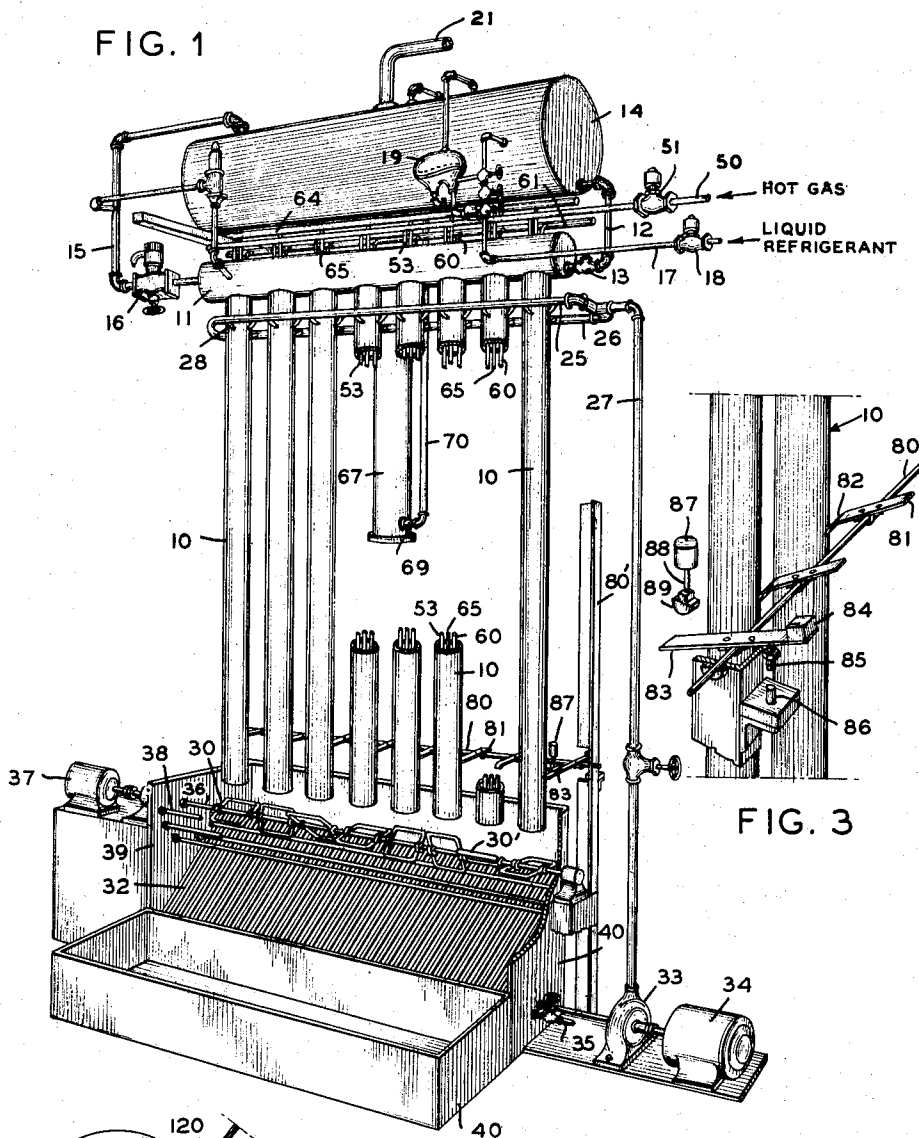
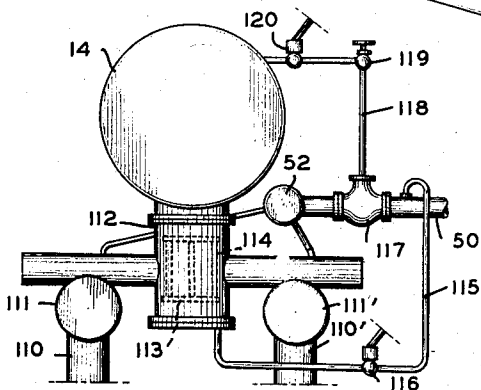


FIG. 3

FIG. 4



INVENTOR
MILTON W. GARLAND

BY *A. Yates Dowell*

ATTORNEY

Jan. 27, 1959

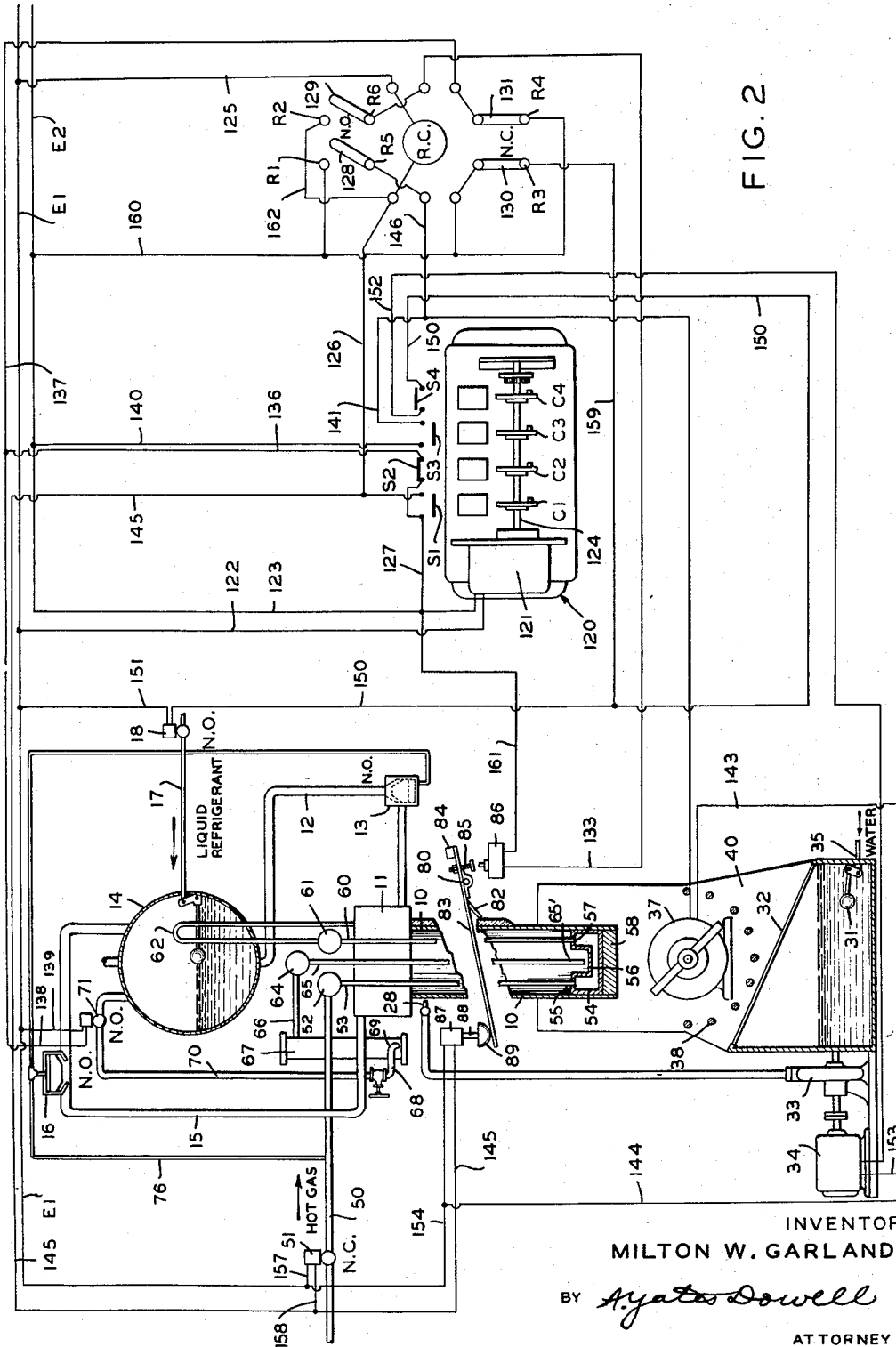
M. W. GARLAND

2,870,612

ICE-MAKING APPARATUS

Filed Aug. 29, 1955

2 Sheets-Sheet 2



1

2,870,612

ICE-MAKING APPARATUS

Milton W. Garland, Waynesboro, Pa., assignor to Frick Company, Waynesboro, Pa., a firm of Pennsylvania

Application August 29, 1955, Serial No. 531,017

14 Claims. (Cl. 62—138)

This application relates to refrigeration and more particularly to efficiently making ice in fragment form, and is adaptable to machines of a wide range of capacities.

Under present day marketing and merchandising conditions ice in fragment or particle form is in large demand. It is used commercially for the cooling of perishable goods during shipment and while it is on display and otherwise awaiting purchase and removal. It is also used to cool beverages by being placed directly in the container therewith.

A large number of machines for producing ice of this general character have been tried, some of which are in use, and the present invention is believed to be an improvement thereover.

It has been proposed heretofore to make ice in substantially the form of an elongated rod by freezing it within a shell, refrigeration being applied to the exterior of the shell. One of the inherent disadvantages of this process is that the removal of heat from the core portion is relatively slow because of heat transmission difficulties through the intervening wall of ice, ice being a relatively poor conductor. The use of lower freezing temperatures results in clouding the ice, which is usually undesirable.

According to the present invention, water is caused to flow down the exterior of a tube, the interior of which is flooded with refrigerant resulting in a cylinder of ice forming on the tube. The problem of heat transmission through the ice, as it is formed, to the flowing water is minimized because of the relatively larger amount of ice which may be formed without the formation of an excessively thick wall of ice.

For example, considering a theoretical tube two inches in internal diameter, of zero wall thickness, on which ice one inch thick is formed, the cross-sectional area of the one inch thick cylinder of ice is three times as great as the area internally of the cylinder, although the radial distance for heat transmission is the same. This difference increases as the wall thickness increases according to the square of the diameter. Applicant's tubes, in certain applications, are approximately four inches in diameter, and ice is formed thereon up to a half-inch in thickness. Thus, it is apparent that ice can be produced more efficiently on the exterior of a cylinder than on the interior, so far as heat transmission through the ice, as it is formed, is concerned.

One of the important factors in the production of ice is the speed with which it is available. When over-all operation is considered, a difference of only a fraction of a minute has a large effect on the output. For example, if an ice machine is set to operate with a ten-minute cycle and this includes two minutes for harvesting, the reduction of the harvesting time to one minute would result in an increase in output of ten percent. Heretofore, the entire cycle, including the harvesting portion has usually been controlled by a timer which necessarily was set for the maximum outside limit contemplated. The differences in the time required for the cycle

2

vary according to weather, condensing pressures, etc. To set a timer for operation under a variety of conditions has required the provision for from one to two additional minutes over what might be necessary under more favorable conditions. Thus, a substantial amount of time has been wasted.

Other difficulties have arisen heretofore because of problems connected with breaking the ice into fragments of substantially uniform size.

Accordingly, it is an object of the present invention to provide an ice maker for efficiently producing substantially uniform fragments of ice and which is adaptable for machines of varying capacities.

A further object is the provision of an ice making machine for producing ice on the outer surface of one or more elongated tubes and controlling the distribution of refrigerant therein in order to produce the ice uniformly and eliminate difficulties normally accompanying complex refrigeration layouts.

A further object is the provision of control means responsive to the removal of ice from the surfaces on which it is formed for initiating further refrigeration of the surfaces whereby the time required for the total refrigeration cycle may be reduced to a minimum and maximum usage made of the time period for which the apparatus is set.

A further object is the provision of simple structure by means of which the ice may be quickly broken into fragments of substantially uniform size in a one-step operation.

A further object is the provision of controls for the system which provide for its operation without unproductive time loss.

These and other objects of the invention will become apparent from the following description in conjunction with the accompanying drawings in which:

Figure 1 is a perspective, with parts broken away for illustrative purposes, of ice making apparatus constructed in accordance with the present invention;

Figure 2, a schematic diagram of apparatus similar to that illustrated in Figure 1 and showing the control circuit;

Figure 3, a fragmentary detail perspective illustrating the ice sensing control mechanism; and

Figure 4 is a fragmentary schematic illustration of a modified form of apparatus.

Briefly stated, the apparatus illustrated includes a plurality of vertical tubes closed at their lower ends and opening at their top ends into a common header, the latter being normally in communication with an accumulator which maintains the tubes in flooded condition during the ice-making portion of the cycle. Water is sprayed onto the upper surfaces of the tubes and a portion thereof frozen as it flows downwardly; water draining off the tubes is re-circulated. Control means actuated by a timer permits the freezing to continue for a period of time during which the desired thickness of ice is formed. For defrosting, or harvesting, hot refrigerant gas is forced into the header through conduits which pass therethrough and heat the lower tube ends initially, the liquid refrigerant then being forced into the accumulator following which the latter is isolated, thus providing for rapid melting of the sheath of ice from the tube. As the sheaths of ice slide off the tube, they engage a rapidly rotating series of lateral members which rotate beneath within a cage having openings of uniform width through which the ice falls onto a grid for deflection into a collecting area. An ice sensing device mounted adjacent to the tubes places the apparatus in condition for the next ice making cycle as soon as the last sheath of ice has been removed from the tubes.

Freezing apparatus

Referring to the drawings and particularly to Figures 1 and 2, the illustrated apparatus includes a plurality of tubes 10 connected at their upper ends to a header 11 which may receive refrigerant by conduit 12 controlled by piston type valve 13 from accumulator 14. Gaseous refrigerant may be drawn through conduit 15 controlled by piston type valve 16 into the upper portion of the accumulator 14. The accumulator receives liquid refrigerant through line 17 controlled by electric valve 18, the proper level being maintained by float valve 19. Suction connection 21 at the upper portion of the accumulator leads to a compressor (not shown).

Pipes 25 and 26 are connected together on opposite sides of the tubes 10 and receive water from pipe 27, the water being sprayed or flowed onto the tube by a plurality of spaced nozzles 28. During the freezing cycle, a portion of the water freezes on the exterior of the tubes and the remainder flows past breaker members 30 and through a grid 32 to a container therebeneath from which it is recirculated by pump 33 driven by motor 34, make-up being provided through conduit 35 controlled by float valve 31.

Defrosting and harvesting apparatus

At the conclusion of the freezing cycle the ice is defrosted from the exterior of the tubes and slides downwardly into contact with the breaker members 30. The breaker members 30 may be of any desired configuration, but in the illustration consist of rectangular rod members connected intermediate their ends to shaft 36 which is suitably mounted for rotation by the breaker drive motor 37.

A breaker member 30 is positioned one under each tube 10 and has a pair of striker bars 30' at each end thereof spaced from the shaft 36 and substantially parallel thereto. The breaker members 30 are angularly disposed with respect to each other, as indicated, in order that operation will be smoother.

Immediately beneath the breaker members is a sizing cage which in the illustrated embodiment consists of a plurality of parallel equally spaced rods 38 having their ends mounted in the walls 39 and 40 of the harvester. The rods are arranged about the axis of the shaft 36 and permit ice which has been broken sufficiently small to pass between the rods to be discharged therebeneath. As a result the fragments of ice are of substantially uniform size.

Ice fragments discharging from the sizing cage are deflected by the grid 32 into a collecting area such as the chute 40. The grid 32 may consist of a plurality of closely spaced rods which deflect fragments of ice but permit water to pass readily therethrough for recirculation by pump 33.

After ice has frozen on the tubes to form a cylinder or shell of desired thickness, it is necessary that it be quickly and efficiently removed with the least delay. It has been found that it is desirable to heat the lower ends of the tubes initially before heating the remainder in order to permit the ice to free itself from the tubes with the least amount of melting, and that it is preferable not to apply refrigerant during freezing to the lower ends. Apparatus for accomplishing this is illustrated in Figs. 1 and 2 as follows.

Pipe 50, which has a normally closed electrically operated valve 51, is connected to the compressor discharge (not shown) in order that hot refrigerant gas may be supplied for defrosting. Pipe 50 is connected by distribution header 52 to a plurality of pipes 53, one for each tube. Each pipe 53 extends down through the header 11 and a tube 10 into communication with a space 54 at the lower end of the tube. The space 54 is formed by a false bottom 55 having a depressed central portion 56 and a raised annular portion 57 and an end closure plug 58 is provided at the lower extremity of each of the tubes.

Also communicating with the space 54 is a pipe 60 which extends upwardly through the tube 10 from the annular portion 57 of the false bottom into a distribution header 61, the header 61 being connected to a non-return loop 62, the upper portion of which is positioned above the normal liquid level in the accumulator 14, and the end of which is connected to the upper portion of the header 11.

Another distribution header 64 has a pipe 65 extending downwardly into the central portion of each tube 10 and has its lower extremity 65' spaced slightly above the depressed portion 56 of the false bottom 55. From the header 64 a common pipe 66 extends into the upper portion of a collecting drum 67. For removing refrigerant liquid from the lower portion of the drum 67 an L 68 has its inlet 69 inverted so that it is disposed toward the bottom of the drum. Pipe 70, controlled by electric valve 71, is connected to the upper portion of accumulator 14 above the normal liquid level therein.

During the freezing portion of the cycle liquid refrigerant flows from the accumulator through conduit 12 controlled by pressure operated valve 13 into the main header 11. Gaseous refrigerant is withdrawn from header 11 through conduit 15 connected to the upper portion of accumulator 14, flow being controlled by the pressure operated valve 16. The pressure operated piston type valves 13 and 16 are connected to line 76 which is connected to the hot gas line 50 so that when hot refrigerant gas flows through line 50, the pressure will cause the normally open valves 13 and 16 to close.

In order to initiate a new ice freezing cycle as soon as all of the ice has been removed from the tubes ice sensing control apparatus is provided, the details of which are illustrated in Fig. 3. The apparatus includes a shaft 80 which is mounted for oscillation between standards 80'. Rigidly connected to the shaft at spaced intervals are a plurality of fingers 81, each having an angularly disposed contacting portion or tip 82 disposed adjacent to its respective tube 10. An arm 83 is rigidly connected to shaft 80 and has a weight 84 at one end thereof which tends to rotate the shaft 80 clockwise, as viewed in Fig. 3 until the tips 82 of the fingers 81 contact the tubes 10, thus stopping further rotation of the shaft 80. An adjusting screw 85 is connected to the under side of the arm 83 adjacent to the weight 84 for contacting a microswitch 86 whose purpose will be described later.

Adjacent to and suitably mounted above the other end of the arm 83 is a solenoid 87 which has a core 88 to which a weight 89 is attached. The solenoid is so disposed adjacent to the arm 83 that during the ice making portion of the cycle the solenoid weight 89 rests on the arm 83 and its weight is sufficient to more than counterbalance the weight 84 to maintain the shaft 80 in such position that the fingers 82 are spaced from the tubes 10 sufficiently far that they do not interfere with the formation of ice thereon or become frozen into the ice.

A modification of the refrigerant connection between the accumulator and the headers for keeping the tubes flooded is illustrated in Fig. 4. This modified form is particularly adapted for large installations in which there might be, for example, a double bank of tubes 110, 110' supplied by headers 111, 111' from valve 112 which is controlled by a floating piston having spaced bases 113 connected by spaced rods or the like 114 which permit fluid flow thereacross when the piston is in the position illustrated in Fig. 4. The hot gas line 50 has bleeder line 115 controlled by electric valve 116 which when the latter is open, permits the high pressure gas to act against the lower end of the piston valve 112 and close the latter so that the accumulator is sealed off from communication with the headers 111, 111'.

Passage of the hot gas in the line 50 into the header 52 is controlled by a piston type valve 117 to which a bleeder line 118 is connected. Bleeder line 118 has an adjustable throttling valve 119 and an electric valve 120

and is connected to the upper portion of the accumulator 14.

The control system

The apparatus is set to operate for a cycle of predetermined time depending on the thickness of ice desired to be formed on the tubes. As an example of the operation, ice one-quarter inch thick may be formed in 10-minute cycles. The time for a cycle is that which elapses between the initiation of freezing in succeeding cycles; thus a cycle includes both freezing and harvesting.

Referring to Fig. 2, a timer clock 120 is shown having a motor 121 which is energized by leads 122, 123 connected to power lines E1, E2. The motor has a shaft 124 on which cams C1, C2, C3 and C4 are provided for operating switches S1, S2, S3 and S4 respectively.

The coil R. C. of a double pole, double throw relay switch is connected by lead 125 to line E1; by leads 126, 145 to switch S1; and by leads 127 and 123 to line wire E2, when switch S1 is closed. Energization of the relay coil R. C. moves the switch arms 128, 129 from their normally open positions into engagement with conduits R1, R2, and moves the arms 130, 131 out of engagement with contacts R3, R4, respectively, from their normally closed position.

Lead 127 from switch S1 extends to one side of micro-switch 86, a lead 133 extending from the other side of the micro-switch to contact R6 of the relay switch.

Switch S2 has one side connected to line 127 which is connected through lead 123 to the power line E2; the other side is connected to electric control valve 71 by means of lines 136, 137 and 138. The other lead 139 from the electrical control valve is connected to power line E1.

Switch S3 has one side connected to line E2 by lead 140. The other lead 141 from switch S3 is connected to the ice breaker motor 37, the other lead 143 from the ice breaker motor being connected through lines 144 and 154 to power line E1. Lead 146 extends from lead 141 to contact R5 of the relay switch.

Switch S4 has one lead 150 connected to valve 18 in the liquid refrigerant line, the other line 151 from valve 18 being connected to line E1. From the other side of switch S4 line 152 is connected to one terminal of water pump motor 33. The other lead 153 from the water pump motor is connected by lines 144 and 154 to line E1.

The solenoid coil 87 has lead 154 connected to E1. The other lead 156 is connected by lead 145 to one of the contacts of switch S1. Valve 51 on the hot gas line is connected to E1 through leads 157 and 154 and to switch S1 through leads 158 and 145.

Operation

In the device as illustrated in Fig. 2 switch S1 is normally open but is closed momentarily by cam S1 at the beginning of the defrosting portion of the cycle. The momentary closing of switch S1 completes the circuit to relay coil RC, thus moving the arms 130, 131 to open contacts R3 and R4, and moving arms 128, 129 to close contacts R1, R2. Even though switch S1 is only closed for a brief instant, the relay coil RC is maintained energized through a holding circuit in series with ice sensing microswitch 86 until the latter is opened by movement of arm 83.

Switch S2 is normally closed but is opened after initiation of the defrosting portion of the cycle, the time lag being sufficient to permit liquid refrigerant to be blown from the tubes into the accumulator past the valve 71 whose operation is controlled by switch S2 after relay RC is energized. During freezing valve 71 is energized through line 137, relay arm 131 and line 160 to line E2, the other side of valve 71 being connected to line E1.

Switch S3 is normally open and is closed at the initiation of the defrosting portion of the cycle at approximately the same instant as switch S1. Cam C3 maintains

switch S3 closed for approximately two minutes, energizing the ice breaker motor 37, although the ice breaker motor continues to be energized by means of connections through the relay coil arm 128 for as long as the relay coil is energized.

Switch S4 is normally closed and is opened just prior to the beginning of the defrosting portion of the cycle in order to stop operation of the water pump which it controls, just prior to defrosting, in order that the ice may have an opportunity to dry.

Fig. 2 illustrates the normal position of the switches S1, S2, S3, S4 and of the relay coil RC during the freezing portion of the cycle. During such freezing portion the water pump 33 is energized through switch S4 and arm 130 of relay coil RC until just prior to completion of the freezing cycle. Valve 18 in the liquid refrigerant line 17 is similarly energized through relay arm 130, thus permitting liquid refrigerant to enter the accumulator. Similarly valve 71 in the conduit 70 from the collecting drum 67 is open.

Just prior to the end of the freezing cycle cam C4 opens switch S4 to stop water pump 33. Shortly afterward cams C1 and C3 close switches S1 and S3. Switch S1 energizes relay coil RC which is maintained energized by the holding circuit previously described. Energization of relay coil RC opens arms 130, 131, thus de-energizing valve 18 in the liquid refrigerant line.

Closing of the relay arms 128, 129 closes the relay coil holding circuit and energizes valve 51 in the hot refrigerant gas line. When hot gas flows into line 50, bleeder tube 76 causes piston valves 13 and 16 to close. Closing of piston valves 13 and 16 prevents flow of refrigerant from the accumulator into the header through pipe 12 and flow from the header 11 through pipe 15 into the accumulator.

The hot gas passes from distribution header 52 downwardly through pipes 53 disposed in tubes 10, and after flowing through space 54 at the lower ends of the tubes, flows upwardly through pipe 60. From pipe 60 the gas passes into distribution header 61 and then into pipe 62 downwardly into the top of header 11.

The gas pressure at the top of header 11 forces liquid refrigerant in the header and the tubes downwardly in the tubes with the result that it is forced upwardly into the pipes 65 and into distribution header 64, tank 67, and through pipe 70 into the top of accumulator 14. The cam C2 is set to open switch S2 a sufficient time after the valve in the hot gas line has opened to permit evacuation of liquid refrigerant into the accumulator.

After valve 71 closes, the hot gas builds up pressure in the pipes and tubes which assists in the defrosting of the same. Space 54 at the bottoms of tubes 10 is thus heated in the early portion of defrosting in order to free the ice around the lower portions of the tubes at the beginning of defrosting.

Switch S3 was energized at the same time as switch S1 and operates the ice breaker motor 37 for approximately two minutes, or as long as relay coil RC is energized.

At the same time that hot gas valve 51 is energized, solenoid 87 is actuated to lift weight 89 off of the arm 83. As long as ice remains on any of the tubes 10, the ice sensing apparatus will be held out of contact with micro-switch 86 by one or more of the fingers 81. After the last sheath of ice has dropped, weight 84 on arm 83 of the ice sensing mechanism rotates shaft 80 until adjusting screw 85 on the under side of arm 83 contacts micro-switch 86 and opens it. The opening of microswitch 86 breaks the holding circuit to relay coil RC thus closing hot gas valve 51 and de-energizing solenoid 87.

Closing of valve 51 and the simultaneous opening of valve 71 permits piston valves 13 and 16 to open thus permitting refrigerant to flow into the header 11 from the accumulator and be vaporized and drawn into the upper portion thereof. Closing of the normally closed arms of relay coil RC permits operation of the water

pump 33, cam C4 having permitted switch S4 to close earlier. Similarly, liquid line valve 18 is energized through arm 130 of the relay coil.

In the modified device illustrated in Fig. 4, during the freezing operation liquid refrigerant in the tubes 110, 110' is in communication through valve 112 with accumulator 114. At the start of defrosting electric valves 116 and 120 are opened simultaneously, the electrical connection being substituted for that of valve 51 in Fig. 2. Opening of valve 116 permits high pressure refrigerant gas to flow through bleeder tube 115 and force piston 113 upwardly against its seat adjacent to the bottom of accumulator 114, thus preventing refrigerant flow therethrough. Although valve 120 is opened simultaneously, the bleeding of refrigerant gas under pressure from the piston valve 117 into the top of the accumulators 114 is delayed because of the throttling action of valve 119. As a result the opening of piston valve 117 to permit hot gas to flow into distribution header 52 is delayed until after valve 112 has been closed.

In the modification of Fig. 4 the valve 112 takes the place of conduits 12 and 15 in Fig. 2 thus eliminating these and their controls. Otherwise the construction and operation of the modified device illustrated in Fig. 4 corresponds to that of Fig. 2.

Accordingly it will be understood that the invention provides for the flooded operation of one or more tubes and for the flowing of water on the exterior thereof so that ice may be formed. The tubes are so constructed that space at the bottom is not directly refrigerated and the space can be heated at the beginning of defrosting in order to free the lower end of the ice cylinder at the initiation of defrosting.

Hot gas defrosting is provided including an arrangement for supplying the hot gas initially to the lower ends of the tubes and without the necessity for having any external pipes or the like extending from the lower ends of the tubes which would interfere with the formation of ice or the operation of the ice breaking mechanism. Other heating means for the lower ends of the tubes could obviously be employed in place of the specific arrangement illustrated. The liquid refrigerant is quickly evacuated from the tubes so that defrosting is accomplished in a brief time and mechanism responsive to the removal of ice from the tubes is provided for placing the apparatus back into freezing operation as soon as defrosting is completed, thus eliminating non-productive time.

Ice breaking mechanism is provided for breaking the ice into fragments of predetermined size, the structure being simple and affording breaking and sizing simultaneously. The system is applicable to large or small units, the modification of Fig. 4 being particularly adapted for the former and that of Figs. 1 and 2 for units of small and moderate capacities.

Although particular apparatus has been disclosed, it will be understood by those skilled in the art that various changes and modifications therein may be made within the spirit and scope thereof and therefore that the invention is only limited as described in the following claims.

What is claimed is:

1. Apparatus for producing ice comprising a plurality of vertical tubes, means for applying water to the exterior of the tubes at their upper portions, a header connected to the upper portions of the tubes, an accumulator for refrigerant, a first conduit from the lower portion of the accumulator connected to the header for supplying refrigerant, a second conduit from the upper portion of the accumulator connected to the header for withdrawing gaseous refrigerant, said conduits being connected to spaced portions of the header whereby liquid and gaseous refrigerant flow through the header in the same direction, valve means in said first and second conduits for controlling flow therethrough, means

for supplying hot refrigerant gas to the header, conduit means for the passage of liquid refrigerant from the tubes into the accumulator, and means responsive to the flow of hot refrigerant gas in said supplying means for closing said first and second conduits.

2. Apparatus for producing ice comprising a plurality of spaced vertical tubes, means for flowing water over said tubes, means for supplying liquid refrigerant to said tubes for freezing the water, and means for removing said liquid during defrosting, said last-mentioned means comprising a false bottom at the lower portion of said tubes enclosing a space, a first pipe extending from the upper portion of said tubes downwardly therethrough and into communication with said space, a second pipe extending from said false bottom in communication with said space to the upper portion of each of said tubes, and a third pipe extending from just above said false bottom to collection means for said liquid refrigerant.

3. The apparatus defined in claim 2 in which a separate distribution header is provided to connect together the upper portions of said first, second and third pipes.

4. Apparatus for producing ice comprising a tube, means for flowing water over said tube, means for supplying liquid refrigerant to said tube for freezing the water, and means for removing said liquid during defrosting, said last-mentioned means comprising a false bottom at the lower portion of said tubes enclosing a space, a first pipe extending from the upper portion of said tube downwardly therethrough and into communication with said space, a second pipe extending from said false bottom in communication with said space to the upper portion of said tube, and a third pipe extending from just above said false bottom to collection means for said liquid refrigerant.

5. For use in a refrigeration system, a tube for receiving cooling fluid in its interior during a freezing cycle in which water is frozen on its exterior, and for receiving relatively warm fluid displacing the cooling fluid during a defrosting cycle in which ice is removed from its exterior, comprising an elongated shell having a first closed end and a second end, wall means adjacent to the first end separating the space between said closed end and the wall means from the remainder of the interior of the shell, first, second, and third conduits extending from said second end longitudinally through the shell, said first and second conduits communicating with each other through said space at said first end, said second conduit having an end adjacent to said second end and in communication therewith, said first and third conduits extending exteriorly of said second end, said third conduit terminating in spaced relation from said wall means, and means for introducing cooling fluid and withdrawing it from said shell through said second end.

6. A defrosting control for sensing the presence of ice on a member and for operating control means as soon as the ice has been removed from the member, comprising a shaft rotatably mounted adjacent to the member, a finger rigidly connected to the shaft and extending laterally from the shaft and positioned to engage the member after rotation of the shaft from a first position to a second position, the engagement of the finger with ice on the member preventing such rotation, an arm rigidly connected to the shaft, a first means for engaging the arm and holding the shaft in first position during the period of formation of ice on the member, means for removing said first holding means from engagement with the arm at the end of the ice formation period, a second means on the arm for biasing it and the shaft toward the second position and for moving said shaft to second position after said first holding means is removed from engagement with the arm and ice is removed from the member, the movement of said shaft to second position operating control means to

initiate the formation of ice on said member and for engaging said first holding means with said arm.

7. A defrosting control for sensing the presence of ice on a member and for operating control means as soon as the ice has been removed from the member, comprising a shaft rotatably mounted adjacent to the member, a finger connected to the shaft and extending laterally from the shaft and positioned to engage the member after rotation of the shaft from a first position to a second position, the engagement of the finger with ice on the member preventing such rotation, means for holding the shaft in first position during the period of formation of ice on the member, means for rendering said first holding means inoperative to hold said shaft in first position at the end of the ice formation period, means for biasing the shaft toward the second position and for moving it to second position after said first holding means is removed and ice is removed from the member, the movement of said shaft to second position operating control means to initiate the formation of ice on said member and for placing said first holding means in operative condition.

8. Apparatus for producing sheaths of ice on a plurality of tubes comprising an accumulator, means for supplying said accumulator with refrigerant, a valve controlled passageway beneath said accumulator, a plurality of tubes connected to said valve controlled passageway, pressure responsive valve means in said passageway, a conduit for hot refrigerant gas under pressure, means for connecting said conduit to said tubes for defrosting the same, pressure controlled valve means in said hot gas conduit, means for bleeding refrigerant from said pressure controlled valve means, first valve means in said bleeding means, second valve means in said bleeding means for restricting flow therethrough when said first valve means is open, means connecting said hot gas conduit to said pressure responsive valve means, and valve means in said hot gas conduit connecting means, whereby opening of said valve means in said hot gas conduit connecting means and said valve means in said bleeder means will cause the valve in said passage means to close before the pressure controlled valve means in said hot gas conduit can open.

9. In apparatus for producing ice and breaking the same into fragments in which the ice is produced in elongated form having a relatively thin wall and is permitted to fall lengthwise downwardly under the influence of gravity substantially without hindrance, an ice breaker and sizing device for engaging the ice as it moves progressively into contact therewith and breaking it into fragments of substantially uniform size, comprising a rotatable shaft disposed transversely of the axis of the ice and in its path as it is moved, means for driving said shaft, abutment means mounted on said shaft for engaging the end portion of the ice as it advances toward said shaft and breaking fragments therefrom and a concave cage mounted beneath the shaft and radially spaced from the abutment means as the latter rotates, the cage having its concavity facing upwardly sufficiently to retain ice during comminution and having spaced openings of substantially uniform size for permitting ice fragments to fall through the cage.

10. The structure of claim 9, the cage being comprised of a plurality of spaced parallel rods arranged substantially equidistantly from the shaft.

11. The structure of claim 9, the cage being comprised of a plurality of spaced rods arranged parallel to the shaft and to each other and substantially equidistantly from the shaft.

12. In a refrigeration system, a heat exchange member and means for supplying refrigerant to said heat exchange member to cool the same and for applying water in heat exchange relation therewith to be frozen, means for interrupting the cooling of said heat exchange member and applying heat thereto in order to free the ice therefrom, and means in contact with the ice and operable responsive to movement of the ice out of contact therewith to engage switch means to initiate cooling of said heat exchange member.

13. In a refrigeration system a heat exchanger, means for supplying refrigerant to said heat exchanger, means for applying water to said heat exchanger for freezing by the refrigerant, means for heating said heat exchanger to defrost the ice therefrom, and control means in contact with the ice and operable responsive to movement of the ice out of contact therewith to engage switch means for controlling the operation of said refrigerant supply means and said water applying means.

14. Apparatus for producing sheaths of ice, comprising a plurality of vertical tubes, means for alternately supplying refrigerant to and removing the same from the interior of said tubes, means for spraying water on the exterior surfaces of said tubes while the same contain such refrigerant whereby cylindrical sheaths of ice are formed about said tubes, means at the lower ends of the tubes for heating the same and freeing the lower ends of the ice sheaths from the tubes before the upper portions thereof are freed, conduit means connecting said heating means to a remote source of supply for said heat, other conduit means connecting said heating means to the upper portions of said tubes and spaced substantially from the lower ends of the tubes, both of said conduit means being within and out of contact with the walls of said tubes and being of substantially less diameter than said tubes whereby the capacity of the tubes is only slightly reduced and substantial heat transfer from said conduit means is avoided.

References Cited in the file of this patent

UNITED STATES PATENTS

53,860	Palmer	Apr. 10, 1866
170,508	Beath	Nov. 30, 1875
173,314	Martin	Feb. 8, 1876
590,748	Williams	Sept. 28, 1897
2,239,234	Kubaugh	Apr. 22, 1941
2,364,559	Storer	Dec. 5, 1944
2,397,347	Gruner	Mar. 26, 1946
2,549,747	Leeson	Apr. 17, 1951
2,552,933	Browne	May 15, 1951
2,585,240	Grow	Feb. 12, 1952
2,595,588	Lee	May 6, 1952
2,618,129	Williams	Nov. 18, 1952
2,650,479	Kattis	Sept. 1, 1953
2,674,101	Calling	Apr. 6, 1954
2,682,155	Ayres	June 29, 1954
2,685,952	Hamlin	Aug. 10, 1954
2,695,502	Muffly	Nov. 30, 1954
2,716,003	Barringer	Aug. 23, 1955
2,717,495	Andersson	Sept. 13, 1955
2,721,452	Brandin	Oct. 25, 1955
2,724,950	Rothwell	Nov. 29, 1955
2,739,457	Chapman	Mar. 27, 1956
2,741,096	Fitzner	Apr. 10, 1956
2,746,262	Gallo	May 22, 1956
2,747,375	Pichler	May 29, 1956