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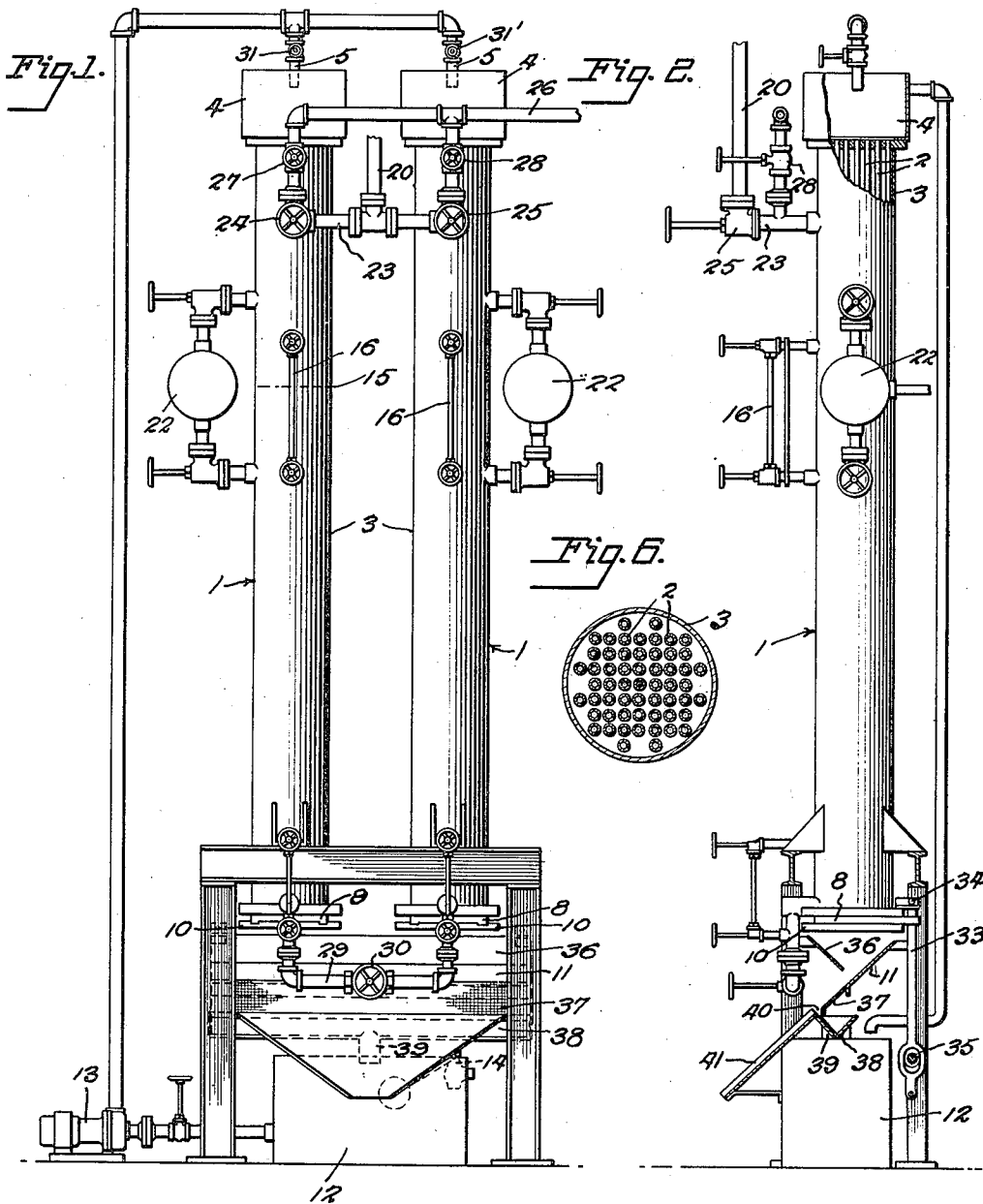
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2,200,424

METHOD AND APPARATUS FOR FREEZING ICE

Filed May 10, 1938

2 Sheets-Sheet 1



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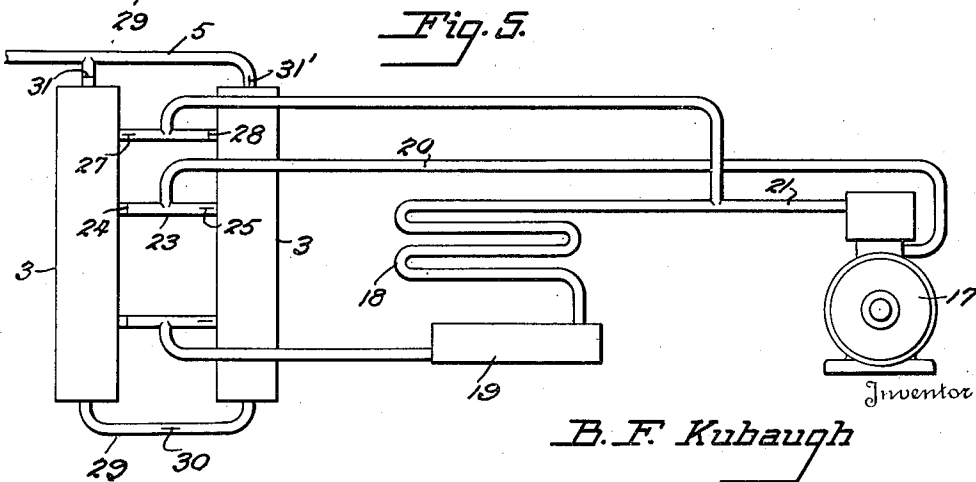
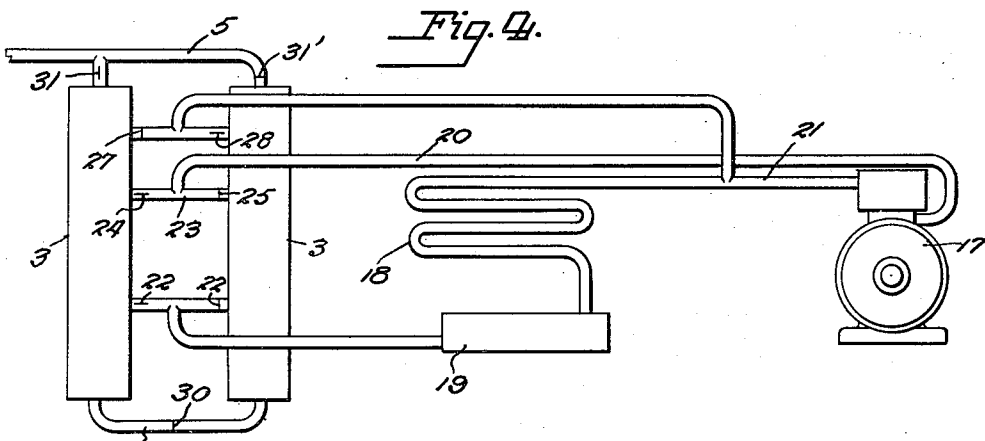
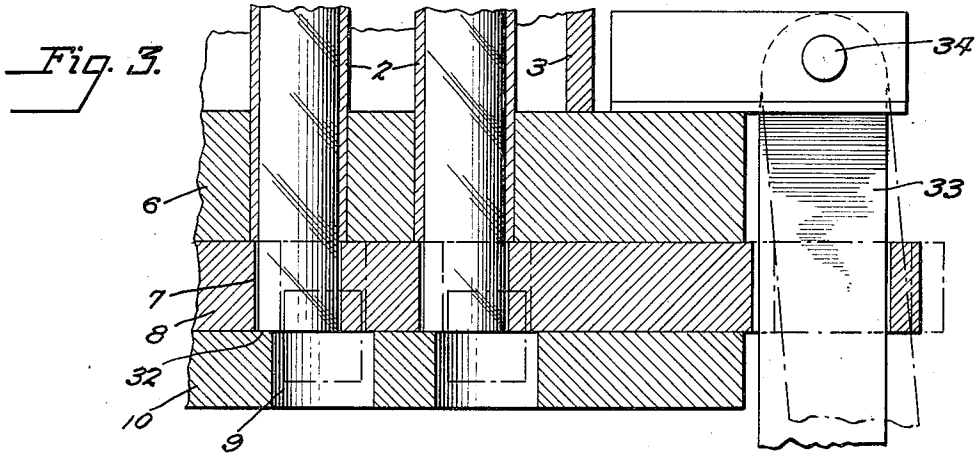
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METHOD AND APPARATUS FOR FREEZING ICE

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UNITED STATES PATENT OFFICE

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METHOD AND APPARATUS FOR FREEZING ICE

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Application May 10, 1938, Serial No. 207,123

12 Claims. (Cl. 62-164)

This invention relates to ice making apparatus and has for its general object the provision of a process as well as means for freezing ice masses of small thickness whereby the freezing can be much more quickly and economically accomplished than in the case of blocks of considerable thickness in which the insulating property of the ice greatly slows up the progress of the freezing toward the center of the block.

Another object of the invention is to produce ice, which is clear throughout by continuously circulating the water while it is being frozen.

A further object of the invention is to provide a continuous process in which a battery of two or more freezing units is employed, in connection with a refrigeration system having liquid and hot gaseous phases in which the freezing is controlled to take place in the units alternately or successively as the case may be, followed by alternate or successive thawing to break the adhesion of the ice to the walls of the freezing units employing the hot gaseous refrigerant for the purpose.

Other objects of the invention will appear as the following description of a preferred and practical embodiment of the invention proceeds.

In the drawings which accompany and form a part of the following specification and throughout the several figures of which the same characters of reference have been used to designate identical parts:

Figure 1 is a front elevation of an ice freezing apparatus employing the principles of the present invention;

Figure 2 is a side elevation partly in section;

Figure 3 is a fragmentary vertical section showing the discharge ends of certain ice tubes in association with the shearing mechanism;

Figure 4 is a diagrammatic side elevation of a refrigeration system in which the ice freezing units are intercalated, showing the valves in one of their alternate positions;

Figure 5 is a similar view showing the valves in the other of their alternate positions; and

Figure 6 is a cross section through one of the column units.

The invention contemplates the freezing of ice in the form of long rods or cylinders which are mechanically sheared off into small units or "cubes". These are best frozen in pipes or tubes and each of the freezing units 1 of which two are shown in the present invention comprises a group or bundle of spaced tubes 2 enclosed within a shell or column 3. The upper ends of the tubes 2 open into the bottom of a water tank 4 to which water is supplied from the pipe 5. The lower ends of the

tubes 2 extend through a plate 6 forming the bottom of the shell or column 3 and open through apertures 7 in a shear plate 8 and corresponding apertures 9 in a discharge plate 10, the open ends of said tubes being above an inclined chute 11 which discharges into a tank 12. A pump 13 picks up water from the tank 12 and delivers it to the tank 4 from which it runs down through the tubes 2. It is within these tubes that the freezing takes place. Make-up water is supplied to the tank 12 through a float actuated valve 14.

The interior of the shell 3 constitutes a refrigerant chamber within which liquid refrigerant normally stands to the level 15 in one of the shells, the level being visible through an appropriately positioned sight glass 16. The mode of operation of the system as will appear is such that when the liquid refrigerant is at the level 15 in one of the shells 3 it has been displaced from another shell.

The shell 3 therefore constitutes the evaporating unit of a refrigeration system which may be an absorption system or a compression system, the latter type being illustrated by way of example, and which, as shown in Figure 4, comprises a compressor 17, condenser 18, receiver 19, the suction line 20 and the hot compressed gas conduit 21 which leads from the compressor to the condenser. The shell 3 is provided with a liquid level control valve 22 of conventional construction through which the evaporated liquid refrigerant is replenished. The shells 3 are connected to the suction line 20 of the refrigeration system by a manifold 23 having valves 24 and 25 controlling the communication of the suction line with either of the shells 3. Said shells are also connected to the hot compressed gas conduit 21 by means of a pipe 26 having branches to each shell controlled by the valves 27 and 28. The shells 3 are interconnected at their bottom by a pipe connection 29 having a control valve 30.

In operation, it will be assumed that liquid refrigerant is in the left hand shell 3 up to the level 15, that the control valve 30 is closed preventing the liquid refrigerant from going into the right hand shell 3, that the valve 24 is open placing the upper part of the left hand shell 3 into operative communication with the suction line of the refrigeration system, that the valve 27 is closed. At this time the pump 13 is pumping water past the open valve 31 into the left hand tank 4 which water is running through the tubes 2 and finally gravitating into the tank 12 being cooled by its passage through those portions of the tubes 2 which are submerged by the liquid

refrigerant below the level 15, and an ice film being formed on the walls of said tubes. This film is permitted to freeze to the desired thickness forming hollow rods or cylinders of ice. Due to the fact that the water was circulating all the time throughout the freezing process, there is no concentration of impurities toward the center or core so that the ice is frozen clear and transparent throughout. The tubes may be of any cross sectional shape; they are here shown as circular. In any event they are of comparatively small cross section so that there is very little insulating resistance of the ice to freezing all the way to the center of the tubes. Much quicker freezing is thus accomplished than where blocks of large cross section are to be frozen.

In that embodiment of the invention illustrated in the drawings, the freezing operation is to be watched by an attendant and when the freezing of the water within the tubes has been fully accomplished so that no water will flow therethrough and there is a backing up of water in the tanks 4, the water supply to the left hand tank 4 is cut off by closing the valve 31. The valve 24 is also cut off closing communication with the suction side of the compressor, the valve 30 is turned on establishing communication between the left and right hand shells 3 and the valve 27 is opened permitting high pressure hot gaseous refrigerant to enter the upper part of the left hand shell 3 above the liquid level therein. This hot gas under pressure displaces the liquid in the left hand shell 3 which liquid descends, passing through the pipe connection 29 backing up into the right hand shell 3 until it stands at the liquid level 15, any make-up liquid being supplied through the liquid level control valve 22. In general, however, no make-up liquid is required as the hot gas admitted for thawing eventually becomes liquefied and produces a slight excess of liquid.

The hot gaseous refrigerant now pervades the entire space within the left hand shell 3, warming the tubes 2 within said shell and thawing the surface of the ice cores within the tubes 2 freeing said cores from adhesion to said tubes. The cores or rods of ice in the tubes of the left hand tank descend gravitationally into the apertures 7 of the shear plate which are normally aligned with the tubes 2 and at least of equal diameter thereto, said cores resting upon the shoulders 32 of the discharge plate 10, the apertures 9 of which are slightly off-set laterally with respect to the bores of the tubes 2. The shear plate 8 is moved laterally until its apertures 7 align with the apertures 9 in the discharge plate. This lateral movement of the shear plate shears or breaks off from the ice cores or rods those portions which occupy the apertures in the shear plate which portions are discharged through the apertures 9 in the discharge plate 10. The shear plate reciprocates back and forth from a position in which its apertures are in alignment with the tubes 2 into a position in which said apertures align with the apertures in the discharge plate. This reciprocation is effected by a pitman 33 suitably pivoted at 34 and swinging under the influence of a power driven cam or eccentric 35. Each time the aperture 7 aligns with the tubes 2, the ice core drops gravitationally into said apertures for the full depth of the shear plate and each time the shear plate moves to the right as shown in Figure 3, those portions of the ice cores which are within the shear plate are sheared off and discharged. This action is per-

mitted to continue until the ice cores are completely used up.

When the freezing in the rightward unit has been completed, as evidenced by the cessation of flow of water from the bottom of said unit into the tank 12, the operator reverses the positions of the several valves. He first closes the valve 31' cutting off the supply of water to the right hand tank 4, then he closes the valve 25 and opens the valve 24 shifting the suction line of the compressor from the right hand unit back to the left hand unit. He closes the valve 27 and opens the valve 28, also he opens the valve 30 in the bottom connection between the two tanks. The hot compressed gas entering by way of the valve 24 forces the body of liquid refrigerant through the right hand shell 3 downward through the valve 30 and up into the shell 3 of the left hand unit 1. When the liquid refrigerant is up to the level 15 in the left hand unit, the attendant then closes the valve 30 and opens the water valve 31. The freezing period then recommences in the left hand unit while thawing is taking place in the right hand unit followed by the gravitational descent of the ice cores in the right hand unit into the shear plate and their severance into individual cylindrical pieces of ice.

It will be understood of course that automatic means may be devised to perform the various valve-reversing manipulations as described. Figures 1 and 2 show that there is a baffle 36 which directs the ice units or cubes against the chute 11. The lower portion of said chute is formed as a screen 37 which overlies a water trough 38 having a spout 39 directed into the tank 12. There is a slight gap 40 between the lower end of the screen 37 and the external cube discharge chute 41.

The water discharging from the bottoms of the tubes of the unit during the freezing period falls upon the chute 11 and upon the baffle 36, and flows through the screen 37 into the trough 38 from which it discharges by way of the spout 39 into the tank 12. The gap 40 prevents the water flowing down the external chute 41. The cubes fall upon the chute 11 and baffle 36, slide over the screen 37, over the gap 40 into the external chute 41 from which they are discharged at a point external to the unit 1.

While I have in the above description disclosed what I believe to be a preferred and practical embodiment of the invention, it will be understood to those skilled in the art that the specific details of construction and the arrangement of parts as shown and described are merely by way of example and not to be construed as limiting the scope of the invention as defined in the appended claims.

What I claim is:

1. Ice freezing apparatus comprising a pair of evaporators adapted to function in recurrent rotation, each comprising a shell, said shells being connected in multiple between the liquid and suction sides of a refrigeration system, and positioned to alternately receive liquid refrigerant up to a predetermined normal level, each shell having a bundle of water tubes passing there-through opening in the top and bottom thereof, water-receiving means above said shells communicating with the open ends of said water tubes, means below said shells into which water discharges from said tubes, a conduit from said discharge means to said receiving means, a pump in said conduit for circulating water through said tubes, valves for cutting water off and on with

respect to said tube bundles, valve-controlled means for permitting the liquid refrigerant in said shells to be displaced from one shell into the other, a conduit connecting said shells above the normal liquid level therein with that part of the refrigeration system in which the refrigerant is in hot compressed gas phase, means whereby the hot compressed gas can be admitted into either shell and excluded from the other for displacing the liquid refrigerant from one to the other and thawing the ice bond between the ice cores and walls of the tubes of the bundle associated with the shell from which the liquid refrigerant has been displaced, the open lower ends of said tubes permitting gravitational discharge of the ice cores from said tubes, a stop plate spaced from the lower openings of said tubes determining the extent of protrusion of said ice cores, and means for shearing the protruding portions of said ice cores.

2. Ice freezing apparatus comprising a pair of evaporators adapted to function in recurrent rotation, each comprising a shell, said shells being connected in multiple between the liquid and suction sides of a refrigeration system, and positioned to receive liquid refrigerant up to a predetermined normal level, each shell having a bundle of open ended water tubes passing therethrough opening in the top and bottom thereof, water-receiving means above said shells communicating with the ends of said water tubes, means below said shells into which water discharges from said tubes, a conduit from said discharge means to said receiving means, a pump in said conduit for circulating water through said tubes, valves for cutting water off and on with respect to said tube bundles, valve-controlled means for permitting the liquid refrigerant in said shells to be displaced from one shell into the other, a conduit connecting said shells above the normal liquid level therein with that part of the refrigeration system in which the refrigerant is in hot compressed gas phase, means whereby the hot compressed gas can be admitted into either shell and excluded from the other for displacing the liquid refrigerant from one to the other and thawing the ice bond between the ice cores and walls of the tubes of the bundle associated with the shell from which the liquid refrigerant has been displaced, the open lower ends of said tubes permitting gravitational discharge of the ice cores from said tubes, a stop plate spaced from the lower openings of said tubes determining the extent of protrusion of said ice cores, and means for shearing the protruding cores of said ice cores and moving them to a discharge point.

3. Ice freezing apparatus comprising a pair of evaporators adapted to function in recurrent rotation, each comprising a shell, said shells being connected in multiple between the liquid and suction sides of a refrigeration system, and positioned to receive liquid refrigerant up to a predetermined normal level, each shell having a bundle of open ended water tubes passing therethrough opening in the top and bottom thereof, water-receiving means above said shells communicating with the ends of said water tubes, means below said shells into which water discharges from said tubes, a conduit from said discharge means to said receiving means, a pump in said conduit for circulating water through said tubes, valves for cutting water off and on with respect to said tube bundles, valve-controlled means for permitting the liquid refrigerant in said shells to be displaced from one shell into the other, a

conduit connecting said shells above the normal liquid level therein with that part of the refrigeration system in which the refrigerant is in hot compressed gas phase, means whereby the hot compressed gas can be admitted into either shell and excluded from the other for displacing the liquid refrigerant from one to the other and thawing the ice bond between the ice cores and walls of the tubes of the bundle associated with the shell from which the liquid refrigerant has been displaced, the open lower ends of said tubes permitting gravitational discharge of the ice cores from said tubes, a stop plate spaced from the lower openings of said tubes determining the extent of protrusion of said ice cores, and a reciprocating shear plate for periodically shearing off protruding portions of said ice cores and moving them to a discharge point.

4. Ice freezing apparatus comprising a pair of evaporators adapted to function in recurrent rotation, each comprising a shell, said shells being connected in multiple between the liquid and suction sides of a refrigeration system, and positioned to receive liquid refrigerant up to a predetermined normal level, each shell having a bundle of open ended water tubes passing therethrough opening in the top and bottom thereof, water-receiving means above said shells communicating with the ends of said water tubes, means below said shells into which water discharges from said tubes, a conduit from said discharge means to said receiving means, a pump in said conduit for circulating water through said tubes, valves for cutting water off and on with respect to said tube bundles, valve-controlled means for permitting the liquid refrigerant in said shells to be displaced from one shell into the other, a conduit connecting said shells above the normal liquid level therein with that part of the refrigeration system in which the refrigerant is in hot compressed gas phase, means whereby the hot compressed gas can be admitted into either shell and excluded from the other for displacing the liquid refrigerant from one to the other and thawing the ice bond between the ice cores and walls of the tubes of the bundle associated with the shell from which the liquid refrigerant has been displaced, the open lower ends of said tubes permitting gravitational discharge of the ice cores from said tubes, a stop plate spaced from the lower openings of said tubes determining the extent of protrusion of said ice cores, said stop plate having discharge ports out of registry with the lower ends of the tubes, and a shear plate for periodically shearing off the protruding portions of said ice cores and moving said portions into registry with the discharge ports in said stop plate.

5. Ice freezing apparatus comprising a pair of evaporators adapted to function in recurrent rotation, each comprising a shell, said shells being connected in multiple between the liquid and suction sides of a refrigeration system, and positioned to receive liquid refrigerant up to a predetermined normal level, each shell having a bundle of open ended water tubes passing therethrough opening in the top and bottom thereof, water-receiving means above said shells communicating with the ends of said water tubes, means below said shells into which water discharges from said tubes, valves for cutting water off and on with respect to said tube bundles, valve-controlled means for permitting the liquid refrigerant in said shells to be displaced from one shell into the other, a conduit connecting

said shells above the normal liquid level therein with that part of the refrigeration system in which the refrigerant is in hot compressed gas phase, means whereby the hot compressed gas can be admitted into either shell and excluded from the other for displacing the liquid refrigerant from one to the other and thawing the ice bond between the ice cores and walls of the tubes of the bundle associated with the shell from which the liquid refrigerant has been displaced, the open lower ends of said tubes permitting gravitational discharge of the ice cores from said tubes, a stop plate spaced from the lower openings of said tubes determining the extent of protrusion of said ice cores, and a shear plate movable between the lower ends of said tubes and said stop plate having a thickness substantially equal to the distance of said stop plate from the lower ends of said tubes and having apertures of a diameter as great as that of the ice cores, said shear plate being adapted to be successively aligned with said tubes and the ports in said stop plate for gravitationally receiving the lower ends of said ice cores, shearing them and discharging them through the ports of said stop plate.

6. Ice freezing apparatus comprising a pair of evaporators adapted to function in recurrent rotation, each comprising a shell, said shells being connected in multiple between the liquid and suction sides of a refrigeration system, and positioned to receive liquid refrigerant up to a predetermined normal level, each shell having a bundle of open ended water tubes passing therethrough opening in the top and bottom thereof, water-receiving means above said shells communicating with the ends of said water tubes, means below said shells into which water discharges from said tubes, a conduit from said discharge means to said receiving means, a pump in said conduit for circulating water through said tubes, valves for cutting water off and on with respect to said tube bundles, valve-controlled means for permitting liquid refrigerant in said shells to be displaced from one shell into the other, a conduit connecting said shells above the normal liquid level therein with that part of the refrigeration system in which the refrigerant is in hot compressed gas phase, means whereby the hot compressed gas can be admitted into either shell and excluded from the other for displacing the liquid refrigerant from one to the other and thawing the ice bond between the ice cores and walls of the tubes of the bundle associated with the shell from which the liquid refrigerant has been displaced, a stop plate spaced from the bottom openings of said tubes determining the extent of protrusion of said ice cores, a shear plate between the lower ends of said tubes and said stop plate of a thickness substantially equal to the distance of said stop plate from the lower ends of said tubes, having openings therethrough of a diameter as great as that of the ice cores, said shear plate being adapted to be successively aligned with said tubes and the ports in said stop plate for gravitationally receiving the protruding portions of said ice cores shearing them from said ice cores and discharging them through the ports of said stop plate, and a separating chute beneath said stop plate and above said water discharge means permitting the passage of the severed ice units to a final discharge point and the passage of water through said separating chute into said water discharge means.

7. Method of freezing ice comprising bringing the liquid and hot compressed gaseous phases of a

refrigerant in a refrigeration system into heat exchanging relationship successively with two or more freezing chambers, in the order named, in recurrent rotation to circulating columns of water in one of said freezing chambers, maintaining the liquid phase in heat exchanging relationship to said columns until said columns are frozen forming ice cores, causing the hot compressed gaseous phase to displace the liquid refrigerant constituting said liquid phase from one freezing chamber to another, maintaining the hot gaseous phase in heat exchanging relationship to said ice cores until they are thawed from adherence with the walls of said freezing chambers, causing said ice cores to descend step by step for a predetermined distance at each step, and periodically cutting off from said ice cores and discharging, the ice units thus formed, the thawing and the cutting up of the ice cores from one freezing chamber being accomplished during the freezing period of the other freezing chamber.

8. Ice freezing apparatus comprising a pair of evaporator tanks adapted to function in recurrent rotation, connected in multiple between the liquid and suction sides of a refrigeration system and positioned to receive liquid refrigerant up to a determined normal level, a plurality of water conduits for each evaporator tank in heat exchanging relation therewith, means for circulating water in said conduits, valve-controlled means for permitting the liquid refrigerant to be displaced from one evaporator tank into the other, a conduit connecting said shells above the normal liquid level therein with that part of the refrigeration system in which the refrigerant is in hot compressed gas phase, means whereby the hot compressed gas can be admitted into either tank and excluded from the other for displacing the liquid refrigerant from one to the other and thawing the ice bond between the frozen water and walls of the water conduits of the evaporator tank from which the liquid refrigerant has been displaced, said conduits being open ended and so directed as to permit gravitational discharge of ice from said water conduits.

9. Ice freezing apparatus comprising a pair of evaporators adapted to function in recurrent rotation, each comprising a shell, said shells being connected in multiple between the liquid and suction sides of a refrigeration system, and positioned to receive liquid refrigerant up to a predetermined normal level, each shell having a bundle of open ended water tubes passing therethrough opening in the top and bottom thereof, water tanks at the upper ends of said shells into which the upper ends of the water tubes open, reservoirs below said shells into which the water discharges from said tubes, a conduit from said reservoirs to said tanks, a pump in said conduit for delivering water to said tanks and circulating said water through said tubes, valves for cutting water off and on with respect to said tube bundles, valve-controlled means for permitting the liquid refrigerant in said shells to be displaced from one shell into the other, a conduit connecting said shells above the normal liquid level therein with that part of the refrigeration system in which the refrigerant is in hot compressed gas phase, means whereby the hot compressed gas can be admitted into either shell and excluded from the other for displacing the liquid refrigerant from one to the other and thawing the ice bond between the ice cores and walls of the tubes of the bundle associated with the shell from which the liquid re-

frigerant has been displaced, the open lower ends of said tubes permitting the ice cores to discharge gravitationally from said tubes.

10. Ice freezing apparatus comprising a pair of
 5 evaporators adapted to function in recurrent rotation, each comprising a shell, said shells being
 connected in multiple between the liquid and suction sides of a refrigeration system, and positioned to receive liquid refrigerant up to a pre-
 10 determined normal level, each shell having a bundle of open ended water tubes passing therethrough opening through the top and bottom thereof, the
 upper openings of said tubes lying in a horizontal plane, water tanks at the upper ends of said
 15 shells into which the upper ends of said water tubes open, and into which tubes the water from said tanks overflows, means below said shells into
 which water discharges from said tubes, a conduit from said discharge means to said tanks, a
 20 pump in said conduit for circulating water through said tubes, valves for cutting water off and on with respect to said tube bundles, valve-
 controlled means for permitting the liquid refrigerant to be displaced from one evaporator
 25 shell into the other, a conduit connecting said shells above the normal liquid level therein with that part of the refrigeration system in which the
 refrigerant is in hot compressed gas phase, means whereby the hot compressed gas can be admitted
 30 into either shell and excluded from the other for displacing the liquid refrigerant from one to the other, and thawing the ice bond between the ice
 cores and walls of the tubes of the bundle associated with the shell from which the liquid refrigerant has been displaced, the open lower ends
 35 of said tubes permitting the ice cores to discharge gravitationally from said tubes.

11. Ice freezing apparatus comprising a pair of
 40 evaporators adapted to function in recurrent rotation, each comprising a shell, said shells being
 connected in multiple between the liquid and suction sides of a refrigeration system, and positioned to receive liquid refrigerant up to a pre-
 determined normal level, each shell having a bundle
 45 of open ended water tubes passing therethrough, opening through the top and bottom thereof, a water tank at the upper end of each shell into
 which the upper ends of said water tubes open and into which tubes the water from said tank
 50 overflows, means below said shells into which water discharges from said tubes, a conduit from said discharge means to said receiving means, a
 pump in said conduit for circulating water through said tubes, valves for cutting water off

and on with respect to said tube bundles, a float-controlled water supply valve in communication with said discharge means for supplying make-up water, valve-controlled means for permitting the liquid refrigerant to be displaced from one evaporator shell into the other, a conduit connecting
 5 said shells above the normal liquid level therein with that part of the refrigeration system in which the refrigerant is in hot-compressed gas phase, and means whereby the hot compressed
 10 gas can be admitted into either shell and excluded from the other for displacing the liquid refrigerant from one to the other and thawing the ice bond between the ice cores and walls of the tubes of the bundle associated with the shell from
 15 which the liquid refrigerant has been displaced.

12. Ice freezing apparatus comprising a pair of
 20 evaporators adapted to function in recurrent rotation, each comprising a shell, said shells being
 connected in multiple between the liquid and suction sides of a refrigeration system, and positioned to receive liquid refrigerant up to a pre-
 determined normal level, each shell having a bundle
 25 of open ended water tubes passing therethrough, opening through the top and bottom thereof, water-receiving means at the upper ends of said
 shells into which the upper ends of said water tubes open, and into which tubes the water overflows, means below said shells into which water
 30 discharges from said tubes, a conduit from said discharge means to said receiving means, a pump in said conduit for circulating water through said
 tubes, valves for cutting water off and on with respect to said bundles, valve-controlled means for
 35 permitting the liquid refrigerant to be displaced from one evaporator shell into the other, a conduit connecting said shells above the normal liquid level therein with that part of the refrigeration
 system in which the refrigerant is in hot compressed gas phase, means whereby the hot
 40 compressed gas can be admitted into either shell and excluded from the other for displacing the liquid refrigerant from one to the other and
 thawing the ice bond between the ice cores and walls of the tubes of the bundle associated with
 45 the shell from which the liquid refrigerant has been displaced, the open lower ends of said tubes permitting the ice to discharge gravitationally
 from said tubes, the thawing and discharge from one tube bundle taking place during the freezing
 50 period of the other tube bundle whereby the production of ice units is substantially continuous.

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