This invention relates to ice making apparatus in general and in particular to apparatus wherein a continuous-flow water circuit is utilized while the ice is being formed.

In recent years considerable attention has been directed toward the development of ice cube makers which would produce ice cubes that are clear and therefore attractive in appearance. Although initially used largely in installations such as restaurants, hotels, etc., where large numbers of cubes were consumed, the domestic market for ice cube makers is developing rapidly as smaller and more economical ice cube makers become available. Such ice cube makers advantageously have relatively simple refrigeration, water circulation, and electrical control circuits with low maintenance requirements. Therefore, the most effective ice maker utilizes, whenever possible, standby proven circuits which function for long periods with little or no attention, while delivering a satisfactory performance. Standard equipment, however, will not completely fulfill all of the desired requirements for the best ice cube maker.

It is, accordingly, an object of this invention to provide improved ice cube making apparatus.

It is a further object of this invention to provide improved ice making apparatus incorporating novel water circulation, feeding and distributing means which is simple in construction yet produces a very satisfactory result.

A further object of this invention provides an improved ice forming tube combination which cooperates with the above-described improved water distributing and feeding apparatus to produce a low maintenance, superior performance ice cube maker which is capable of delivering ice cubes in quantity for domestic use or ice cubes in consistent sections of the ice forming tube.

A still further object of this invention is to provide an improved ice cube maker wherein the electrical, water-circulating, and refrigerant circuits cooperate to produce a low maintenance, high performance apparatus.

The ice making apparatus of this invention including means for freezing, harvesting, and storing ice cubes from at least one ice forming tube. Features include a means circulating water into said ice forming tube including water manifold means, header trough means having formed therein discharge orifice means communicating with said ice forming tube. The discharge orifice means may be formed such that its upper diameter is larger than its lower diameter and is operative to direct water flowing over its upper diameter into said ice forming tube in a substantially tangential direction, as opposed to an axial direction, thereby insuring that the entire inner surface of the ice forming tube is uniformly wetted. Further the ice forming tube may be joined to the water header beneath the discharge orifice by a relatively low heat conductive member while the lower extremity of the ice forming tube may have attached thereto a skirt of similar low heat conductive material confining the formation of ice to the high heat conductive material which is in contact with the refrigerant for freezing means. This not only insures that the formation of the ice cube will be confined to the section of the ice forming tube having the high heat conductivity but also prevents formation of icicles or ice on the bottom or exterior areas of the high heat conductive material when the ice forming tube is not being used for the formation of ice for freezing means thereon but are not available for defrosting or which require too much heat to produce the harvesting of the ice formed in the tube. Such extra heat could necessitate an extra amount of refrigeration and cause a clouding or cracking of the ice cube at the time of harvesting.

Other objects, features and advantages of this invention will become apparent when the following description is taken in conjunction with the accompanying drawings in which:

FIG. I is a schematic representation of the refrigerant circuit utilized;
FIG. II is a schematic representation of the water-circulating circuit utilized;
FIG. III is a schematic diagram of the electrical control circuit utilized in this invention;
FIG. IV is an enlarged, detailed cross-sectional view of the water-circulating and distributing apparatus; and
FIG. V is a plan view of the apparatus shown in FIG. IV.

In ice cube makers of the type to be described, as stated hereinbefore, it is of utmost importance to produce ice cubes which are clear and thus attractive in appearance.

To accomplish this the ice cubes are best built up gradually so that air and impurities are not entrapped in the ice cubes, and so that no formation or cracks due to strain set up by excessively rapid freezing appears within the cube. Thus the ice cubes are formed by the apparatus of this invention from a controlled amount of running water proceeding through the ice forming tubes so that part of the water remains unfrozen. The excess unfrozen portion of the running water, containing the dissolved air and impurities, proceeds on through the tube and thus does not contribute any cloudiness to the frozen portion remaining in the tube.

Another important procedure in the making and formation of clear ice cubes is that a complete wetting of the inner surface of the ice forming tube must be accomplished or white streaks will appear on the cubes where the inner surface of the tube is not wetted. Uniform wetting of the inner surface of the tube is also requisite for uniform formation of ice in order to provide a symmetrical cube. In attaining a symmetrical cube it is also important to confine the formation of ice within the tube to a restricted area. This may be accomplished by utilizing metals of different heat conductive values to confine the formation. Examples of two metals which will accomplish this are a copper tube portion having a stainless steel skirt at the bottom and a stainless steel ring or other configuration joining the upper portion of the tube to the feeding means. This construction prevents the freezing of ice up to the water feeding means and prevents the formation of icicles at the bottom of the ice forming tube or the formation of ice on the exterior of the bottom of the ice forming tube such that it is difficult to loosen the ice cube, when fully formed, from its position in the tube by a normal defrosting or harvesting operation. The use of low heat conductive materials as shown also helps prevent dissipation of the refrigeration applied to the high heat conductive portion.

Referring to FIG. I there is shown a schematic diagram of a refrigeration circuit which may be utilized in this invention. A compressor 30 has its high pressure side connected through conduit 31 to a condenser 32. The condenser 32 is connected through conduit 33 to a receiver 34. The receiver 34 is connected by a conduit 35 through a parallel connection of an expansion valve 36 and a solenoid operated valve 37, to an evaporator 38. The evaporator 38 is connected through a suction line 40 to the low pressure side of the compressor 30. The evaporator 38 is disposed in heat exchange relationship with a plurality of ice forming tubes 39. The suction line 40 is disposed in heat exchange relationship with the liquefied refrigerant conduit 35 on the high pressure side of the system.

In operation the compressor 30 compresses low pres-
sure refrigerant received from the suction line 40 and forces said pressurized refrigerant to the condenser 32 where the refrigerant is liquefied. The liquefied refrigerant, still under pressure, is gathered in the receiver 34 from whence it is forced by the pressure through the expansion valve 36. The refrigerant expands and vaporizes in evaporator 38 thereby absorbing heat from the plurality of ice forming tubes 39 causing ice to form within the tubes. The vaporized refrigerant is then returned through the suction line 40 to the low pressure side of the compressor 30. This is a normal refrigerating or freezing cycle for the apparatus of FIG. 1.

To accomplish a harvesting operation, operation to remove the ice formations from the tubes 39 the solenoid operated valve 37 is opened allowing the hot compressed refrigerant to bypass the expansion valve 36 and proceed directly into the evaporator 38. The hot compressed refrigerant from the receiver and condenser 34 and 32, respectively, operates to heat the ice forming tubes 39 thereby causing a loosening of the cubes formed therein such that they may be removed from the tubes, usually by gravity.

Referring to FIG. II there is illustrated a schematic diagram of the water circulation circuit and the general disposition of the components of the ice making apparatus. The ice storage bin 50, having a drain 51, is located generally around the water circulating apparatus since the cubes when formed and harvested must be discharged into the ice storage area, said area being accessible from the outside. A thermostatic switching element 90 may be located in the storage bin near the door so that when the ice cubes fill the bin to capacity the proximity of the ice cubes to the thermostatic element 90 will automatically shut down the unit as will be explained hereinafter. A sump tank 52 is located generally within the ice storage bin 50 as shown. A water inlet 53 cooperates with the float valve assembly designated generally at 54 to keep the water level within the sump tank automatically at a predetermined height. A pump 55 is located in the sump tank and pumps water through the conduit 56 to a water manifold 57. Pumping the water from the sump tank 52 to the water manifold 57 rather than directly into the ice forming cylinders provides a quieting action for the water such that it may be uniformly distributed to a plurality of cylinders. The overflow from the water manifold 57 over a feeder dam 58 of a predetermined width provides the header trough 59 with water to be distributed to the ice forming tubes 39. The plurality of ice forming tubes 39 are connected from the actuating orifices 60 through a like plurality of discharge orifices 60. Thus the water proceeds from the manifold tank 57, over the feeder dam 58, into the header trough 59, through the discharge orifices 60, and the ice forming tubes 39 and returns to the sump tank 52.

To avoid splashing and, particularly, in domestic use, to avoid the irritating dripping sound that sometimes accompanies ice making machines of this type an ice chute and baffle assembly designated generally at 70 is mounted directly below the ice forming tube 39. The baffle 72 of the assembly 70 acts as a support for a plurality of fins 71, which are curved to receive the ice cube as it falls and to act as a chute to protect the cubes into the ice storage bin 50. The baffle 72 deflects the water running through the ice forming tubes 39 from dripping directly into the water in the sump tank 52. The edge 73 of the sump tank 52 cooperates with the baffle 72 of the assembly 70 to form a trough which prevents the return water from entering the ice forming tube 39, from flowing into the ice storage area. This allows the preservation of the ice cubes in a dry state and prevents their sticking together since the only moisture in the ice storage bin 50 would be that resulting from the melting of the cubes. This, of course, may be prevented by the maintenance of a proper temperature in the ice storage bin 50 by direction of chilled air from the evaporator 38 in a suitable manner, such as an evaporator fan, to keep the storage area cold. An evaporator fan may not always be required, however, since gravity alone may be sufficient in some applications to move the cold air from the evaporator 38 into the lower ice storage area of the bin 50. Referring to FIG. III there is illustrated a control circuit adapted to cooperate with the other components of the apparatus to provide improved ice making apparatus. The relays and other components illustrated in FIG. III are shown in across the line diagrams. The contacts of the relays are located remote from the actuating coils. In order to facilitate the relationship and location of actuating coils and contacts in addition to providing an easy reference system, a marginal key has been employed with the circuit diagram whereby the circuit is divided in horizontal bands which are identified by line numbers in the right hand margin of the figure. Relay symbols are located in that margin to the right of the key numerals and in horizontal alignment with the relay actuating coil positions. Each contact actuated by a relay coil is designated to the right of the relay symbol by the numerals of its line location. Back contacts, those which are normally closed when the relay armature is dropped out and actuated, are energized when the relay is energized, are underlined in the key to distinguish them from front contacts, those which are closed upon the coil being energized. Thus, for example, the harvest relay HR has its actuating coil located in line 19 of FIG. III and when energized closes its front contacts at line 18 of FIG. III designated in the margin as 18, and opens its back contacts at line 21, designated in the margin by 21. Each contact is also labeled with the symbol of its actuating means and is illustrated in the condition it assumes while its armature is dropped out so that the front contacts of the harvest relay are shown open as in line 18 and back contacts, which in line 21 are shown closed.

The circuit of FIG. III is supplied by power leads L1 and L2. A double pole switch designated generally at 80 and located in lines 11 and 12 of FIG. III is disposed in power lead L1, connecting power lead L1 to the control circuitry. Blade 81 and blade 82 of switch 80 may be mechanically linked so that actuation of one automatically actuates the other. Terminal 83 associated with blade 81 of the switch 80 connects the power lead L1 to the control circuit. That is, blades 81 and 82 are contacting terminals 83 and 84, respectively, for normal "on" operation of the circuit. Terminals 85 and 86 represent the "off" state of the switches 81 and 82. Terminals 87 and 88 will be utilized as hereinafter described for purposes of a cleaning cycle.

Referring again to the "on" position of switch 80 for operation as is shown in FIG. III, power lead L1 is connected to terminal 83 and to the control circuitry through thermo-sensitive switching element 90. As was explained above the thermo-sensitive element 90 is responsive to a full bin or full capacity and will shut the control circuit or the operation of the machine off when the bin is full. The compressor is connected in series in line 15 with the bin control element 90. A harvest control device 100 located in lines 19 to 21 has a thermo-sensitive switching element 101. In line 20, (best seen for its physical disposition within the center of the ice forming tubes 39 in FIG. IV) which controls the formation and the harvesting of the ice within the ice forming tubes 39. The cycle control device 100 has outlet terminals 102 and 103. The thermo-sensitive switching element 101 is shown in its normal position in line 20. When the actuating coil of terminal 102 and energizing a compressor fan in line 21 through the normally closed back contacts HR of the harvest relay HR. Connection of the power lead L1 with the terminal 102 also activates the pump in line 23 through conductor 120, terminal 84, blade 82, and conductor 121. Terminal 103 of the cycle control element is connected to power lead L2 through the harvest relay.
5 HR. A time delay switch relay TDS and a solenoid valve control relay SV in lines 16 and 18 are connected in parallel and are to be energized through the normally open contacts HR of the harvest relay in line 18. The parallel circuit including the time delay switch relay TDS and the solenoid valve relay SV alternatively receives energization from terminal 103 through back contacts TDS in line 17.

The operation of the just described circuit is as follows. Assume that the blades 81 and 82 of the switch 80 have been turned to the "on" terminals 85 and 86. If the tank 52 is not full of ice, thermostatic switch element 90 is closed and power is supplied to the control circuit. The compressor in line 15 is started immediately. The pump in line 23 and the compressor fan in line 21 are activated through the thermo switching element 101 and the terminal 102 of the cycle control element 100. Water therefore starts to flow through the ice forming tubes 39 while the compressor is circulating heat absorbing refrigerant in heat exchange with the tubes 39 through the refrigerant circuit shown in FIG. 1. The compressor fan is running to cool the compressor. It is to be noted that the compressor moving the refrigerant cycles, thus permitting the compressor to increase or maintain a heated condition to decrease the defrosting interval.

Ice begins to form on the inner surfaces of the ice making tubes 39 and begins to build outwardly, forming a hollow cylindrical piece of ice until, as best seen in FIG. IV, the ice formation is within a predetermined distance of the thermo switching element 101 of the cycle control device 100. Such predetermined distance may be adjusted to produce as small or as large a hole in the center of the cubes as desired. The formation of a hole in the center of the cube provides a larger cooling surface, for cooling liquids more quickly than a solid surface cube. When the predetermined distance from the thermal switching element 101 is reached the thermal element 101 flips over center and makes contact with terminal 103.

When the thermostatic switching element 101 energizes terminal 103 the harvest relay HR in line 19 is also energized. The deenergization of the harvest relay HR opens back contacts HR in line 21 insuring deenergization of the compressor fan and the pump in line 23. Front contacts HR in line 18 close energizing the solenoid valve relay SV and the time delay switch relay TDS in line 16. The solenoid valve relay SV opens the bypass valve 37 (best seen in FIG. 1). Since the control relay 30 is still running hot gas is now bypassed around the expansion valve 36 and directly into the evaporator 38 initiating a defrost action within the ice forming tubes 39. Upon the application of a sufficient amount of heat the cubes are loosened from the inside of the ice forming tubes 39 and are dropped on the fins 71 of the ice chute and propelled into the ice storage bin 56 by gravity.

The time delay switch TDS opens back contacts TDS in line 17 at a predetermined interval after the energization of the relay coil TDS in line 16. Thus, the contacts TDS in line 17, while still in, act as a seal-in circuit for the harvest relay HR throughout its now closed front contacts HR in line 18 until the time delay switch back contacts TDS open. This prevents a deenergization of the harvest relay HR by any fluctuation of the thermostatic switching element 101 during the defrosting interval. The defrosting interval is terminated when the thermostatic element 101 has returned to contact with terminal 102 of cycle control 100, and when the time delay switch relay TDS has timed out opening the back contacts TDS in line 17. Upon termination of the defrost interval another ice freezing or forming cycle starts and the control circuit of FIG. III automatically continues such ice forming and harvesting operations until the capacity control or bin element 90 is actuated to remove energization from the control circuit. The ice making operation may of course be interrupted at any time by manually or otherwise moving the blades 81 and 82 of switch 80 to "off" terminals 85 and 86, respectively.

Since the water circulation elements are most easily and most economically constructed from molded plastics it is desirable to include in the control circuit means for cleaning the tanks and conduits which are a part of the water circulation circuit. By turning the blades 81 and 82 to terminals 87 and 88 it may be seen that a separate circuit is completed for energizing the pump 55 alone. By placing a small amount of cleaner in either the sump tank 52 or the water storage tank 57 and by turning the pump "on," the water can be circulated through the system to remove stains from the surfaces that are continuously in contact with the water. If the surfaces are plastic, such a cleaning agent might be a predetermined amount of citric acid. If the surfaces are of metal other cleaning agents may be utilized. The cleaning cycle for running the pump applies as readily to cleaning metal surfaces in the water circulation system as plastic surfaces. Although not shown the sump tank 52 may be provided with a drain from which the water may be removed at any time. Such a drain may communicate with the ice storage bin or may communicate directly with the drain 51 of the ice storage bin 56.

To appreciate certain novel features in the water circulation system an enlargement of the water circulation system is shown in FIGS. IV and V. As was stated above proper distribution of water to a plurality of ice forming tubes has long been a problem in the ice cube making art. Further, even after the proper amount of water has been distributed in particular ice forming tubes the problem remains of uniformly wetting the interior surface of each of the tubes to avoid uneven formation of ice within the tube and to avoid the white streaks or other undesirable features of the ice after it is fully formed. Viewing the enlarged manifold 57 and header trough 59 shown in FIGS. IV and V it may be seen that they are connected by a feeder dam 58 formed either by the manifold 57 or, alternatively, by the header trough 59. The width of the feeder dam 58 is of prime importance. A sharp edge will, in all instances, promote an uneven or discontinuous flow over the dam 58 such that some of the plurality of ice forming tubes 39 may have a surplage of water while other of the plurality of tubes 39 may have little or no water. If the feeder dam 58, on the other hand, is too wide, presenting a wide plane surface for the water from the manifold 57 to flow over, again there is usually discontinuous flow over certain portions such that all of the ice forming tubes will not be receiving the same amount of water. Therefore, the width of the crest of the feeder dam 58 is critical if one desires the best performance from an ice cube maker of this type. Experimentation has shown that widths in the range of ¼ to ¾ of an inch provide the best performance in allowing an even flow of water from the manifold 57 over the feeder dam 58 into the header trough 59. An attempt to avoid this problem in prior art led to pumping the water directly from the sump tank 52 to the header trough 59. However, only a relatively small water flow in each tube is desired, creating flow problems because of the turbulence of ejection from conduit 56. Thus the manifold 57 is utilized to still such turbulence.

After an equally distributed amount of water is over the feeder dam 58 into the header trough 59 the problem of uniformly wetting the interior surface of the ice forming tube 39 may be solved by forming spiral runways 110 in each discharge orifice 60 which tends to direct the flow of water in a tangential direction. It is most desirable not to form the fins or runways such that they direct all water to run down the runways or fins and allow no flow over the top of the runways or fins since portions of the interior of the tube may not be uniformly wetted. If it is desired to direct all of the water down the spiral runways or fins 110, more spiral runways
should be provided than the three shown for purposes of illustration in FIGS. IV and V. The spiral runways may be flat as they descend or they may have a slight groove formed therein as best seen in the sectional view of FIG. IV, to hold and direct a portion of the water rather than letting it flow over the runway or step. The spiral grooved runways are meant to be representative of any construction in the discharge orifice which will precipitate a vortex-like motion to the water being fed to the tube 39. It is recognized that under ordinary circumstances when a substantial volume of water is being discharged through an orifice, that formation of a vortex-like motion of the water results naturally. However, in order to attain the results desired in the ice maker being described a volume of water substantial enough to precipitate a natural vortex formation produces a number of undesirable results. First, the circulation of such a volume acts as an agent to carry additional B.T.U.'s of heat over the freezing surface, thereby slowing the production of ice on that surface. To overcome this slower production of ice an increased freezing rate or demand on the refrigeration system would require a larger compressor, etc. If, under these circumstances, the ice were then frozen too quickly in some of the tubes, then fracture lines within the ice (associated with the air or gas) would appear cloudy or unclear ice as discussed hereinbefore. Secondly, the quick freezing of the water would tend to entrap air and impurities in the ice, again contributing to a cloudy, undesirable appearance. Thirdly, the water circulation system itself would, of necessity, have to be larger and more expensive and have elaborate overflow provisions. In addition to the above-cited examples, other undesirable results make it clear that the formation of cubes in the system herein is most effectively accomplished by a flow of water through the ice forming tubes that approaches a layer or film stage rather than a volume sufficient to create a natural vortex. Thus, the discharge orifice 60 is constructed to impart a vortex-like motion to the water entering the ice forming tube. This may be accomplished by the formation of convolutions of whorls either protruding from the surface or recessed in the surface of the discharge orifice, depending on the general shape of the discharge orifice.

As may be best seen in the sectional view of FIG. IV the upper extremities of the ice forming tube 39 is joined to the discharge orifice 60 by an annulus 61 of low heat conductive metal such as stainless steel. Further, at the bottom or lower extremity of the ice forming tube 39 there depends an annular skirt 62, also of low heat conductive properties. As explained hereinbefore the utilization of two such low heat conductive materials on either extremity of the ice forming tube 39 confines the formation of ice to the surface of the high heat conductive portion of the ice forming tubes 39, which may be of a material such as copper. Thus, a very symmetrical cube may be obtained. The use of stainless steel and copper is advantageous from another point of view in that they are resistant to corrosion in water. Other corrosion-resistant materials or materials having a relatively low or high heat conduction characteristic as desired may, of course, be utilized. It is to be noted that this invention allows for preferably utilized with cylindrical ice forming tubes or with an orifice utilized with other geometrical convolutions of ice forming tubes as desired to produce the shape of ice cube wanted.

If the stainless steel or other low heat conductive material skirt 62 were not provided as shown in FIG. IV ice would tend to form not only within the confines of the ice tube 39 but also around the lower edges and possibly between the lower edges and the first of the evaporator coil fins. This not only reduces the desirable appearance of the cube but also obviously entails more difficulty in loosening the ice cube during the harvesting operation. To further prevent any possibility of undesirable ice formation and to facilitate the easy passage therethROUGH of the ice cube during the harvesting operation it will be noted that the low heat conductive material skirt 62 may be formed from a parent from the foregoing description it may readily be seen from the drawings that the various components such as the header trough 59, the manifold 57, the feeder dam 58, the conduits 56, the ice chute and drip deflector assembly 70, and the sump tank 82 may be easily and economically formed from machined or cast plastics in great numbers. This reduces construction costs, and replacement costs, if and when a component becomes defective or is broken. The components may also be more readily cleaned when the choice of their composition may be made from any number of suitable materials that are not toxic.

Thus it may be seen from the description hereinbefore that there has been provided improved ice making apparatus incorporating novel water circulation, feeding and distributing means which is simple in construction yet produces a very satisfactory result; a novel ice forming tube combination which improves the symmetry and final appearance of the cube; novel control circuitry; etc., all of which combination results in a low maintenance, superior performance ice making apparatus which is capable of delivering ice cubes in quantity for domestic use or on a commercial basis.

It is to be appreciated that no invention disclosed herein is to be interpreted as limited to the specific form of ice making apparatus illustrated or, if a particular part of the invention is applicable in systems or apparatus other than ice makers, not limited to ice makers. That is, the present disclosure is to be read as illustrative of but one utilization of the invention and not in the limiting sense. For example, reference to water and ice is meant to be representative of any solution which is to be conjugated by lowering its temperature. Therefore, the system is more broadly referred to as temperature conjugation apparatus including solution circulating means, conjugation tubes, conjugation storage bin, and so forth. As a further example, a particular feature of the control circuitry, although advantageously utilized in the temperature conjugation apparatus described herein, is of interest for other applications. That is, the seal-in circuit produced by the time delay switch contacts and the thermo-switching element of the cycle control cooperate to insure that the purpose of the defrost cycle is completed. Stated in terms of the system disclosed, the refrigeration means includes an evaporator coil disposed in heat exchange relationship with a conjugation tube. A defrost cycle of said refrigeration means is initiated by means responsive to a predetermined amount of conjugation in said tube. The defrost cycle is terminated by means responsive to the coincidence of an expiration of a predetermined time interval after initiation of said defrost cycle and the absence of conjugation in said tube (or responsive to a second predetermined amount of conjugation in said tube which may be zero). That is, water, for example, is sometimes frozen in this manner to remove impurities and then melted to provide improved drinking, cooking, etc., water.

In conclusion, it is pointed out that while the illustrated example constitutes a practical embodiment of my invention, I do not limit myself to the exact details shown, since modification of the same may be varied without departing from the spirit of this invention. Having described the invention, I claim:

1. In temperature conjugation apparatus, in combination; a conjugation tube having refrigeration means in heat transfer relation therewith means circulating a solution to be conjugated through said conjugation tube including header trough means having discharge orifice means formed therein communicating with said conjugation.
tion tube, the surface of said discharge orifice means having convolutions which impart a vortex-like motion to solution flowing through said orifice.

2. In temperature congelation apparatus, in combination; a congelation tube having refrigeration means in heat transfer relationship therewith; means circulating a solution to be congealed through said congelation tube including header trough means having discharge orifice means formed therein communicating with said congelation tube, the surface of said discharge orifice means having convolutions which impart a vortex-like motion to solution flowing through said orifice; said congelation tube including low heat conductive and high heat conductive sections, a low heat conductive section connecting said high heat conductive section to said discharge orifice.

3. In temperature congelation apparatus, in combination; a congelation tube having refrigeration means in heat transfer relationship therewith; means circulating a solution to be congealed through said congelation tube including header trough means having discharge orifice means formed therein communicating with said congelation tube, the surface of said discharge orifice means having convolutions which impart a vortex-like motion to solution flowing through said orifice; said congelation tube including low heat conductive and high heat conductive sections, a low heat conductive section connecting said high heat conductive section to said discharge orifice.

4. In temperature congelation apparatus, in combination; a congelation tube having refrigeration means in heat transfer relationship therewith; means circulating a solution to be congealed through said congelation tube including header trough means having discharge orifice means formed therein communicating with said congelation tube, the surface of said discharge orifice means having convolutions which impart a vortex-like motion to solution flowing through said orifice; said congelation tube including low heat conductive and high heat conductive sections, a low heat conductive section connecting said high heat conductive section to said discharge orifice; said high heat conductive section having depending therefrom a low heat conductive skirt.

5. In temperature congelation apparatus, in combination; a congelation tube having refrigeration means in heat transfer relationship therewith; means circulating a solution to be congealed through said congelation tube including header trough means having discharge orifice means formed therein communicating with said congelation tube, the surface of said discharge orifice means having convolutions which impart a vortex-like motion to solution flowing through said orifice; said congelation tube including low heat conductive and high heat conductive sections, a low heat conductive section connecting said high heat conductive section to said discharge orifice; said high heat conductive section having depending therefrom a low heat conductive skirt flared at its lower extremity providing an enlarged discharge passage for the congealed solution.

6. In temperature congelation apparatus, in combination; a congelation tube having refrigeration means in heat transfer relationship therewith; means circulating a solution to be congealed through said congelation tube including manifold means for receiving said solution and removing flow turbulence therefrom, feeder dam means connecting said manifold means to a header trough, said feeder dam having a flat crest less than three eighths of an inch in width; header trough means having discharge orifice means formed therein communicating with said congelation tube, the surface of said discharge orifice means having convolutions which impart a vortex-like motion to solution flowing through said orifice; said congelation tube including low heat conductive and high heat conductive sections, a low heat conductive section connecting said high heat conductive section to said discharge orifice; said high heat conductive section having depending therefrom a low heat conductive skirt.

7. In temperature congelation apparatus, in combination; a congelation tube having refrigeration means in heat transfer relationship therewith; means circulating a solution to be congealed through said congelation tube including manifold means for receiving said solution and removing flow turbulence therefrom, feeder dam means connecting said manifold means to a header trough, said feeder dam having a flat crest less than three eighths of an inch in width; header trough means having discharge orifice means formed therein communicating with said congelation tube, the surface of said discharge orifice means having convolutions which impart a vortex-like motion to solution flowing through said orifice; said congelation tube including low heat conductive and high heat conductive sections, a low heat conductive section connecting said high heat conductive section to said discharge orifice; said high heat conductive section having depending therefrom a low heat conductive skirt.

8. In temperature congelation apparatus, in combination; a congelation tube having refrigeration means in heat transfer relationship therewith; means circulating a solution to be congealed through said congelation tube including manifold means for receiving said solution and removing flow turbulence therefrom, feeder dam means connecting said manifold means to a header trough, said header trough means having discharge orifice means formed therein communicating with said congelation tube, the surface of said discharge orifice means having convolutions which impart a vortex-like motion to solution flowing through said orifice; said congelation tube including low heat conductive and high heat conductive sections, a low heat conductive section connecting said high heat conductive section to said discharge orifice; said high heat conductive section having depending therefrom a low heat conductive skirt.

9. In temperature congelation apparatus, in combination; a congelation tube having refrigeration means in heat transfer relationship therewith; means circulating a solution to be congealed through said congelation tube including manifold means for receiving said solution and removing flow turbulence therefrom, feeder dam means connecting said manifold means to a header trough, said feeder dam having a flat crest less than three eighths of an inch in width; header trough means having discharge orifice means formed therein communicating with said congelation tube, the surface of said discharge orifice means having convolutions which impart a vortex-like motion to solution flowing through said orifice; said congelation tube including low heat conductive and high heat conductive sections, a low heat conductive section connecting said high heat conductive section to said discharge orifice; said high heat conductive section having depending therefrom a low heat conductive skirt.

10. In temperature congelation apparatus, in combination; a congelation tube having refrigeration means in heat transfer relationship therewith; means circulating a solution to be congealed through said congelation tube including manifold means for receiving said solution and removing flow turbulence therefrom, feeder dam means connecting said manifold means to a header trough, said feeder dam having a flat crest less than three eighths of an inch in width; header trough means having discharge orifice means formed therein communicating with said congelation tube, the surface of said discharge orifice means having convolutions which impart a vortex-like motion to solution flowing through said orifice; said congelation tube including low heat conductive and high heat conductive sections, a low heat conductive section connecting said high heat conductive section to said discharge orifice; said high heat conductive section having depending therefrom a low heat conductive skirt.

11. In temperature congelation apparatus, in combination; a congelation tube having refrigeration means in heat transfer relationship therewith; means circulating a solution to be congealed through said congelation tube including manifold means for receiving said solution and removing flow turbulence therefrom, feeder dam means connecting said manifold means to a header trough, said header trough means having discharge orifice means formed therein communicating with said congelation tube, the surface of said discharge orifice means having convolutions which impart a vortex-like motion to solution flowing through said orifice; said congelation tube including low heat conductive and high heat conductive sections, a low heat conductive section connecting said high heat conductive section to said discharge orifice; said high heat conductive section having depending therefrom a low heat conductive skirt.

12. In ice making apparatus including means for freezing, harvesting and storing ice cubes from ice forming tube means; means circulating water into said tube including header trough means having formed therein dis-
charge orifice means communicating with said ice forming tube means; said discharge orifice means having convolutions operative to impart a vortex-like motion to water flowing therethrough such that the entire inner surface of said ice forming tube is uniformly wetted.

14. In ice making apparatus including means for freezing, harvesting and storing ice cubes from ice forming tube means; means circulating water into said tube including water manifold means connected to header trough means by a feeder dam, said header trough means having formed therein discharge orifice means communicating with said ice forming tube means; said discharge orifice means having convolutions operative to impart a vortex-like motion to water flowing therethrough such that the entire inner surface of said ice forming tube is uniformly wetted.

15. In ice making apparatus including means for freezing, harvesting and storing ice cubes from ice forming tube means; means circulating water into said tube including water manifold means connected to header trough means by a water manifold, said manifold being operative to substantially remove turbulence from said water, feeder dam means connecting said manifold to a header trough, said header trough means having formed therein discharge orifice means communicating with said ice forming tube means; said discharge orifice means having convolutions operative to impart a vortex-like motion to water flowing therethrough such that the entire inner surface of said ice forming tube is uniformly wetted.

16. In ice making apparatus including means for freezing, harvesting and storing ice cubes from ice forming tube means; means circulating water into said tube including header trough means having formed therein discharge orifice means communicating with said ice forming tube means; said discharge orifice means having convolutions operative to impart a vortex-like motion to water flowing therethrough such that the entire inner surface of said ice forming tube is uniformly wetted, said ice forming tube means comprising a low heat conductive section connecting a high heat conductive section to said discharge orifice.

17. In ice making apparatus including means for freezing, harvesting and storing ice cubes from ice forming tube means; means circulating water into said tube including header trough means having formed therein discharge orifice means communicating with said ice forming tube means; said discharge orifice means having convolutions operative to impart a vortex-like motion to water flowing therethrough such that the entire inner surface of said ice forming tube is uniformly wetted, said ice forming tube means comprising a low heat conductive section connecting a high heat conductive section to said discharge orifice.

References Cited in the file of this patent

UNITED STATES PATENTS

1,504,864 Buellina ------------------ Aug. 12, 1924
1,667,943 Munz ------------------ May 1, 1928
2,295,088 Kleeckler ---------------- Sept. 8, 1942
2,524,815 Leeson -------------------- Oct. 10, 1950
2,593,874 Grandia ------------------ Apr. 22, 1952
2,598,429 Pownall ------------------ May 27, 1952
2,701,452 Hopkins ------------------ Feb. 8, 1955
2,753,902 Eckstrom ----------------- July 10, 1956
2,775,098 MacLeod ------------------ Dec. 25, 1956
2,962,869 Bartels ------------------ Dec. 6, 1960

FOREIGN PATENTS

367,510 Italy --------------------- Jan. 25, 1939
989,273 France ------------------ Apr. 22, 1949