Sept. 11, 1962 E. J. KOCHER 3,053,058

ICE MAKING EQUIPMENT

Filed May 5, 1961

Fig. 1

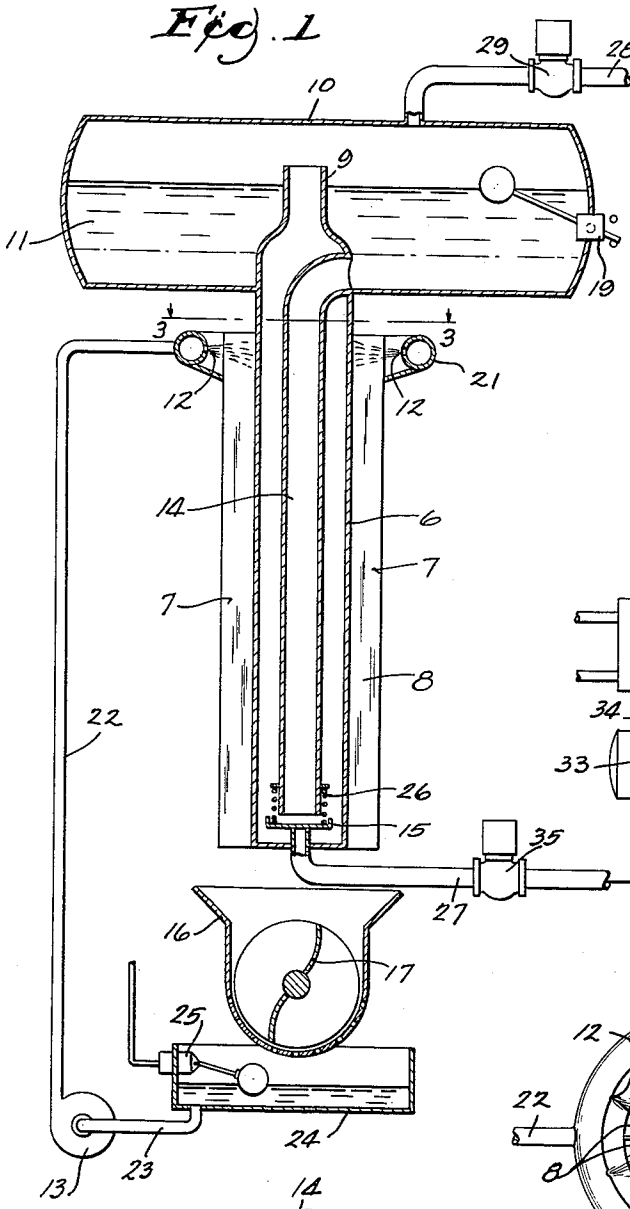
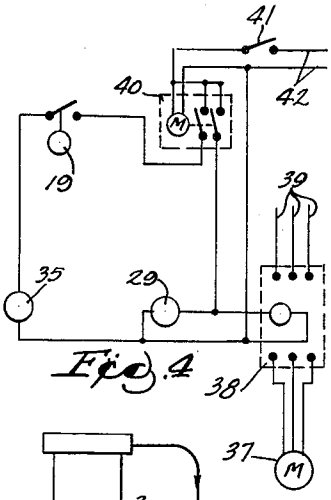
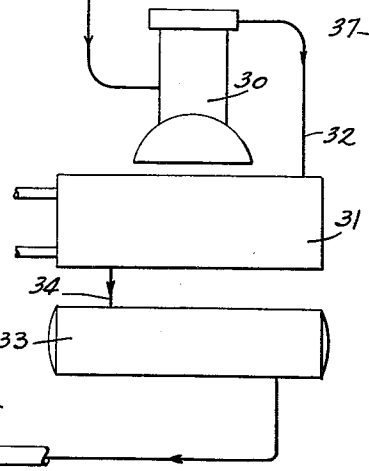


Fig. 4





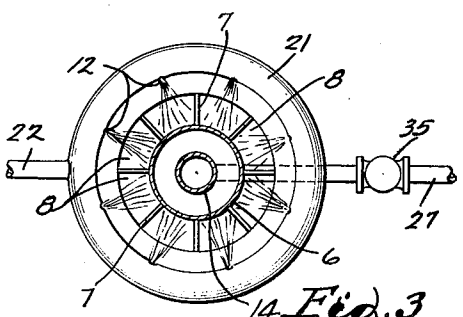


Fig. 3

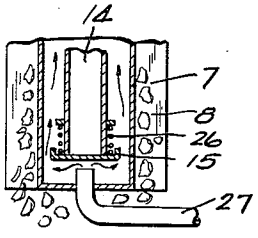


Fig. 2

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ICE MAKING EQUIPMENT

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The present invention relates generally to improvements in the art of artificially producing ice, and it relates more specifically to an improved system for converting water into ice suitable for diverse commercial uses.

The primary object of the invention is to provide an improved system for rapidly and effectively producing ice with the aid of simple equipment and at moderate cost.

Many different types of refrigeration systems and machines for congealing water into ice flakes and/or solid briquettes have heretofore been proposed, and in some of these prior proposals the water was confined in spaces exposed to refrigerant and the ice was removed with the aid of externally applied warm gas to which the spaces were subjected while in others water was sprayed and congealed upon a cold surface from which the ice film was scraped. But all of these prior systems were objectionable either because of the complicated apparatus required, or because of the limited production thereof, or because the product was not commercially useable.

It is therefore an important specific object of the present invention to provide an improved ice making assemblage which functions to automatically produce more or less solid ice or flakes with the aid of an externally finned and internally refrigerated simple tube without the use of movable mechanism or parts for effecting removal of the final product from the freezing zone.

Another important object of this invention is to provide an improved ice producing unit comprising an upright stationary tube having longitudinal external radial fins forming open water congealing spaces, and which is normally internally subjected to low pressure direct gas expansion to effect freezing of the water, but wherein high pressure warm refrigerant liquid is periodically employed to remove the accumulated ice.

A further important object of the invention is to provide an improved system wherein low pressure refrigerant is normally employed to produce ice deposits upon an approximately vertical externally finned stationary tube internally communicable with an accumulator from which liquid refrigerant is fed by gravity, and wherein liquid refrigerant under pressure automatically stops this feeding operation and effects defrosting and removal of the ice deposits by gravity.

Still another object of this invention is to provide an improved assemblage for producing successive batches of ice upon the exterior of an upright tube which is internally cooled to water congealing temperature by low pressure liquid refrigerant delivered by gravity into the lower portion of the tube from a refrigerant accumulator in open communication with the upper tube end, and wherein the refrigerant in the accumulator is periodically replenished by high pressure refrigerant which also serves to release and remove the ice from the tube exterior by gravity.

These and other more specific objects of the invention will be apparent from the following detailed description:

A clear conception of the features constituting the present improvement and of the construction and functioning of a system embodying the invention may be had by referring to the drawing accompanying and forming a part of this specification wherein like reference characters designate the same or similar parts in the various views.

FIG. 1 is a diagrammatic layout of the entire ice making equipment showing a central vertical section through the freezing tube and the refrigerant accumulator associated therewith, and a transverse vertical section through the water supply reservoir and the ice discharge conveyor, and also depicting this apparatus in normal ice freezing condition;

FIG. 2 is a fragmentary, central vertical section through the lower portion of the freezing tube, showing the check valve therein closed as during defrosting and ice removal operations;

FIG. 3 is a transverse horizontal section through the apparatus taken along the line 3—3 of FIG. 1 and looking downwardly; and

FIG. 4 is a wiring diagram of the electrical control system for periodically actuating the switches and valves for effecting freezing and restoration of the improved ice making system.

While the invention has been shown and described herein as having been embodied in a system operable to automatically produce successive batches of flake or slush ice from water sprayed into open segregated spaces completely surrounding a circular upright tube having an internal refrigerant conducting conduit therein, it is not intended to limit the use of the improved features to such specific structure; and it is also contemplated that descriptive terms employed herein be given the broadest possible interpretation consistent with the disclosure.

Referring to the drawing, the improved ice making system shown therein by way of illustration comprises in general an upright freezing tube **6** surrounded by radial fins **7** forming segregated open spaces **8** and having its upper end **9** in open communication with an accumulator **10** adapted to confine a body of liquid refrigerant **11** below the tube end **9**; an annular series of nozzles **12** and a pump **13** cooperable therewith to deliver water spray along the exterior of the tube **6** and fins **7** within the spaces **8**; a conduit **14** connecting the lower interior of the accumulator **10** with the lower interior of the tube **6** and having a check valve **15** at its lower end; electrically controlled means for withdrawing gaseous refrigerant from within the upper portion of the accumulator **10** and for converting the same into high pressure liquid refrigerant cooperable with the valve **15** to periodically close the same and to defrost the spaces **8**; and a combined dewatering trough **16** and crushing conveyor **17** for the ice delivered from the spaces **8** during defrosting operation.

The tube **6** has a sealed lower end but the spaces **8** formed by the radial fins **7** coacting with the tube exterior may be open at their outer sides and bottoms, but both the tube **6** and the fins **7** are preferably formed of metal having high heat conductivity. The interior of the accumulator **10** is provided with a float actuated electric switch **19** for establishing a high level of the confined liquid refrigerant **11** below the upper open end **9** of the tube **6** and for preventing this refrigerant from flowing down the tube, and the volume of this refrigerant between the high and low levels indicated in FIG. 1 represents the quantity of liquid refrigerant available during each freezing period of the system.

The spray nozzles **12** which are directed into the upper ends of the spaces **8** communicate with the interior of an annular water supply duct **21** which is connected with the discharge side of the pump **13** by a pipe **22**, while the pump inlet line **23** communicates with a water supply basin **24** which receives fresh water from any suitable source past a float valve **25**.

The trough **16** is provided with perforations in its bottom for draining free water into the basin **24**, and the crushing conveyor **17** may be of any suitable type adapted to the use desired.

The conduit **14** which connects the lower interior of the accumulator **10** with the lower interior of the freezing

tube 6 may be disposed centrally within this tube, and the check valve 15 is suspended from the lower end of the conduit 14 by a helical spring 26 and is adapted to be automatically opened by low pressure liquid refrigerant descending by gravity from the accumulator 10 through the conduit 14 during freezing periods and to be likewise closed against the lower conduit end by high pressure liquid refrigerant admitted into the bottom of the tube 6 through an inlet pipe 27 during defrosting periods.

The electrically controlled apparatus for withdrawing refrigerant gas from within the accumulator 10 above the liquid refrigerant 11 therein, comprises a vapor discharge pipe 28 having a solenoid actuated valve 29 therein, a compressor 30 for compressing the vapor or refrigerant gas and for delivering the same into a condenser 31 under high pressure through a pipe line 32, a receiver 33 for condensed high pressure liquid refrigerant delivered from the condenser through a connection 34 and which communicates with the inlet pipe line 27 leading into the bottom of the tube 6, and another solenoid actuated valve 35 within the pipe line 27, see FIG. 1.

The electric system for controlling alternate freezing and defrosting is shown in the diagram of FIG. 4, wherein the electric motor 37 which actuates the refrigerant compressor 30 is provided with a motor starter 38 adapted to receive current from a power line 39 and a cycle repeater or timer 40 for effecting desired periods of freezing and defrosting is cooperable with the float switch 19 and with the solenoid actuated valves 29, 35. The timer 40 is controllable by a switch 41 in a control line 42, and the motor starter 38 and timer 40 are of well-known construction.

When the improved ice making equipment has been properly constructed and installed as hereinabove described, the system functions as follows: The accumulator 10 should be supplied with only enough liquid refrigerant 11 so that none will normally space over the upper end 9 of the freezer tube 6, and the water circulating pump 13 may be operated continuously to circulate fresh water from the basin 24 through the pipe lines 22, 23 and the duct 21 and spray nozzles 12 while the float valve 25 controls the quantity of fresh water admitted to the basin 24.

During the freezing period, the solenoid valve 29 is open and the solenoid valve 35 is closed, so that the compressor 30 is operating to withdraw refrigerant gas from within the accumulator above the low pressure liquid refrigerant 11 and to compress and deliver the withdrawn gas into the condenser 31 from which the heated high pressure condensate is discharged into the receiver 33, but no refrigerant is being delivered from the receiver 33 to the tube 6. However, since the level of the liquid refrigerant 11 in the accumulator is well above the upper inlet end of the conduit 14, low pressure liquid refrigerant will flow by gravity downwardly through this conduit and will open the check valve 15 and enter the lower portion of the freezing tube 6 where it evaporates and the resultant gas rises through this tube to cool the same and the fins 7 radiating therefrom. The water delivered into the spaces 8 between the fins 7 from the spray nozzles 12 descends by gravity along the cold bounding surfaces of the spaces 8 and is congealed into ice.

When it is desired to harvest the ice formed in the spaces 8, the compressor 30 is stopped and the suction solenoid valve 29 will simultaneously close. The liquid solenoid valve 35 will then open to admit warm high pressure liquid refrigerant from the receiver 33 into the lower end of the freezing tube 6. The refrigerant thus admitted under pressure promptly closes the check valve 15 to prevent liquid from backing up through the conduit 14, while the admitted warm liquid forces the cold liquid within the tube 6 up into the accumulator 10 and replenishes the liquid refrigerant 11 therein until the float switch 19 acts to close the solenoid valve 35. At this point the freezing tube 6 will be completely filled with warm liquid refrigerant which heats the exterior surface of this tube and the fins 7 and melts the hard ice deposit within the spaces 8 only along a thin layer directly adjoining the frezing surfaces, thereby releasing the solid ice and permitting it to gravitate into the trough 16 wherein the free water drains into the basin 26 while the relatively hard dry ice is removed by the crusher conveyor 17, thus completing the defrosting portion of the cycle.

The timer 40 may be set to automatically produce the desired periods of freezing and defrosting, and the various switches 19, 29, 35 cooperate with this timer to insure uniform repetition of the entire cycle. The entire system is obviously simple and dependable in operation, and the timer 40 may also be set to produce ice deposits of any desired thickness within the spaces 8. The dry ice removed from the trough 16 may be used as desired, and the system requires no manual attention other than manipulation of the starting switch 41 in order to insure its automatic operation.

Various modes of carrying out the invention are contemplated as being within the scope of the following claims particularly pointing out and distinctly claiming the subject matter which is regarded as the invention:

1. An ice maker comprising, a refrigerant accumulator, an upright freezing tube having a sealed bottom and an upper open end projecting upwardly into the accumulator beyond the high liquid refrigerant level in the latter and being provided with external fins forming segregated open spaces extending longitudinally along the tube, means for delivering water onto the tube and fins within said spaces, a conduit connecting a lower portion of said accumulator with the lower interior of said tube, a check valve at the discharge end of said conduit formed to be opened by low pressure liquid refrigerant flowing from the accumulator into the lower end portion of said tube and which vaporizes to congeal the water delivered into said spaces into ice, means for establishing a predetermined high liquid refrigerant level in said accumulator, and means for converting refrigerant gas derived from within said accumulator into warm high pressure liquid refrigerant and for periodically utilizing said high pressure liquid refrigerant to close said check valve and to defrost said spaces through the tube sufficiently to release the ice for delivery by gravity from the spaces.

2. An ice maker comprising, a refrigerant accumulator, an upright freezing tube having a sealed bottom and an upper open end projecting upwardly into the accumulator beyond the high liquid refrigerant level in the latter and being provided with segregated open external spaces extending longitudinally along the tube, means for delivering water along the bounding surfaces of said spaces, a conduit connecting a lower portion of said accumulator with the lower interior of said tube, a check valve at the lower end of said conduit formed to be opened by low pressure liquid refrigerant gravitating from the accumulator into the lower end portion of said tube and which vaporizes therein to congeal the water deposited within said spaces into ice, means for establishing a predetermined high liquid refrigerant level in said accumulator below the upper open end of said tube, and means for converting refrigerant gas derived from said accumulator into warm high pressure liquid refrigerant and for periodically utilizing said high pressure liquid refrigerant to close said check valve and the temperature thereof to defrost said spaces sufficiently to release the ice for delivery by gravity from within the spaces.

3. An ice maker comprising, a refrigerant accumulator, an upright freezing tube having a sealed bottom and an upper open end projecting upwardly into the accumulator beyond the bottom thereof and being provided with external fins forming segregated open spaces extending longitudinally along the tube exterior, means for constantly spraying water into all of said spaces during freezing operation, a conduit disposed within said tube and

connecting the bottom of said accumulator with the lower inner portion of the tube, a check valve at the lower end of said conduit formed to be opened by low pressure liquid refrigerant delivered by gravity from the accumulator into the lower end portion of said tube and which vaporizes while rising through the tube to congeal the water sprayed into said spaces into ice, means for establishing a maximum high liquid refrigerant level in said accumulator below the upper end of said tube, and a compressor for converting refrigerant gas derived from said accumulator into warm high pressure liquid refrigerant and for periodically delivering said high pressure liquid refrigerant into said tube to close said check valve and to defrost said spaces sufficiently to release the ice for delivery by gravity from within the spaces.

4. An ice maker comprising, a refrigerant accumulator, an upright freezing tube having a sealed bottom and an upper open end projecting upwardly into the accumulator beyond the bottom of the latter and being provided with external fins forming segregated open spaces extending longitudinally along the tube exterior, means for constantly delivering water into the upper ends of said spaces, a conduit connecting the lowermost portion of said accumulator with the lower interior of said tube, a check valve at the lower discharge end of said conduit formed to be opened by the weight of low pressure liquid refrigerant delivered by gravity from the accumulator into the lower end portion of said tube and which vaporizes within the latter to congeal the water admitted to said spaces into ice, means for predetermining a high liquid refrigerant level in said accumulator below the upper open end of said tube, and means including a compressor and a condenser for converting refrigerant gas derived from said accumulator into warm high pressure liquid refrigerant and for periodically utilizing said warm high pressure liquid refrigerant to close said check valve and to defrost said spaces through the tube sufficiently to release the ice for delivery by gravity while also replenishing the liquid refrigerant in the accumulator.

5. An ice maker comprising, a refrigerant accumulator, an upright freezing tube having a sealed bottom and an upper open end projecting upwardly into the accumulator beyond the high liquid refrigerant level in the latter and being provided with external fins forming segregated open spaces extending longitudinally along the tube, means for delivering water onto the tube and fins within said spaces, a conduit connecting a lower portion of said accumulator with the lower interior of said tube, a check valve at the discharge end of said conduit formed to be opened by low pressure liquid refrigerant flowing from the accumulator into the lower end portion of said tube and which vaporizes to congeal the water delivered into said spaces into ice, means for establishing a predetermined high liquid refrigerant level in said accumulator, means for converting refrigerant gas derived from within said accumulator into warm high pressure liquid refrigerant and for periodically utilizing said high pressure liquid refrigerant to close said check valve and to defrost said spaces through the tube sufficiently to release the ice for delivery by gravity from the spaces, and means for dewatering the ice and crushing the dehydrated ice for commercial use.

6. An ice maker comprising, a refrigerant accumulator, an upright freezing tube having a sealed bottom and an upper open end projecting upwardly into the accumulator beyond the high liquid refrigerant level in the latter, means for delivering water onto the exterior of the tube, a conduit connecting a lower portion of said accumulator with the lower interior of said tube, a check valve at the discharge end of said conduit formed to be opened by low pressure liquid refrigerant flowing from the accumulator into the lower end portion of said tube and which vaporizes to congeal the water delivered onto the tube into ice, means for establishing a predetermined high liquid refrigerant level in said accumulator, and means for converting refrigerant gas derived from within said accumulator into warm high pressure liquid refrigerant and for periodically utilizing said high pressure liquid refrigerant to close said check valve and to defrost said tube sufficiently to release the ice formed thereon for delivery by gravity.

7. An ice maker comprising, a refrigerant accumulator, an upright freezing tube having a sealed lower end and an upper open end projecting directly into and upwardly beyond the bottom of said accumulator, means for depositing water upon the exterior of said tube, a conduit disposed centrally within said tube in annular spaced relation to the tube interior and connecting the bottom of said accumulator with the lower interior of the tube, a check valve at the lower discharge end of said conduit formed to be opened by liquid refrigerant flowing from said accumulator into the annular space within said tube surrounding the conduit and which refrigerant vaporizes to congeal the water deposited upon the tube exterior into ice, means for establishing a predetermined high liquid refrigerant level in said accumulator, and means for periodically delivering warm liquid refrigerant under pressure into the lower interior of said tube to close said check valve and to thereby cause said warm refrigerant to flow upwardly through said space and to release said external ice deposits.

8. An ice maker comprising, a refrigerant accumulator, an upright freezing tube having a sealed lower end and an upper open end projecting directly into and upwardly beyond the bottom of said accumulator, means for depositing water upon the exterior of said tube, a conduit disposed centrally within said tube in annular spaced relation to the tube interior and connecting the bottom of said accumulator with the lower interior of the tube, a check valve coacting directly with the lower discharge end of said conduit and formed to be opened by liquid refrigerant gravitating from said accumulator through the conduit and into the annular space within said tube surrounding the conduit and which refrigerant vaporizes to congeal the water deposited upon the tube exterior into ice, means for establishing a predetermined high liquid refrigerant level in said accumulator, and means for periodically delivering warm liquid refrigerant under pressure into the lower interior of said tube to close said check valve and to thereby cause said warm liquid refrigerant to flow upwardly through said space and to release said external ice deposits.

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