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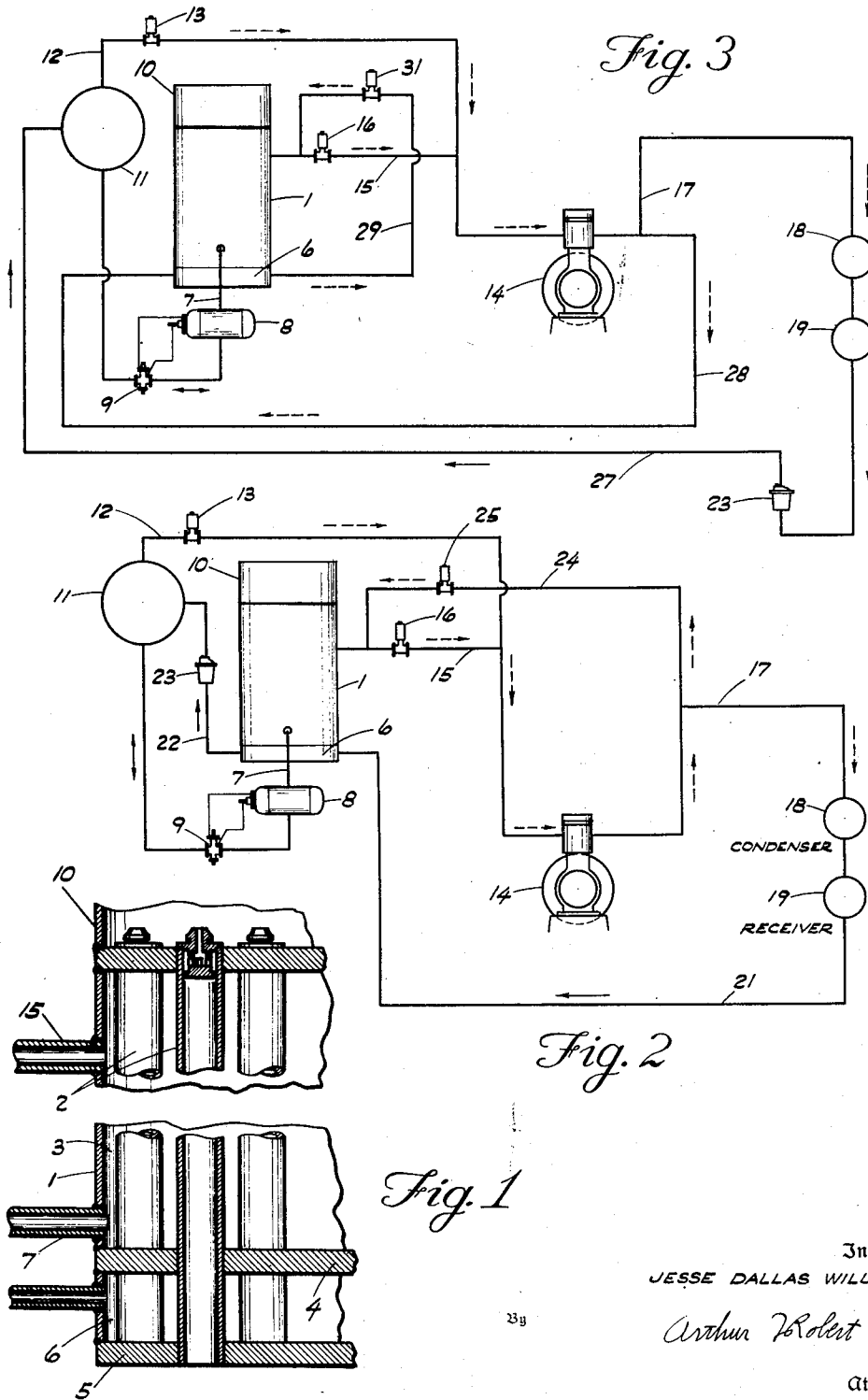
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2,618,129

ICE-MAKING APPARATUS

Filed May 26, 1949

2 SHEETS—SHEET 1



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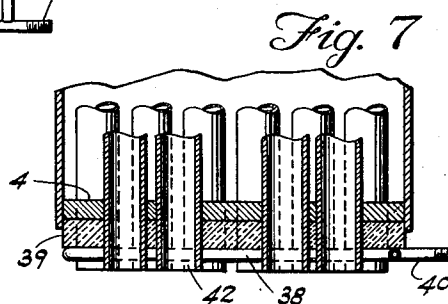
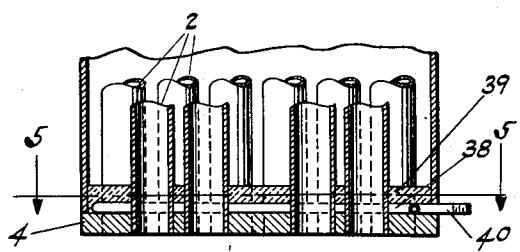
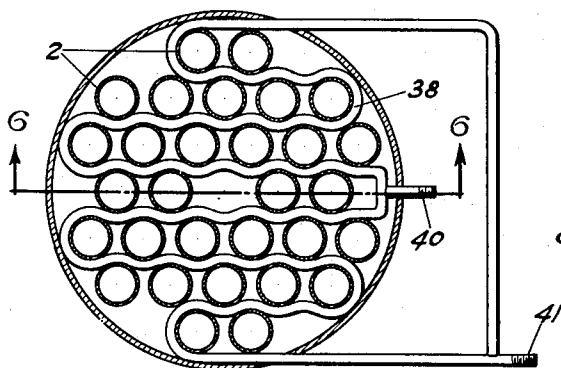
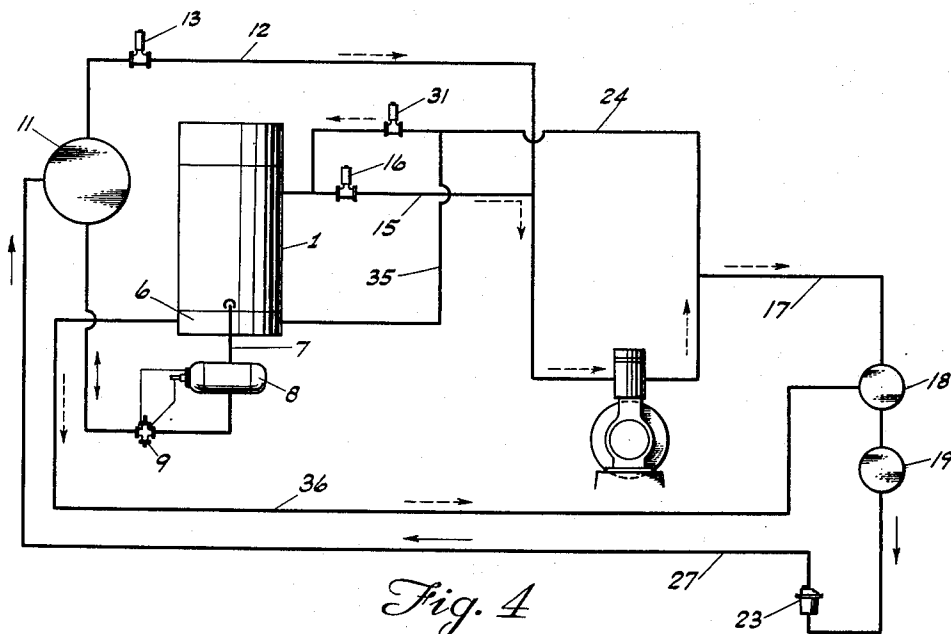
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2 SHEETS—SHEET 2



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ICE-MAKING APPARATUS

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6 Claims. (Cl. 62-106)

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The present invention relates to an improvement in the construction and method of operation of tube ice machines.

In the apparatus of U. S. Patent No. 2,239,234, issued April 22, 1941, to Kubaugh for Ice Freezing Apparatus, during the thawing cycle hot gaseous refrigerant is admitted at the top of the evaporator to expel liquid refrigerant and thaw the ice rods free from the ice tubes. The freezing zone of the evaporator extends beyond the lower physical confines of the evaporator compartment by reason of the heat conductivity of the tubes, and in order to quickly release the ice rods at the lower end of the freezing zone, and prevent ice formation on the lower freezer head, the ice tubes are extended below the freezer or evaporator compartment and are embraced by a chamber at the bottom, separate from the evaporator, through which chamber warm water is circulated during the thawing cycle. The warm water quickly thaws the ice rods loose at the lower freezing zone. This arrangement necessitates the provision of a warm water supply for the thawing chamber, and the piping, pumps, and ancillary control apparatus. Furthermore, the thawing action of the warm water introduces heat into the thermodynamic system of the refrigerator, over and above that introduced by the freezing of water in the tubes, and thus adds to the cost of operation.

It is an object of the present invention to provide an ice making machine which eliminates the use of water for thawing the bottoms of the ice tubes in the thawing cycle.

A further object is the provision of an ice making machine which operates at an increased thermal efficiency.

A further object is the provision of an ice making machine in which the thawing of the ice tubes is accomplished without the introduction of extraneous heat into the thermodynamic cycle.

Another object is the provision of an ice making machine in which freezing at the lower ends of the ice tubes is substantially prevented during the freezing cycle.

In accordance with the present invention the introduction of such extraneous heat in the thermodynamic system of the refrigerator is eliminated by applying warm refrigerant in liquid or gaseous state at the lower ends of the ice tubes, which extend below the freezing chamber in the evaporator. The heating action of the warm refrigerant may be confined to the thawing cycle for the purpose of thawing the ice in the tubes, or the heating action may occur during the freezing

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cycle, in which case the heat thus applied substantially prevents freezing at the lower ends of the tubes during the freezing cycle. If desired, heat may be applied during only one cycle, or may be applied in both the freezing and thawing cycles. The invention may be applied to an absorption or compression type refrigeration system, and liquid refrigerant is supplied to the evaporator chamber during the freezing cycle at the required rate by any suitable control means.

In applying the invention to a compression type system, the heating of the refrigerant gas is incidental to its compression, and the warm gaseous refrigerant may be applied around the bottom zone of the ice tubes substantially at the same time that the freezer is undergoing the thawing cycle. The application of refrigerant in the hot gaseous state may be continued around the ends of the ice tubes during the freezing cycle only, or may be applied in a limited amount during both the thawing and freezing cycles. Or, by a simple arrangement warm liquid refrigerant is supplied around the bottom of the tubes during the freezing cycle to thereby prevent freezing at the bottoms of the tubes.

The invention will be described in greater detail in connection with the accompanying drawing illustrating preferred embodiments of the invention by way of example, and wherein:

Figure 1 is a fragmentary section through a freezer,

Figure 2 is a diagrammatic view illustrating an embodiment of the invention,

Figure 3 is a diagrammatic view of a modification,

Figure 4 is a diagrammatic view of a further modification,

Figure 5 is a sectional view of a modified freezer taken on line 5-5 of Figure 6,

Figure 6 is a fragmentary vertical sectional view taken on line 6-6 of Figure 5, and

Figure 7 is a view similar to Figure 6 of a modification.

Referring to Figure 1, the freezer 1 of the ice making machine provides ice tubes 2, through which the water to be frozen flows downwardly, surrounded by a freezer or evaporator chamber 3 adapted to receive liquid refrigerant. The freezing occurs by evaporation of the liquid refrigerant from this chamber. The tubes 2 extend past the bottom header 4 of the freezer for a short distance, and extend through a second header 5. The space 6 between the headers provides a heating chamber for reception of fluid above freezing temperature, so that the heat sup-

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plied to the lower ends of the tubes prevents freezing over at the bottoms of the tubes or accumulation of ice on the header 5. A water distributing chamber 10 at the top of the freezer supplies water to the tubes 2 through suitable distributing orifices. The chamber 3 is connected at the bottom by a conduit 7 through a float chamber 8 (Figure 2) and automatic control valve 9 to a transfer drum 11 which serves to store the liquid refrigerant during the thawing cycle. The automatic control valve 9 and float chamber 8 are described and claimed in the application of Archie Fulkerson, Serial No. 773,421, filed September 11, 1947, for Fluid Flow Controller.

The top of the transfer drum is connected by a conduit 12 having a solenoid operated valve 13 therein to the intake side of the compressor 14, so that vapor therefrom is returned to the intake side of the compressor. A conduit 15 having a solenoid valve 16 therein also is connected between the freezing chamber 3 above the level of liquid refrigerant therein and the intake side of compressor 14. The gaseous refrigerant from the evaporator is reconditioned in known manner for return to the evaporator. In the modification illustrated the compressed gas leaving the compressor by conduit 17 passes through a condenser 18 where it is liquefied and then enters a receiver 19 where it is stored until required. The conduit 21 is connected between the outlet side of compressor 14 and the thawing chamber 6, by way of condenser 18 and receiver 19, and a conduit 22 having a float operated valve 23 therein is connected between chamber 6 and transfer drum 11. Another conduit 24 having a solenoid operated valve 25 therein is connected between conduits 17 and 15 to thereby connect the outlet side of the compressor to the freezer chamber 3. The solenoid operated valves may be replaced by any other type of valve, and may be timed manually or may be operated by a cycle control mechanism, such as that described and claimed in my Patent No. 2,396,308 issued March 12, 1946 for Timing System for Ice Making Apparatus, or by any other suitable means.

Operation

The flow of liquid and gases in the operation of the apparatus is indicated by solid and dotted arrows, respectively. During the freezing cycle valve 16 is open and valves 13 and 25 are closed, so that the compressor applies suction to the evaporating compartment 3 through conduit 15, and thereby causes valve 9 to open, so that liquid refrigerant is drawn from transfer drum 11 into the evaporator compartment. The amount of liquid refrigerant in chamber 3 is such that its level is below conduit 15. Under reduced pressure some of the liquid refrigerant in compartment 3 volatilizes, the heat of evaporation being supplied mainly from the water trickling down through the ice tubes, which thereupon freezes to the walls of the tubes in a hollow cylinder or shell. The gaseous refrigerant drawn by conduit 15 to the inlet side of the compressor is compressed thereby, and then flows to the condenser 18 where it is liquefied, at a temperature of about 75-90° F., the exact temperature depending on operating conditions. The liquefied refrigerant is stored in receiver 19 under pressure until needed and is automatically fed to the freezer chamber 3 by float operated feed valve 23 by way of warming chamber 6 and transfer drum 11. Feed

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valve 23 is a known type of float operated valve provided with a vented bell float, so that as long as the liquid level is maintained its outlet valve is open. Accumulation of gas in the bell causes the bell to rise and operate the valve to cut off flow. Thus, valve 23 automatically regulates the flow of liquid refrigerant in accordance with the accumulation of liquid in the receiver. During the freezing phase the heat supplied to the lower ends of the tubes by the warm liquified refrigerant in chamber 6 substantially prevents freezing at the bottom of the tubes.

At the end of the freezing cycle valves 13 and 25 are opened, and valve 16 is closed, so that warm compressed gas from the discharge side of the compressor is introduced into the top of freezer chamber 3 by conduits 17 and 24. This gas, which is maintained under pressure, forces the liquid refrigerant downwardly out of the freezer through conduit 7 into the transfer drum 11, while suction is applied to the transfer drum through conduit 12 to assist in the transfer of liquid refrigerant and carry off vapors. The refrigerant gas introduced into freezer 3 is under pressure at a temperature of about 160-190° F., depending on operating conditions, and thaws the ice rods from the tubes to release them, so that they fall out of the tubes at the bottoms. At the end of the thawing cycle, valves 13 and 25 are closed and valve 16 is opened, whereupon suction is applied to the chamber 3 by the pump through conduit 15 and valve 16 to draw liquid refrigerant into the freezing chamber from the transfer drum, and the freezing cycle is repeated as above described.

In the modification shown in Figure 3, wherein like parts are designated by like reference numerals, the warm liquified refrigerant from receiver 19 is supplied by conduit 27 containing feed valve 23 directly to the transfer drum 11. The high pressure side of the pump is connected by a conduit 28 to warming chamber 6, and from there is conducted by conduit 29 containing solenoid valve 31 and conduit 15 to the top of the freezer chamber 3 (Figure 1). In this modification, during the freezing cycle, valves 31 and 13 are closed while valve 16 is open so that the compressor draws gas from the evaporator. During the thawing cycle valve 16 is closed and valves 31 and 13 are open so that the warm compressed refrigerant gas, passes first through heating chamber 6 to thaw the bottoms of the ice cylinders, and then to the top of chamber 3 to expel liquid refrigerant and thaw the ice cylinders loose from the tubes. By supplying hot gaseous refrigerant to chamber 6 the thawing at the bottoms of the ice rods is accelerated and the heating at the upper ends of the ice rods is reduced, so that the rods are quickly released without excessive melting of the ice. The thawing in chambers 6 and 3 occurs substantially simultaneously.

The invention may be modified to supply warm refrigerant gas to the lower ends of the ice tubes during both the thawing and freezing cycles, as illustrated in Figure 4, wherein like parts are indicated by like reference numerals. A conduit 35 is connected between conduit 24 and the heating chamber 6 at the lower ends of the ice tubes, and a conduit 36 connects the heating chamber with the condenser 18. During the freezing cycle valves 13 and 31 are closed while valve 16 is open, and gas is drawn from the evaporator chamber through valve 16 in conduit 15 to the compressor. The stream of hot compressed gas from the high pressure side of the compressor is divided, part

going through conduit 17 to the condenser 18. The part flowing through conduits 24 and 35 to the heating chamber 6 serves to prevent freezing in the lower ends of the tubes, and from this chamber it flows by conduit 36 to condenser 18.

During the thawing cycle, valves 31 and 13 are open and valve 16 is closed, and the gas introduced into the evaporator from the compressor by conduit 24 expels the liquid refrigerant into transfer drum 11. At the same time gas continues to flow by conduit 35 to heating chamber 6, and by conduit 36 to the condenser 18. The gas drawn by conduit 12 from the transfer drum passes through the compressor and is distributed by conduits 24 and 35 to the evaporator and to the lower chamber 6. Thus it will be seen that the flow of warm gas to the lower ends of the ice tubes occurs in both the freezing and thawing cycles, the flow of gas being suitably proportioned to avoid excessive heating of the ice tubes. Thus, if desired, the flow of heat to the lower ends of the ice tubes during the freezing cycle can be such as to allow slight freezing, with thawing taking place in the thawing cycle.

The construction of the freezer may be modified to provide only a single header 4 at the bottom, in which case the heating chamber is formed by a tubing surrounding the lower ends of the ice tubes. Referring to Figure 5, a tube 38 is wound around the ends of the ice tubes in heat exchange relation thereto. The tube 38 is covered by a layer of poor heat conducting material 39, such as paraffine, to a suitable depth so that the heat supplied from tubes 38 can prevent ice formation on the bottom 4 and in the lower ends of the tubes. The heat is conducted upward along the ice tubes and the depth of insulating layer 39 should not be so great as to allow freezing at too great a distance below the top surface of the layer. Freezing at too great a depth will increase the time required to release the ice from the tubes, and will result in excessive melting of the ice in the upper ends of the tubes during the thawing cycle. The inlet 40 for warm refrigerant may be connected to conduit 21 in Figure 2; or to conduit 28 in Figure 3; or to conduit 35 in Figure 4, and the outlet 41 will be suitably connected according to the modification employed.

In Figures 5 and 6 the coil 38 is located on the evaporator side of the header 4, and the insulating layer 39 is on the same side. However, if desired, the ice tubes 2 may be extended beyond the header 4 at 42, as shown in Figure 7, and the coil 38 then is located exterior of the header around the extended ends 42 of the tubes. The insulation layer 39 may be interposed between the header 4 and the coil as shown, or may be located below the coil 40, or in some cases may be omitted.

I claim as my invention:

1. A freezing apparatus operating on alternate freezing and thawing phases, comprising: a vertical tube internally accommodating the downward flow of a liquid to be solidified; supply means for feeding said liquid to the upper portion of the tube during the freezing phase; shell means providing a chamber around the upper portion of the tube adapted to contain a liquid refrigerant during the freezing phase, with the lower end portion of the tube projecting beyond the evaporator chamber; refrigerant recondi-

tioning means including a condenser connected to the evaporator chamber to recondition vapor drawn from said chamber and promote the evaporation of liquid refrigerant in said chamber so as to refrigerate said tube and solidify said medium into a rod therein; means for supplying liquid refrigerant from the condenser to said evaporating chamber during the freezing phase; means operative during the thawing phase to introduce warm gas into the evaporating chamber to thaw the rod loose from the upper part of the tube and promote the gravitational discharge of the rod through the bottom end portion of the tube; means providing a thawing compartment around the projecting lower end portion of the tube; and means for introducing warm refrigerant fluid into said thawing compartment from the refrigerant reconditioning means during at least one of said phases to supply heat to prevent any solidified material from adhering to said lower end portion of the tube so as to enable said rod to begin to discharge from the lower end of the tube as soon as it is thawed loose from the upper part thereof.

2. The freezing apparatus of claim 1 wherein; said thawing compartment is connected to the refrigerant reconditioning means below the liquid refrigerant level in the condenser to supply warm liquid refrigerant to the thawing compartment.

3. The freezing apparatus of claim 1 having a valve controlled conduit means between the thawing compartment and the evaporating chamber for the flow of warm refrigerant fluid in sequence through the thawing compartment and evaporating chamber.

4. The freezing apparatus as specified in claim 1 wherein the means for introducing warm refrigerant fluid into the thawing compartment comprises a branch connection between the thawing compartment and the means to introduce warm gas into the evaporating chamber during the thawing phase.

5. The freezing apparatus of claim 4 having an additional conduit means connected between the thawing compartment and the refrigerant reconditioning means above the level of liquid refrigerant for flow of refrigerant fluid from the thawing compartment to the condenser.

6. The freezing apparatus as specified in claim 2 having a valve controlled conduit means between the thawing compartment and the evaporator chamber for the flow of warm liquid refrigerant in sequence through the thawing compartment to the evaporating chamber.

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