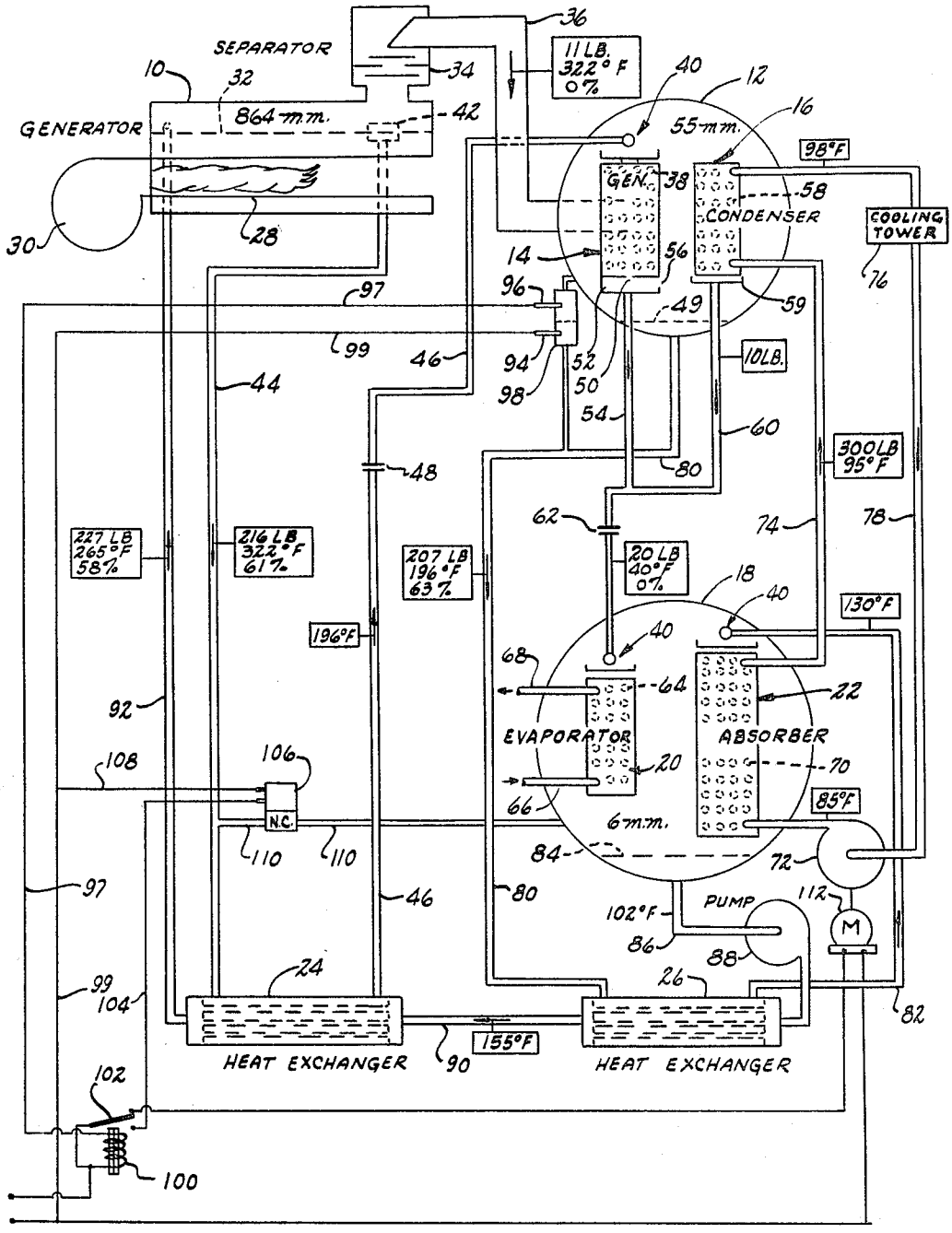
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DECRYSTALLIZER MEANS FOR DOUBLE EFFECT ABSORPTION REFRIGERATION SYSTEM

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DECRYSTALLIZER MEANS FOR DOUBLE EFFECT ABSORPTION REFRIGERATION SYSTEM

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This invention relates to means for decrystallizing solutions in double effect absorption refrigeration systems.

In co-pending patent application Serial No. 299,547, filed August 2, 1963, there is disclosed a double effect refrigeration system having two serially arranged refrigerant generators. The first generator operates at a relatively high pressure to generate refrigerant vapor at a relatively high temperature, as for example 322° F. Liquid solution from the first generator is supplied at an intermediate pressure to the outer surfaces of heat exchange tubes in the second generator, and high temperature vaporous refrigerant from the first generator is fed through the heat exchange tubes to cause additional refrigerant vapor to be released from the tube surfaces.

The released refrigerant vapor is fed to a water-cooled condenser, from whence it is directed in liquid form at a lower pressure to a tube-shell evaporator. The evaporated refrigerant is then passed over a water-cooled absorber and ultimately returned to the first generator to complete the cycle.

In the above-described system the operating efficiency is improved by causing the relatively hot solution from the second generator to exchange heat with relatively cool solution discharged from the absorber. In this manner solution fed to the first generator is at a relatively high temperature, thereby lessening the heat input requirements in the first generator; the solution fed to the absorber is at a relatively low temperature, thereby improving the operating efficiency of the absorber.

In operation of the above-described system there is a possibility of absorbent crystal formation in the heat exchanger in the event of improper solution temperatures and/or solution concentrations. It is an object of the present invention to provide means for preventing such crystals from having an adverse effect on the performance of the described system.

Another object of the invention is to provide a decrystallization mechanism which comprises first means for sensing blockage of the system due to crystal formation, and second means operated by the first means for automatically removing the crystals.

An additional object is to provide a refrigeration system of the above-described type with means which removes crystals from the system automatically without human attention.

A further object of the invention is to provide a decrystallizer mechanism which can be incorporated in the above-described refrigeration system at relatively low cost.

Other objects of this invention will appear from the following description, accompanying drawing and appended claims.

In the drawing:

The single figure is a diagrammatic view of an absorption refrigeration machine having one embodiment of the invention incorporated therein.

Before explaining the present invention in detail, it is to be understood that the invention is not limited in its application to the details of construction and arrangement of parts illustrated in the accompanying drawings, since the invention is capable of other embodiments and of being practiced or carried out in various ways. Also, it is to be understood that the phraseology or terminology

employed herein is for the purpose of description and not of limitation.

In the drawing there is diagrammatically shown a refrigeration machine of the type particularly described in copending application Serial No. 299,547, filed August 2, 1963. As schematically shown in the present drawing, the machine comprises an upper cylindrical shell **10** containing a first refrigerant generator, an intermediate cylindrical shell **12** containing a second generator **14** and condenser **16**, a lower cylindrical shell **18** containing an evaporator **20** and absorber **22**, and heat exchangers **24** and **26** located below shell **18**. Various absorbents and refrigerants can be employed in the system, but as an illustration the absorbent can be lithium bromide and the refrigerant can be water. To facilitate the disclosure various illustrative absorbent solution percentages, flows in pounds per minute, and temperatures in degrees Fahrenheit are indicated in the drawing.

The diagrammatically illustrated shell **10** is provided with a cylindrical fire tube **28** extending therethrough to accommodate the flame from an oil or gas burner **30**. The space surrounding fire tube **12** is occupied by an absorbent-refrigerant solution having a normal level **32**. It will be understood that the solution in shell **10** is heated by the burner flame to expel pure water vapor (refrigerant) through eliminator **34** and into vapor pipe **36**.

In the illustrated system vapor pipe **36** discharges into the tubes **38** of generator **14**. The outer surfaces of tubes **38** are supplied with solution by the diagrammatically illustrated drip type distribution means **40**; the details of the distribution means are more particularly shown in co-pending patent application, Serial No. 299,274 filed August 1, 1963. Originally the solution is fed as an overflow through trap **42**, downwardly through liquid line **44**, across the shell side of heat exchanger **24**, and upwardly through liquid line **46** past restriction **48** to the distributor **40**, from whence it is introduced in drip form onto the outer surfaces of tubes **38**. During its passage through heat exchanger **24** the solution has its temperature lowered, for example from about 322° to about 196°.

The pressure in shell **12** is maintained lower than the pressure in shell **10**, and the flow of high temperature vapor through tubes **38** therefore causes additional refrigerant vapor to be released from the solution wetting the outer surfaces of the tubes. The absorbent-rich solution falling from the tube surfaces collects in the lower portion of shell **12**, and under normal circumstances attains the approximate level designated by numeral **49**.

Generator tubes **38** communicate with a header which discharges a mixture of liquid refrigerant and vaporous refrigerant through a restriction **50** to a chamber **52** having an unrestricted communication with the interior of shell **12**. The refrigerant liquid is discharged from chamber **52** into a line **54**, and the vaporous refrigerant escapes through passage **56** to the interior of shell **12**. The vaporous refrigerant in shell **12** is then condensed on the outer surfaces of condenser tubes **58**. Condensed refrigerant is collected in trough **59** which discharges same into a liquid line **60**.

The combined refrigerant stream from lines **54** and **60** is fed through a restriction **62** and thence into a second drip-type distributor **40** located above the tubes **64** of evaporator **20**. Pipe **64** supplies the evaporator tubes with water at an elevated temperature, as for example 55° F.; during the evaporation process the water is chilled and exits through pipe **68** at a relatively low temperature, as for example 45° F. After passage through the load, which may for example be a series of room cooling units, the water is returned to the evaporator tubes through pipe **66**.

The evaporated refrigerant is automatically drawn to the outer surfaces of absorber tubes **70** which are supplied

with cold water by means of a pump **72**. As will be seen from the drawing, the water is heated in the absorber and is discharged to a line **74** which feeds same to the tubes **58** of condenser **16** before discharge to the conventional cooling tower **76**. After cooling the water is returned to pump **72** vie a line **78**.

In the illustrated system the absorber is supplied with absorbent-rich solution originating in the intermediate shell **12**. The supply path includes the pool of liquid at **49**, line **80**, the shell side of heat exchanger **26**, line **82** and a third drip type distributor **40**. As the evaporated refrigerant goes into solution with the liquid from distributor **40** the heat is taken up by the water in tubes **70**, and the refrigerant-rich solution is discharged gravitationally from the lowermost tubes **70** to form a liquid pool having a normal level **84**. Recirculation of this refrigerant-rich solution to generator **10** is effected through a path which includes line **86**, pump **88**, the tube side of heat exchanger **26**, line **90**, the tube side of heat exchanger **24**, and line **92**.

The invention

The system thus far described corresponds with that disclosed in aforementioned co-pending patent application Serial No. 299,547. The present invention is concerned particularly with mechanism for removing absorbent crystals which may inadvertently form in the shell side of heat exchanger **26**. Such crystals can for example form when the solution in the heat exchanger has a lithium bromide concentration in excess of 66% and a temperature less than 120° F. The crystals have the adverse effect of retarding the flow of solution through lines **80** and **82** and thus preventing the system from operating.

In the illustrated mechanism the decrystallizing means comprises a pair of electrical sensing probes **94** and **96** arranged in a chamber **98** which is suitably connected into the system to normally have the same liquid level as the level **49** in shell **12**. If desired the sensing probes **94** and **96** could be mounted directly in the shell. As shown in the drawings, probes **94** and **96** are connected with a relay coil **100** via two electrical lines **97** and **99**. Therefore a rising level in chamber **98** (due to crystal formation in the shell side of heat exchanger **26**) causes the uppermost probe **96** to contact the liquid and thus complete an energizing circuit through relay coil **100**. Switch element **102** of the relay thus moves downwardly from its illustrated normal-run position to complete a circuit through line **104**, the solenoid of a normally closed solenoid valve **106**, line **108**, and line **99**.

During normal operations (without crystal formation) solenoid valve **106** is closed, and there is no flow through liquid line **110**. However when probe **96** senses the presence of crystals in heat exchanger **26** the solenoid valve is opened to allow hot solution from generator **10** to flow through line **110** to shell **18**. Pump **88** continues to run, whereby to force the hot solution through the tube side of heat exchanger **26** and thereby melt the crystals formed on the shell side. Restriction **48** cooperates with the elevated location of shell **12** to effectively halt solution flow through line **46**. Generator **14** is thereby effectively disconnected from the system.

The crystal-melting process is facilitated by the fact that during the melting period switch **102** not only opens valve **106** but also de-energizes motor **112** for pump **72**. De-energization of the pump discontinues the flow of cooling water through absorber tubes **70** and condenser tubes **58**. The condenser therefore stops delivering condensed refrigerant to line **60**, and the absorber stops putting evaporated refrigerant into solution on the outer surfaces of tubes **70**. In effect, the condenser and absorber are removed from the system, so that the temperature of liquid in line **86** is rapidly raised toward the value prevailing in generator **10**. The decrystallizing operation is therefore greatly facilitated by the expedient of de-energizing pump **72** during the decrystallizing period.

As soon as the crystals are melted the level in chamber **98** is lowered to expose probe **96** thereby de-energize relay coil **100**. Switch **102** thereupon moves to the illustrated position in which solenoid valve **106** is closed and pump motor **112** is energized.

It will be seen that the decrystallizing operation is performed automatically and without human attention. It will also be noted that the decrystallizing apparatus is fairly simple and does not add an appreciable cost item to the total cost of the system.

The drawings shows an electrical sensing and control mechanism for valve **106** and pump motor **112**. It is contemplated however that the sensing and control mechanisms can be at least partly pneumatic in nature if desired. The drawings show line **110** discharging into shell **18**, but this line can of course discharge directly into line **86** if desired. If pump **88** is located downstream from heat exchanger **26** line **110** can discharge directly into the tube side of the heat exchanger.

What is claimed is:

1. In an absorption refrigeration system comprising a first upper shell containing a generator; a second intermediate shell containing a second generator and condenser; a third lower shell containing an evaporator and absorber; a heat exchanger arranged below the lower shell; a first line leading from the bottom of the intermediate shell through one side of the heat exchanger to the absorber; and a second line leading from the bottom of the lower shell through the other side of the heat exchanger to the first generator: the improvement comprising a third line leading from the first generator to a point in the second line located upstream from the heat exchanger; valve means normally closing said third line; means responsive to the liquid level in said intermediate shell for sensing the build-up of crystals in said other side of the heat exchanger; and means operated by the sensing means to open said valve means.

2. In an absorption refrigeration system comprising first and second serially arranged generators; a condenser; an evaporator; an absorber; a heat exchanger for effecting heat interchange between a first solution flowing from the second generator to the absorber and a second solution flowing from the absorber to the first generator; and means for pumping coolant through the absorber and condenser: the improvement comprising means sensing the formation of crystals in the first solution flowing through the heat exchanger; means controlled by the sensing means for interrupting the flow of coolant through the absorber and condenser; and means controlled by the sensing means for passing hot solution from the first generator into the second solution flowing from the absorber to the heat exchanger.

3. In an absorption refrigeration system comprising first and second serially arranged generators; a condenser; an evaporator; an absorber; and a heat exchanger arranged to effect heat interchange between solutions flowing to and from the absorber: the improvement comprising sensing means responsive to blockage of the system by the formation of absorbent crystals in the side of the heat exchanger handling solution flow to the absorbers; and means controlled by the sensing means for temporarily disconnecting the second generator, condenser, evaporator and absorber from the system, whereby to enable the first generator to feed hot solution into the non-crystallized side of the heat exchanger.

4. In an absorption refrigeration system comprising a first generator; a second generator supplied with solution and vapor from the first generator for generating additional vapor; a condenser; an evaporator; an absorber; a first line from the second generator to the absorber; a second line from the absorber to the first generator; and a heat exchanger arranged to effect heat interchange between the solutions in the first and second lines: the improvement comprising electrical probe means positioned to sense a rising liquid level in the second gen-

erator due to crystal formation in the first line; a third line connecting the first generator with a portion of the second line upstream from the heat exchanger; a normally closed solenoid valve in said third line; means for pumping coolant through the absorber and condenser during normal operation of the system; an electrical relay energized by the probe means; and relay-operated switch means connected with the pumping means and solenoid valve for alternately energizing the pumping means while keeping the valve closed or opening the valve while keeping the pumping means de-energized.

5. In an absorption refrigeration system comprising a first upper shell containing a generator; a second intermediate shell containing a second generator and condenser; a third lower shell containing an evaporator and absorber; a heat exchanger arranged below the lower shell; a first line leading from the bottom of the intermediate shell through one side of the heat exchanger to the absorber; and a second line leading from the bottom of the lower shell through the other side of the heat exchanger to the first generator: the improvement comprising a third line leading from the first generator to a point in the second line located upstream from the heat exchanger; a normally closed solenoid valve in said third line; means for pumping coolant through the absorber and condenser during normal operation of the system; electrical probe means positioned to sense a rising liquid level in said intermediate shell due to crystal formation in said first line; an electrical relay energized by the probe means; and relay-operated switch means connected with the pumping means and solenoid valve for alternately energizing the pumping means while keeping the valve closed or opening the valve while keeping the pumping means de-energized.

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