Jan. 6, 1942. E. S. LYNGER 2,269,102

REFRIGERATION

Filed Feb. 18, 1939 2 Sheets-Sheet 1

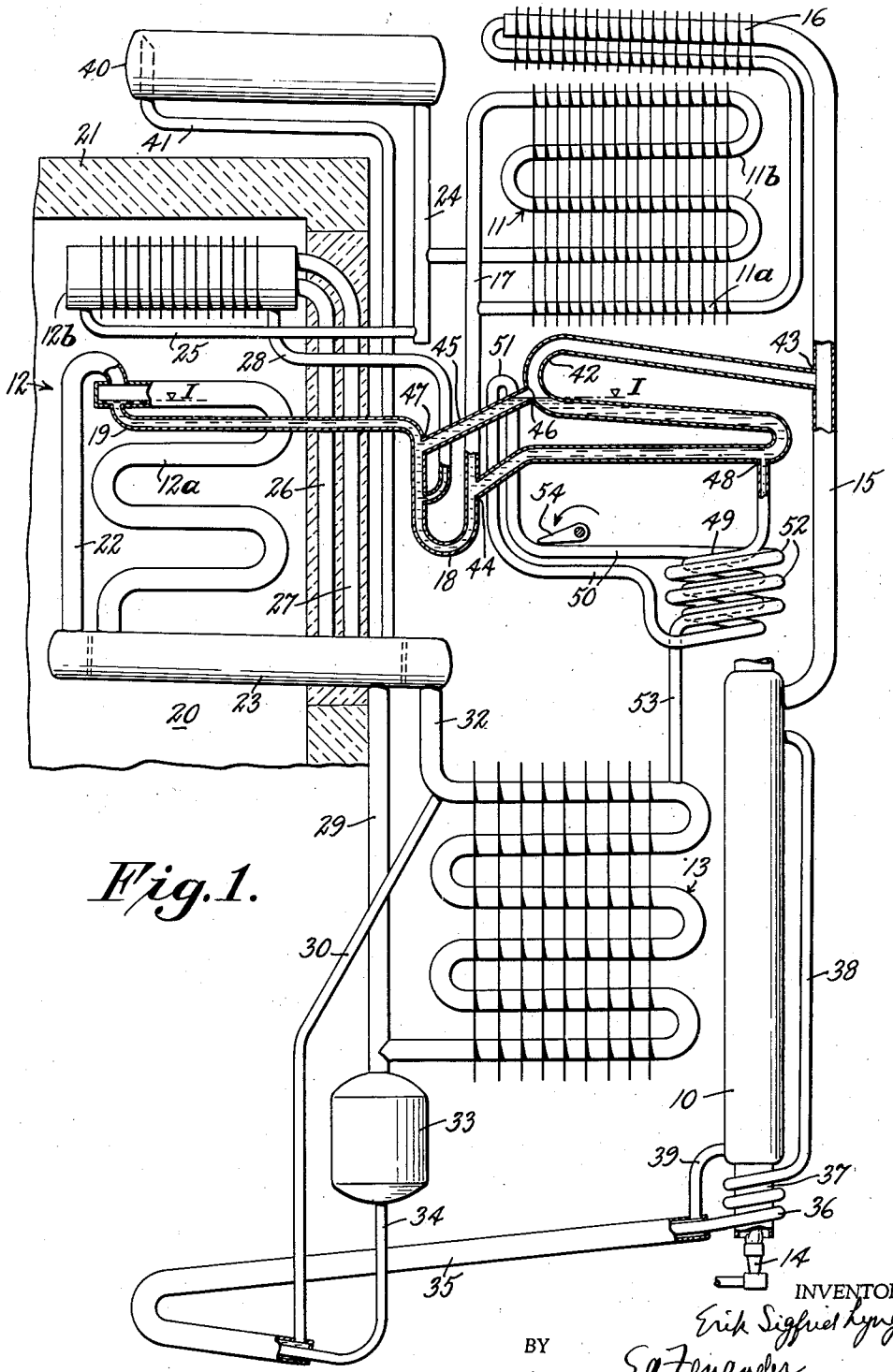


Fig. 1.

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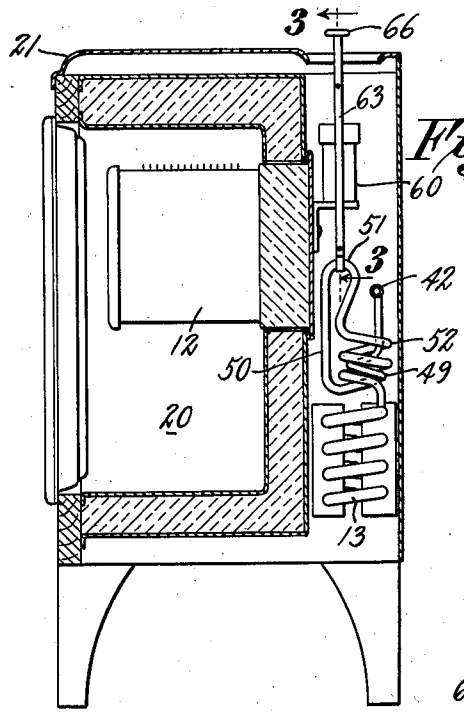


Fig. 2.

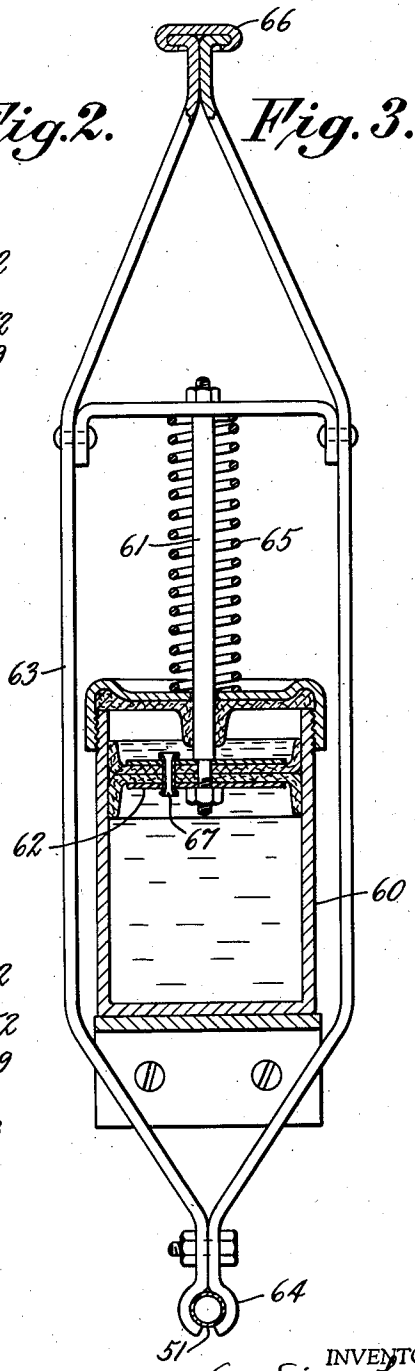


Fig. 3.

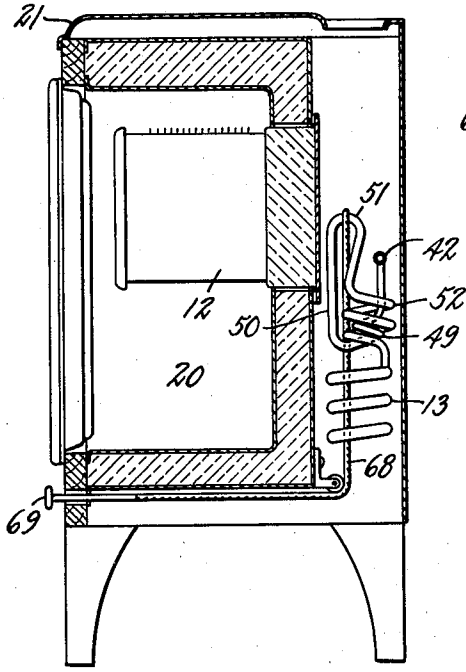


Fig. 4.

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UNITED STATES PATENT OFFICE

2,269,102

REFRIGERATION

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In Germany February 19, 1938

15 Claims. (Cl. 62—5)

This invention relates to refrigeration, and more particularly to control of refrigeration systems.

It is an object of the invention to provide an improvement for controlling refrigeration systems to initiate defrosting by passing hot gases in a system through a cooling element or evaporator on which frost has accumulated. This is accomplished by collecting liquid in an accumulator in the system to form a liquid seal in the path of flow of the gases to the cooling element. The accumulator is formed and connected to other parts in the system in such a manner that at least a portion thereof can be lowered to cause flow of liquid therefrom to open the seal, and when defrosting is substantially terminated, automatically accumulate liquid again to block the flow of gases to the cooling element. The liquid accumulator preferably includes flexible or elastic members to permit raising and lowering of at least a portion thereof. Suitable control mechanism may be provided to cause raising and lowering of the flexible portion of the liquid accumulator. Such control mechanism may include a control member located at the front of the refrigerator cabinet. The control mechanism associated with the control member may be arranged to raise the flexible portion of the liquid accumulator automatically after it has been lowered to initiate defrosting, the automatic raising of the flexible portion preferably being delayed sufficiently so that the liquid seal is opened to initiate defrosting. The liquid seal remains open while the flexible portion is in its raised position until defrosting is substantially terminated. When defrosting is substantially completed the liquid seal automatically forms again to block off flow of gases to the cooling element.

The above and other objects and advantages of the invention will be more fully understood upon reference to the following description and accompanying drawings forming a part of this specification, and of which Fig. 1 illustrates more or less diagrammatically a refrigeration system embodying the invention;

Fig. 2 is a vertical sectional view of a refrigerator associated with a refrigeration system like that illustrated in Fig. 1, only part of which is shown, and embodying a control mechanism operable from the top of the refrigerator to initiate defrosting;

Fig. 3 is an enlarged fragmentary sectional view, taken on line 3—3 of Fig. 2, to illustrate parts of the control mechanism more clearly; and

Fig. 4 is a vertical sectional view similar to Fig. 2 illustrating another control mechanism operable at the front of the refrigerator to initiate defrosting.

Referring to Fig. 1, the invention is embodied in an absorption refrigeration system of a uniform pressure type containing a pressure equalizing gas. A system of this type includes a generator 10, condenser 11, cooling element or evaporator 12, and an absorber 13 which are interconnected in a manner well known in the art and which will briefly be described hereinafter. The system contains a solution of refrigerant in absorption liquid, such as ammonia in water, for example, and also an auxiliary agent or inert gas, such as hydrogen.

The generator 10 is heated in any suitable manner, as by a gas burner 14, for example, whereby refrigerant is expelled from solution in generator 10. Refrigerant vapor flows upwardly through conduit 15 and an air-cooled rectifier 16 into first condenser section 11*a* of air-cooled condenser 11.

Refrigerant liquefied in condenser section 11*a* flows through a conduit 17 into a trap 18. When sufficient liquid accumulates in the liquid trap, liquid flows through conduit 19 into lower evaporator section 12*a* which is disposed in a thermally insulated storage space 20 of a refrigerator cabinet 21.

Refrigerant fluid in evaporator section 12*a* evaporates and diffuses into inert gas which enters through a conduit 22, thereby producing a refrigerating effect. The rich gas mixture of refrigerant and inert gas formed in evaporator 12*a* flows into an outer passage of a gas heat exchanger 23.

Refrigerant vapor not liquefied in first condenser section 11*a* flows from the upper end of conduit 17 into a second condenser section 11*b*. Refrigerant liquefied in condenser section 11*b* flows through conduits 24 and 25 into upper evaporator section 12*b* which is also disposed in thermally insulated space 20.

Evaporator section 12*b* is connected by conduits 26 and 27 to the outer passage of the gas heat exchanger 23. Refrigerant fluid in evaporator section 12*b* evaporates and diffuses into rich gas which circulates therethrough, thereby producing a refrigerating effect and precooling liquid flowing to evaporator section 12*a* through conduit 28, the left-hand leg of liquid trap 18, and conduit 19.

From the outer passage of gas heat exchanger 23 the rich gas mixture flows through a conduit 29 into the lower end of air-cooled absorber 13. Absorber 13 is diagrammatically shown in the form of a looped coil having a plurality of cooling fins fixed thereto.

In absorber 13 the rich gas mixture flows counter-current to downwardly flowing weak absorption liquid which enters through a conduit 30. The absorption liquid absorbs refrigerant vapor from the inert gas, and inert gas weak in refrigerant flows from absorber 13 through conduit 32, an inner passage of gas heat exchanger 23, and conduit 22 into the upper part of lower evaporator section 12a.

Absorption liquid enriched in refrigerant flows from the lower part of absorber 13 into a vessel 33. From vessel 33 enriched absorption liquid flows through a conduit 34 and an inner passage of a liquid heat exchanger 35 to a coil 36 which is disposed about the lower end of a generator flue 37. Liquid is raised by vapor-lift action from coil 36 through tube 38 into the upper part of generator 10. Refrigerant vapor expelled out of solution in generator 10, together with refrigerant vapor entering through tube 38, flows upwardly through conduit 15 into condenser section 11a, as explained above.

Absorption liquid from which refrigerant has been expelled flows from generator 10 through conduit 39, outer passage of liquid heat exchanger 35, and conduit 30 into the upper part of absorber 13. This circulation of absorption liquid is effected by raising of liquid in tube 38 by vapor-lift action.

The lower end of condenser section 11b is connected by conduit 24, vessel 40, and conduit 41 to the gas circuit, as at gas heat exchanger 23, for example, so that any inert gas which may pass through the condenser can flow into the gas circuit. Refrigerant vapor not liquefied in condenser 11 flows through conduit 24 to displace inert gas in vessel 40 and force such gas through conduit 41 into the gas circuit. By forcing gas into the gas circuit in this manner, the total pressure in the system is raised whereby an adequate condensing pressure is obtained to insure condensation of refrigerant in the condenser.

Since rich gas flows through evaporator section 12b while gas weak in refrigerant enters evaporator section 12a through conduit 22, the gas in evaporator section 12b contains a greater amount of refrigerant vapor than the gas in evaporator section 12a.

Evaporator section 12b may be primarily employed for cooling space 20 and is preferably provided with a relatively extensive heat transfer surface. Evaporator section 12a is preferably provided with a limited heat transfer surface and may be employed as a freezing unit since evaporation of liquid takes place at a lower temperature therein.

During normal operation of the system, refrigerant fluid, inert gas, and absorption liquid circulate in the manner described above, whereby evaporator sections 12a and 12b produce a refrigerating effect. Inert gas or hydrogen circulates continuously in the gas circuit including evaporator 12 and absorber 13. This circulation of inert gas is due to the difference in specific weight of the rich gas mixture in evaporator section 12a, outer passage of gas heat exchanger 23, and conduit 29; and the weak gas mixture in absorber 13, conduit 32, inner passage of gas heat exchanger 23, and conduit 22.

In accordance with this invention one end of an approximately S-shaped conduit 42 is connected at 43 to the generator vapor conduit 15. The other end of conduit 42 is connected at 44 to the right-hand leg of liquid trap 18. The upper end of an inclined conduit 45 is connected at 46 to an upper bend of S-shaped conduit 42. The lower end of conduit 45 is connected at 47 to the left-hand leg of liquid trap 18 above the connection of conduit 28. The connection 46 of conduit 45 to S-shaped conduit 42 is so located that liquid will collect in liquid trap 18 and connecting conduits to the liquid level I, as shown in Fig. 1, so that liquid will flow from connection 46 through conduit 45 and conduit 19 into the upper part of lower evaporator section 12a.

To the lower bend of S-shaped conduit 42 at 48 is connected the upper end of a coil 49. The lower end of coil 49 is connected to one end of a conduit 50 having an inverted U-shaped portion or loop 51 which extends above the liquid level I during normal operation of the refrigeration system. The opposite end of conduit 50 is connected to the upper end of a second coil 52 which is arranged concentrically about coil 49. The lower end of coil 52 is connected by a conduit 53 to the upper part of coil absorber 13.

The coil 49, conduit 50 including the loop 51, coil 52, and conduit 53 are flexible with respect to the other parts of the system to which they are connected, so that loop 51 can be lowered and raised. Lowering and raising of loop 51 may be effected by an eccentric or crank 54 which is pivotally connected in any suitable manner adjacent conduit 50.

When operation of the refrigeration system is first started by applying heat to generator 10, refrigerant vapor is expelled from solution and flows upwardly in conduit 15, as explained above. Refrigerant vapor flowing in conduit 15 divides into two paths of flow, one path of flow being the normal path through air-cooled rectifier 16 into conduit 11. Refrigerant vapor also flows through a second path of flow including S-shaped conduit 42, trap 18 and also conduit 45, and finally through conduit 19 into lower evaporator section 12a.

Condensation of refrigerant vapor starts in condenser section 11a and in S-shaped conduit 42, and the condensate accumulates in liquid trap 18. The liquid level rises in trap 18 and the lower part of S-shaped conduit 42 and then flows into inner coil 49. The liquid also accumulates in conduits 17 and 45 and to the upper end of conduit 19 from which liquid overflows into lower evaporator section 12a. This liquid level is the liquid level I indicated in Fig. 1. The liquid level is now the same in conduits 17, 45, 19, the left-hand arm of loop 51, and the S-shaped conduit 42.

If the eccentric or crank 54 is now turned in a counter-clockwise direction and the upper end of loop 51 is lowered below the liquid level I, the liquid in coil 49 is siphoned and flows through coil 52 and conduit 53 into the upper part of the absorber. This siphoning of liquid drains and removes all of the liquid out of S-shaped conduit 42, conduit 45, liquid trap 18 and conduit 17. By removing all of the liquid from these conduits, the flow of refrigerant vapor through the second path of flow is no longer blocked, and the hot refrigerant vapors from generator 10 can pass directly into the lower evaporator section 12a, as explained above.

Since the temperature of evaporator section

12a is below freezing and considerably below that of condenser section 11a, the major part of the vapors will condense in the evaporator section. The heat liberated with such condensation of vapors quickly melts ice or frost which has accumulated on lower evaporator section 12a.

During defrosting the partial pressure of refrigerant in condenser section 11a may fall whereby hydrogen is withdrawn from vessel 40 into this condenser section. When the lower evaporator section 12a is substantially defrosted, its temperature rises and approaches the temperature of trap 18 and S-shaped conduit 42. Condensation of vapors will therefore gradually begin to take place in S-shaped conduit 42 whereby the conduits forming the second passage will begin to fill with liquid.

When the liquid level in trap 18 reaches the connection 47 of conduit 45 the second path of flow of vapors to lower evaporator section 12a is blocked.

All of the refrigerant vapor expelled from generator 10 now flows through conduit 15 into condenser section 11a in which condensation of the vapors again takes place. In the event that any hydrogen gas has been withdrawn from vesssel 40 into condenser section 11a, the flow of refrigerant vapor into this condenser section drives out the hydrogen therefrom. With condensation of refrigerant vapor in lower condenser section 11a, condensate again flows through conduit 17, liquid trap 18 and conduit 19 into lower evaporator section 12a, thereby producing a refrigerating effect in the manner explained above.

The duration of the defrosting period is dependent upon the size of the conduits and can be determined in advance in the building of the refrigeration system. Among the determining factors are the capacity of the lower liquid accumulating portion of S-shaped conduit 42 as well as the condenser surface of the middle portion of this conduit in which condensation of generator vapors takes place and from which the condensate flows into the lower part of the S-shaped conduit.

The elasticity and flexibility of coils 49 and 52 and conduit 50 including the loop 51 may be accomplished in any suitable manner. In any event, however, it may be desirable to make the loop 51 of such length that sufficient flexibility is obtained. The flexible members may be made up in any form and shape with due consideration given to the thickness and elasticity of the material used.

The crank 54 may be operated by a suitable control mechanism including a control member which is accessible from the front of the refrigerator cabinet. The connecting control mechanism may consist of rods, wires, or electric or hydraulic transmission members. A suitable indicating dial may be provided so that the control member can be moved from and "off" to an "on" position to instigate defrosting.

The control mechanism may be constructed so that the crank 54 will automatically turn in a clockwise direction to permit raising of loop 51 after it has been lowered. In such case it is desirable to provide a suitable delaying action so that sufficient time is given for all of the liquid to drain from S-shaped conduit 42, conduit 45 and liquid trap 18.

After all of the liquid has been drained from these conduits the loop 51 can again be raised to the position shown in the drawings and defrosting of lower evaporator section 12a will continue until the liquid level rises in the left-hand leg of trap 18 to the connection 47 of conduit 45.

A suitable control mechanism to instigate defrosting and operable at the top of the refrigerator is shown in Figs. 2 and 3. Fig. 2 illustrates a refrigerator including the cabinet 21 having the thermally insulated storage space 20, only a part of which is shown in Fig. 1. The evaporator or cooling element 12 is only diagrammatically shown in Fig. 2, and the generator 10, condenser 11, gas heat exchanger 23, liquid heat exchanger 35 and other parts of the refrigeration system have not been shown in order to simplify the drawings, their illustration not being necessary in Fig. 2 for an understanding of the control mechanism. The S-shaped coil 42, conduit 50 including the loop 51, coils 49 and 52, and absorber 13 are disposed in a flue at the rear of the cabinet.

The control mechanism includes a dash pot 60 which is filled to the level shown with a suitable liquid, such as glycerine, for example. The dash pot 60 is mounted on a bracket which is secured to the rear wall of thermally insulated space 20. A piston rod 61 extends through an opening in the cover of dash pot 60 and the lower end thereof is secured to a piston 62 having an opening 67 and disposed within dash pot 60. The upper end of piston rod 61 is connected to an upper cross connection of a rectangular-shaped frame 63. The sides of frame 63 extend upwardly and toward each other, and at the extreme upper end of the sides of the frame is provided a handle 66 which is accessible at the top of the cabinet 21 at the rear thereof. The sides of frame 63 also extend downwardly below the dash pot 60 and toward each other, and the extreme lower ends thereof are clamped at 64 about the pipe 50 including the inverted loop 51. This connection of frame 63 to the pipe 50 may be at the region where the eccentric or crank 54 in Fig. 1 acts against pipe 50 to lower the loop 51.

The piston 62 and frame 63 are urged toward an upper position by a coil spring 65 disposed about the piston rod 61, the upper end of the spring acting against the upper cross connection of the frame 63 and the lower end thereof acting against the top of the dash pot 60.

When it is desired to initiate defrosting by lowering the loop 51 below the liquid level I in Fig. 1, the handle 66 at the top of refrigerator cabinet 21 is pushed downwardly against the action of spring 65. When this is done, liquid in dash pot 60 is forced through opening 67 from the space below to the space above the piston 62. With the loop 51 lowered below the liquid level I in Fig. 1, defrosting is initiated in the manner explained above in connection with the first described embodiment. When handle 66 is no longer pushed downward, the spring 65 tends to move loop 51, piston 62, and frame 63 to their normal upper position. However, this upward movement of these parts is delayed for an interval of time to allow liquid in the dash pot 60 to pass through opening 67 from the space above to the space below the piston 62. Due to this delay effected by the action of dash pot 60, sufficient time is given for all of the liquid to drain from S-shaped conduit 42, conduit 45, and liquid trap 18.

In the embodiment of Fig. 4 an arrangement is shown whereby defrosting may be initiated by a control member at the front of the refrig-

erator. In this embodiment a pulling member 68 is fastened at one end to the upper end of loop 51. The member 68 is arranged to move about a rotatable part and includes a horizontal portion which extends through an opening at the front of the refrigerator. The outer end of member 68 is provided with a handle portion 69.

When handle 69 is pulled outwardly, loop 51 is lowered below the liquid level I in Fig. 1, whereby siphoning of liquid takes place in the manner described above to permit hot gases to flow into evaporator 12. In order to make certain that all of the liquid drains from S-shaped conduit 42, conduit 45 and liquid trap 18, the handle portion 69 must be held for an interval of time. After all of the liquid drains from these parts, the handle portion 69 may be released whereby defrosting of the evaporator will continue until the flow of hot gases again is blocked off by rise of liquid level in the left-hand leg of trap 18 to the connection 47 of conduit 45, as explained above.

Instead of draining liquid through conduit 53 to the top part of coil absorber 13, this liquid may be drained to any suitable place in the system. For example, the lower end of conduit 53 may be connected to vessel 33 or to generator 10.

Although several embodiments of the invention have been shown and described, it will be apparent to those skilled in the art that various modifications and changes may be made without departing from the spirit and scope of the invention.

What is claimed is:

1. In absorption refrigeration apparatus having an evaporator and a condenser connected to said evaporator by means including a liquid trap seal, a flexible conduit connected so that it can be bent to drain liquid out of said trap and admit vapor directly into said evaporator for causing defrosting of the evaporator.

2. Refrigeration apparatus as set forth in claim 1 in which said flexible conduit has an upward U-bend extending above the normal overflow level of liquid in said trap and which may be pushed down to drain liquid from the trap.

3. Refrigeration apparatus as set forth in claim 1 in which said flexible conduit forms a syphon tube for draining said trap upon predetermined flexure of said conduit.

4. Refrigeration apparatus as set forth in claim 1 including an absorber, said flexible conduit being connected to drain liquid from said trap into said absorber upon flexure of said conduit.

5. Refrigeration apparatus as set forth in claim 1 also including a generator connected to deliver vapor to said condenser, a conduit for conducting vapor from said generator to said evaporator only when liquid is withdrawn from the upper part of said trap, said conduit forming a second condenser and also being connected to deliver liquid to said trap.

6. In absorption refrigeration apparatus having an evaporator, a generator, condensing means connected to receive vapor from said generator, and deliver liquid to said evaporator through a liquid trap seal and including a conduit for conducting vapor from said generator directly to said evaporator when liquid is withdrawn from said trap, a drain for withdrawing liquid from said trap, and means for rendering said drain operative, said drain being adapted to become inoperative upon predetermined emptying of said trap.

7. In a refrigerating system having a place of evaporation subject to formation of frost or ice and in which liquid refrigerant evaporates in the presence of an auxiliary agent to produce a refrigerating effect, the improvement which consists in collecting liquid in a place of accumulation, and vertically moving a part associated with the place of accumulation to cause removal of liquid from the latter to effect an increase in the partial pressure of refrigerant vapor in the place of evaporation and cause the temperature of the place of evaporation to rise sufficiently to melt frost or ice formed thereon.

8. In a method of refrigeration which includes maintaining a supply of vaporous refrigerant fluid, condensing to liquid vapor from said supply, and evaporating condensed liquid to produce a refrigerating effect, the steps of accumulating a body of liquid in a trap, and vertically moving at least a part of said trap to effect withdrawal of liquid therefrom and cause transfer of vapor from said supply into the presence of evaporating condensed liquid whereby rapid rise in temperature is effected and any frost which may have been formed due to said refrigerating effect is melted.

9. In a method of refrigeration which includes maintaining a supply of vaporous refrigerant fluid, condensing to liquid vapor from said supply, and evaporating condensed liquid to produce a refrigerating effect, the steps of accumulating liquid in a trap, and siphoning liquid from said trap to cause transfer of vapor from said supply into the presence of evaporating condensed liquid to cause rapid rise in temperature and melting of any frost which may have been formed due to said refrigerating effect.

10. In a refrigeration system having a place of evaporation subject to formation of frost or ice and in which liquid refrigerant evaporates in the presence of an auxiliary agent to produce a refrigerating effect, the improvement which consists in collecting fluid in liquid phase in a place of accumulation, and removing fluid only in liquid phase from said place of accumulation to effect an increase in the partial pressure of refrigerant vapor in the place of evaporation and cause the temperature of the place of evaporation to rise sufficiently to melt frost or ice formed thereon.

11. In a refrigeration system including a source of vaporous refrigerant fluid, a condenser, and an evaporator, a trap to accumulate liquid, structure including a flexible conduit to provide a path of flow for liquid from said trap, and said structure including said flexible conduit being so constructed and arranged that liquid is withdrawn from said trap through said path of flow with vertical movement of said flexible conduit to effect an increase in the partial pressure of refrigerant vapor in the evaporator and cause the temperature of the evaporator to rise sufficiently to melt frost or ice formed thereon.

12. In a refrigeration system including a source of vaporous refrigerant fluid, a condenser, and an evaporator, a first conduit including a liquid trap for conducting vapor from said source to said evaporator, structure including a flexible conduit to provide a path of flow for liquid from said trap, and said structure being so constructed and arranged that with vertical movement of said flexible conduit liquid is removed from said trap through said path of flow to permit flow of vapor through said first conduit.

13. In a refrigeration system including an evap-

orator subject to formation of frost or ice and in which liquid refrigerant evaporates to produce a refrigerating effect, a trap to accumulate liquid, structure including a part associated with said trap so connected and arranged in the system that, when said part is moved vertically from a first position to a second position, liquid is withdrawn from said trap to cause the temperature of said evaporator to rise sufficiently to melt frost or ice formed thereon, and mechanism to move said part vertically from said first position to said second position, said mechanism including means normally urging said part to said first position and being so constructed and arranged that, when said part is moved from said first position to said second position and said mechanism is then released, the movement of said part from said second position back to said first position is delayed.

14. In a refrigerating system including a generator, condenser, evaporator, and connections therebetween for conducting vaporous refrigerant fluid from said generator to said condenser and liquid refrigerant fluid from said condenser to said evaporator, a trap for liquid and a flexible conduit associated therewith, said trap and flexible conduit being so connected and arranged in the system that, when said flexible conduit is moved vertically from a normal position, liquid is removed from said trap to effect an increase in the partial pressure of refrigerant vapor in said evaporator and cause the temperature of said evaporator to rise sufficiently to melt frost or ice formed thereon.

15. In a refrigeration system having an evaporator subject to formation of frost or ice and in which liquid refrigerant evaporates to produce a refrigerating effect, a trap, structure including a flexible conduit connecting said trap to the system whereby liquid is collected in said trap, said flexible conduit providing a path of flow for liquid from said trap, said structure being so constructed and arranged that, with movement of said flexible conduit, liquid is withdrawn from said trap to permit flow of vaporous refrigerant fluid in the system into said evaporator.

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