May 22, 1934. N. WIDELL 1,960,040

REFRIGERATION

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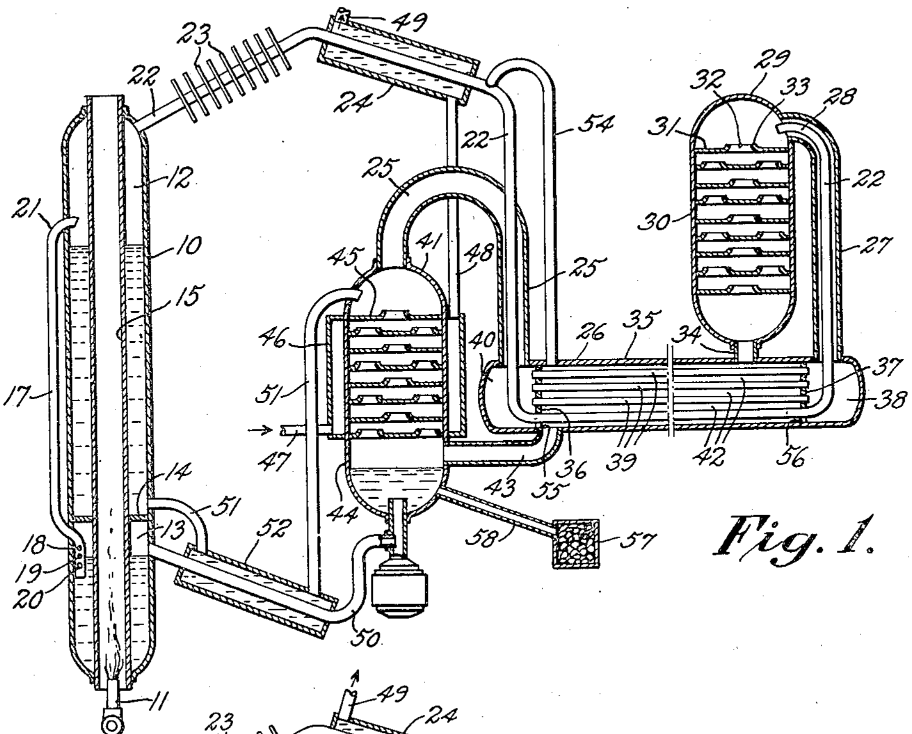

Fig. 1.

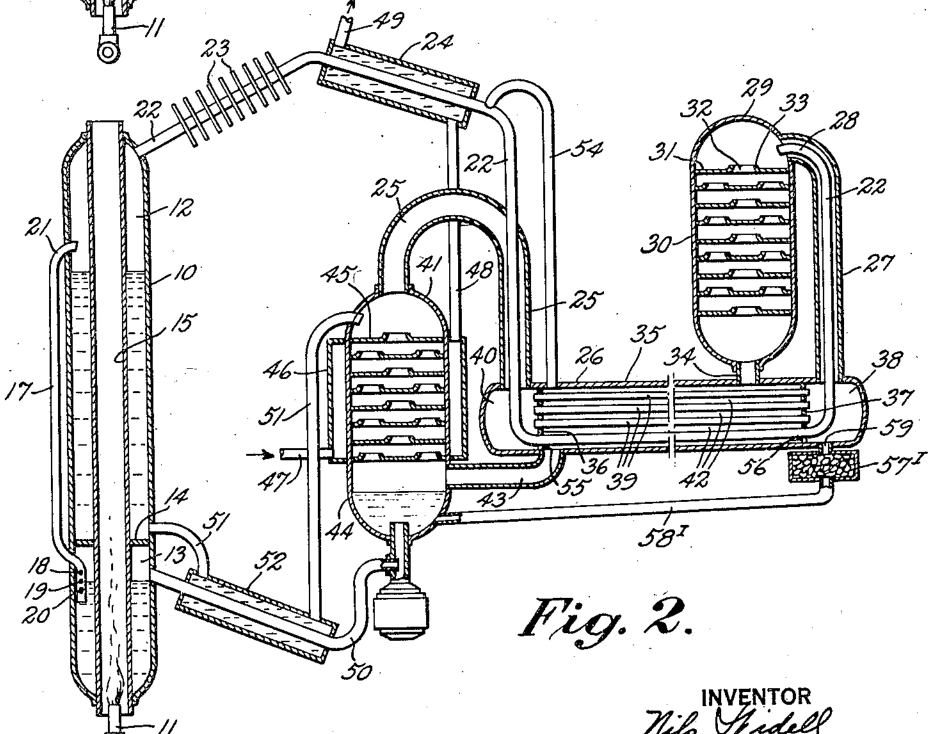

Fig. 2.

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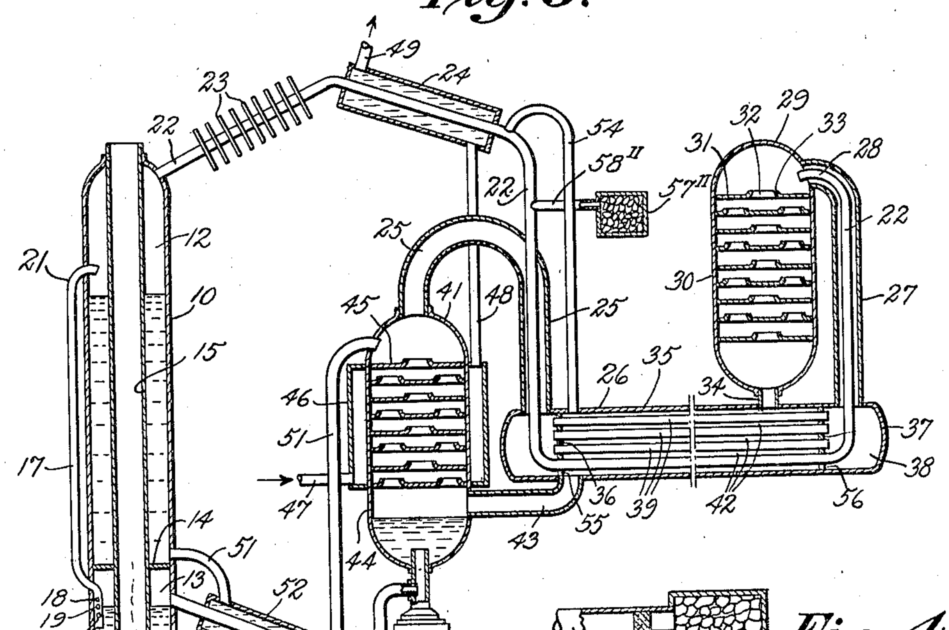
Fig. 3.



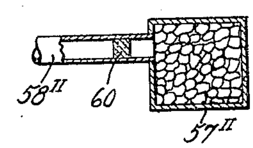


Fig. 4.

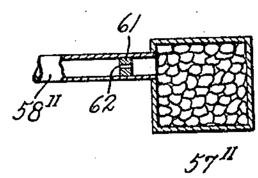


Fig. 5.

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Patented May 22, 1934

1,960,040

UNITED STATES PATENT OFFICE

1,960,040

REFRIGERATION

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Application July 8, 1931, Serial No. 549,431
In Germany July 8, 1930

20 Claims. (Cl. 62—179)

My invention relates to the art of refrigerating, more particularly to refrigerating apparatus of the absorption type and still more particularly to refrigerating apparatus wherein circulation of fluids is produced by forces generated entirely within the system.

The object of the present invention is to prevent corrosion of the metal parts of such refrigerating apparatus, directly or indirectly, due to the presence of the fluids therein, which object is attained by the use of the novel method and the provision of the novel means hereinafter more fully described in connection with the forms of apparatus illustrated in the accompanying drawings forming a part of this specification.

In the drawings:

Fig. 1 is a more of less diagrammatic representation of a refrigerating apparatus embodying the invention; Fig. 2 is a similar view illustrating another application of the invention; Fig. 3 is a similar view of still another application of the invention; Fig. 4 is a view on a larger scale of one form of a part of the apparatus; and Fig. 5 is a view similar to Fig. 4 showing another form of the same part of the apparatus.

Refrigerating apparatus of the type in question is usually constructed of iron or steel when ammonia is used as the refrigerant and it has been found that after more or less prolonged use, the metal forming the parts of the apparatus is subject to a certain amount of corrosion. In order to prevent or delay corrosive action, and thereby prolong the life of the apparatus, substances other than those used to effect refrigeration, which latter substances will hereinafter be referred to generally as working substances or fluids, have been introduced into the refrigerating apparatus.

One class of substance which has been found suitable for the purpose of preventing corrosion is that containing chromium. The particular substance may for example be potassium or sodium chromate or bichromate, carried in solution by the absorption liquid, the latter in the case of ammonia apparatus advantageously being water. As heretofore employed, however, the entire quantity of corrosion preventing substance has been introduced at one time directly into the body of the working fluids, and it has been found that after extended operation of the apparatus, the chrome solution dissociates and becomes ineffective as a corrosion preventing agent. The chrome solution can not be rendered effective for an increased length of time by increasing its original strength, which should be limited to that concentration which can be carried in solution in the apparatus without the precipitation of crystals of a chrome salt, since such crystals might interfere with the proper circulation of the working fluids.

In accordance with one phase of my invention, a solution of an agent comprising a corrosion preventing substance is employed in the refrigerating apparatus and this solution is maintained at proper strength by diffusion into the apparatus of an additional quantity of a corrosion preventing agent which maintains the effective corrosion preventing action by preventing the strength of the original solution from decreasing due to dissociation.

The added agent is obtained from a reserve supply located outside of the path of circulation of the working fluids but in contact with one or more of them, and such reserve supply is perferably in the form of crystals of a salt of the corrosion preventing substance employed.

Some of the corrosion preventing agents, upon decomposition, produce substances which themselves are corrosive in action after the entire corrosion preventing solution has become dissociated, and in accordance with another phase of my invention, such action is prevented by adding to the original solution, as it dissociates, a quantity of an agent which acts to regenerate the original and thus maintain its effectiveness as a corrosion resisting agent.

In order to facilitate an understanding of the invention I will now describe one type of refrigerating apparatus embodying the invention, but it is to be understood that the apparatus described is illustrative only and that the invention is applicable to many other specific forms of absorption refrigeration devices.

Referring more particularly to Fig. 1, reference character 10 designates a generator which is heated by any suitable means, as for instance the gas burner 11. Generator 10 consists of an upper annular chamber 12 which may be considered as the main generator and a lower annular chamber 13 which may be considered as the auxiliary generator and which are separated from each other by the partition 14. The central space 15 of the generator is a flue for the hot gases of combustion. A conduit 17, the greater part of which is outside of the generator proper, leads from chamber 13 to chamber 12. The lower end of conduit 17 extends within chamber 13 to a point some distance below the normal level at which the liquid is maintained therein. A hole or port 18 is provided in the side of conduit 17 which, in operation, is slightly above the liquid level in chamber 13, and which determines the level of liquid therein. Additional ports, as 19 and 20, of successively larger diameter, may be provided in the side of conduit 17 below hole 18. The bottom of conduit 17 is open providing a lower end opening for conduit 17 within the auxiliary generator. The upper end of conduit 17 communicates with chamber 12.

A conduit 22 communicates with the upper end of the upper chamber 12 of generator 10. Fins 23 are preferably provided on conduit 22 which increase the radiating area thereof. Conduit 22 passes through water jacket 24, thence through conduit 25, heat exchanger 26 and conduit 27. It ends in a goose neck 28 in the top of evaporator 29. Evaporator 29 consists of a cylindrical member 30 in which are located baffles 31 which are provided with holes 32 around which are rims 33. The holes in adjacent baffles are preferably staggered as shown. A conduit 34 leads from the bottom of member 30 to heat exchanger 26. Heat exchanger 26 consists of a cylindrical member 35 near the ends of which are located two heads 36 and 37 containing drain holes 55 and 56. A conduit 27 leads from the space 38 formed between header 37 and one end of the heat exchanger to the top evaporator 29. Any number of tubes 39 connect space 38 with space 40 which latter space is formed between head 36 and the other end of the heat exchanger. Conduit 25 connects the top of absorber 41 with space 40. Evaporator 29 communicates by means of conduit 34 with space 42 which surrounds tubes 39 and is included between heads 36 and 37. Conduit 43 connects space 42 with the bottom of absorber 41. Absorber 41 consists of a hollow cylindrical member 44 which is supplied with baffles 45 which may be similar to baffles 31 in evaporator 29. It is also surrounded by a water jacket 46, which is supplied with cooling water through conduit 47 and discharges it through conduit 48 to water jacket 24 from whence the cooling water is finally discharged through conduit 49. A conduit 50 leads from the bottom of absorber 41 to near the top of chamber 13 in generator 10. Another conduit 51 leads from near the bottom of chamber 12 in generator 10 to the top of absorber 41. Conduits 50 and 51 are arranged in heat exchange relation as is shown at 52. Gas vent 54 connects the condenser outlet with space 42.

A closed receptacle 57 is in communication with the lower portion of absorber 41 through a tubular member 58 which is preferably of small diameter and of considerable length with respect to its diameter.

The apparatus operates as follows:

Heat is applied to generator 10 by any suitable means as, for instance, by the gas burner 11. Within chamber 12 is contained the refrigerant dissolved in an absorbing medium. For convenience it will be assumed that the refrigerant is ammonia and that the absorbing liquid is water but it is to be understood that the use of other refrigerants and absorbing media is contemplated. Application of heat to the solution in chamber 12 serves to drive the ammonia out of solution as a vapor. Vaporous ammonia passes upwardly through conduit 22. Fins 23 serve to cool a portion of conduit 22 wherein any water vapor which may be mixed with the ammonia vapor is liquefied and runs back to chamber 12. This cooling effect is not sufficient, however, to liquefy the ammonia and it passes to that portion of conduit 22 which is surrounded and cooled by water jacket 24. Here the ammonia is liquefied and passes through the remainder of conduit 22 to the top of the evaporator 29. In the evaporator refrigeration is produced due to the diffusion of the ammonia into a gas, which is inert with respect to ammonia, for instance hydrogen, which is admitted through conduit 27. Baffles 31 are provided to aid this diffusion. As the mixture of ammonia and hydrogen in evaporator 29 has a greater specific weight than the hydrogen in conduit 27, the mixture will flow downwardly through the evaporator, through conduit 34, through the space 42 in heat exchanger 26, and through conduit 43 to the lower part of absorber 41. In the absorber, the ammonia is absorbed by the water. Baffles 45 are provided to aid in this absorption. The hydrogen is not absorbed by the water and passes upwardly through the absorber, through conduit 25, the tubes 39 in heat exchanger 26, and finally through conduit 27 to the top of evaporator 29. Within heat exchanger 26 liquid ammonia, hydrogen passing to the evaporator and the mixture of gaseous ammonia and gaseous hydrogen passing to the absorber are in heat exchange relation with each other.

The rich solution of ammonia in water passes out the bottom of absorber 41 through conduit 50 to chamber 13 of generator 10. The application of heat to chamber 13 from burner 11 causes some of the liquid to vaporize and collect in the upper part of chamber 13. This vapor is under a pressure somewhat (though very slightly) higher than that maintained in the rest of the system due to the head of liquid in absorber 41. This pressure causes the liquid in chamber 13 to pass upwardly through conduit 17 to a point above the hole 18. A small film of liquid forms in hole 18 and is held there by capillary attraction. Formation of more vapor in chamber 13 causes a slight increase in pressure therein and this pressure breaks the capillary film in hole 18 and a bubble of gas enters conduit 17. This causes a slight drop in pressure in chamber 13 and another capillary film is formed in hole 18. A continuation of this formation and destruction of the capillary film results in the admittance of a series of vapor bubbles into conduit 17. Thus the weight per unit area of the column of liquid and gas in conduit 17 is less than the weight per unit area of the shorter liquid column below absorber 41 and thence flow will take place upwardly through conduit 17 to the upper part of chamber 12. In chamber 12 the ammonia is driven out of solution as previously described and the water flows by gravity through conduit 51 to the top of absorber 41.

With ammonia as the refrigerant and water as the absorbing liquid, the apparatus is preferably charged with a quantity of a chromium salt in solution for the purpose of preventing corrosion of the parts. This salt may for example be potassium chromate. Additional crystals of the same salt may be placed in the receptacle 57, in which case the original strength of the chrome containing solution is maintained by diffusion from the salt crystals through tube 58. Since dissociation of the solution is relatively slow, the rate of diffusion is advantageously slow and the arrangement shown is productive of the desired action since the liquid in the bottom of the absorber is relatively cool and is also rich in ammonia. If the original corrosion preventing agent is potassium chromate (K_2CrO_4), dissociation thereof will produce potassium lye (KOH) in the aqueous solution, which lye will produce a high corrosive action especially after complete dissociation of all of the corrosion preventing agent in the apparatus. The same holds true of sodium chromate (Na_2CrO_4), which dissociates to form sodium lye ($NaOH$).

If, instead of utilizing the same salt for the reserve supply in the receptacle 57, an alkaline chromate salt such as $(H_2N)_2CrO_4$ is employed, the lye formed by the dissociation of either potassium or sodium chromate will be neutralized and the solution regenerated to its original state. Ammonium chromate is a particularly advantageous salt to use for this purpose, since, in the regenerating reaction, it dissociates into two of the working fluids in the apparatus, viz. NH_3 and H_2O. From the foregoing it will be evident that whether the reserve supply in the receptacle is the same or a different salt of the substance in the original solution, the effective life of the corrosion preventing agent will be prolonged.

Referring to Fig. 2 I have shown a different arrangement, in which the reserve supply of corrosion preventing substance is introduced into the absorber in a manner different from that according to the apparatus shown in Fig. 1. In the present embodiment of the apparatus, the receptacle 57^I is located above the level of the liquid in the bottom of absorber 41, the diffusion of the reserve supply into the working part of the apparatus is accomplished by the flow of a small amount of condensed water vapor which enters the receptacle 57^I through the connection 59 in the bottom of chamber 38 of the heat exchanger 26 and, after dissolving some of the reserve substance in receptacle 57^I, diffuses into the liquid contained in the bottom of the absorber through the liquid in the connecting pipe 58^I. The rate of diffusion is slow in this form of the apparatus due to the fact that most of the water vapor carried over from the absorber is condensed in the heat exchanger 26 before it reaches the chamber 38. In the apparatus illustrated in Fig. 3 the receptacle 57^{II} is connected by means of the pipe 58^{II} to the conduit 22 at a point therein through which substantially pure ammonia flows. Due to the relatively low capacity of the ammonia to absorb the chorme-containing substance, the rate of diffusion is slow, and may be further retarded by placing in pipe 58^{II} a porous plug 60, as shown in Fig. 4, or a plug 61 having a small orifice 62, as shown in Fig. 5. Retarding means such as are illustrated in Figs. 4 and 5 may be placed if desired in the forms of apparatus shown in Figs. 1 and 2 as well as in the form shown in Fig. 3.

It will be evident that the reserve supply of corrosion preventing substance may be, in all of the forms of apparatus hereinbefore described, either crystals of the same salt as that forming the original protecting solution or of a salt which when diffused acts to regenerate the original solution. In the latter case, the reserve salt should have a solubility factor in the working fluids which is not greater than that of the salt used in the original solution. Preferably the solubility factors of the two salts should be as nearly as possible the same.

Obviously, the invention is not limited to refrigerating apparatus employing ammonia as a refrigerant, nor is it necessary to employ a chrome-containing substance as the corrosion preventing agent. Other protecting substances and other working media may be used. If the original corrosion preventing agent dissociates to form an undesirable product, the reserve substance is preferably chosen so that it either neutralizes the undesirable product of dissociation or regenerates the original agent as above described. It is also desirable to so choose either the original agent or the reserve so that when the molecules dissociate they form products the same as one or more of the working media.

I claim:

1. That improvement in inhibiting corrosion in an absorption refrigerating system containing liquid which consists in maintaining a reserve supply of solid corrosion resisting substance soluble in said liquid in a relatively still body of liquid in communication with the active portion of the system.

2. That improvement in inhibiting corrosion in an absorption refrigerating system which consists in maintaining a reserve supply of solid corrosion resisting substance in a relatively still body of liquid in communication with the active portion of the system and substantially preventing transfer of liquid between said body and the active portion of the system.

3. That improvement in inhibiting corrosion in an absorption refrigerating system containing refrigerant fluid and a solvent therefor which consists in adding to the refrigerant and solvent in the active portion of the system a quantity of corrosion inhibiting substance and providing a reserve supply of undissolved corrosion inhibiting substance soluble in said solvent in communication with the active portion of the system.

4. That improvement in inhibiting corrosion in an absorption refrigerating system which consists in adding to the working substances in the active portion of the system a quantity of corrosion inhibiting substance and providing a reserve supply of corrosion inhibiting substance in a relatively still body of liquid in restricted communication with the active portion of the system.

5. That improvement in inhibiting corrosion in an absorption refrigerating system which consists in maintaining a reserve supply of corrosion resisting substance in communication with the active portion of the system and causing said substance to pass into the system by diffusion in liquid during operation of the system.

6. That improvement in inhibiting corrosion in an absorption refrigerating system which consists in maintaining a reserve supply of solid corrosion resisting substance in a relatively still body of liquid in communication with the active portion of the system through a relatively narrow channel and continuously feeding the corrosion resisting substance into the active portion of the system by diffusion in the liquid in said channel.

7. That improvement in inhibiting corrosion in an absorption refrigerating system containing a refrigerant fluid and a solvent therefor which consists in charging into the system with the refrigerant fluid and solvent a corrosion resisting substance soluble in the solvent and providing a reserve supply of undissolved corrosion resisting substance of different composition than the first mentioned substance out of and in communication with the active portion of the system.

8. That improvement in inhibiting corrosion in an absorption refrigerating system containing a refrigerant fluid and a solvent therefor which consists in charging into the system with the refrigerant fluid and solvent a corrosion re-

sisting substance soluble in the solvent and providing a reserve supply of corrosion resisting substance of different composition than the first mentioned substance in restricted communication with the active portion of the system.

9. That improvement in inhibiting corrosion in an absorption refrigerating system which consists in charging into the system with the working fluids a corrosion resisting substance and providing a reserve supply of corrosion resisting substance of different composition than the first mentioned substance in a relatively still body of liquid in restricted communication with the active portion of the system.

10. That improvement in inhibiting corrosion in an absorption refrigerating system which consists in introducing a soluble chromium salt into the system with the working fluids and providing a reserve supply of ammonium chromate in restricted communication with the active portion of the system.

11. The combination with a refrigerating system including a plurality of vessels and means for circulating a plurality of substances including a liquid through said vessels, of a receptacle separate from the active part of the system containing corrosion inhibiting material soluble in said liquid and having restricted communication with the active part of the system.

12. The combination with a refrigerating system including a plurality of vessels and means for circulating a plurality of substances including a liquid through said vessels, of a receptacle separate from the active part of the system containing corrosion inhibiting material soluble in said liquid and a relatively narrow pipe connecting said receptacle with the active part of the system.

13. The combination with a refrigerating system including a plurality of vessels and means for circulating a plurality of substances through said vessels, of a receptacle separate from the active part of the system containing corrosion inhibiting material, a pipe connecting said receptacle with the active part of the system and flow restricting means in said pipe.

14. Corrosion protection for a refrigerating system containing liquid characterized by a reserve supply of undissolved corrosion inhibiting material soluble in said liquid in a reserve container directly associated with the interior of the apparatus.

15. The combination with a hermetically sealed refrigerating apparatus containing liquid of a vessel adapted to discharge a reserve supply of corrosion inhibiting material soluble in said liquid into the active portion of the apparatus while the apparatus is hermetically sealed.

16. Corrosion protection for a refrigerating system containing liquid characterized by a reserve supply of undissolved corrosion inhibiting material soluble in said liquid in a reserve container of the apparatus adapted to automatically pass into the active part of the system as the system operates.

17. The combination with a refrigerating system having directly charged thereinto a corrosion inhibiting salt, of a reserve container directly associated with the interior of the system holding a quantity of salt of such nature as to neutralize the action of the first mentioned salt.

18. The combination with a refrigerating system having directly charged thereinto a corrosion inhibiting salt, of a receptacle directly associated with the interior of the system and containing a different salt capable of regenerating the first mentioned salt.

19. The combination with a hermetically sealed absorption refrigerating apparatus containing liquid adapted to circulate therethrough and having a corrosion preventing material dissolved in said liquid to circulate therewith, of a reserve quantity of undissolved corrosion preventing material stored up within said apparatus and adapted to automatically pass into said liquid when the amount of corrosion preventing material circulating in said liquid is reduced.

20. The combination with a hermetically sealed absorption refrigerating apparatus containing liquid adapted to circulate therethrough and having a corrosion preventing material dissolved in said liquid to circulate therewith, of a reserve container holding undissolved corrosion preventing material having restricted communication with the active circulatory part of the system, the reserve material being adapted to automatically pass into said liquid when the amount of corrosion preventing material circulating in said liquid is reduced.

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