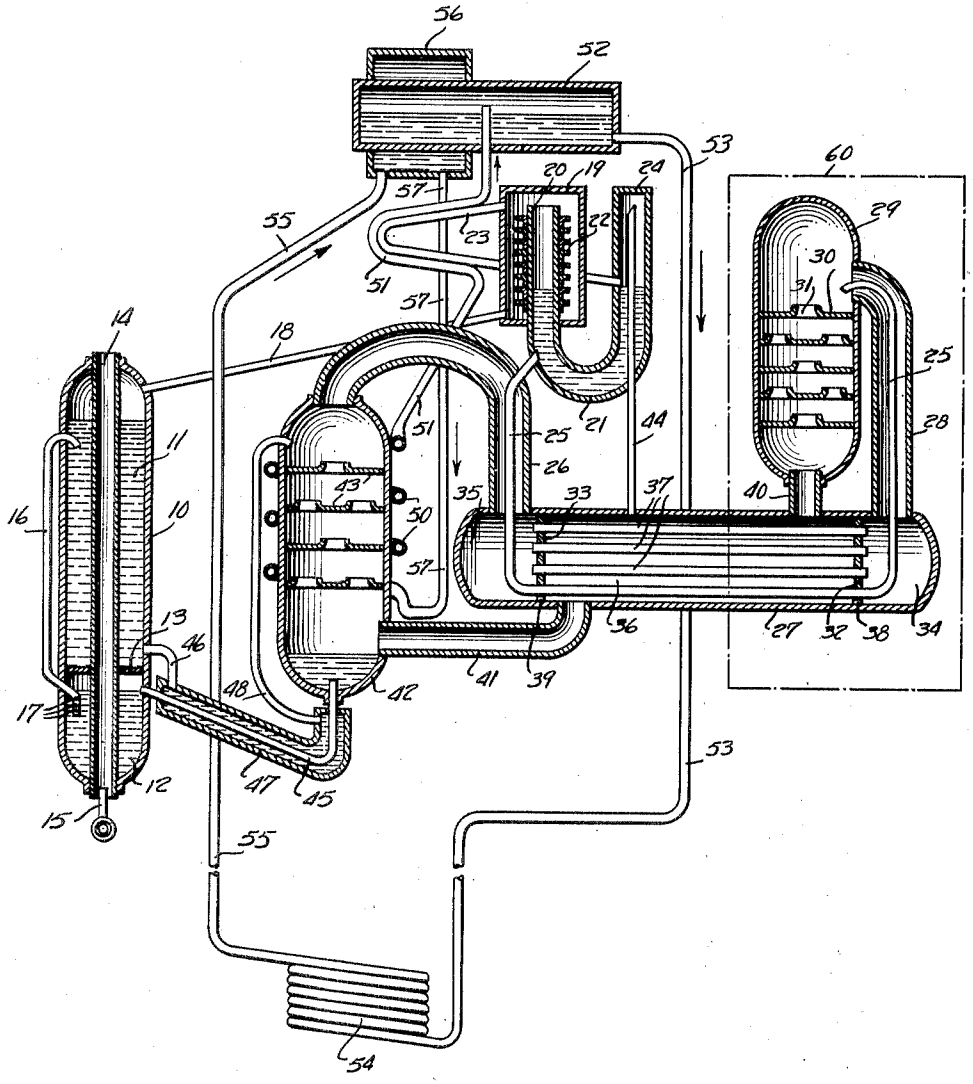
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REFRIGERATION

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REFRIGERATION

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My invention relates to the art of refrigeration and particularly to a method of and apparatus for cooling a refrigerating system. Under certain conditions it is desirable to cool a refrigerating system by an ultimate cooling medium such as the earth or a natural body of water which is located at a point below the refrigerating system and which cannot conveniently be brought into direct heat exchange relation therewith. In such case it is necessary to circulate a heat conveying liquid between the heat rejecting parts of the refrigerating system and the ultimate cooling medium in order to convey heat from the former to the latter. It is one of the objects of my invention to provide a circulating system serving this purpose, having no moving parts and in which the circulation is produced by the heat rejected by the refrigerating system.

Additional objects and advantages will be apparent from the following description of a preferred embodiment of my invention which is illustrated by the accompanying drawing which is an elevational view, chiefly in cross-section, of apparatus comprising my invention used in connection with an absorption refrigerating apparatus.

In the drawing, reference character 10 indicates a generator which is divided into a main generator 11 and an auxiliary generator 12 by a partition 13. A flue 14 extends centrally through the generator and is arranged to be heated by a gas burner 15 or other suitable source of heat. A conduit 16 extends from within auxiliary generator 12 to the upper part of main generator 11. The lower part of conduit 16 which is within auxiliary generator 12 is provided with one or more apertures 17 as well as having an open lower end.

A conduit 18 extends from near the top of main generator 11 to the bottom of a rectifier chamber 19. Chamber 19 is arranged around leg 20 of a U-shaped member 21. The top of leg 20 is in open communication with the interior of chamber 19 and the leg is provided therein with a series of radiating collars 22. A condenser conduit 23 communicates with the upper part of chamber 19 and extends in a downwardly direction to the more central part of leg 24 of the U-shaped member.

A conduit 25 communicates with the lower part of U-shaped member 21, extends within a conduit 26, a gas heat exchanger 27, a conduit 28 and terminates within the upper part of an evaporator 29. Evaporator 29 preferably comprises a closed cylindrical member in which are posited a series of distributing disks 30 in which are formed apertures 31.

Gas heat exchanger 27 comprises a cylindrical drum closed at both ends. Near the ends of the drum are positioned tube heads 32 and 33 which, together with the respective ends of the drum, form spaces 34 and 35. The space between heads 32 and 33 is designated by reference character 36. A series of tubes 37 are secured in heads 32 and 33, extend through space 36 and establish communication between spaces 34 and 35. Capillary ports 38 and 39 are provided in the bottoms of headers 32 and 33 respectively. A gas vent conduit 44 extends from within the upper part of leg 24 of U-shaped member 21 to space 36 in heat exchanger 27.

Conduit 28 connects space 34 in the heat exchanger with the upper part of evaporator 29 while a conduit 40 provides a passageway from the bottom of the evaporator to one end of space 36. A conduit 41 connects the other end of space 36 with the lower part of an absorber 42.

The absorber comprises a cylindrical member in which are posited a series of disks 43 which may be similar to disks 30 in evaporator 29. Conduit 26 establishes communication between the upper part of absorber 42 and space 35 in gas heat exchanger 27.

A conduit 45 connects the bottom of absorber 42 with auxiliary generator 12. A conduit 46 connects the lower part of main generator 11 with one end of a liquid heat exchanger jacket 47 through which extends conduit 45. A conduit 48 connects the other end of jacket 47 with the upper part of absorber 42.

The above described elements comprise the refrigerating apparatus proper. In order that this apparatus shall produce refrigeration, as later described, it is necessary that

heat be removed from certain of the elements, namely, condenser conduit 23 and absorber 42. The apparatus for effecting this heat removal in accordance with my invention will now be described.

A conduit in the form of a coil 50 is secured in heat exchange relation with absorber 42, preferably by being welded thereto. Conduit 48 may also be in heat exchange relation with coil 50 by being welded to successive turns thereof. A conduit 51 communicates with the top of coil 50, extends upwardly and is brought in heat exchange relation with condenser conduit 23, preferably by welding thereto, and thence extends upwardly to within about the center of a liquid receiver 52. Coil 50 and conduit 51 comprise what may be termed a thermo-siphon conduit. A conduit 53 extends downwardly from the bottom of receiver 52 and communicates with one end of a coil 54. Coil 54 is placed in heat exchange relation with the ultimate cooling medium, such as for instance the earth, a natural body of water or in a well. A conduit 55 is connected to the other end of coil 54 and extends upwardly to a jacket 56 placed around liquid receiver 52. A conduit 57 extends from jacket 56 downwardly and thence a short distance upwardly and communicates with the lower end of coil 50 around absorber 42.

The operation of the refrigerating apparatus is substantially as follows: A refrigerant, such as ammonia, dissolved in an absorption liquid, for instance water, is contained in generator 10. The application of heat from burner 15 drives the ammonia from solution in the form of a gas or vapor in both main generator 11 and auxiliary generator 12. The gas formed in the auxiliary generator enters conduit 16 through ports 17 and there entraps portions of liquid which are raised in accordance with the thermo-siphon principle to the higher level within main generator 11.

The vapor, consisting chiefly of ammonia with a little water vapor, formed in the generator passes therefrom through conduit 18 to within rectifier chamber 19. Here the water vapor is precipitated by condensation and runs back to the generator. The practically pure ammonia gas passes from chamber 19 into condenser conduit 23 where it is condensed to a liquid by reason of a reduction in temperature resulting from the ammonia coming in heat exchange relation with the cooler fluid in conduit 51. The liquid ammonia runs from conduit 23 into leg 24 of U-shaped member 21 which it fills up to the level of the end of conduit 25 within evaporator 29. The liquid ammonia in leg 20 serves to cool the vapors in chamber 19 sufficiently to condense the water vapor but not the ammonia. The liquid ammonia passes from U-shaped member 21 through conduit 25 to the upper part of evaporator 29.

In the evaporator the liquid ammonia is brought into intimate contact with a gas inert with respect to ammonia, for instance hydrogen, which is introduced through conduit 28 and in the presence of which the ammonia evaporates and into which it diffuses. The drop in temperature accompanying the evaporation produces refrigeration within the compartment designated diagrammatically by the broken line rectangle 60.

The gaseous mixture of ammonia and hydrogen has a greater specific weight than the relatively pure hydrogen which enters through conduit 28 and hence the mixture passes downwardly through the evaporator, through conduit 40 into space 36 in heat exchanger 27 and thence through conduit 41 into the lower part of absorber 42.

In the absorber the mixture comes in contact with weak absorption liquid which enters through conduit 48 and is distributed over disks 43. The absorption liquid absorbs the ammonia gas and this process generates heat which is removed by the fluid passing through coil 50 around the absorber. The hydrogen gas is not absorbed and passes from the absorber through conduit 26 to space 35 in the heat exchanger. From space 35 it passes through tubes 37 to space 34 and thence through conduit 28 into evaporator 29. In heat exchanger 27 the liquid ammonia in conduit 25 and the hydrogen in tubes 37 are precooled before entering the evaporator by the cold gaseous mixture of ammonia and hydrogen in space 36 which has just left the evaporator.

The strong solution of ammonia in water formed in absorber 42 passes therefrom through conduit 45 to auxiliary generator 12 from where it is raised, as was previously explained, through conduit 16 to main generator 11. Here a large percentage of the ammonia is driven out of solution and the weak solution passes from the bottom of the main generator through conduit 46 into liquid heat exchanger jacket 47. Here an exchange of heat occurs between the cool strong solution in conduit 45 and the hot weak solution within the jacket. From the jacket the weak solution passes through conduit 48, where it is further cooled by passing in heat exchange relation with the fluid in coil 50, and is finally discharged into the upper part of the absorber 42.

The circulating system for the cooling fluid functions as follows: The entire system comprising coil 50, conduit 51, receiver 52, conduit 53, coil 54, conduit 55, jacket 56 and conduit 57 contains a suitable liquid, such as dichlormethane, which has a satisfactory vapor pressure at the temperature at which it is desired to maintain condenser 23 and absorber 42. The system is exhausted of air

and filled with this liquid to about the level shown in receiver 52 and is then hermetically sealed.

The heat abstracted by the liquid in coil 50 from absorber 42 causes vaporization of some of the liquid in the coil. This vapor lightens the column in coil 50 and conduit 51 as comparted with the column in conduit 57 and hence flow upwardly through coil 50 takes place. Within the portion of conduit 51 which is in heat exchange relation with condenser conduit 23 more vapor is formed which aids in causing this upward flow. The liquid and vapor is discharged from the upper end of conduit 51 into receiver 52. Here the vapor is condensed to a liquid, as will be explained presently, and the liquid flows therefrom through conduit 53 to coil 54.

While passing through coil 54 the liquid is cooled by the ultimate cooling medium with which the coil is in heat exchange relation. From coil 54 the cooled liquid passes through conduit 55 to jacket 56. Here it cools the contents of receiver 52 sufficiently to condense therein the vapor which is discharged from conduit 51. From jacket 56 the liquid passes through conduit 57 to coil 50. The above circulation takes place due to gravity because the liquid column in coil 50 and pipe 51 is lightened relatively to the liquid column in either pipe 57 or pipe 53 whereas the other liquid columns substantially balance each other. In normal operation, jacket 56 is filled with liquid since the temperature therein is below the corresponding vapor pressure of the liquid in the heat transfer circuit, the liquid flowing into this jacket being cold liquid from the cooling source 54. The liquid is lifted to receiver 52 due to the formation of vapor whence it flows downwardly due to gravity to the cooling member 54 and thence through the circuit back to the source of heat.

If desired, conduit 57 may be extended down so as to be brought in heat exchange relation with the ultimate cooling medium in order to remove the heat absorbed by the liquid in jacket 56 from the contents of receiver 52, but the amount of heat so absorbed is ordinarily so small as to make this unnecessary.

While I have illustrated and described a more or less specific form of my invention, it is to be realized that modifications thereof fall within its scope. For instance, coil 54 may be replaced by any other suitable heat exchanger member and may be extended so as to be adjacent a greater quantity of the ultimate cooling medium. Also, the cooling system may be used for either the absorber or condenser alone or two independent systems may be used, particularly if it is desired to maintain the absorber at a temperature considerably different from that of the condenser.

What I claim is:

1. The method of cooling a refrigerating system by an ultimate cooling medium situated below a heat rejecting portion of the system which comprises vaporizing a portion of a heat conveying liquid by heat exchange with the heat rejecting portion, utilizing the vapor to raise the remaining liquid to a higher level, condensing the vapor and circulating the liquid from the higher level by gravity first in heat exchange relation with the ultimate cooling medium and then again in heat exchange relation with the heat rejecting portion of the system.

2. The method of cooling a refrigerating system by an ultimate cooling medium situated below a heat rejecting portion of the system which comprises vaporizing a portion of a heat conveying liquid, utilizing the vapor to raise the remaining liquid to a higher level, condensing the vapor and circulating the liquid from the higher level by gravity first in heat exchange relation with the ultimate cooling medium and then in heat exchange relation with the heat rejecting portion of the system.

3. The method of cooling a refrigerating system by an ultimate cooling medium situated below a heat rejecting portion of the system which comprises vaporizing a portion of a heat conveying liquid by heat exchange with the heat rejecting portion, utilizing the vapor to raise the remaining liquid to a higher level, condensing the vapor and circulating the liquid from the higher level by gravity first in heat exchange relation with the ultimate cooling medium, second in heat exchange relation with the vapor to effect the aforementioned condensation and then again in heat exchange relation with the heat rejecting portion of the system.

4. A refrigerating system comprising a heat rejecting portion, a thermo-siphon conduit in heat exchange relation with said heat rejecting portion, a liquid receiver situated above said heat rejecting portion, said thermo-siphon conduit extending into said liquid receiver, a cooling element in heat exchange relation with an ultimate cooling medium situated below said heat rejecting portion, a conduit extending downwardly from said liquid receiver to said cooling element and a conduit connecting said cooling element with said thermo-siphon conduit.

5. A refrigerating system comprising a heat rejecting portion, a thermo-siphon conduit in heat exchange relation with said heat rejecting portion, a liquid receiver situated above said heat rejecting portion, said thermo-siphon conduit being connected to said liquid receiver, a member in heat exchange relation with said liquid receiver, a cooling element in heat exchange relation with an ultimate cooling medium situated below said heat rejecting portion, a conduit extending

downwardly from said liquid receiver to said cooling element, a conduit connecting said cooling element with said member and a conduit connecting said member with said thermo-siphon conduit.

6. Refrigerating apparatus comprising a generator, a condenser, an evaporator, an absorber and interconnecting conduits, a thermo-siphon conduit in heat exchange relation with said condenser and said absorber, a liquid receiver situated at a higher level into which said thermo-siphon conduit extends, a cooling element in heat exchange relation with an ultimate cooling medium situated at a lower level, a conduit extending downwardly from said liquid receiver to said cooling element and a conduit extending from said cooling element to said thermo-siphon conduit.

7. Refrigerating apparatus comprising a generator, a condenser, an evaporator, an absorber and interconnecting conduits, a thermo-siphon conduit in heat exchange relation with said condenser and said absorber, a liquid receiver situated at a higher level into which said thermo-siphon conduit extends, a member in heat exchange relation with said liquid receiver, a cooling element in heat exchange relation with an ultimate cooling medium situated at a lower level, a conduit extending downwardly from said liquid receiver to said cooling element, a conduit extending upwardly from said cooling element to said member and a conduit extending downwardly from said member to said thermo-siphon conduit.

8. Refrigerating apparatus comprising a system having a heat rejecting portion and a closed heat transfer fluid flow circuit including a cooled portion below said heat rejecting portion, a heated portion adapted to receive heat from said heat rejecting portion, a first upper portion arranged to receive vapor from said heated portion, a downflow portion connecting said first upper portion with said cooled portion, a second upper portion, an upflow portion connecting said cooled portion with said second upper portion, a downflow portion connecting said second upper portion with said heated portion, and said upper portions being in heat exchange relation.

9. Refrigerating apparatus comprising a system having a heat rejecting portion and a closed heat transfer fluid flow circuit including a cooled portion below said heat rejecting portion, a heated portion in heat exchange relation with said heat rejecting portion and means whereby fluid cooled in said cooled portion condenses vapor formed in said heated portion.

In testimony whereof I hereunto affix my signature.

DONALD BRANCH KNIGHT.