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REFRIGERATION

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Fig. 1.

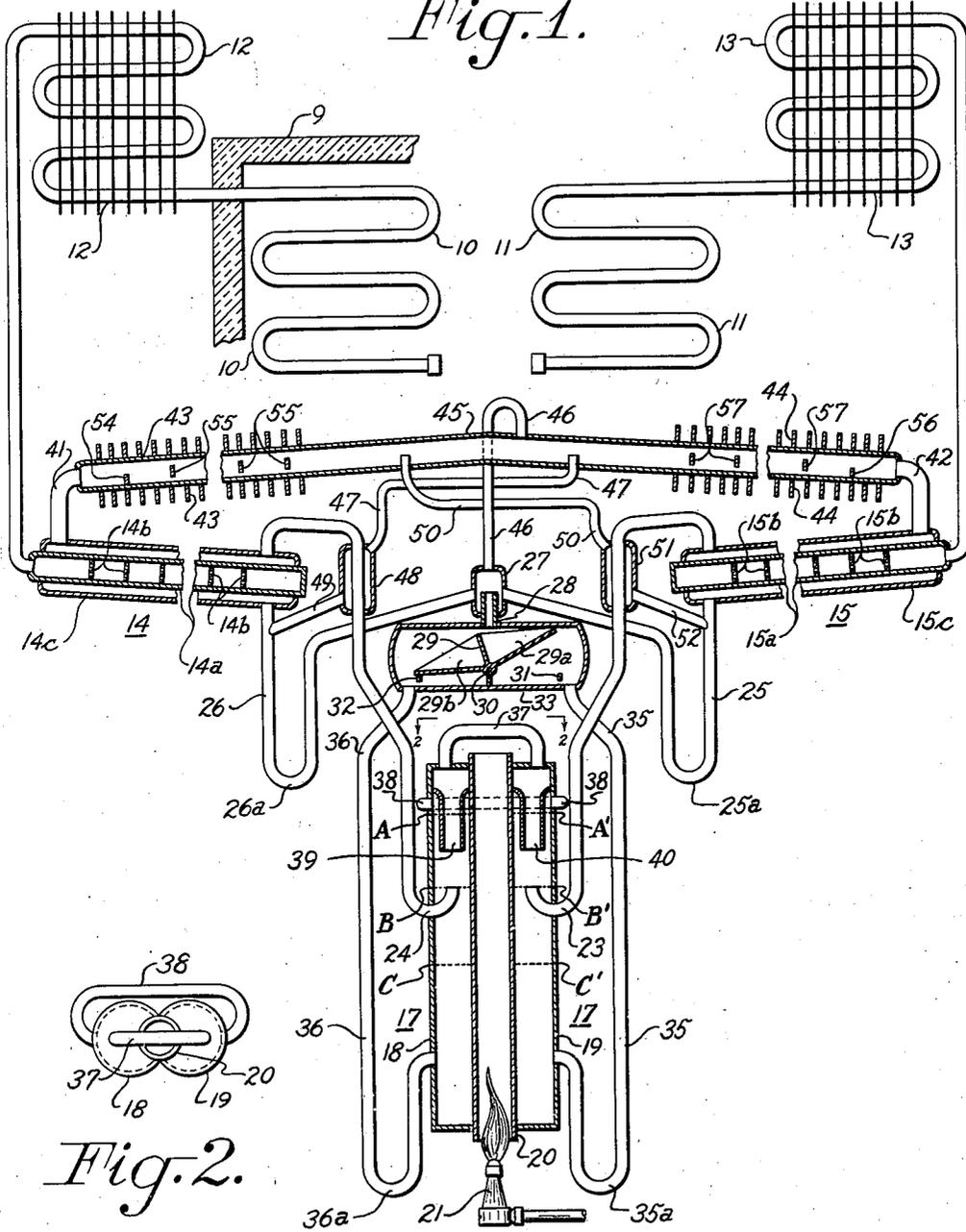


Fig. 2.

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## UNITED STATES PATENT OFFICE

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## REFRIGERATION

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16 Claims. (Cl. 62-5)

My invention relates to refrigeration and more particularly to operation of intermittent absorption refrigeration systems in alternation.

It is an object of the invention to provide a single continuous heat source for a plurality of intermittent absorption refrigeration systems and transfer heat to one of the systems while at the same time cooling another of the systems and automatically reversing the heating and cooling with respect to these systems without the use of valves, electric switches, or the like.

This is accomplished by providing a heat transfer system containing two fluids and arranged so that one fluid transfers heat to one intermittent refrigeration system while the other fluid transfers heat away from another intermittent refrigeration system, the heat transfer effects of the fluids being automatically reversed with respect to the refrigeration systems at desired intervals.

The invention, together with further objects and advantages thereof, will be more fully understood upon reference to the following description and the accompanying drawing forming part of this specification, and of which Fig. 1 shows more or less diagrammatically a refrigeration system assembly embodying the invention, and Fig. 2 is a detail view on line 2-2 in Fig. 1.

Evaporators 10 and 11 are disposed within a refrigerator compartment 9. The evaporators 10 and 11 may form the cooling elements of air-conditioning apparatus. The evaporators 10 and 11 are respectively connected through condensers 12 and 13 with generator-absorbers 14 and 15. The inner portions 14a and 15a of each generator-absorber contain a suitable solid absorbent. To retain the solid absorbent in place, a plurality of perforated partitions 14b and 15b are provided. To liberate refrigerant from the solid absorbent each generator-absorber is heated by means of a fluid such as, for example, steam, which may traverse heating jackets 14c and 15c, respectively surrounding the inner portions 14a and 15a.

When refrigerant is liberated by the heating of absorbent, the refrigerant, for example, that in the generator-absorber 14, flows into the condenser 12 where it is liquefied and by gravity flows into the evaporator 10. If the heating of the generator-absorber 14 is now discontinued and it is cooled instead, the liquid refrigerant in evaporator 10 evaporates, producing cold, and the vaporized refrigerant returns through the condenser 12 to the inner portion of the generator-absorber where it is absorbed. The system comprising the boiler-absorber 15, the condenser 13, and the evaporator 11 operates in the same manner.

Selectively and automatically to control the heating and cooling of the generator-absorbers

14 and 15, I provide a pair of interconnected steam boilers or a single steam boiler 17 having compartments 18 and 19 disposed in heat exchange with a central heating flue 20. The compartments 18 and 19 are heated by a burner 21 arranged to project a flame into the lower end of flue 20. The flame and combustion gases heat the fluid, preferably water, in the boiler to produce a heating medium such as steam.

A steam outlet conduit 23 extends from compartment 19 to the jacket 15c, a similar conduit 24 connecting compartment 18 to jacket 14c. Steam when introduced into the jackets 14c and 15c condenses and flows from the lower ends thereof into conduits 25 and 26, respectively provided with liquid seals or traps 25a and 26a. Both of conduits 25 and 26 are connected to a vessel 27 from which condensate flows through a pipe 28 into one or the other of compartments 29a and 29b of a vessel 29 pivoted at its mid-portion at 30 for tilting movement between stops 31 and 32. The vessel 29 is disposed within a container 33 from opposite sides of which extend conduits 35 and 36 to the boiler compartments 18 and 19, the conduits including liquid traps 35a and 36a. The two compartments 18 and 19 are interconnected by conduits 37 and 38, the latter entering each compartment adjacent and below baffles 39 and 40 provided to prevent transfer of boiling water from one to the other of compartments 18 and 19.

To remove the heat of absorption from absorbers 14 and 15, a cooling system is provided in conjunction with the jackets 14c and 15c which alternately act as evaporators therefor. From jackets 14c and 15c there extend conduits 41 and 42, respectively connected to condensers 43 and 44, themselves interconnected at 45. From the mid-portion 45 an equalizing conduit 46 is connected to vessel 27. The cooling circuit includes a conduit 47 communicating with condenser 44, a vessel 48, and a conduit 49 connected to a leg of trap 26a at a point which is slightly lower than the upper end of overflow conduit 28 in vessel 27. The cooling circuit also includes a conduit 50, communicating with condenser 43, a vessel 51, and a conduit 52 connected to a leg of trap 25a at a level corresponding with that of the connection of conduit 49 to trap 26a. Within condenser 43 is a baffle 54 forming a dam in the lower end. Other baffles 55 are spaced above the bottom of the condenser 43. Similarly, baffle 56 forms a dam for condenser 44 and additional baffles 57 are spaced above the bottom thereof.

The primary refrigeration circuits may contain calcium chloride as absorbent, and ammonia as refrigerant. The auxiliary circuit may contain water as heating fluid and pentane as cooling fluid. Pentane is lighter than water and is

immiscible therewith. The pressure within the heat transfer circuit will correspond approximately to the condensing temperature of pentane, which temperature is determined by the room temperature. For a condensing temperature of 57° C., the pressure is two kilograms per square centimeter. At this pressure, the boiling point of water is 120° C., which is sufficiently high for the steam delivered to jackets 14c and 15c to liberate and drive from the absorbent the absorbed ammonia.

The traps 25a and 26a are filled with water. The pentane floats on the water in trap 25a, with the surface level of the pentane within the jacket 14c. The level of the pentane in jacket 15c and in vessel 51 depends on the height of the trap 25a and is above the vessel 27. The level of water in compartment 18 is at A and the level in compartment 19 at B'. The flame and combustion gases from burner 21 heat the water in boiler compartments 18 and 19. The steam produced in compartment 18 flows by way of conduit 37 into compartment 19, and joins with the steam from the latter for flow through conduit 23 to jacket 15c.

Upon the initial flow of steam, the pentane is vaporized and flows through conduit 50, and through connection 45 into condenser 43 which is air-cooled, and in which the pentane is condensed into liquid. The liquid pentane flows by way of conduit 41 and jacket 14c into liquid trap 26a, where it floats on the water and reaches a level in the vessel 48.

The heat from the steam expels ammonia vapor from the absorbent within the generator-absorber 15. The vapor flows into condenser 13 where it condenses into a liquid. The liquid ammonia accumulates in the evaporator 11. As the heating proceeds, the levels within the boiler compartments 18 and 19 fall. The steam entering jacket 15c is condensed into a liquid which flows from jacket 15c by way of trap 25a into vessel 27. Through the outlet 28, the condensate is delivered to compartment 29a of the pivoted container 29. As compartment 29a is filled, the center of gravity of the stored condensate is progressively moved to the right and away from pivot 30 until the weight of the stored condensate becomes effective to tilt the vessel or container 29 in a clockwise direction and to dump or spill the stored condensate into container 33. The vessel 29 comes to rest against stop 31, while the condensate drains directly through conduit 35 into boiler compartment 19.

When the vessel 29 is tilted the levels within the boiler compartments 18 and 19 have dropped respectively to B and C'. The capacity of compartment 29a is such that the condensate returned to boiler compartment 19 raises the liquid level therein to A'. The steam outlet conduit 23 is thereby liquid sealed and the inlet of steam outlet conduit 24 is opened for passage of steam to heating jacket 14c.

My invention in one aspect thereof is characterized by the automatic transfer of the heating medium from boiler-absorber 15 to boiler-absorber 14 in response to the accumulation of a predetermined quantity of condensate; and in a further aspect by the simultaneous transfer of action of the cooling system.

As the steam, passing in heat exchange through the vessel 48, heats the liquid pentane therein, the pentane is vaporized and flows through conduit 47 into condenser 44 where it condenses into a liquid. The liquid pentane then

flows over baffle 56 and into the jacket 15c. Cessation in the heating of generator-absorber 15 initiates the evaporation of the liquid ammonia from evaporator 11 with consequent production of refrigeration. Vaporized ammonia flows by way of condenser 13 to the stored absorbent within generator-absorber 15 where it is absorbed. The heat of absorption produces vaporization of the pentane in jacket 15c; or conversely the inner portion 15a is cooled by the evaporation of pentane, the vapors thereof flowing into condenser 44 by way of conduit 42, where they again condense into a liquid, which returns through conduit 42 to the jacket 15c.

During the production of refrigeration by evaporator 11, the steam delivered to jacket 14c continuously heats, and liberates from, the absorbent in 14a, ammonia vapors which in condenser 12 condense into a liquid. As evaporator 11 produces cold, liquid ammonia is stored in evaporator 10, preparatory to its own evaporation to produce cold.

Since the vessel 29 has been operated to its right-hand position as viewed in Fig. 1, the condensate returning from jacket 14c by way of liquid trap 26a is discharged through outlet 28 into the left-hand compartment 29b. As it fills, the center of gravity of the stored condensate moves to the left away from pivot 30 until, as it is entirely filled, the weight of the condensate tilts and rotates the vessel 29 to its original position, as shown in Fig. 1. As this occurs, the liquid level in compartment 18 has fallen to C and in compartment 19 to B'. The return of the condensate through conduit 36 to compartment 18 again raises the level therein to A, liquid-sealing steam outlet 24 and transferring flow of steam from boiler 17 to the jacket 15c.

As described above, the pentane in vessel 51 and in jacket 15c is vaporized and in condenser 43 condensed into a liquid which by evaporation in jacket 14c cools the refrigerant absorption zone 14a. The liquid ammonia within evaporator 10 evaporates to produce cold, taking up the refrigeration load previously carried by the evaporator 11.

The conduit 38 is for the purpose of automatically adjusting the levels within the boiler 17. For example, upon starting the system the charge may be unevenly distributed, and with respect to the existing liquid levels the vessel 29 may be in the wrong position. In such a case if compartment 29a should be discharged into compartment 19 at a time when the level thereof was at B', the liquid would rise to level A' and all additional liquid would then flow by conduit 38 into compartment 18, to produce the required levels of liquid in compartments 18 and 19 for best operation of my invention.

While I have shown a particular embodiment of my invention, it will be understood that I do not limit myself thereto, since many modifications may be made, and I therefore contemplate by the appended claims to cover any such modifications as fall within the spirit and scope of my invention.

What is claimed is:

1. In an absorption refrigeration system, a boiler, a plurality of generator-absorbers, a condenser and an evaporator connected to each of said generator-absorbers, means for causing expulsion of refrigerant first in one and then in another of said generator-absorbers comprising a conduit from said boiler to each of said generator-absorbers for flow of a heating medium,

said boiler having compartments individual to said conduits, and means operable by change in the level of liquid within said compartments for heating one and then another of said generator-absorbers.

2. In an absorption refrigeration system, a double-compartment boiler, two generator-absorbers, a condenser and an evaporator connected to each of said generator-absorbers, means for causing expulsion of refrigerant first in one and then in the other of said generator-absorbers comprising outlet conduits respectively interconnecting each of said generator-absorbers with one of the compartments of said boiler for flow of a heating medium from the boiler in heat exchange with said generator-absorbers, means individual to said generator-absorbers for returning heating medium to said boiler, and means for storing a predetermined quantity of returning heating medium and for delivering said stored quantity alternately into the compartments of said boiler to change the level of liquid therein, and means operable by change in the level of liquid for supplying the heating medium first to one and then to the other of said generator-absorbers.

3. A refrigeration system as set forth in claim 2, in which the storing means comprise a pivoted double-compartment vessel operable by a predetermined accumulation of liquid in one compartment to discharge liquid therefrom and to move the other compartment into liquid receiving position.

4. A refrigeration system as set forth in claim 2, in which the outlet conduits from the compartments of said generator are disposed at approximately the same level, and an equalizing connection between said compartments at a level above that of said conduit.

5. A refrigeration system as set forth in claim 2, in which the storing means comprises a pivoted double-compartment vessel operable by a predetermined accumulation of liquid in one compartment to discharge liquid therefrom and to move the other compartment into liquid receiving position, and in which the outlet conduits from the compartments of said generator are disposed at approximately the same level, and an equalizing connection between said compartments at a level above that of said conduits.

6. In an absorption refrigeration system, a double-compartment boiler, two generator-absorbers, a condenser and an evaporator connected to each of said generator-absorbers, means for producing evaporation of refrigerant first in one and then in the other of said evaporators comprising conduits respectively interconnecting each of said generator-absorbers with one of the compartments of the boiler for flow of a heating medium from the boiler in heat exchange with said generator-absorbers, and means including a pair of condensers and conduit connections for transfer of a volatile cooling fluid from one to the other of said generator-absorbers for cooling one of them while the other is being heated.

7. A refrigeration system comprising two vessels for holding absorbent for a refrigerant, a jacket for each of said vessels, a condenser connected to each of said jackets and in communication with each other, liquid traps connected to each of said jackets, means for heating and supplying vaporized liquid, first to one and then to the other of said jackets, means interconnecting the liquid trap connected to one jacket to the condenser connected with the opposite jacket for transfer of a cooling fluid immiscible with

said liquid, from one to the other of said jackets, initial flow of said heated, vaporized, liquid into one or the other of said jackets vaporizing the cooling fluid and producing flow thereof into the condenser connected with the other of said jackets for cooling the vessel in which the refrigerant is being absorbed.

8. In combination with a plurality of intermittent absorption refrigeration systems, a heat transfer system containing a plurality of heat transfer fluids in heat transfer relation with said refrigeration systems, means to direct flow of fluids in said heat transfer systems so that one of said fluids circulates in heat exchange relation with one of said refrigeration systems while another of said fluids circulates in heat exchange relation with another of said refrigeration systems, means to heat one of said fluids, means to cool the other of said fluids, said fluid directing means being operative to change the flow of fluids in said heat transfer circuit so that the fluid being cooled and the fluid being heated alternately flow in thermal exchange relation with each of said refrigeration systems.

9. A combination as set forth in claim 8 in which said fluids in the heat transfer system are immiscible.

10. A combination as set forth in claim 8, in which said fluids in the heat transfer system are volatile and undergo vaporization and condensation in transferring of heat.

11. A combination as set forth in claim 8, in which the fluid which is cooled is pentane and the fluid which is heated is water, both fluids undergoing vaporization and condensation in transfer of heat.

12. A combination as set forth in claim 8, in which said fluid flow directing means is operative responsive to rate of flow of one of said heat transfer fluids.

13. A method of refrigeration with the aid of a plurality of intermittent absorption refrigeration systems which includes flowing a heated fluid in thermal exchange relation with one of said systems, flowing a cooled fluid in thermal exchange relation with another of said systems, accumulating one of said fluids at a place in its path of flow, and reversing the refrigeration systems with which said fluids flow in thermal exchange relation responsive to said accumulation.

14. A method as set forth in claim 13, in which said reversal includes release of the accumulated fluid.

15. A method of refrigeration with the aid of a plurality of intermittent absorption refrigeration systems which includes maintaining a plurality of immiscible fluids in the presence of each other, and causing one of said fluids to vaporize in thermal exchange relation with first one and then another of said refrigerating systems to cause alternate cooling thereof, and causing another of said fluids to condense in thermal exchange relation with first one and then another of said refrigeration systems in alternation with the cooling thereof.

16. The method of alternately heating two intermittent absorption refrigeration systems which includes vaporizing a heat transfer fluid, condensing the vapor in heat transfer relation with one or the other of said refrigeration systems, and causing said alternation by blocking flow of vapor to first one and then the other of said systems by means of trapped liquid.

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