April 21, 1942. R. S. TAYLOR 2,280,273

REFRIGERATION

Filed May 14, 1940

Fig. 1.

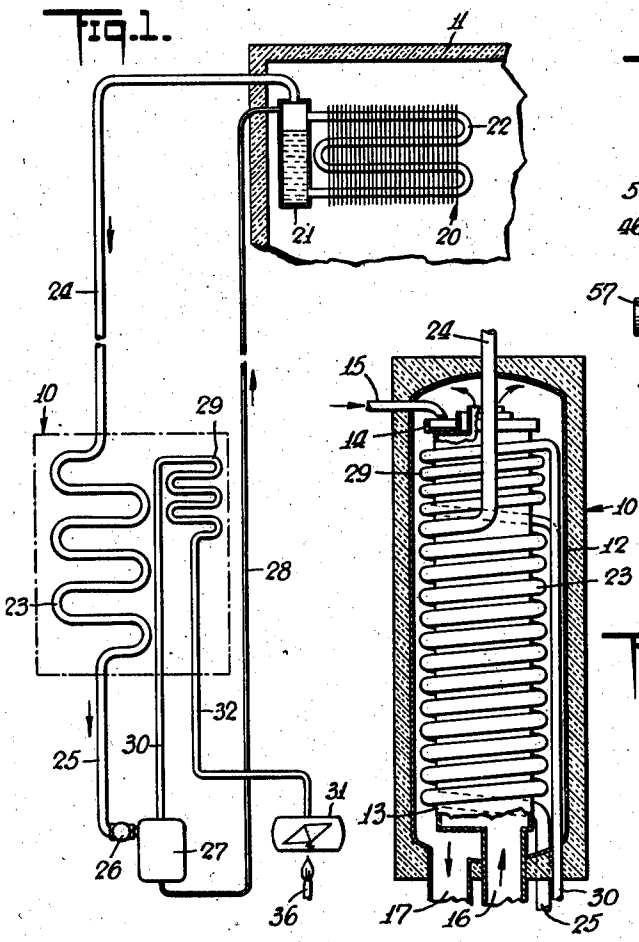


Fig. 2.

Fig. 4.

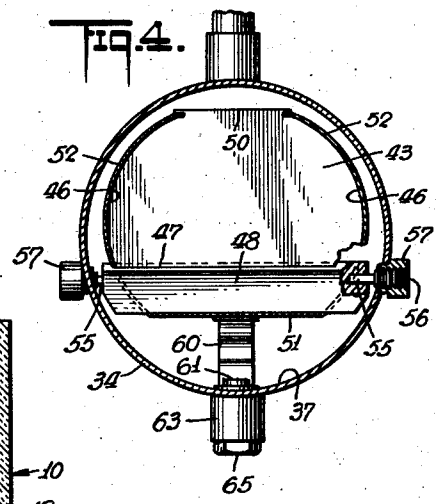
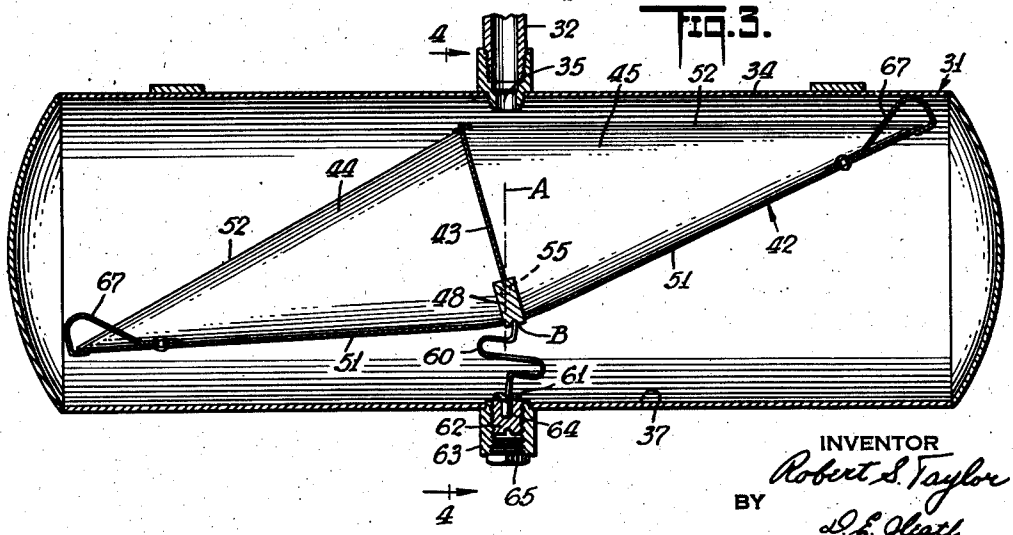


Fig. 3.



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REFRIGERATION

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9 Claims. (Cl. 62—125)

The present invention relates to the art of refrigeration, and more particularly to a new and improved system for transferring heat to effect cooling at a region above a source of refrigeration.

One object of the present invention is to provide a new and improved heat transfer system of the general type above referred to.

Another object is to provide a heat transfer system of the above type, having new and improved means for raising liquid refrigerant from a low level to a higher level without resorting to the expedients of mechanical power pumps or other similar power means.

Another object is to provide a heat transfer system of the above type, in which the number of valves for raising liquid refrigerant to a higher level is reduced to a minimum.

Another object is to provide a heat transfer system of the above type, in which refrigeration loss is reduced to a minimum.

Another object is to provide a new and improved device for creating liquid lifting vapor pressure.

Another object is to provide a heat transfer system of the above type, having a liquid refrigerant lifting device, which is of simple, rugged and practical construction, which is more positive and more dependable in operation than for example a simple syphoning arrangement, and which is well suited to meet the requirements of economical manufacture.

Various other objects of the invention will be apparent from the following particular description, and from an inspection of the accompanying drawing, in which—

Fig. 1 is a diagrammatic view, partly in side elevation and partly in section, showing a refrigerating system embodying my invention,

Fig. 2 is a vertical section of a combined primary evaporator unit and secondary condenser unit, forming part of the system indicated in Fig. 1, but shown on a larger scale,

Fig. 3 is a longitudinal section through a vaporizing unit of a refrigerant liquid lifting device, forming part of the system indicated in Fig. 1, but shown on a larger scale, and

Fig. 4 is a transverse section taken on line 4—4 of Fig. 3.

The invention is shown in connection with a primary refrigerating system of the Platen-Munters absorption type, having an evaporator or cooling unit 10, which is located remotely below a heat insulated region or chamber 11 to be refrigerated, and which constitutes a source of refrigeration for said chamber. This primary evaporator unit 10 is shown of the type comprising a cylinder 13, enclosed in a heat insulated shell 12, and provided at its upper end with an annular tray 14, into which is delivered a suitable volatile liquid refrigerant such as ammonia by means of a pipe 15. This ammonia overflows from the tray 14, over the outer rim thereof or through porous or wire mesh outer walls thereof, and then passes downwardly along the sides of the cylinder 13.

A suitable inert gas such as hydrogen is admitted into the cylinder 13 through an inlet 16, and flows upwardly to the top of the shell 12, and then downwardly along the outside of said cylinder to diffuse the ammonia. The effect of introducing hydrogen into the evaporator unit 10 is to reduce the partial pressure of the ammonia vapor in accordance with Dalton's law of partial pressures, and to cause evaporation of the ammonia with consequent absorption of heat from the surroundings.

The mixture of ammonia vapors and hydrogen is discharged from the bottom of the shell 12 through an outlet 17, and delivered to the other parts of the primary refrigerating system. These other parts may comprise generally an absorber into which the mixture of ammonia vapors and hydrogen is delivered for absorption of the ammonia into a liquid absorbent such as water. The separated inert hydrogen gas is returned to the cylinder 13 through the inlet 16, while the enriched absorption liquid is conducted to a generator. Ammonia is then expelled from the absorption solution by heating of the generator. This expelled ammonia is liquified in a condenser, and then returned to the evaporator unit 10 through the conduit 15 to complete the cycle in the primary refrigerating system. The weakened absorption solution from which the ammonia has been expelled is conducted from the generator to the absorber to absorb ammonia gas.

The primary refrigerating system, which is not completely shown in the drawing for the sake of simplicity, forms per se no part of the present invention, and as far as certain aspects of the invention are concerned may be of any other suitable type.

The secondary system for transferring the heat from the storage chamber 11 to be cooled to the primary evaporator unit 10 comprises a secondary evaporator unit 20, disposed in said chamber, and shown of the flooded type with a

header or receiver 21, and a finned serpentined coil 22 connected to said header.

The secondary heat transfer system also includes a condenser coil 23, forming with the secondary evaporator unit 20 part of a closed fluid circuit containing a suitable volatile refrigerant. This condenser coil 23 is disposed below the secondary evaporator unit 20, and is arranged around the cylinder 13 so that the liquid ammonia in the shell 12 overflows from the tray 14 in sheet-like form over the successive turns of said coil. Refrigeration resulting from the evaporation of the ammonia in the primary evaporator unit 10 cools the condenser coils 23, and thereby causes evaporation of the liquid refrigerant in the secondary evaporator unit 20, and resultant cooling of the storage chamber 11. The vapor flows from the evaporator unit 20 downwardly through a conduit 24, and into the upper inlet end of the condenser coil 23 where it is cooled and condensed by the primary evaporator unit 10.

It is seen that the secondary transfer heat system in effect transfers the heat from the storage compartment 11 to the primary evaporator unit 10 constituting the point of refrigeration of the primary refrigerating system.

Since the condenser 23 is disposed at a lower level than the secondary evaporator unit 20, means must be provided to return the condensate liquid in the secondary heat transfer system from the condenser 23 to said evaporator unit, so that this system is cyclically operated for continuous cooling of the storage space 11. For that purpose, the refrigerant condensate from the condenser 23 flows by gravity down along a pipe 25 and through a check valve 26, and is discharged into a vessel or receiver 27 forming part of a liquid lift device for returning the condensate to the evaporator header 21. The outlet side of this receiver 27 is connected to the evaporator header 21 by means of a riser pipe 28.

Means are provided for intermittently creating sufficient vapor pressure in the receiver 27 to force the liquid in said receiver out through the riser conduit 28 and into the header 21. In the specific form shown, said means includes an auxiliary condenser 29 in the form of a coil, arranged in the low temperature section of the primary evaporator unit 10 so as to operate at a lower temperature than the condenser 23. For that purpose, the auxiliary condenser 29 is arranged above the main condenser 23 and around the cylinder 13. The upper end of this auxiliary condenser 29 is connected to the upper end of the receiver 27 by means of a pipe 30. The lower end of this auxiliary condenser is connected to an intermittently operated vaporizing device 31 by means of a pipe 32.

The vaporizing device 31 comprises a vessel 34, shown in the form of a horizontal cylinder drum, and having centrally at its top an inlet 35 to which the pipe 32 is connected. The vessel 34 is provided in the interior thereof with a surface which is hot enough to vaporize the refrigerant of the secondary heat transfer system when said refrigerant is dumped in thermal contact therewith as will be described. For that purpose, the vessel 34 can be kept at a vaporizing heat by means of a regulated burner 36, so that the inner wall surface 37 of said vessel will constitute the refrigerating vaporizing surface of the device. The vaporizing heat may be supplied to the vessel 34 by any other suitable source, as for instance by means of the circulation of the outlet water in thermal contact with said vessel 34. If the hot water pipe extends into the interior of the vessel 34, the outer surface of said pipe will serve as the refrigerant vaporizing surface, and may impart sufficient heat to the walls of the vessel 34, so that these walls also serve as refrigerant vaporizing surfaces.

If the vessel 34 is located in a warm room, the heat of this room may be sufficient to maintain the walls of this vessel at a vaporizing temperature, without necessity of additional heating means.

Means are provided in the interior of the vessel 34 for collecting the refrigerant condensate as it is discharged into said vessel through the inlet 35, and supporting it away from the refrigerant vaporizing surfaces of the device until said refrigerant is dumped into thermal contact with said surfaces. In the specific form shown, this means comprises a receptacle 42, divided by a central plate 43 into a pair of adjoining similar buckets 44 and 45. This partition plate 43 is desirably shaped with arcuate side edges 46, a flat bottom edge 47 secured to a frame bar 48, and a flat top edge 50. The bottom wall of the receptacle 42 is shown formed by a pair of flat plates 51, diverging slightly upwardly from the frame bar 48, while the side walls of said receptacle are shown formed by curved plates 52, extending from the arcuate sides of the partition plate 43 and along the sides of the respective bottom plates 51. These side plates 52 taper towards the outer edges of the bottom plates 51, so that the two buckets 44 and 45 will be substantially scoop-shaped as shown.

The receptacle 42 is pivotally supported for tilting movement desirably by means of trunnions 55, journalled into the opposite ends of the frame bar 48, and extending axially inwardly from screws 56 respectively, these being threaded into respective bushings 57 on the sides of the vessel 34.

The receptacle 42 is tilted from the position shown in Fig. 3 to a reverse position with respect thereto, and is yieldably held in either one of these two extreme positions by means of a spring snap device, desirably comprising a leaf spring 60, compressively coiled as shown, and having its upper end anchored in a V-shaped recess in the lower edge of the frame bar 48, and having its lower end anchored in a V-shaped recess of a headed pin 61. The tension of this spring 60 may be regulated by means of a stud 62, which is threaded in a bushing 63 on the lower side of the vessel 34, and which serves as a seat for the head of the pin 61, and as a journal for the depending shank 64 of said pin. A plug 65 may be threaded in the lower end of the bushing 63 to close said bushing.

The lower end of the spring 60, and the pivot axis of the trunnions 55 are in substantial vertical alignment along a common center line A, while the lines of action of the frame bar 48 and of said spring meet at the point B on either side of said center line in either extreme tilted position of the receptacle 42. By means of this arrangement, the snap device described operates as a spring toggle.

In order to predetermine the two extreme tilted positions of the receptacle 42, limiting stops are provided, desirably in the form of curved plates 67, connected to the outer ends of the bottom bucket walls 51 respectively, and adapted to engage the top wall of the vessel 34 in said extreme positions. These curved plates 67 have a

certain spring action, so that they act as bumpers to dampen the shock caused by the snap stop engagement of these plates with the top wall of the vessel 34.

It should be noted that the receptacle 42 is pivotally supported near the heel of the two component scoop-like buckets 44 and 45, so that the liquid in the buckets in filling position has its center of gravity spaced horizontally from the vertical plane of the pivot supports 55, and thereby creates a gravitational leverage on the filling bucket tending to tilt it.

It should also be noted that the receptacle 42 is so constructed and so positioned with respect to the inlet 35, that either bucket in extreme position of said receptacle will be disposed directly below said inlet in filling position, with its bottom wall 51 inclined upwardly from the frame bar 48, while the other bucket is in dumping position with its bottom wall 51 inclined downwardly.

In the operation of the vaporizing device 31, assuming that the receptacle 42 is in tilted position shown in Fig. 3, the bucket 45 will be in filling position with respect to the inlet 35. Since the auxiliary condenser 29 is operated in the low temperature section of the evaporator unit 10 and is operated at a lower temperature than the main condenser 23, the liquid collected in the receiver 27 from said main condenser will evaporate and condense in said auxiliary condenser 29, and the resultant condensate will flow by gravity into the vessel 34 through the inlet 35 to fill the bucket 45. When the weight of the liquid in the bucket 45 is sufficient to gravitationally over balance the spring tension of the toggle yieldably holding the receptacle 42 in the position shown, said receptacle will rotate clockwise about its pivotal supports 55 until the left hand stop 67 reaches the top wall of the vessel 34. In this position of the receptacle 42, the bucket 45 will dump its contents into contact with the warmer surfaces of the walls of the vessel 34, and the dumped refrigerant will evaporate at a rate faster than the rate of condensation in the auxiliary condenser 29. This will create a vapor pressure in the vessel 34, which is transmitted back into the receiver 27, and which will push the liquid in said receiver up through the riser conduit 28 and into the header 21. During this phase of the operation, the check valve 26 will be automatically closed against return flow therethrough.

When all of the liquid dumped from the bucket 45 has been evaporated from the vaporizing vessel 34, the auxiliary condenser 29 will again start its condensing function, and will thereby cause the pressure in the receiver 27 to drop, and the liquid condensate to flow again from the main condenser 23 through the check valve 26 and into the receiver 27.

An additional check valve can be used between the receiver 27 and the secondary evaporator unit 20, if desired, to function in case the pressure of the vapor formed in the vaporizing chamber 34 is not sufficient to blow out all the liquid from the receiver 27 in one operation of the dumping bucket.

When the unit 29 starts to function again as a condenser, the condensate from said unit will start flowing into the bucket 44, which has been raised into filling position by the previous dumping operation of the bucket 45, so that the operation previously described is repeated.

As far as certain aspects of the invention are concerned, in place of the spring snap arrangement shown, the receptacle 42 may be weighted as for instance at the upper end of the partition plate 43, or if desired a combination of spring snap device or counter-weight may be used. Also, instead of using a double alternately operating bucket arrangement as described, as far as certain aspects of the invention are concerned, a single bucket may be provided which is automatically returned in position by some spring or counter-weight device after said bucket has been tilted into dumping position.

Although certain novel features of the invention have been shown and described and are pointed out in the annexed claims, it will be understood that various omissions, substitutions and changes in the several steps of the method and in its operation and in the form and details of the apparatus illustrated may be made by those skilled in the art without departing from the spirit of the invention.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent is:

1. A method of heat transfer, which includes the steps of simultaneously vaporizing liquid at one station and condensing the vaporized liquid at a lower station, collecting the condensate from said lower station in a receiver at a level below said latter station, vaporizing a portion of the liquid in said receiver and condensing the vaporized liquid, delivering the condensed liquid from this last mentioned operation into a vaporizing vessel to create liquid lifting vapor pressure therein, and transmitting this vapor pressure to the receiver to force the liquid therefrom into said first mentioned station.

2. A heat transfer circuit including an evaporator, a condenser at a level below that of said evaporator and connected to receiver vapor from said evaporator, and a vessel connected to receive liquid from said condenser and deliver liquid to said evaporator respectively upon decrease and increase of pressure in said vessel, and means to cause said pressure changes including a second condenser connected to receive vapor from said circuit, a heater communicating with said vessel, and means for intermittently delivering liquid from said second condenser to said heater.

3. A heat transfer circuit including an evaporator, a condenser at a level below that of said evaporator and connected to receive vapor from said evaporator, and a vessel connected to receive liquid from said condenser and deliver liquid to said evaporator respectively upon decrease and increase of pressure in said vessel, and means to cause said pressure changes including a second condenser connected to receive vapor from said circuit, a heater communicating with said vessel, and means including a tilt-type bucket for collecting liquid from said second condenser and intermittently delivering collected liquid to said heater.

4. A heat transfer circuit including an evaporator, a condenser below said evaporator and connected to receive vapor therefrom, and a vessel connected to receive liquid from said condenser and deliver the liquid to said evaporator respectively upon decrease and increase of pressure in said vessel, and means to cause said pressure changes including a second condenser which is smaller than said first condenser and connected to receive vapor from said circuit, a heater communicating with said vessel, and

means for intermittently delivering liquid from said smaller condenser to said heater.

5. A heat transfer circuit including an evaporator, a condenser at a level below that of said evaporator and connected to receive vapor from said evaporator, a vessel connected to receive liquid from said condenser and deliver the liquid to said evaporator respectively upon decrease and increase of pressure in said vessel, and means to cause said pressure changes including a second condenser connected to receive vapor from said vessel, a heater communicating with said vessel, and means for intermittently delivering liquid from said second condenser to said heater.

6. A heat transfer circuit including an evaporator, a condenser at a level below that of said evaporator and connected to receive vapor from said evaporator, a vessel connected to receive liquid from said condenser and deliver the liquid to said evaporator respectively upon decrease and increase of pressure in said vessel, and means including a tilt-type bucket for collecting liquid from said second condenser and intermittently delivering collected liquid to said heater.

7. A heat transfer circuit including an evaporator, a condenser below said evaporator and connected to receive the vapor from said evaporator, a vessel connected to receive liquid from said condenser and deliver liquid to said evaporator respectively upon decrease and increase of pressure in said vessel, and means to cause said pressure changes including a second condenser smaller than said first condenser and connected to receive vapor from said vessel, a heater communicating with said vessel, means for intermittently delivering liquid from said second condenser to said heater, and means to receive heat from said condensers operative to cool said second condenser to a lower temperature than said first condenser.

8. A heat transfer circuit including an evaporator, a condenser below said evaporator and connected to receive vapor therefrom, a vessel connected to receive liquid from said condenser and deliver liquid to said evaporator respectively upon decrease and increase of pressure in said vessel, and means to cause said pressure changes including a second condenser smaller than said first condenser and connected to receive vapor from said vessel, a heater communicating with said vessel through said second condenser, means including a tilt-type bucket for collecting liquid from said second condenser and intermittently delivering collected liquid to said heater, and refrigerating apparatus for taking heat from said condensers and operative to cool said smaller condenser to a lower temperature than said first condenser.

9. A method of transferring heat which includes producing a cooling effect by evaporating liquid at a first elevation, conducting the resulting vapor to a lower elevation and there condensing the vapor to liquid, segregating a portion of the condensed liquid by distillation, and vaporizing said portion to produce pressure for raising another portion upward to said evaporator.

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