May 23, 1939. R. T. BRIZZOLARA 2,159,251

REFRIGERATION METHOD AND APPARATUS

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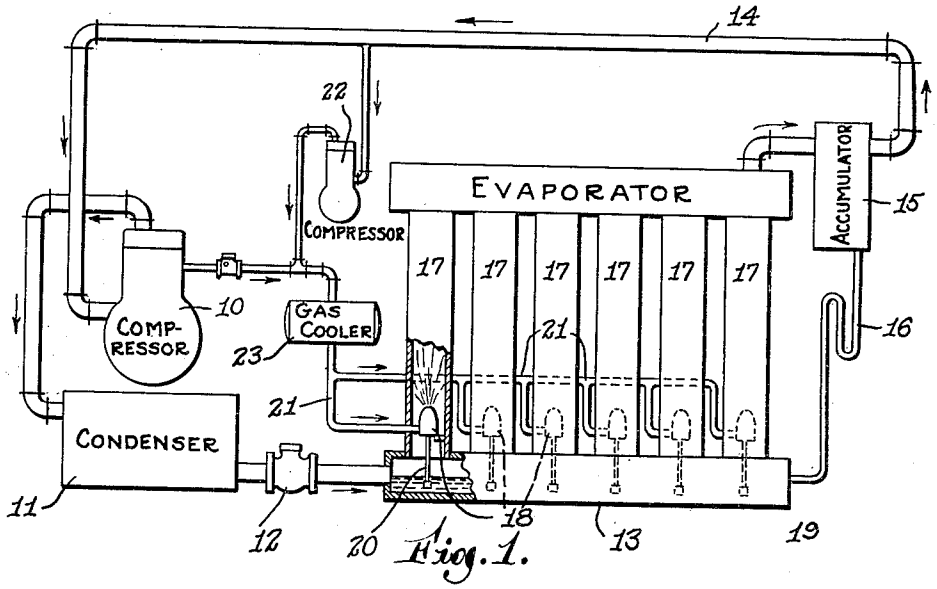

Fig. 1.

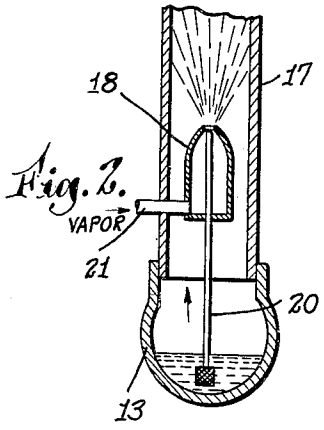

Fig. 2.

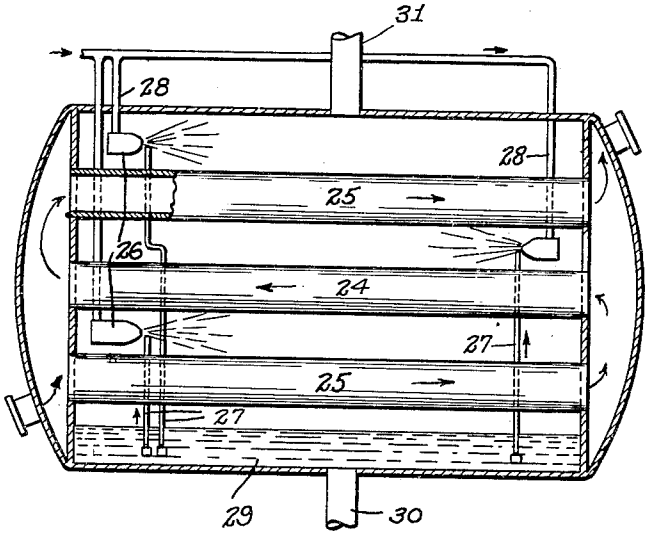

Fig. 3.

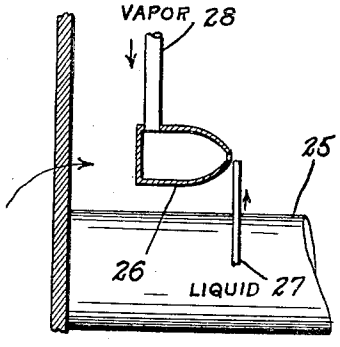

Fig. 4.

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Fig. 5.

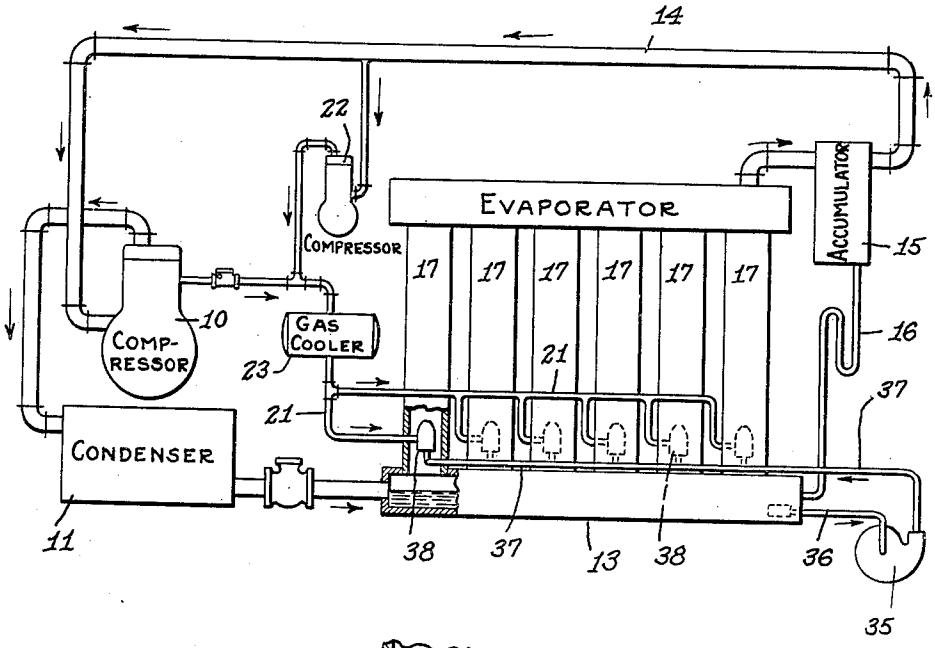
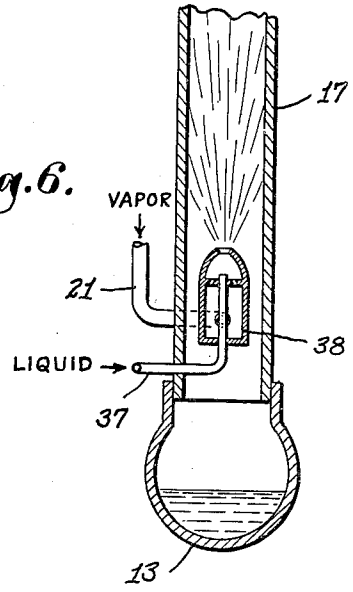


Fig. 6.



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REFRIGERATION METHOD AND APPARATUS

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12 Claims. (Cl. 62—115)

This invention relates to refrigeration methods and apparatus, and relates more particularly to methods and apparatus for the spraying of liquid refrigerant within the evaporators of refrigerating systems.

In refrigerating systems in common use, it is the practice to use relatively large quantities of refrigerant for each unit for a given refrigerating effect. This, because it is the practice to flood the evaporators completely, thus requiring heavy charges of refrigerants to make the cooling surfaces effective, and such systems have not only the risk of sucking over some of the refrigerant liquid into the vapor compressors, but it is necessary to overcome with the suction pressure, the liquid head trying to hold the generated vapors on the evaporator surfaces. Vapor bubbles formed on these tubes tend to adhere and thus destroy the surface effectiveness.

According to this invention, relatively small quantities of refrigerant are required for a given refrigerating effect, and this is accomplished by spraying the liquid refrigerant into the evaporators of refrigerating systems. By spraying the liquid upon the inner or outer surface of the evaporators, the surface is continuously kept wetted as the refrigerant is evaporated by the heat applied upon the opposite surface of the evaporators. The spraying of the refrigerant also wipes away as fast as it forms, the vapor upon the evaporating surface of the evaporators.

A feature of the invention resides in its usefulness with those refrigerants that are miscible in oil. In the past, it has been a problem to get the oil from the evaporators back to the compressor, but according to the present invention, any oil in the refrigerant is kept in a fog-like state of suspension with the refrigerant, and in this form can readily be sucked back to the compressor without difficulty or danger since it is finely atomized.

An object of the invention is to provide in a refrigerating system, an efficient evaporator arrangement in which the liquid is sprayed upon the inner surface of the evaporators.

Another object of the invention is to provide methods and apparatus for efficiently and effectively spraying the inner or outer surface according to the design of the evaporators with refrigerant.

Other objects of the invention will be apparent from the following description, taken together with the drawings.

The invention will now be described with reference to the drawings of which:

Fig. 1 is a diagrammatic view of a refrigerating system according to this invention;

Fig. 2 is a view in section of an atomizing device, arranged to discharge within an evaporator, according to this invention;

Fig. 3 is a view partially in section of an evaporator with horizontal tubes which may be used to replace the evaporator with the vertical tubes of Fig. 1;

Fig. 4 is a sectional view of an atomizing device for use with the evaporators of Fig. 3;

Fig. 5 is a diagrammatic view of a refrigerating system according to this invention similar to that of Fig. 1 except that the liquid is forced into the atomizing nozzles by positive pressure, and

Fig. 6 is a sectional view of an atomizing nozzle particularly suitable for use with the evaporator of Fig. 5.

With reference to Fig. 1, the compressor 10 which may be of any well known type, reciprocating or centrifugal, compresses a refrigerant vapor which may be ammonia or any other known refrigerant, and supplies it to the condenser 11 which may be of the usual type, in which condenser the vapor is converted to a liquid which ultimately passes through the expansion valve 12 and then following a reduction in pressure in the expansion valve, passes into the evaporator 13. The evaporated refrigerant vapor leaving the evaporator passes through the tube 14 to the suction side of the compressor 10. The usual accumulator 15 and trap 16 may be provided.

According to a feature of the invention, each of the evaporator tubes 17 has associated with it, the spray device or nozzle 18. The refrigerant entering the evaporator accumulates as liquid in the lower header 19. A tube 20 having its lower end below the level of the liquid in the lower header, enters the lower portion of each nozzle 18 and terminates as shown by Fig. 2 just short of the upper tip of the nozzle. Gas or vapor from any suitable source is supplied through a pipe 21, to each of the nozzles. In the embodiment of the invention illustrated, this gas or vapor is preferably bled off from the compressor 10 before the vapor therein reaches the condenser pressure, or the vapor at the same or a higher pressure may be supplied from an auxiliary compressor 22 which may be provided for the purpose of supplying this vapor to the nozzles. Where required, the gas cooler 23 may be provided for cooling the vapor before it is supplied to the nozzles.

The compressed vapor entering the nozzles through the pipes 21 expands upon being dis-

charged from the nozzles, and inspirates by well known injector action, liquid from the lower header 13 through the tubes 20. The liquid is then sprayed in a finely divided condition upon the inner walls of the evaporator tubes. As this liquid is evaporated, it is continuously replaced by newly atomized liquid which not only serves to keep the inner surface of the evaporator tubes continuously wetted, but also serves to wipe away the vapor as it is formed by evaporation, upon the inner surface of the tubes.

Any excess refrigerant drains back into the lower header 19 which serves as a sump. The supply of refrigerant in the lower header 19 is augmented by a refrigerant supplied from the condenser equal to the amount evaporated through any well known type of liquid receiver. It is obvious, of course, that the expansion valve 12 may be omitted and that the usual high pressure and low pressure floats may be provided to serve as expansion valves and for maintaining the desired liquid levels in the liquid receiver or condenser, and in the lower header 19 serving in this case, as a liquid sump.

In the form of evaporators shown by Fig. 1, the tubes are arranged vertically, and each tube is provided with its own spray nozzle. This form of evaporator may be replaced with the form of shell and tube evaporator shown by Fig. 3, where the exterior surface of one or more intermediate evaporator tubes 24 is sprayed from above with refrigerant in one direction, while the outer surface of the evaporator tubes 25 placed on either side is sprayed with the refrigerant in the opposite direction. Fig. 4 illustrates the nozzles 26 which may be used with this form of evaporator, the liquid entering through the tube 27 under the action of the vapor supplied through the tubes 28. A sump 29 is provided in the bottom of the evaporator and the liquid is supplied through the tube 30 and the vapor is returned to the suction side of the compressor through the tube 31. In this form of evaporator, the liquid or gas to be cooled circulates through the heads and tubes. The refrigerant wets the external surfaces of these tubes. A modification of this same type of cooler circulates the agent to be cooled through the shell from top to bottom or end to end. In this modification, the refrigerant is sprayed through the tubes and heads.

The embodiment of the invention shown by Fig. 5 is similar to that shown by Fig. 1, except that the liquid refrigerant, instead of being supplied by the injector effect of the vapor supplied to the nozzles, is forced into the nozzles by the pump 35, which draws liquid through the pipe 36 from the lower header 13 and forces it through the pipe 37 into each of the nozzles 38, which are shown in detail by Fig. 6. Except for the addition of the pump described above, and the modification of the nozzles, the embodiment illustrated by Fig. 1 is the same as that illustrated by Fig. 5, and hence the corresponding devices of Figs. 1 and 5 have been given the same reference characters. The gas or vapor entering the nozzles 38 of Figs. 5 and 6 serves only however, to atomize the liquid refrigerant and does not serve as illustrated by Figs. 1 and 2 to induce the flow of refrigerant into the nozzles. This, in the embodiment illustrated by Figs. 5 and 6, is accomplished by the positive pressure of the pump 35. By pumping the refrigerant into the individual spray nozzles 38, the spray nozzles can be removed further away from the source of the liquid supply or sump; heavier refrigerants and oil loaded refrigerants can be more effectively sprayed on the surface of the evaporators, and the vapor formed by evaporation can be more effectively removed.

It is obvious, of course, that a pump such as shown by Fig. 5 could be used with the form of evaporator shown by Fig. 3. It is also believed to be obvious that more or less nozzles than are illustrated may be used. If desired, nozzles may be placed in each end of each evaporator tube, the nozzles spraying towards each other, likewise each evaporator tube could be provided at its center with nozzles spraying in both directions.

It is also believed to be apparent that vapor supplied to the nozzles for inducing the flow of refrigerant and for vaporizing same in the embodiments shown by Figs. 1 to 4 inclusive, or for merely atomizing the refrigerant as shown by embodiments illustrated by Figs. 5 and 6, may be bled off from the compressor at any point during compression and which supplies the refrigerant for the condenser and subsequently for evaporation or may be wholly supplied by a separate compressor, all of which compressors may be of the centrifugal, reciprocating, rotary, or any other type. Likewise, an auxiliary compressor may be used to augment the supply of vapor from a main compressor to the spray nozzles. Likewise, other forms of atomizing devices than those illustrated may be used, such devices having reached a high state of development in their individual field, and the spray form, shape, direction and density may be controlled as desired.

The nozzles may be supported in any suitable manner in association with the evaporator tubes, and made accessible for ready removal.

It is also believed to be apparent that the introduction of strainers or filters at the points where liquid refrigerant in the sump enters tubes for distribution by the nozzles may be furnished to eliminate possibilities of clogging by foreign materials.

While, several embodiments of the invention have been described for the purpose of illustration, it should be understood that the invention not be limited to the precise arrangements described, since many departures may be suggested by those skilled in the art, without departing from the spirit of the invention.

What is claimed is:

1. The method in refrigeration which comprises spraying liquid refrigerant on to the surface of an evaporator, and utilizing compressed refrigerant vapor to atomize the liquid which is being sprayed.

2. The method in refrigeration which comprises compressing a refrigerant vapor, condensing a portion of the vapor to a liquid, spraying the liquid upon a surface of an evaporator, and utilizing non-condensed refrigerant vapor to atomize the liquid which is being sprayed.

3. Refrigeration apparatus comprising in combination, means for compressing refrigerant vapor, a condenser, an evaporator, atomizing means arranged to discharge upon the evaporating surface of said evaporator, means for passing refrigerant from said first mentioned means to said condenser, means for passing liquid refrigerant from said condenser to said atomizing means, and means for passing vapor refrigerant from said first mentioned means in a course bypassing said condenser, to said atomizing means.

4. Refrigeration apparatus comprising in com-

bination, a compressor, a condenser connected to said compressor, an evaporator tube, an atomizing nozzle arranged to discharge a spray of liquid refrigerant upon the evaporating surface of said tube, means for conveying liquid from said condenser to said nozzle, and means for supplying compressed refrigerant vapor to said nozzle to atomize said liquid.

5. Refrigeration apparatus comprising in combination, a compressor, a condenser connected to said compressor, means forming a liquid sump, connected to said condenser, an evaporator tube, an atomizing nozzle arranged to discharge a spray of liquid refrigerant upon the evaporating surface of said tube, means for conveying liquid from said sump to said nozzle, and means for supplying compressed refrigerant vapor to said nozzle to atomize said liquid.

6. Refrigeration apparatus comprising in combination, refrigerant compressor means, a condenser connected to said means, an evaporator, a spray nozzle arranged to discharge a spray of liquid refrigerant upon the evaporating surface of said evaporator, means for conveying liquid from said condenser to said nozzle, and means for supplying compressed refrigerant vapor from said compressor means in a course by-passing said condenser, to said nozzle for aiding in atomizing said liquid.

7. Refrigeration apparatus comprising in combination, refrigerant compressor means, a condenser connected to said means, means forming a liquid sump, connected to said condenser, an evaporator, a spray nozzle arranged to discharge a spray of liquid refrigerant upon the evaporating surface of said evaporator, means for conveying liquid from said sump to said nozzle, and means for supplying compressed refrigerant vapor from said compressor means, in a course by-passing said condenser, to said nozzle for aiding in atomizing said liquid.

8. The method in refrigeration which which comprises compressing a refrigerant vapor, bleeding off a portion of the vapor before it reaches condenser pressure, condensing the other portion of the vapor to a liquid, projecting the liquid upon a surface of an evaporator, and utilizing the bled off vapor to atomize the liquid which is being projected.

9. Refrigeration apparatus comprising in combination, means for compressing refrigerant vapor to condenser pressure, a condenser connected to said means for liquefying compressed vapor, an evaporator tube, means for bleeding off a portion of said vapor before it reaches condenser pressure, and means for projecting liquid from said condenser and said bled off vapor in a spray upon the evaporating surface of said tube.

10. The method in refrigeration which comprises compressing a refrigerant vapor, condensing a portion of the vapor to a liquid, and utilizing the non-condensed portion of the refrigerant vapor to spray the liquid upon a surface of an evaporator and to atomize the liquid which is being sprayed.

11. Refrigeration apparatus comprising in combination, means for compressing refrigerant vapor, a condenser for liquefying a portion of the compressed vapor, an evaporator, atomizing means arranged for projecting a blast of compressed vapor and liquid droplets upon an evaporating surface of said tube, means for pumping liquid from said condenser to said atomizing means, and means for supplying non-condensed vapor from said first mentioned means to said atomizing means.

12. Refrigeration apparatus comprising in combination, means for compressing refrigerant vapor, a condenser for liquefying a portion of the compressed vapor, an evaporator, atomizing means arranged for projecting a blast of compressed vapor and liquid droplets upon an evaporating surface of said tube, means forming a liquid sump for receiving liquid from said condenser, and means for supplying non-condensed vapor to said atomizing means for drawing liquid from said sump and for spraying it upon a surface of said evaporator.

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