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REFRIGERANT CONTROLLING AND EXPANSION APPARATUS

Original Filed May 17, 1941

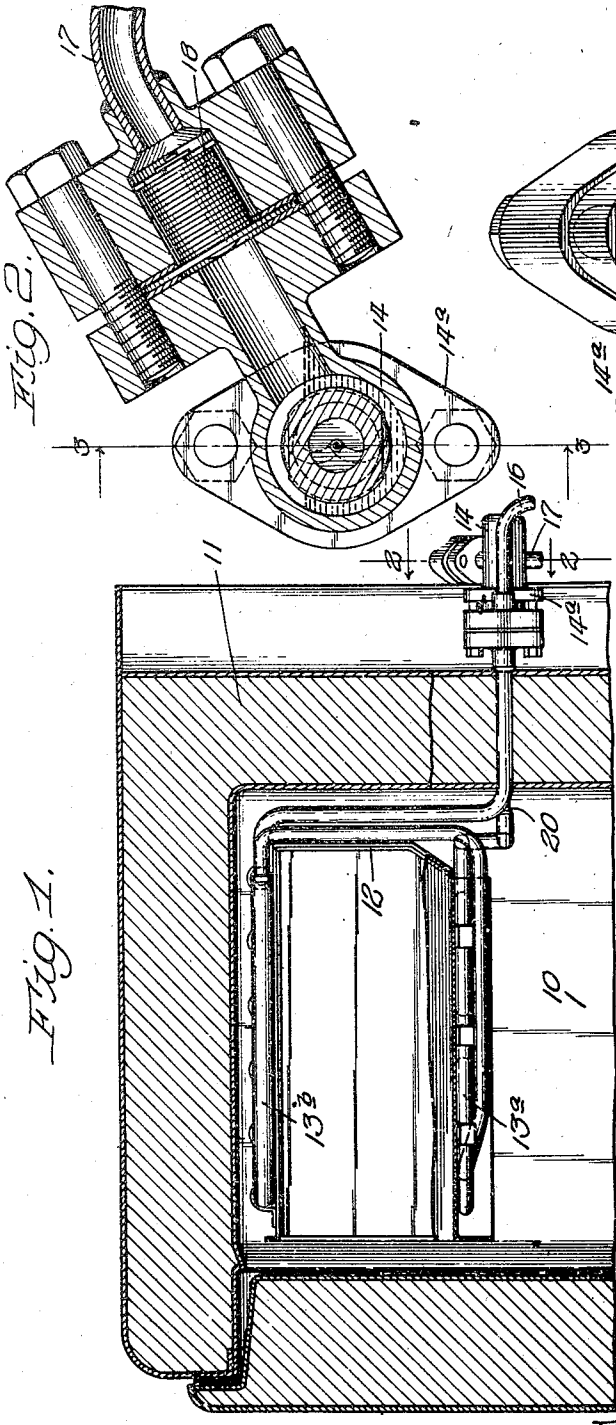


Fig. 1.



Fig. 2.

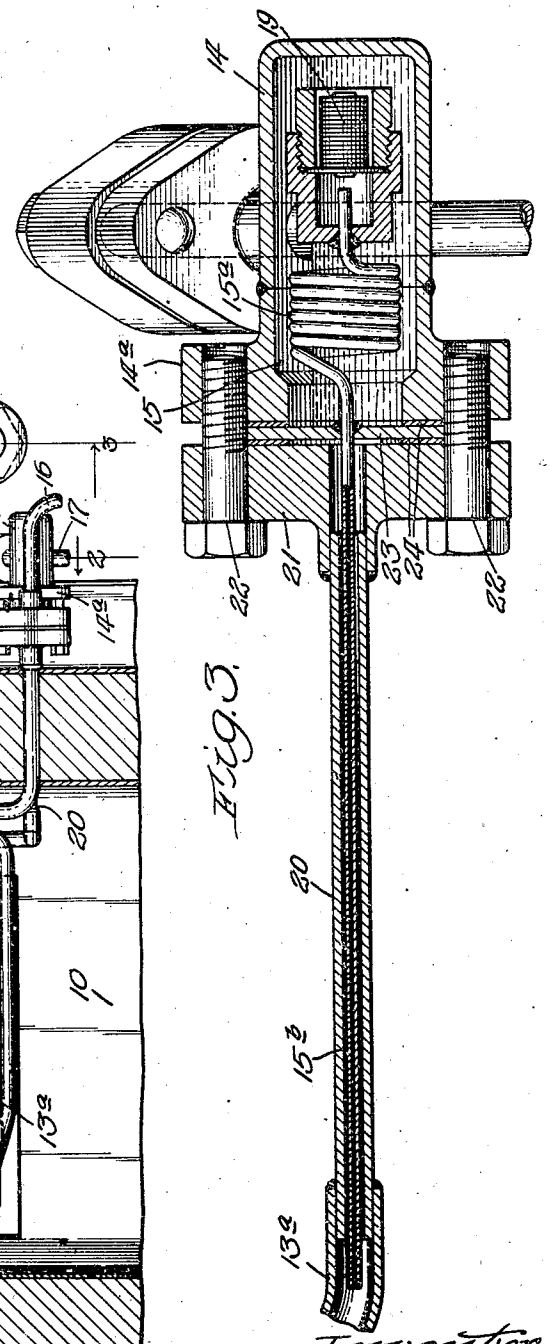


Fig. 3.

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## REFRIGERANT CONTROLLING AND EXPANSION APPARATUS

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5 Claims. (Cl. 62—127)

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This invention relates to refrigerant controlling and expansion apparatus, and more particularly to a capillary tube and an evaporator of the continuous tubing type, with an improved means for connecting them.

One feature of this invention is that it provides improved means for operatively associating an automatically controlled capillary tube and an evaporator, particularly where the two lie primarily on opposite sides of an insulated wall, as the back wall of the food compartment of a refrigerator; another feature of this invention is that it increases the efficiency of the refrigerator by preventing frosting back on the inlet side of the evaporator; and yet another feature of this invention is that the capillary tube and its associated receiver may be readily separated from the evaporator in the field for servicing or replacement. Other features and advantages of this invention will be apparent from the following specification and the drawing, in which:

Figure 1 is a partial vertical cross sectional view of a domestic refrigerator of the absorption type; Figure 2 is a sectional view along the line 2—2 of Figure 1; and Figure 3 is a sectional view along the line 3—3 of Figure 2.

This application is a divisional of my copending application Serial No. 394,031, filed May 17, 1941, which issued as Patent No. 2,334,219 on November 16, 1943; and a continuation-in-part of my copending application Serial No. 361,629, filed October 17, 1940, which issued as Patent No. 2,339,815 on January 25, 1944.

Flat plate or "shelf" types of evaporators have met with increasing favor in domestic refrigerators, yet such evaporators present certain problems, particularly with respect to uniform cooling over the entire area of the shelf of the evaporator at various refrigeration rates, claims to my improved arrangement in this regard being incorporated in the first of my above-mentioned patents. In addition, where a capillary tube is used, with an arrangement for automatically controlling the rate of flow through the capillary, the subject matter of the second of my above-mentioned patents, a problem of considerable importance is presented in arranging a satisfactory connection between the evaporator in the interior of the food compartment and the capillary tube having its major portion outside of the food compartment, particularly in a continuous absorption refrigerator. The primary problem, of course, is to prevent frosting back through the food compartment wall on the inlet side of the evaporator; and where the refrigerator is of the continuous absorption type this problem cannot

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be met by the use of an accumulator, but must be solved in some other way.

I have solved this problem by providing a section of straight tubing of small diameter extending through one of the insulated walls of the food compartment and having its inner end connected to the evaporator, and by having the capillary tube terminate in a straight portion received by such section of tubing in a close but removable fit, the section of tubing and the capillary tube being removably sealed together, outside of the food compartment, by flanges and bolts.

Referring now more especially to the particular embodiment of my invention illustrated in the accompanying drawing, a domestic refrigerator is shown having a food compartment 10 with insulated walls, including the back wall 11. While the arrangement which is the subject matter of this application has advantages in any type of refrigerator, it was particularly designed for a continuous absorption domestic refrigerator, where its advantages are realized to the fullest. The evaporator is shown at the top of the food compartment 10 and comprises a sheet metal box 12 and upper and lower loops of tubing, here identified as 13*a* and 13*b*, the tubing extending continuously from its inlet to its outlet connection, although it is looped in two different planes.

The particular continuous absorption system which I employ for circulating refrigerant is shown in a schematic diagram and fully described in the second of my above-mentioned patents. Accordingly, it is believed sufficient to merely briefly describe the system here.

Rich liquor (a refrigerant-absorbent mixture) is boiled in a still by the application of heat, and the refrigerant vapors are passed through analyzing and rectifying means to remove any entrained water vapors, then liquified in an air-cooled condenser. From the condenser the refrigerant is delivered (in liquid slugs separated by refrigerant vapor) to a receiving chamber or capillary tube housing 14 at the back of the food compartment. Liquid refrigerant in this receiver passes through a capillary tube 15 and is delivered to the inlet end of the lower section of evaporator tubing 13*a*, the details of this connection being described more fully hereafter. The liquid refrigerant vaporizes in the evaporator tubing, in a manner more fully described in the first of my above-mentioned patents, and then passes out through the outlet and a pipe 16 to an absorber, where it is reabsorbed (at low pressure) in the absorbent liquid. In the case of my particular system, the refrigerant is ammonia and the absorbent water.

The still and condenser of a water-ammonia absorption system operate at high pressure, generally from 150 to 250 pounds per square inch; and the evaporator and absorber operate at low pressure, generally from 10 to 20 pounds per square inch. In order to maintain the desired quantities and concentrations of liquid throughout the system, it is necessary to have a liquid circuit between the absorber and the still, moving weak liquor from the still to the absorber and rich liquor from the absorber to the still at intervals. This is accomplished by an intermediate transfer chamber which receives liquid from the absorber at low pressure and is then raised to high pressure to deliver it to the still. This basic system was fully illustrated and described in a number of issued Schurtz patents, a representative one in this regard being Patent No. 1,414,527, which issued May 2, 1922.

While the particular view shown in the accompanying drawing is a side elevation, and therefore does not make the continuity of the evaporator tubing perfectly obvious, it will be understood that there is a single continuous refrigerant flow path from the receiver to the outlet pipe **16**. While for purposes of manufacturing convenience, this single continuous flow path may be formed by welding together various sections of tube, in finished form it is in effect a single tube leading from its connection with the receiver to the lower horizontal plane, looping back and forth in that plane, passing up to and looping back and forth in a higher plane parallel to but spaced from the first-mentioned plane, and then connecting to the pipe **16**. It will be noted that, in the arrangement shown here, all of the active or operative part of the evaporator is above the level of the receiver **14**. This complicates the problem of making a connection on the inlet side which does not frost back through the insulated wall, since all of the refrigerant delivered to the evaporator must, in effect, be forced up-hill from the point of delivery.

If all of the capillary tube were placed in the food compartment, on the inner side of the insulated wall, the problem would be greatly simplified. On the other hand, if the capillary tube could be split in the middle when it was desired to open the connection, trouble with frosting back might also be more easily overcome. The first of these alternatives is undesirable, however, because it is desirable to have the major portion of the capillary tube coiled in a helix (here identified as **15***a*) and lying within the receiver. The second is impracticable because any separation of a capillary tube throughout its course would result in almost inevitable plugging up of the tube when the parts were reconnected.

The slugs of refrigerant are delivered to the receiver **14** from the condenser through a pipe **17** and a filter **18**. When the refrigerant reaches the receiver **14** the liquid and vapor separate, as may be best seen in Figure 3, the liquid occupying the lower part of the receiver and the vapor the upper part. Refrigerant in the receiver passes through another filter **19** and enters the inlet end of the capillary tube **15**, passing through the coils **15***a*, and then along the straight portion **15***b* in which the capillary tube terminates. Heat transfer to the liquid refrigerant passing through the capillary tube tends to gasify it and retard its flow; and practically all of the heat transfer is from condensation of hot refrigerant vapor in the upper part of the receiver on the exposed portions of the capillary coils. As was fully described in the second of my above-mentioned patents, the level of liquid in the receiver is a function of the rate at which refrigerant is delivered to the receiver and the rate at which it leaves it through the capillary tube; and variations in these rates cause variations in the height of the liquid in the receiver, automatically causing the rate of delivery of refrigerant through the capillary tube to be the function of the rate of delivery of the refrigerant to the receiver.



This is a very important factor in an absorption refrigerator, and has for the first time enabled the use of a capillary tube in such a refrigerator. This desired automatic flow regulation can only be achieved where the receiver is hot, at substantially condenser temperatures; and the receiver cannot be kept hot unless it is on the outside of the insulated wall **11**, and not within the food compartment, where it would be cooled.

In order to enable the receiver and the major portion of the capillary tube to be located outside the food compartment wall, and to deliver refrigerant to a continuous tubing evaporator located above the level of the receiver, so that refrigerant works up through the evaporator to get the desired uniformity of cooling in the manner brought out in the first of my above-mentioned patents, I have devised the connection arrangement which is the subject matter of this application.

The inlet side of the evaporator tubing has a straight section **20** of small diameter, this section passing through the insulated wall **11**. The outer end of this section is provided with a flange **21** permanently connected to it as by welding, soldering and the like. As may be best seen in Figure 3, one end of the receiver **14** is provided with a flange **14***a* adapted to be removably fastened to the flange **21**, as by the bolts **22**. The straight end portion **15***b* of the capillary tube projects through an opening in the center of a plate member **23**, the capillary tube being permanently sealed in this opening in any appropriate manner. When the parts are assembled, the capillary tube-plate-filter combination is placed in the position shown in the drawing, with the straight end portion of the capillary tube slipped into the straight section of tubing **20**. Then the receiver **14** is brought into place over the outer end of this combination and the flanges joined together, gaskets **24** preferably being used to provide a good seal.

The straight portion **15***b* of the capillary tube is preferably a close but sliding fit, with only a very few thousandths of an inch difference in the external diameter of the capillary tube and the internal diameter of the section **20**. The space between the outer wall of the capillary tube and the inner wall of the section **20** of tubing should be so small that refrigerant will not pass through it. Under these conditions refrigerant is delivered from the outlet end of the capillary tube (the left-hand end in Figure 3) to a larger diameter section of the evaporator tubing, and at a point well within the food compartment, to the inner side of the insulated wall **11**. The fit of the straight portion of the capillary tube in the section **20** of evaporator tubing, however, is so close the liquid refrigerant does not back down to the outside of the insulated wall; yet the connection is such that it is readily removable, and unbolting the flanges enables the capillary tube to be removed and replaced, the filter **19** to be serviced, and the like.

While I have shown and described certain embodiments of my invention, it is to be understood that it is capable of many modifications. Changes, therefore, in the construction and arrangement may be made without departing from the spirit and scope of the invention, as disclosed in the appended claims.

I claim:

1. In combination with a refrigerator cabinet with a food compartment having insulated walls and an evaporator therein having an inlet, refrigerant controlling and expansion apparatus, including: a section of straight tubing of small diameter extending through one of the insulated walls, the inner end of said section opening into the inlet of the evaporator; and a capillary tube having the major portion thereof outside of said one insulated wall and terminating in a straight portion received by said section of tubing in a close fit, the inner end of the capillary tube extending within said insulated wall.

2. In combination with a refrigerator cabinet with a food compartment having insulated walls and an evaporator therein having an inlet, refrigerant controlling and expansion apparatus, including: a section of straight tubing of small diameter extending through one of the insulated walls, the inner end of said section opening into the inlet of the evaporator; a chamber outside of said one insulated wall adapted to receive liquid refrigerant; and a capillary tube having the major portion thereof in said chamber and terminating in a straight portion received by said section in a close but removable fit, the inner end of the capillary tube extending within said insulated wall.

3. Apparatus of the character claimed in claim 2, wherein the outer end of said section of tubing is provided with a flange and there is a cooperating member permanently connected to the capillary tube and removably connected to the first mentioned flange.



4. In combination with a refrigerator cabinet with a food compartment having insulated walls and an evaporator therein having an inlet, refrigerant controlling and expansion apparatus, including: a section of straight tubing of small diameter extending through one of the insulated walls, the inner end of said section opening into the inlet of the evaporator and at least the outer end thereof being lower than the evaporator, the outer end being provided with a flange; a chamber outside of said one insulated wall adapted to receive liquid refrigerant; and a capillary tube having the major portion thereof coiled in said chamber and terminating in a straight portion received by said section in a close but removable fit, the inner end of the capillary tube extending within said insulated wall, the chamber being provided with a flange, the capillary tube being provided with a plate member through which the straight portion of the capillary tube projects and to which it is permanently connected, this member being removably sealed between said flanges.

5. In combination with a refrigerator cabinet with a food compartment having insulated walls and an evaporator conduit therein, said evaporator comprising part of the low pressure portion of the refrigerator and there being a conduit in the high pressure portion, refrigerant flow controlling apparatus connecting said conduits, including: a capillary tube having a portion snugly but removably enclosed within a reduced portion of the evaporation conduit, the remainder and major portion of the capillary tube being enclosed within the high pressure conduit.

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