Sept. 14, 1954 D. E. HILLIKER ET AL 2,688,855

EVAPORATOR CIRCUIT

Filed Sept. 27, 1952

Fig. 1.

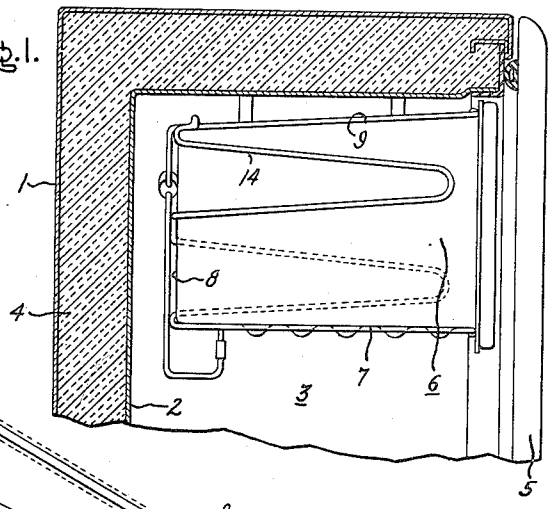


Fig. 2.

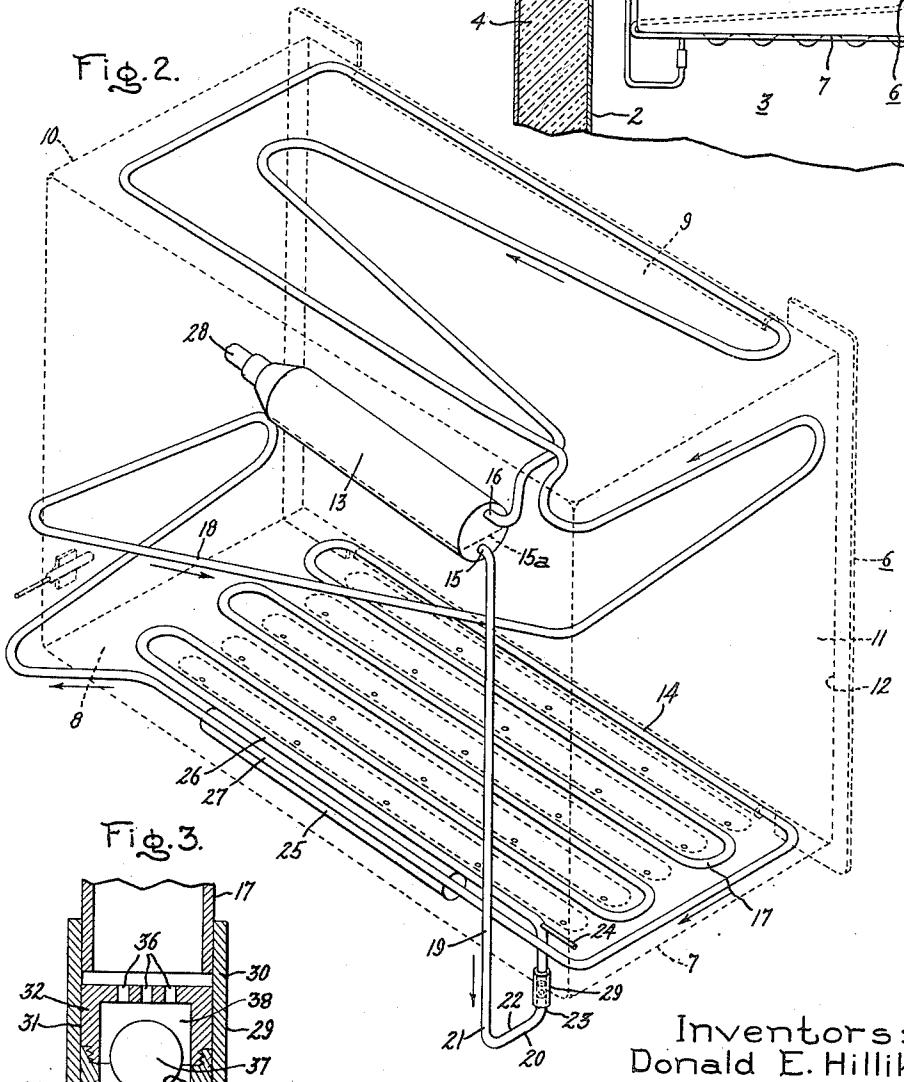


Fig. 3.

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EVAPORATOR CIRCUIT

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Application September 27, 1952, Serial No. 311,876

3 Claims. (Cl. 62—126)

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This invention relates to refrigerating systems and more particularly to such systems including defrosting arrangements.

In many household refrigerators, the evaporator for cooling the food storage compartment is exposed to the air within the compartment and is operated at a temperature below the freezing point of water. As a result, the moisture in the air within the food storage compartment condenses on the evaporator and collects thereon in the form of frost. This layer of frost on the surface of the evaporator has an insulating effect, reducing the efficiency of the evaporator in cooling the food storage compartment. It is accordingly necessary to remove this frost from time to time in order to prevent too serious a reduction in the operating efficiency of the refrigerating apparatus. In many cases, this defrosting is accomplished manually by stopping operation of the condensing unit and placing trays of warm water on the refrigerated surfaces of the evaporator. Defrosting in this manner is a somewhat time-consuming and disagreeable operation. This manual operation may be avoided by supplying heat in some manner to the evaporator or the tubing of which the evaporator is formed. In some cases, where such a defrosting system is incorporated, there may occasionally be erratic operation and it is desirable that this be avoided.

It is an object of this invention to provide an improved refrigerating system incorporating a defrosting arrangement.

It is another object of this invention to provide an improved defrosting arrangement including an improved arrangement for insuring circulation of refrigerant in the desired direction.

It is a further object of this invention to provide an improved refrigerating system including an improved arrangement for minimizing surging of refrigerant into the header and suction line.

Further objects and advantages of this invention will become apparent as the following description proceeds and the features of novelty which characterize this invention will be pointed out with particularity in the claims annexed to and forming a part of this specification.

In carrying out the objects of this invention, a refrigerating system is employed which includes a flooded evaporator having a header, and a continuous generally depending conduit connected at both ends thereto. The continuous conduit is connected to the header at one end through a vertical section which communicates with the header below the level of liquid refrigerant

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therein. A trap is provided at the bottom of this vertical section, and in accordance with this invention, a check valve is provided between the trap and the remainder of the conduit. This check valve minimizes surging of refrigerant upwardly through the aforementioned vertical section and into the header and suction line.

For the better understanding of this invention, reference may be had to the accompanying drawing in which Fig. 1 is a side elevation view of a portion of the refrigerator incorporating an embodiment of this invention.

Fig. 2 is a perspective, partially phantom, view of the evaporator.

Fig. 3 is a sectional enlarged view of the check valve structure.

Referring to the drawing, there is shown a refrigerator cabinet including an outer wall 1 and a spaced inner wall or liner 2, the inner wall 2 defining a food storage compartment 3. The space between the inner and outer walls is filled with a suitable insulating material 4. The access opening of the food storage compartment is closed by a door 5.

In order to cool the food storage compartment 3, an evaporator 6 is mounted in the upper portion of this compartment. The evaporator 6 includes a supporting wall structure, including a bottom horizontal wall 7, a rear vertical wall 8, a top wall 9, and two end walls 10 and 11. The wall structure defines a compartment 12 for the storing of frozen foods and the like.

The evaporator 6 is of the flooded recirculating type. The refrigerating portion of the evaporator includes a header 13, which is positioned near the top of the rear vertical wall 8. The evaporator includes continuous tubing 14 arranged in generally serpentine form and secured to the supporting wall structure. One end of the continuous tubing 14 is connected at 15 to the header 13 at a point below the normal level of the liquid refrigerant, indicated at 15a, in the header. The other end 16 of the continuous tubing 14 is connected in communication with the interior of the header 13 above the normal level of liquid refrigerant therein. By this arrangement, liquid refrigerant flows from the header to the tubing 14 through the connection at 15 and vaporized refrigerant is discharged into the header at 16. The continuous serpentine tubing 14 includes a first portion or section 17 which is arranged in a generally horizontal plane and is secured to the lower surface of the bottom wall 7 of the wall structure in any suitable manner, as by brazing or welding. The tubing fur-

ther includes a second portion or section 18 which is arranged in series with the first portion 17. The second portion, in the form illustrated, extends in heat exchange engagement with the rear wall 8, the end walls 10 and 11, and the top wall 9 of the wall structure. The tubing of the second portion 18 is secured to the exterior surfaces of these walls in any suitable manner, as by brazing or welding.

Liquid refrigerant is supplied from the header to the first portion 17 of the continuous tubing 14 through a vertical section 19. The tubing is formed to provide a trap 20 at the bottom of the vertical section 19, immediately preceding the beginning of the first portion 17 of the tubing. This trap 20 includes one vertical leg 21 aligned with the vertical section 19, a horizontal section 22, and a second vertical leg 23. The refrigerating system includes a condensing unit (not shown) and liquid refrigerant is supplied from the condensing unit to the evaporator through a capillary tube 24. The capillary tube 24 is connected to the tubing 14 at the beginning of the first or horizontal portion 17 thereof. The end of the capillary tube 24 is formed as an injector to inject liquid refrigerant into the evaporator circuit in the direction of the normal circulation of liquid refrigerant in the evaporator.

The evaporator 6 and the tubing 14 thereof are exposed to the air within the food storage compartment during operation of the refrigerator. In order to maintain a sufficiently low temperature in the food storage compartment 3, and in order to maintain a temperature within the compartment 12 sufficiently low for the preservation of frozen foods, evaporators of this type are normally operated at a temperature substantially below the freezing point of water. As a result, moisture in the air within the food storage compartment condenses on the evaporator and collects thereon as frost, eventually forming a blanket of such frost over the tubing and the walls of the evaporator. This frost acts as an insulating medium, reducing the cooling effect of the evaporator and reducing the efficiency of the refrigerating system. It is desirable, therefore, to remove this blanket of frost from time to time to maintain the operation of the refrigerating system at a reasonably high efficiency. In the embodiment illustrated, heat is supplied to the evaporator for vaporizing refrigerant within the tubing, so that the vaporized refrigerant, as it recondenses, gives up heat to the tubing for melting the frost therefrom. Specifically, a heater 25 is positioned in heat exchange relationship with two spaced sections 26 and 27 of the continuous tubing 14. The heater may be any type of device suitable for supplying heat to the tubing and to the liquid refrigerant therein; for example, it may be the sheathed insulated type of electrical heating element sold under the trade name Calrod.

During normal operation, refrigerant circulates through the tubing 14 of the evaporator in a direction indicated by the arrows, liquid refrigerant being supplied from the header to the vertical section 19 and vaporized refrigerant returning to the header 13 at the point 16. Vaporized refrigerant returns from the heater to the condensing unit through a suction line 28. Under such normal operation, the trap 20 assists in maintaining proper direction of circulation of refrigerant, and the proper direction of circulation of the refrigerant is further assisted, as mentioned above, by the injecting arrangement from the capillary tube 24 into the tubing 14. The arrangement thus far described is not our invention but is described and claimed in the copending application of Ralph E. King and Harley H. Bixler, Serial No. 261,174, filed December 12, 1951, now Patent No. 2,665,567, issued January 12, 1954, and assigned to the General Electric Company, the assignee of the present invention.

During normal operation, intermittent pressure drops in such a system may under some conditions cause surging up the vertical section 19 and into the header and the suction line. This situation may be particularly acute under ice freezing conditions, where the freezing trays are placed on the bottom wall of the evaporator, resulting in a greater tendency toward surging up the vertical section 19. Similarly, under defrosting conditions described below there may be a tendency toward surging of refrigerant up the vertical section 19 and into the header and the suction line. In accordance with the present invention, such surging is minimized by the provision of a check valve 29 in the vertical leg 23 of the trap 20 adjacent the first or horizontal section 17 of the tubing 14, or, expressed in another way, the check valve is disposed between the trap 20 and the first or horizontal portion 17 of the tubing 14.

The structure of the check valve is shown in detail in Fig. 3. The check valve includes a sleeve 30 connecting the leg 23 of the trap 20 and the end of the portion 17 of the tubing. The sleeve 30 is secured to the leg 23 and to the tubing in any suitable manner, as by brazing or welding. The valve body 31 is mounted within the sleeve 30, being secured to the sleeve in any suitable manner, for example, by welding, peening, etc. The valve body 31 includes an upper hollow cylindrical member 32 and a complementary lower member 33. Members 32 and 33 are threadedly engaged to form the valve body 31. The lower member 33 includes an opening 34 centrally located therein. The portion of the member 33 adjacent the opening 34 provides a valve seat 35. The upper member 32 includes a plurality of openings 36 providing for passage of refrigerant therethrough. A ball valve 37 is disposed within the chamber 38 formed by the members 32 and 33. This ball valve 37 is biased by gravity into engagement with the valve seat 35 to close the opening or passage 34, blocking flow of refrigerant in a downward direction through the valve 29. When a sufficient differential pressure exists, the ball valve 37 is moved upwardly away from the seat 35, affording flow of refrigerant upwardly through the check valve 29. Even if the ball valve 37 is moved under the differential pressure into engagement with the upper member 32, upward flow of refrigerant through the valve 29 is not blocked since, because of the provision of the plurality of spaced openings 36 in the upper member, the ball valve 37 cannot close all the openings therethrough.

During the normal operating cycle, any intermittent pressure variations that would ordinarily cause surging of refrigerant up the vertical section 19 and into the header 13 and the suction line 28 instead results in movement of the ball valve 37 into engagement with the valve seat 35. For example should freezing trays be placed in heat exchange relationship with the horizontal portion 17 of the tubing, the increase in vaporization of refrigerant in the portion 17 because of the relatively warm water in the trays effects a slight increase in the pressure in this portion of the tubing. This increase in pressure causes

the ball valve 37 to seat, preventing any surge up the vertical section 19. The vaporized refrigerant, therefore, must proceed in the direction of the arrows upwardly through the portion 18 to the top of the evaporator. As the vaporized refrigerant flows upwardly in this manner, it causes a decrease in the density of refrigerant in the upwardly extending portions along the sides and back of the evaporator. When the density has been decreased sufficiently, the liquid refrigerant head in the header and the vertical section 19 forces the ball valve 37 from its seat, allowing circulation of liquid refrigerant from the header into the tubing 14 in the direction of the arrows. The above arrangement insures that all circulation of refrigerant during the normal operating period is through the first portion 17 and upwardly through the second portion 18 along the ends, back and top in the direction of the arrows, resulting in excellent refrigeration of all portions of the evaporator.

When it is desired to defrost the evaporator, heat is supplied by the heater 25 to the tubing 14 at the sections 26 and 27 thereof which are spaced along the series circuit of the tubing. Liquid refrigerant vaporized by the heater circulates through the tubing 14, and the recondensation of the vaporized refrigerant effects melting of frost from the tubing. During the defrost operation, with the refrigerating unit de-energized and the heater 25 energized, the vaporization of refrigerant in the portion 17 by the heater causes an increase in pressure in the portion 17 and forces the ball valve 37 into engagement with its seat 35. This blocks surging of refrigerant upwardly through the vertical section 19 and into the header 13 and the suction line 28. The vaporized refrigerant is therefore forced to flow through the portion 17 and upwardly in the direction of the arrows through the portion 18 to the top of the evaporator and into the header 13. As in the case of normal operating conditions, this upward flow of vaporized refrigerant through the upwardly extending portion 18 along the ends and back of the evaporator causes a decrease in the density of refrigerant in the portion 18. Ultimately this decrease in density is sufficient that the pressure exerted by the liquid refrigerant in the vertical section 19 and the header 13 exceeds the pressure exerted on the opposite side of the check valve and the ball valve 37 is moved upwardly from its position shown in Fig. 3 to afford flow of liquid refrigerant downwardly through the vertical section 19 and into the first portion 17 of the evaporator. This insures a fresh supply of liquid refrigerant to the region adjacent the heater. Subsequent vaporization of this refrigerant, circulation thereof through the continuous tubing 14 and recondensation thereof in this tubing 14 effects removal of frost therefrom. It has been found that the time required for defrosting under identical frost conditions is reduced by provision of the check valve 29 because of the improvement in desired flow of refrigerant and in the maintenance of a supply of liquid refrigerant to the tubing in the region of the heater 25.

For purposes of illustration, our invention has been shown applying to a refrigerating system such as that disclosed in the aforementioned King and Bixler application. So illustrated it includes a heater 25 which supplies heat to the tubing 14 at two points spaced along the series circuit thereof. It will be apparent, however, that the application of our invention is not

limited to such a defrosting arrangement and could be equally applied to systems including other arrangements for supplying heat for defrosting, for example, to arrangements in which heat is supplied at only one point in the refrigerant circuit or in which heat is supplied to a substantial length of the refrigerant circuit. Therefore, while a specific embodiment of this invention has been disclosed, it is not desired that this invention be limited to the particular construction shown and described and it is intended, by the appended claims, to cover all modifications within the spirit and scope of this invention.

What we claim as new and desire to secure by Letters Patent of the United States is:

1. A flooded recirculating evaporator comprising a header and continuous tubing connected at both ends to said header, said tubing depending from said header, one end of said tubing being connected to said header below the level of liquid refrigerant therein, said one end including a vertical section for supplying liquid refrigerant from said header, the other end of said tubing being connected to said header above the level of liquid refrigerant in said header, said tubing being formed to provide a trap between said vertical section and the remainder of said tubing, said trap extending below said remainder of said tubing, a heater disposed in heat exchange relationship with a section of said remainder of said tubing, a check valve between said trap and said remainder of said tubing, said check valve including a hollow valve body having a valve seat in the lower portion thereof, and a ball valve within said valve body gravity-biased into engagement with said seat to block flow of refrigerant downwardly through said valve whereby surge of refrigerant upwardly in said vertical section toward said header is blocked.

2. A flooded recirculating evaporator comprising a header and continuous tubing connected at both ends to said header, said tubing depending from said header, one end of said tubing being connected to said header below the level of liquid refrigerant therein, said one end including a vertical section for supplying liquid refrigerant from said header, the other end of said tubing being connected to said header above the level of liquid refrigerant in said header, a trap between said vertical section and the remainder of said tubing extending below said remainder of said tubing, said trap including one vertical leg in alignment with said vertical section, a horizontal leg and a second vertical leg arranged to communicate with said remainder of said tubing, a heater in heat exchange relationship with a section of said remainder of said tubing, and a check valve in said second vertical leg of said trap adjacent said remainder of said tubing for blocking surge of refrigerant upwardly in said vertical section toward said header.

3. A flooded recirculating evaporator comprising a header and continuous tubing connected at both ends to said header, said tubing depending from said header, said tubing including a horizontal first portion and a second portion in series with said first portion and extending upwardly therefrom, one end of said tubing being connected to said header below the level of liquid refrigerant therein, said one end including a vertical section communicating with said first portion for supplying liquid refrigerant to said first portion, said second portion of said tubing being connected to said header above the level of liquid refrigerant in said header, a trap be-

tween said vertical section and said first portion of said tubing extending below said first portion, said trap including one vertical leg in alignment with said vertical section, a horizontal leg and a second vertical leg arranged to communicate with said first portion, a heater in heat exchange relationship with a section of at least one of said portions of said tubing, a check valve in said second vertical leg of said trap adjacent said first portion, said check valve including a hollow valve body having a valve seat in the lower portion thereof, and a ball valve within said valve body gravity-biased into engagement with said seat to block flow of refrigerant downwardly through said valve whereby surge of refrigerant upwardly in said vertical section toward said header is blocked.

References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
1,926,384	Hull	Sept. 12, 1933
2,008,628	Ruff	July 16, 1935
2,040,744	Hull	May 12, 1936
2,138,612	Philipp	Nov. 29, 1938
2,665,566	Grimshaw	Jan. 12, 1954