Jan. 12, 1954 C. S. GRIMSHAW 2,665,566

EVAPORATOR DEFROSTING ARRANGEMENT

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Fig. 1.

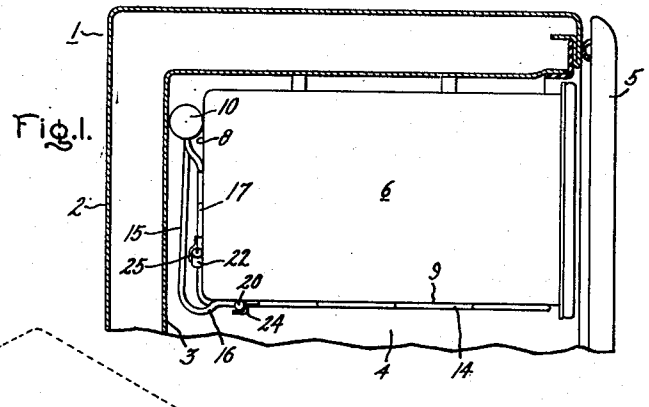
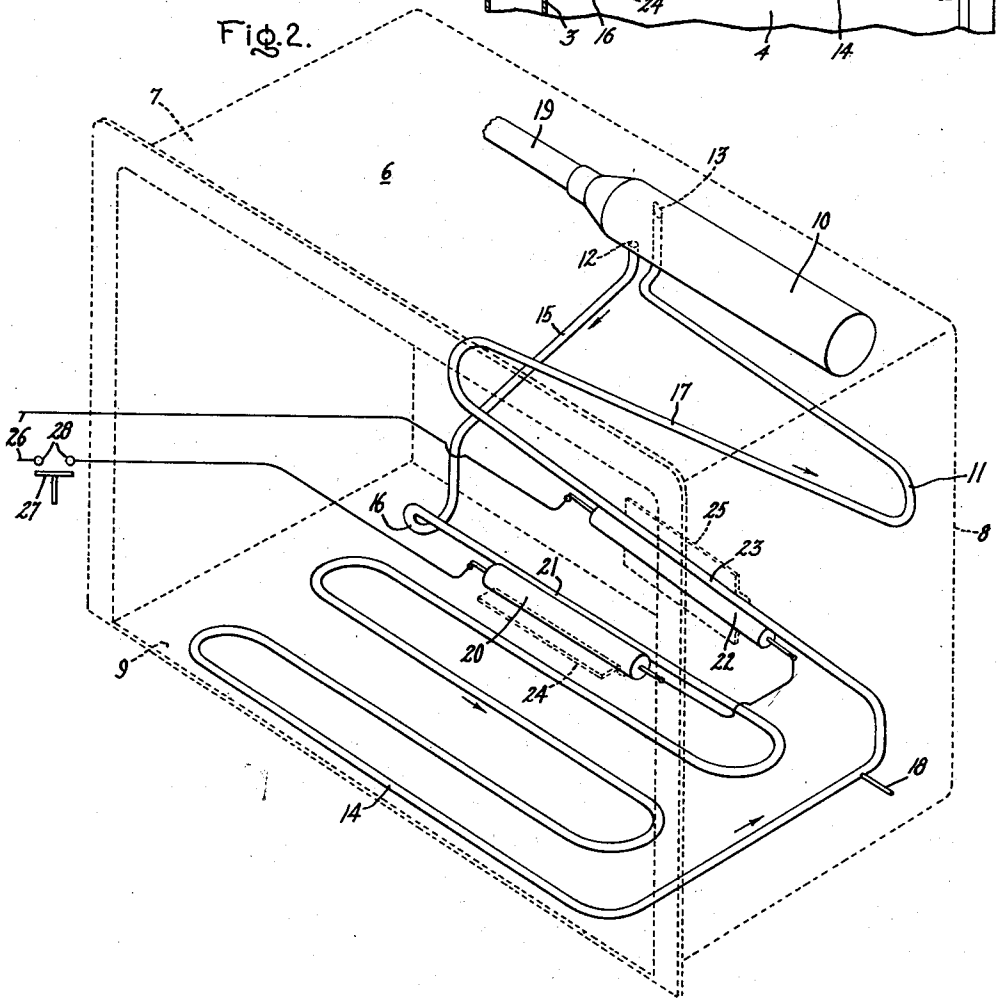


Fig. 2.



Inventor:
Charles S. Grimshaw,

by Sheridan & Ross
His Attorney.

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EVAPORATOR DEFROSTING ARRANGEMENT

Charles S. Grimshaw, Erie, Pa., assignor to General Electric Company, a corporation of New York

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13 Claims. (Cl. 62—126)

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My invention relates to refrigerator evaporators and more particularly to defrosting arrangement for evaporators.

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, moisture in the air within the 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. By my invention a relatively uniform heating of the evaporator surface is accomplished and defrosting is achieved without the necessity of using trays of warm water and the like, and the time required for the completion of the operation is materially reduced.

Accordingly, it is an object of my invention to provide an improved arrangement for defrosting a refrigerator evaporator.

It is another object of my invention to provide an improved arrangement for defrosting a refrigerator evaporator which maintains a substantially uniform temperature throughout the entire evaporator during the defrosting operation.

Further objects and advantages of my invention will become apparent as the following description proceeds and the features of novelty which characterize my 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 my invention, a flooded evaporator including continuous serpentine tubing is employed. Defrosting is accomplished by circulating vaporized refrigerant through the evaporator. The heating and circulating of the refrigerant is achieved by providing means for supplying heat to the continuous serpentine tubing of the evaporator at two points spaced along the series circuit thereof. In the specific embodiment illustrated, the tubing includes a horizontal portion and a vertical portion, one of the heating points being

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located in the horizontal portion of the evaporator and the other of the points being located in the vertical portion of the evaporator.

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

Fig. 2 is an isometric view of the evaporator including a schematic wiring diagram, the walls upon which the evaporator tubing is mounted being shown in dotted lines for clarity.

Referring to Fig. 1, there is shown a refrigerator cabinet 1 including an outer wall 2 and a spaced inner wall or liner 3, the inner wall 3 defining a food storage compartment 4. The access opening of the food storage compartment is closed by a door 5.

In order to cool the food storage compartment 4, an evaporator 6 is mounted in the upper portion of this compartment. In the form illustrated, the evaporator 6 includes a supporting sheet structure or wall structure 7 including a vertical rear wall or sheet 8 and a horizontal bottom wall or sheet 9. The refrigerating portion of the evaporator includes a header 10 which is positioned near the top of the rear vertical sheet or wall 8. The evaporator 6 is of the flooded recirculating type and includes continuous tubing 11 arranged in serpentine form and secured to the supporting sheet structure 7. One end of the continuous tubing 11 is connected to the header 10 of the evaporator at 12 below the normal level of liquid refrigerant in the header 10. The other end 13 of the continuous tubing 11 is connected in communication with the interior of the header 10 above the normal level of liquid refrigerant in the header. By this arrangement, the liquid refrigerant flows from the header to the tubing 11 at the connection 12 and vaporized refrigerant is discharged into the header at 13.

In the form illustrated, the serpentine tubing 11 includes a first portion 14 which is arranged in a horizontal plane and secured in any suitable manner, as by brazing or welding, to the exterior or bottom surface of the bottom horizontal wall 9. Liquid refrigerant is supplied to the horizontal portion 14 through a vertical tubing section 15 extending between the connection 12 at the header and the horizontal portion 14 of the tubing. A trap 16 is provided at the bottom of the tubing section 15 immediately preceding the horizontal portion 14. The vertical tubing section 15 is spaced from the vertical wall or sheet 8 of

the evaporator, and hence is not in heat exchange relationship therewith. The tubing further includes a second portion 17 which is arranged in a vertical plane and is secured in any suitable manner, as by brazing or welding, to the exterior or rear surface of the rear vertical wall 8. Liquid refrigerant is supplied to the evaporator from a condensing unit (not shown) through a liquid line or capillary tube 18. This capillary tube is connected to the tubing 11 in the first or horizontal portion 14 thereof near the junction between the horizontal portion 14 and the second or vertical portion 17. Vaporized refrigerant from the header is returned to the condensing unit through a suction line 19.

The evaporator 6 and the tubing 11 thereof are exposed to the air within the food storage compartment 4 during operation of the refrigerator. In order to maintain a sufficiently low temperature in the food storage compartment 4, and in order to maintain a temperature within the compartment formed by the wall structure 7 sufficiently low for 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 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 operation of the refrigerating system at a reasonably high efficiency. In accordance with my invention, an arrangement is provided whereby heat is supplied to the evaporator for vaporizing refrigerant within the tubing and for assisting in circulating the refrigerant through the tubing so that the vaporized refrigerant as it recondenses gives up heat to the tubing for melting the frost therefrom. Specifically, I provide a defrosting arrangement in which heat is supplied to the continuous tubing at two points or sections thereof spaced along the series circuit of the continuous tubing. In the form illustrated, one of these sections is located in a horizontal portion of the tubing and the other is located in the vertical portion of the tubing.

Thus one heater 20 is located adjacent a section 21 of a horizontal portion of the tubing 11. The heater 20 is located at the beginning of the horizontal portion of the tubing 11, that is, immediately following the trap 16. This heater may be an electric heating element or other suitable heating device for supplying heat to the tubing and to the refrigerant therein. By way of example, this heater may conveniently be the sheathed insulated type of heating element sold under the trade-mark Calrod. A similar type of heater 22 is positioned in heat exchange relationship with a section 23 of the vertical portion of the tubing 11. This heater 22 is located near the bottom of this vertical portion 17 and the vaporization of liquid refrigerant within the tubing at this point assists in promoting upward circulation of both vaporized and liquid refrigerant in the vertical portion 17. The heater 20 vaporizes refrigerant and, because of the circulation induced by heater 22, the refrigerant circulates through the tubing of the horizontal portion 14 and, in recondensing, it gives up heat to the tubing, thereby effecting melting of frost therefrom. The heaters

20 and 22 may be secured in heat exchange relationship with the sections 21 and 23 of the tubing respectively in any suitable manner. By way of example, the heaters may be held in such heat exchange engagement with the tubing by clamps 24 and 25, respectively. The clamp 24 is removably secured to the bottom sheet 9 of the evaporator wall structure in any suitable manner, as by screws (not shown) and the clamp 25 is similarly removably secured to the rear sheet 8 of this wall structure.

As indicated schematically in Fig. 2, the heaters 20 and 22 are supplied in series with power from any suitable electrical power supply through lines 26. It is desirable that the heaters 20 and 22 be connected in series. Should the two heaters be connected in parallel and should the heater 22 in the vertical portion 17 burn out, the heater 20 in the horizontal portion 14 might merely form a large pocket of vaporized refrigerant without effective circulation thereof. Such lack of circulation and, hence, lack of replenishment of liquid refrigerant in the area of the heater 20 might result in damage from overheating in this region of the evaporator. A switch 27 is provided for controlling the energization of the heaters 20 and 22, the switch 27 being adapted in its closed position to engage contacts 28 to close the circuit to the heaters 20 and 22 in series. The switch 27 may be operated in any suitable manner for initiating energization of the heaters; for example, it may be manually closed to initiate this heating, it may be closed by some mechanism for automatically initiating defrosting at predetermined intervals, etc.

When a switch 27 is closed, heat is supplied to the tubing 11 for defrosting of the evaporator at two points in the series circuit thereof. As mentioned above, the evaporator 6 is of the flooded type, the tubing 11 and the lower portion of the header 10 being normally filled with liquid refrigerant. Aside from that being continuously vaporized during the refrigerating process, during normal operation of the refrigerating system, the heat supplied by the heater 20 to the horizontal portion 14 of the tubing causes a vaporization of liquid refrigerant in the section 21 of the tubing. Refrigerant normally circulates in the direction of the arrows shown in Fig. 2 because of the head of liquid refrigerant imposed on the tubing through the connection at 12. During defrosting, the refrigerant vaporized by the heater 20 in the section 21 circulates in the direction of the arrows moving with it a quantity of liquid depending upon the head produced by the difference in density of the refrigerant in the two vertical sections 15 and 17 of the closed refrigerant path. A circulation rate will be established so that the flow losses will be equal to this head. The trap 16 blocks any tendency of refrigerant vaporized by the heater 20 to rise upwardly through the section 15 at the tubing and insures circulation of refrigerant in the normal direction. The circulating vaporized refrigerant, in recondensing, supplies heat to the horizontal portion 14 of the tubing, effecting melting of frost from this horizontal portion. The heater 22 on the vertical portion 17 of the tubing also effects vaporization of liquid refrigerant in the tubing, specifically at the section 23 adjacent the heater, and the rising bubbles of vaporized refrigerant reduce the head in the vertical tubing portion 17, assisting circulation of refrigerant and causing flow of liquid refrigerant downwardly from the header into the horizontal

portion 14. The vaporized refrigerant in rising upwardly through the tubing portion 17 recondenses therealong, giving up heat to this portion of the tubing and effecting melting of frost therefrom.

The utilization of the two heaters shown and the disposition of these heaters, one at the beginning of the horizontal portion and one at the bottom of the vertical portion causes a relatively uniform temperature to be maintained throughout the evaporator and allows the utilization of a tubing of relatively small size since the vaporized refrigerant need flow only a substantially shorter distance than would be the case were the defrosting attempted with a single heater. It also provides for effective defrosting of a horizontal sheet which is more acceptable than a sloping sheet for the bottom of an evaporator.

The significance of the flooded recirculating evaporator in the defrosting operation should be noted. In cases where a series system is employed, that is where the capillary tube is connected at one end of the evaporator tubing and the header at the other, it is possible for the heater to blow the tubing dry. Under these circumstances, continued application of heat by the heater could burn out the heater or cause damage to the evaporator through local overheating. By my arrangement employing a flooded recirculating evaporator where both ends of the evaporator tubing are connected to the header, a supply of liquid refrigerant to the tubing in the region of the heater is assured, and the possibility of the evaporator being blown dry, with resultant damage, is minimized.

While I have shown and described a specific embodiment of my invention, I do not desire my invention to be limited to the particular construction shown and described, and I intend, by the appended claims, to cover all modifications within the spirit and scope of my invention.

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

1. A flooded evaporator comprising a header and a single continuous length of tubing connected at both ends to said header and providing a series circuit for refrigerant, said tubing including a first portion and a second portion in series circuit with said first portion, one end of said tubing being connected to said header below the level of liquid refrigerant therein for supplying liquid refrigerant to said first portion, the other end of said tubing being connected to said header above the level of liquid refrigerant therein for conducting vaporized refrigerant from said second portion to said header, and means for supplying heat to said evaporator at two sections of said tubing spaced along the series circuit thereof for defrosting said evaporator, heat supplied to at least one of said sections being also effective for inducing circulation of refrigerant through said continuous tubing.

2. A flooded evaporator comprising a header and continuous tubing connected at both ends to said header, said tubing including a first portion arranged in a horizontal plane and a second portion in series circuit with said first portion and arranged in a vertical plane, one end of said tubing being connected to said header below the level of liquid refrigerant therein for supplying liquid refrigerant to said first portion, the other end of said tubing being connected to said header above the level of liquid refrigerant therein for conducting vaporized refrigerant from said second portion to said header, and means for supplying heat to said evaporator at two sections of said tubing for defrosting said evaporator, one of said sections being located in the horizontal portion of said tubing whereby heat is supplied to liquid refrigerant in said tubing at said one of said sections to vaporize said refrigerant for defrosting said horizontal portion, the other of said sections being located in the vertical portion of said tubing whereby heat is applied to liquid refrigerant in said tubing at said other of said sections to vaporize said refrigerant for defrosting said vertical portion and for inducing circulation of refrigerant in said tubing.

3. A flooded evaporator comprising a header and continuous tubing connected at both ends to said header, said tubing including a first portion arranged in a horizontal plane and a second portion in series with said first portion and arranged in a vertical plane, one end of said tubing being connected to said header below the level of liquid refrigerant therein for supplying liquid refrigerant to said said first portion, the other end of said tubing being connected to said header above the level of liquid refrigerant therein for conducting vaporized refrigerant from said second portion to said header, and means for supplying heat to said evaporator at two sections of said tubing spaced along the series circuit thereof for defrosting said evaporator, one of said sections being located near the beginning of said horizontal portion for vaporizing liquid refrigerant to defrost said horizontal portion, the other of said sections being located at the bottom of said vertical portion for vaporizing liquid refrigerant to defrost said vertical portion and to induce circulation of refrigerant through said continuous tubing.

4. A flooded evaporator comprising a header and continuous tubing including a first portion arranged in a horizontal plane and a second portion in series with said first portion and arranged in a vertical plane, one end of said tubing being connected to said header below the level of liquid refrigerant therein for supplying liquid refrigerant to said horizontal portion, the other end of said tubing being connected to said header above the level of liquid refrigerant therein for conducting vaporized refrigerant to said header, and means for supplying heat to said evaporator at two sections of said tubing for defrosting said evaporator, one of said sections being located near the point where liquid refrigerant reaches said horizontal portion from said header, the other of said sections being located near the bottom of said vertical portion of said tubing.

5. A flooded evaporator comprising a header and continuous tubing including a first portion arranged in a horizontal plane and a second portion in series with said first portion and arranged in a vertical plane, said tubing including a vertical section connected to said header below the level of liquid refrigerant in said header for supplying liquid refrigerant to said horizontal portion, said tubing being formed to provide a trap between said vertical section and said horizontal portion, the other end of said tubing being connected to said header above the level of liquid refrigerant therein for conducting vaporized refrigerant to said header, and means for supplying heat to said evaporator at two sections of said tubing for defrosting said evaporator, one of said sections being located in said horizontal portion immediately following said trap, the other of said sections being located near the bottom of said vertical portion of said tubing.

6. A refrigerating system including a condensing unit and a flooded evaporator, said evaporator comprising a header and continuous tubing including a first portion arranged in a horizontal plane and a second portion in series with said first portion and arranged in a vertical plane, one end of said tubing being connected to said header below the level of liquid refrigerant for supplying liquid refrigerant to said horizontal portion, the other end of said tubing being connected to said header above the level of liquid refrigerant therein for conducting vaporized refrigerant to said header, and means for supplying heat to said evaporator at two sections of said tubing for defrosting said evaporator, one of said sections being located near the point where liquid refrigerant reaches said horizontal portion from said header, the other of said sections being located near the bottom of said vertical portion of said tubing, and a conduit for supplying liquid refrigerant to said evaporator from said condensing unit to said evaporator, said conduit being connected to said horizontal portion of said tubing at a point immediately preceding said vertical portion.

7. In combination with a flooded evaporator comprising a header and a single continuous length of tubing connected at both ends to said header and providing a series circuit for refrigerant, said tubing including a first portion and a second portion in series with said first portion, one end of said tubing being connected to said header below the level of liquid refrigerant therein for supplying liquid refrigerant to said first portion, the other end of said tubing being connected to said header above the level of liquid refrigerant therein for conducting vaporized refrigerant to said header, a defrosting arrangement for said evaporator comprising a first heater disposed in heat exchange relationship with a section of said first portion of said tubing for supplying heat to liquid refrigerant therein to vaporize said refrigerant for defrosting said first portion, and a second heater disposed in heat exchange relationship with a section of said second portion of said tubing for supplying heat to liquid refrigerant therein to vaporize said refrigerant for defrosting said second portion, said second heater also being effective for inducing circulation of refrigerant through said continuous tubing.

8. A refrigerating system including a flooded evaporator, said evaporator comprising a header and continuous tubing including a first portion arranged in a horizontal plane and a second portion in series with said first portion and arranged in a vertical plane, one end of said tubing being connected to said header below the level of liquid refrigerant therein for supplying liquid refrigerant to said horizontal portion, the other end of said tubing being connected to said header above the level of liquid refrigerant therein for conducting vaporized refrigerant to said header, a first heater for supplying heat to said horizontal portion for vaporizing liquid refrigerant to effect defrosting of said horizontal portion, said first heater being disposed in heat exchange relationship with a section of said horizontal portion located substantially in the region where liquid refrigerant reaches said horizontal portion from said header, and a second heater for supplying heat to said vertical portion for effecting vaporization of liquid refrigerant to effect defrosting of said vertical portion and to induce circulation of refrigerant through said tubing, said second heater being disposed in heat exchange relationship with a section of said vertical portion located near the bottom of said vertical portion.

9. A refrigerating system including a flooded evaporator, said evaporator comprising a header and continuous tubing including a first portion arranged in a horizontal plane and a second portion in series with said first portion and arranged in a vertical plane, said tubing including a vertical section connected to said header below the level of liquid refrigerant in said header for supplying liquid refrigerant to said horizontal portion, said tubing being formed to provide a trap between said vertical section and said horizontal portion, the other end of said tubing being connected to said header above the level of liquid refrigerant therein for conducting vaporized refrigerant to said header, a first heater for supplying heat to said horizontal portion for vaporizing liquid refrigerant to effect defrosting of said horizontal portion, said first heater being disposed in heat exchange relationship with a section of said horizontal portion located immediately following said trap, and a second heater for supplying heat to said vertical portion for effecting vaporization of liquid refrigerant to effect defrosting of said vertical portion and to induce circulation of refrigerant through said tubing, said second heater being disposed in heat exchange relationship with a section of said vertical portion located near the bottom of said vertical portion.

10. A refrigerating system including a flooded evaporator, said evaporator comprising a header and continuous tubing including a first portion arranged in a horizontal plane and a second portion in series with said first portion and arranged in a vertical plane, one end of said tubing being connected to said header below the level of liquid refrigerant therein for supplying liquid refrigerant to said horizontal portion, the other end of said tubing being connected to said header above the level of liquid refrigerant therein for conducting vaporized refrigerant to said header, a first heater for supplying heat to said horizontal portion for vaporizing liquid refrigerant to effect defrosting of said horizontal portion, said first heater being disposed in heat exchange relationship with a section of said horizontal portion located substantially in the region where liquid refrigerant reaches said horizontal portion from said header, and a second heater for supplying heat to said vertical portion for effecting vaporization of liquid refrigerant to effect defrosting of said vertical portion and to induce circulation of refrigerant through said tubing, said second heater being disposed in heat exchange relationship with a section of said vertical portion located near the bottom of said vertical portion, said first heater and said second heater being connected in a series electrical circuit to insure simultaneous energization and deenergization of said heaters.

11. A refrigerating system including a flooded evaporator, said evaporator comprising a header and continuous tubing including a first portion arranged in a horizontal plane and a second portion in series with said first portion and arranged in a vertical plane, one end of said tubing being connected to said header below the level of liquid refrigerant therein for supplying liquid refrigerant to said horizontal portion, the other end of said tubing being connected to said header above the level of liquid refrigerant therein for

conducting vaporized refrigerant to said header, a first heater for supplying heat to said horizontal portion for vaporizing liquid refrigerant to effect defrosting of said horizontal portion, a clamp for holding said first heater against a section of said horizontal portion located substantially in the region where liquid refrigerant reaches said horizontal portion from said header, and a second heater for supplying heat to said vertical portion for effecting vaporization of liquid refrigerant to effect defrosting of said vertical portion and to induce circulation of refrigerant through said tubing, a second clamp for holding said second heater against a section of said vertical portion located near the bottom of said vertical portion.

12. In combination with an evaporator including a horizontal sheet and a vertical sheet and continuous tubing including horizontal and vertical portions secured to said horizontal and vertical sheets respectively and a header at the upper portion of said vertical sheet having both ends of the serpentine tubing connected thereto, one end of said tubing being connected to said header below the level of liquid refrigerant therein for supplying liquid refrigerant to said horizontal portion, the other end of said tubing being connected to said header above the level of liquid refrigerant therein for conducting vaporized refrigerant to said header, a defrosting arrangement for said evaporator comprising a first heater disposed in heat exchange relationship with a section of said horizontal portion of tubing for supplying heat to liquid refrigerant therein for vaporizing said refrigerant to defrost said horizontal sheet, and a second heater disposed in heat exchange relationship with a section of said vertical portion of tubing for supplying heat to liquid refrigerant therein for vaporizing said refrigerant to defrost said vertical sheet and to induce circulation of refrigerant through said tubing.

13. A refrigerating system including a flooded evaporator, said evaporator comprising a horizontal sheet and a vertical sheet and continuous tubing including a horizontal portion secured to said horizontal sheet and a vertical portion in series with said horizontal portion and secured to said vertical sheet, said evaporator further including a header at the upper portion of said vertical sheet, one end of said tubing being connected to said header below the level of liquid refrigerant therein for supplying liquid refrigerant to said horizontal portion of said tubing, and the other end of said tubing being connected to said header above the level of liquid refrigerant therein for conducting vaporized refrigerant to said header, a first heater for supplying heat to said horizontal portion for vaporizing liquid refrigerant to effect defrosting of said horizontal portion, said first heater being disposed adjacent a section of said horizontal portion located substantially in the region where liquid refrigerant reaches said horizontal portion from said header, a first clamp secured to said horizontal sheet for holding said first heater in heat exchange relationship with said section of said horizontal portion of said tubing for vaporizing liquid refrigerant to defrost said horizontal sheet, a second heater disposed adjacent a section of said vertical portion of said tubing located near the bottom of said vertical portion, and a second clamp secured to said vertical sheet for holding said second heater in heat exchange relationship with said section of said vertical portion for effecting vaporization of liquid refrigerant to defrost said vertical portion and to induce circulation of refrigerant through said tubing.

CHARLES S. GRIMSHAW.

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