

March 13, 1956

E. T. MORTON
REFRIGERATOR EVAPORATOR

2,737,785

Filed Oct. 9, 1951

3 Sheets-Sheet 1

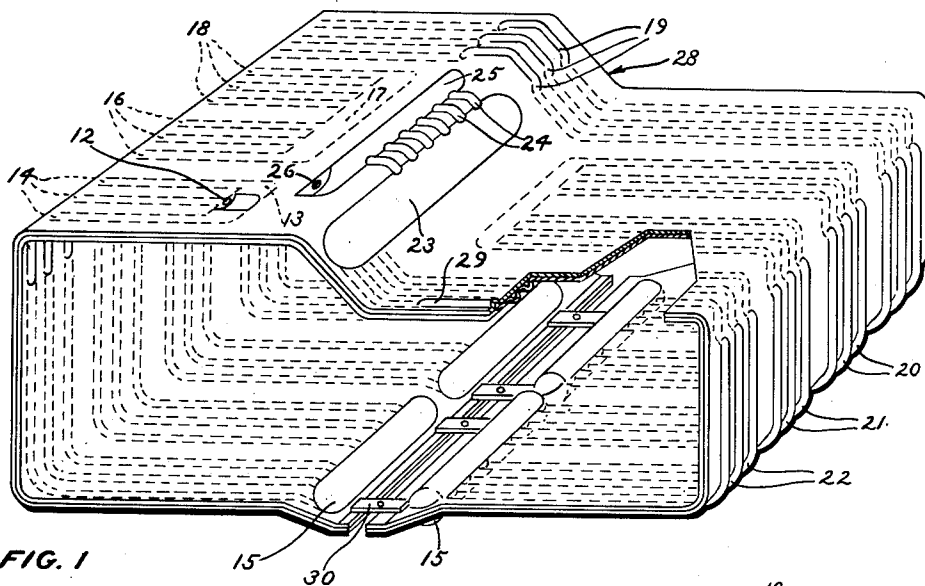


FIG. 1

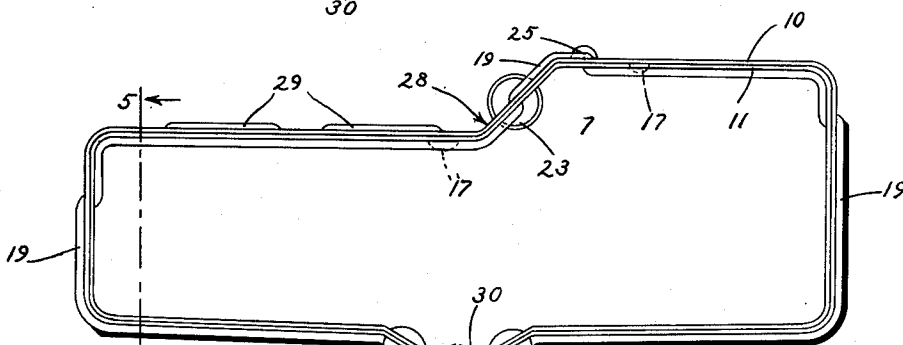


FIG. 2

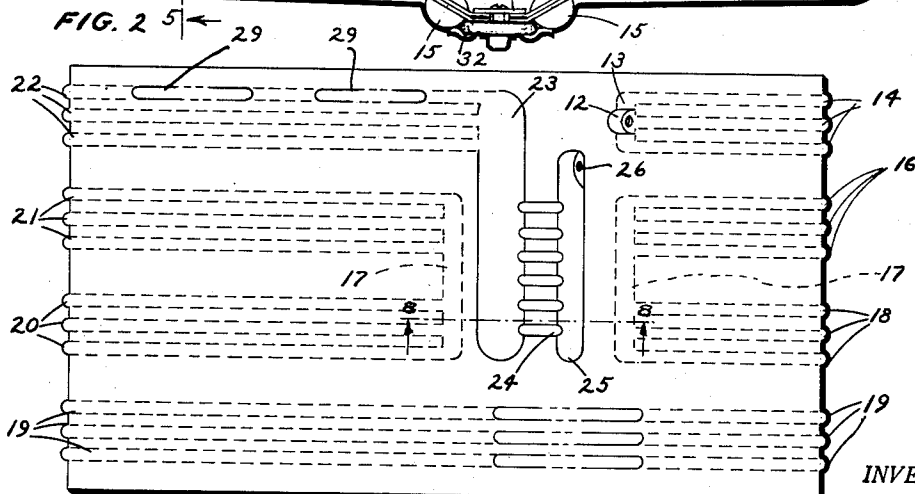


FIG. 3

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3 Sheets-Sheet 2

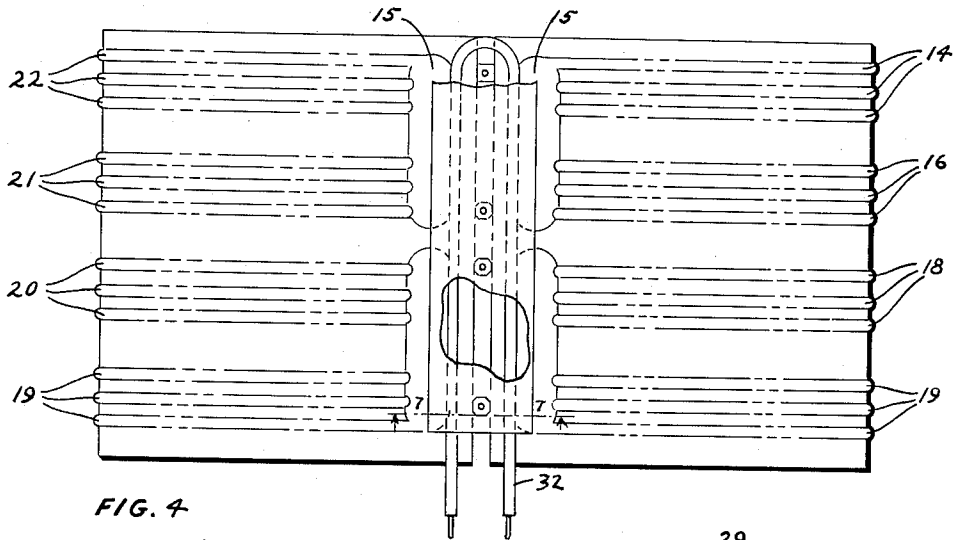


FIG. 4

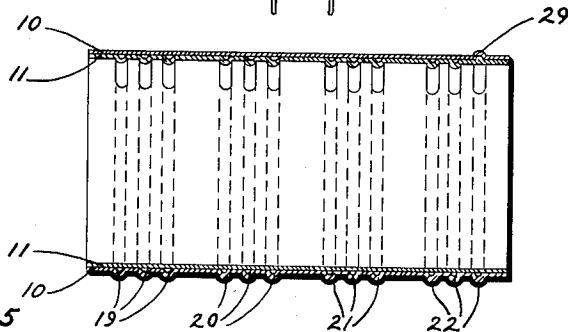


FIG. 5

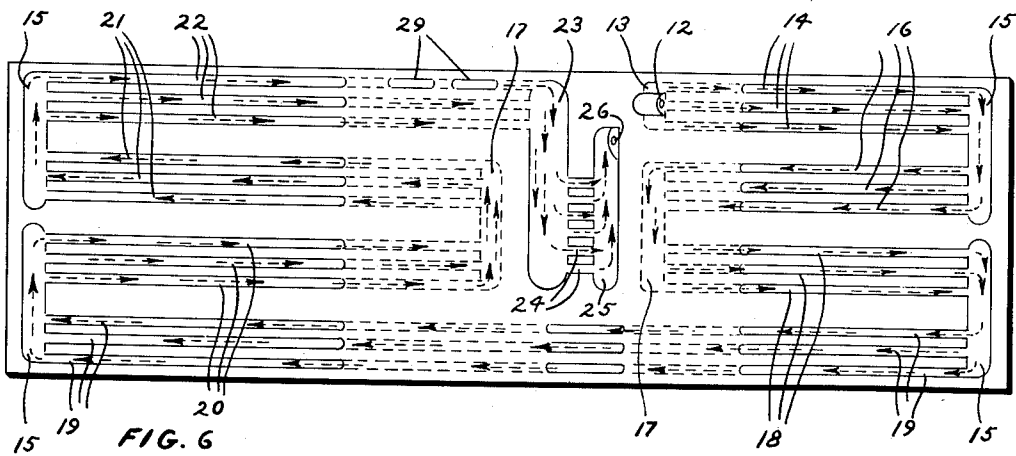


FIG. 6

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3 Sheets-Sheet 3

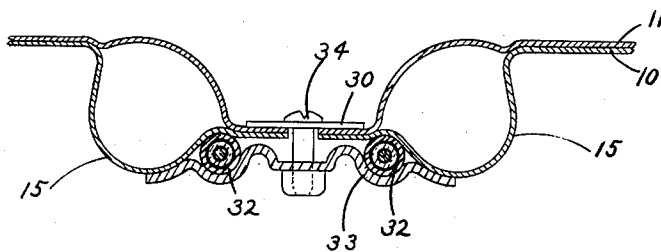


FIG. 7

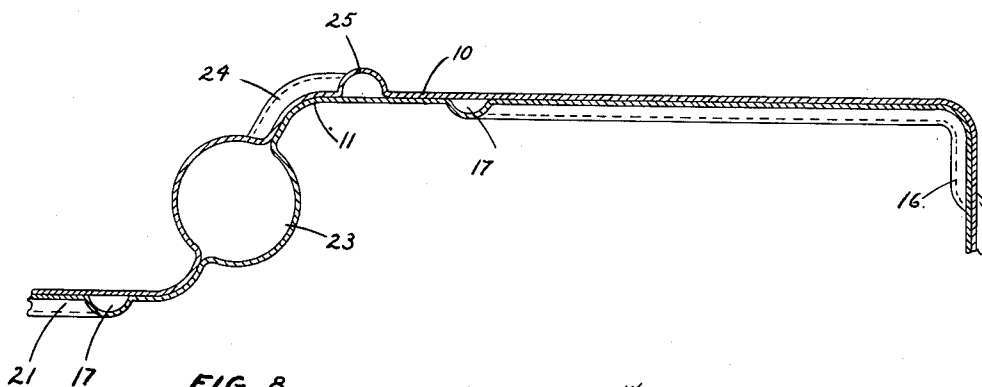


FIG. 8

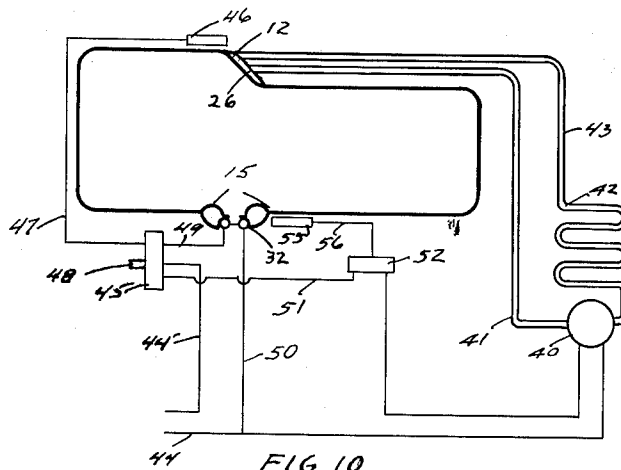


FIG. 10

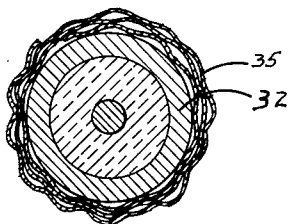


FIG. 9

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2,737,785

REFRIGERATOR EVAPORATOR

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10 Claims. (Cl. 62—126)

This invention pertains to household refrigerators, and more particularly to an improved evaporator for a refrigerator.

One of the problems met in the construction of household refrigerators is the severe decrease in heat transfer from the cold compartment to refrigerant caused by the formation of frost on the refrigerant evaporator coils. Many attempts have been made to eliminate this problem. These have included control of refrigerant temperature to keep it above the freezing point of water. This system makes a freezing compartment impossible. Still another expedient utilizes an ordinary type of household refrigerator and provides for an automatic defrosting cycle when the frost on the evaporator coils is melted either by artificially heating the coils or by simply preventing further circulation of the refrigerant until the frost is all melted. These latter devices may operate on a time cycle (once every twenty-four hours or the like) or may be controlled by some device which senses the formation of a certain amount of frost. Both have certain inherent disadvantages well known in the art.

My invention is concerned with the latter described expedient, and particularly with an evaporator for use in a refrigerator chest and especially adapted for artificial heating to melt the frost off the coils in response to a control device which may be one of the many well-known expedients including a clock, a frost-sensing device or a manual control. By my invention I provide a quick acting defrosting device capable of quick removal of all frost from the evaporator such that frozen foods do not have an opportunity to thaw out. Space is provided, by the unique shape of my evaporator, for storage of open trays while defrosting without danger of condensate or melted frost dropping into the tray. By its shape and arrangement, a more efficient accumulator and separator of refrigerant vapors from liquid refrigerant is also provided.

Many other benefits and advantages of my invention will become apparent from the following description and accompanying figures which form a part of this specification.

In the drawings:

Fig. 1 is a perspective view from the rear of an evaporator embodying my invention;

Fig. 2 is a front elevational view of the evaporator;

Fig. 3 is a top plan view thereof;

Fig. 4 is a bottom plan view thereof showing the heater element in place;

Fig. 5 is a partial sectional view along line 5—5 of Fig. 2;

Fig. 6 is a developed plan view of the evaporator showing the paths of flow of the refrigerant.

Fig. 7 is a sectional view along line 7—7 of Fig. 4;

Fig. 8 is a partial sectional view along line 8—8 of Fig. 3;

Fig. 9 is a sectional view through the heater element showing a means for increasing its heat transfer; and

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Fig. 10 is a schematic view of a refrigerator system including my improved evaporator and defroster.

Briefly, my invention comprises an evaporator for a household refrigerator, which evaporator is formed and arranged to provide for more efficient defrosting, whether automatic or manually controlled, better evaporation and more complete separation of vapor and liquid in the return line to the compressor. The evaporator is arranged with a cold shelf having no refrigerant tubes above it so that open trays having no refrigerant tubes in close thermal contact therewith and no condensate or melted frost will be dropped into the trays during the defrosting phase. The refrigerant path is through a series-parallel system of pipes conveniently making eight passes approximately half-way around the evaporator. Each pass may have three tubes. It will be appreciated, however, that there may be more or less than eight passes, and that each of the passes may include one or more tubes. The headers at the bottom of the evaporator for these tubes are formed with sumps for the collection of liquid refrigerant as it condenses in the pipe. A heating element is disposed in contact along these sumps, and to defrost, it heats the condensed refrigerant in the sump which evaporates and circulates through the tubes where it gives up its heat of vaporization, condenses and runs back to the sumps, during this cycle acting as a true secondary type of system and melting the frost. The accumulator for vaporized refrigerant is conveniently built into the top of the evaporator along with a header chamber in which the vapors are further separated from liquid, thus easing the load on the compressor unit.

More specifically, and with reference to the drawings, my evaporator comprises two sheets 10 and 11 of metal stamped to shape and then spot or seam welded together by the usual process to form passageways for the refrigerant.

As best shown in Fig. 6, the passages extend from an inlet 12 through a small manifolding passage 13 to a set of one or more parallel passageways or tubes 14 extending outwardly. It will be apparent from the other figures that the inlet 12 and first manifold 13 are on the top of the evaporator, and that the first tubes extend around one side to the bottom of the evaporator where they empty into a first sump manifold 15. This manifold is quite large for a purpose to be made clear hereinafter. From this manifold, three more parallel tubes or passageways 16 extend back up around the side of the evaporator in spaced parallel relation to the first three tubes 14 to another upper manifold 17. It will be noted (Fig. 1) that on the side and bottom of the evaporator, the passageways are formed only in the outer sheet 10 of the two sheets which make up the evaporator, while at the top the passageways are formed in the inner sheet 11. This formation preserves a flat surface both at the bottom and at the top horizontal surfaces on which open trays of water for ice cubes or with material to be frozen or preserved in a frozen state may be placed.

From the upper manifold 17 another set of three tubes 18 extends around the sides to the bottom of the evaporator and joins a second sump manifold 15 exactly like the first. From thence a fourth group of three tubes 19 extends back parallel to the first three sets. These latter tubes 19, however, go completely over the top of the evaporator and down the opposite side to a third sump manifold 15 similar to the first two. From here the sets of tubes 20 and 21 continue in a path back and forth between sump manifolds 15 and an upper manifold 17 in the same manner as on the first described side.

The final set of three tubes 22 extends into an accumulator 23 formed in both sheets 10 and 11 of the evaporator. This accumulator is in the form of a large tube having the tubes 22 coming into one end thereof and a plu-

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 rality of exit tubes 24, extending outward from the other end. The refrigerant, by the time it reaches this point, consists of a liquid and gas mixture. Due to the decrease in velocity, the liquid carried by the gas falls because of gravity. The small particles of liquid carried to this point by the gas refrigerant will collect on the walls of the accumulator 23 and will evaporate therefrom and be carried through the tubes 24 into the header chamber 25 which augments the action of the accumulator and further separates the liquid from the gas refrigerant. In each of the accumulator and header chambers the velocity of the refrigerant is considerably reduced, and therefore, there is little or no entrainment of any liquid in the vapor as it passes through the chambers. From the header chamber 25, the vapor returns to the compressor 40, Fig. 10, through an exit 26 via conduit 41.

It will be noted (Figs. 1 and 2) that the evaporator in its front elevation is shaped in the form of two contiguous four-sided figures, one of which is greater than the other in its vertical dimension. The lower surfaces are substantially flush with each other. There is, however, a step 28 formed between the upper surfaces. This whole formation is carried out by bending the evaporator from the blank or developed shape shown in Fig. 6. The accumulator lies right on the rising part of the step 28, and the header chamber is above it on the higher of the upper surfaces. It may also be noted that the upper surface at both levels is flat and the tubes or passageways are formed in the inner metal sheet 11. This provides, particularly on the lower of the two stepped surfaces, a convenient cold shelf for the freezing of ice cubes, sherbet or the like, in open trays with no refrigerant tubes above the open trays from which condensate or frost could drip into the tray. The rearmost tube of the group 22 may be formed in part in the outer sheet 10 to provide stops 29 for the tray.

It will be obvious to those skilled in the art from the above description, that this evaporator is in the nature of a dry type evaporator. This is almost completely true during the pumping cycle of the compressor while the refrigerant is being circulated. However, during the off-cycle, considerable refrigerant condenses within the tubes and drains down into the sump manifolds 15. To facilitate this, the bottom tubes all slope slightly toward the sums, which always have liquid therein.

After the evaporator is bent to the shape shown in Fig. 2 from the flat blank, the bottom edges adjacent the sump manifolds 15 are joined together by lateral braces 30 (Fig. 1) spot welded or otherwise fastened to the edges. This helps to hold the evaporator in shape, as well as providing a convenient means for attaching an auxiliary heater as will be described.

The heater is in the form of a U-shaped element 32 lying with each of its legs alongside two adjacent sump manifolds 15. It is held in intimate contact with these manifolds by clip devices 33 (Fig. 7) fastened to the lateral straps 30 by screws 34 or other convenient fastener. The heater is preferably an electrical device connected to a suitable source of electrical power through a system of automatically or manually controlled switches, not shown. The effectiveness of the heater may be increased by increasing the area of contact between the heater element 32 and the sump manifolds 15. It is important therefore that these manifolds be formed with a fillet of a radius approximately that of the tube of the element 32.

Another way of increasing the contact, as shown in Fig. 9, is to surround the element with a layer or two of crinkly aluminum foil 35 or the like before fastening it in place. When the heater then is fixed into place, the foil is crushed between the heater element 32 and the evaporator walls. This crushing causes a metal-to-metal contact over a greater area than would be present in the surfaces of the two units, and therefore increases the heat transfer between them.

This heater is effective to hasten the defrosting process

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 and may, as stated, be automatically or manually controlled. It is also contemplated that an aluting compound of good heat transfer properties, such as metallic perma gum, be used to increase the heat transferring ability by placing a quantity around the heater element at the place where it contacts the sump.

By a suitable system, the heater can be controlled so that it is turned on only when the compressor is not running. Such a system is well within the ability of those skilled in the art. At those times during the "off-cycle," the liquid refrigerant drains into the sumps 15 which are normally full of liquid. When the heater is turned on, it causes this liquid to vaporize and further causes a circulation of the warmed vapor throughout the evaporator, heating all the tubes quickly to a temperature above the freezing point of the frost, which quickly melts off and is caught in a drip tray as is well known in the art. Thus, by utilizing the sumps to collect the liquid where it can be heated easily and turned into a warmed vapor which circulates more easily, a much quicker defrosting is accomplished. Moreover, by having all of the liquid drain into the sumps and by utilizing the accumulator and header chamber, a vapor is returned to the sump almost entirely free of liquid. When heat is applied to the sumps, each pair of which is connected to opposite or meeting ends of the evaporator, the liquid in all of the sumps is vaporized at approximately the same time. Therefore, it spreads outwardly and upwardly through the tubes where it gives up its lateral heat of vaporization to the tubes and the surrounding walls in such a manner that the frost is melted from the entire unit uniformly throughout nearly all of the surfaces. The condensed refrigerant runs back into the sumps where it is again vaporized, and the process is continued until the rise in temperature of the unit is such that all of the frost has melted. Preferably, a thermostat placed adjacent the unit at a point where the greatest frost accumulates, operates at this time to discontinue the current to the heater. As previously stated, this action is of the true secondary type. The frost on the tubes acts as the condenser for the system, and the heater the material from which the heat is abstracted. It will also be noted that, during the regular refrigeration cycle, the evaporator acts as a dry evaporator with the portions series parallel fed; whereas, during the defrosting cycle without any change, the unit acts as a secondary refrigeration system.

In Fig. 10 I have shown schematically a refrigeration system in which my invention may be used. In this case, there is provided a compressor 40 having one side connected by a suction tube 41 to the outlet 26 of the evaporator. The high pressure side of the compressor discharges to the condenser 42 which is connected by a capillary tube 43 to the inlet 12 of the evaporator. Current from the one side of the line 44 is applied to the compressor motor and heater. The other side of the line goes to a switch 45 which may be controlled by a thermostat 46 placed at the point where the most frost accumulates. The thermostat may be of the usual bulb type connected by the tube 47 into the switch where the usual bellows controls the movable switch blade. Normally, the thermostat 46 is sensitive only to a high temperature such as is obtained after the ice is melted from the evaporator. The switch 45 may be of the over center type provided with a control button 48 which, when depressed, causes a circuit to be made from the side 44' through the line 49 heater element 32 back through line 50 to line 44. At this time, current is supplied to the heater and the defrosting action takes place.

When the temperature of the evaporator rises to the point where all of the ice has melted, which occurs very rapidly, the thermostat operates the switch 45 to throw it back to normal position where current passes from the side 44' of the line through the line 51 to the temperature control switch 52 and thence through the line 53

to the compressor motor and back to the line 44, completing the circuit.

The switch 52 is controlled by a thermostat including a bulb 55 and tube 56 placed at a point where the temperature will control the temperature in the refrigerator commonly called a "cold control."

It will be appreciated that my invention is useful in other combinations than that shown of which there are many known to the art. For instance, the push button or manual control may be replaced with a clock which will operate the switch at predetermined time intervals. In lieu of the clock, mechanism responsive to the number cycles of refrigeration may be used or one of the many types of frost feeling devices may be used operated by the door, or by other well known means.

By the stepped form of the top of the evaporator, a drip free freezer shelf is provided, and a centrally located accumulator and header chamber formed in the evaporator itself becomes feasible:

It will be obvious to those skilled in the art that the evaporator need not be formed in exactly the form described, but that the basic idea of causing the evaporation to act as a secondary type refrigeration system by collecting a liquid refrigerant in a sump in an evaporator, and heating the liquid to cause it to vaporize and circulate the warm vapor throughout the tubes, could be applied to many forms of evaporator. The only requisite for this action is the provision, in the evaporator of the sump manifolds at the lowest part of the tube system to provide a supply of liquid, and a heater in heat transfer relationship to the sumps, to heat the collected liquid. The other improvements in the shape and formation of my evaporator are refinements thereto and are not essential to the functioning of the defrosting system.

Having thus described my invention, I am aware that numerous and extensive departures may be made therefrom without departing from the spirit or scope of my invention.

I claim:

1. An evaporator for a refrigerator comprising a series of refrigerant carrying tubes substantially enclosing a freezing compartment, the top of said compartment being of stepped formation, thereby providing a cold, drip free shelf for open trays on the lower step of the stepped formation, and accumulator means to collect and return any liquid refrigerant to said tubes connected to at least one of said tubes at its outlet, said accumulator means being formed at the rising part of said stepped formation.

2. An evaporator for a refrigerator comprising a series of refrigerant carrying tubes substantially enclosing a freezing compartment, the top of said compartment being of stepped formation, thereby providing a cold, drip free shelf for open trays on the lower step of the stepped formation, accumulator means to separate liquid refrigerant from gaseous refrigerant and to collect and return liquid refrigerant to said tubes connected to at least one of said tubes at the outlet thereof, said accumulator means being formed at the rising part of said stepped formation, and header means formed on the upper part of said stepped formation being connected to said accumulator means by connecting tube means and operable to assist said accumulator in separating liquid refrigerant from gaseous refrigerant.

3. An evaporator for a refrigerator comprising a series of refrigerant carrying tubes substantially enclosing a freezing compartment, the top of said compartment being of stepped formation, thereby providing a cold, drip free shelf for open trays on the lower step of the stepped formation, accumulator means to separate liquid refrigerant from gaseous refrigerant and to collect and return liquid refrigerant to said tubes connected to at least one of said tubes at the outlet thereof, said accumulator means being formed at the rising part of said stepped formation, and header means formed on the upper part of said stepped formation being connected to said accumu-

lator means by connecting tube means and operable to assist said accumulator in separating liquid refrigerant from gaseous refrigerant, said connecting tube means being displaced from said outlet to prevent a straight through path for the refrigerant.

4. An evaporator for a refrigerator comprising refrigerant tubes substantially enclosing a freezing compartment, said tubes being connected together as a plurality of parallel connected groups of tubes, said groups being connected in series through a plurality of manifolds, a first of said groups extending from an inlet manifold around said compartment to a first sump manifold on the bottom of said compartment, a second group extending from said sump manifold in parallel spaced relation back to the first upper manifold atop said compartment, a third group extending from said upper manifold to a second sump manifold on the bottom of said compartment, a fourth group extending from said second sump manifold completely around said compartment to a third sump manifold adjacent said second sump manifold, a fifth group of tubes extending from said third sump manifold to a second upper manifold, adjacent said first upper manifold, a sixth group of tubes extending from said second upper manifold to a fourth sump manifold adjacent said first sump manifold and a seventh group of tubes extending from said fourth sump manifold to an accumulator manifold means, and outlet means from said accumulator means to conduct the refrigerant away from said evaporator.

5. An evaporator for a refrigerator comprising refrigerant tubes substantially enclosing a freezing compartment, said tubes being connected together as a plurality of parallel connected groups of tubes, said groups being connected in series through a plurality of manifolds, a first of said groups extending from an inlet manifold around said compartment to a first sump manifold on the bottom of said compartment, a second group extending from said sump manifold in parallel spaced relation back to the first upper manifold atop said compartment, a third group extending from said upper manifold to a second sump manifold on the bottom of said compartment, a fourth group extending from said second sump manifold completely around said compartment to a third sump manifold adjacent said second sump manifold, a fifth group of tubes extending from said third sump manifold to a second upper manifold, adjacent said first upper manifold, a sixth group of tubes extending from said second upper manifold to a fourth sump manifold adjacent said first sump manifold and a seventh group of tubes extending from said fourth sump manifold to an accumulator manifold means, and outlet means from said accumulator means to conduct the refrigerant away from said evaporator, and heater means in heat transferring relationship to said sump manifolds adapted to heat said manifolds intermittently and thereby cause defrosting of said evaporator.

6. An evaporator for a refrigerator comprising sheet means substantially surrounding a freezing compartment, said sheet means having two opposite edges closely adjacent each other at the bottom of said compartment, bracing means connected between said edges, tube means formed in said sheet means adapted to carry a refrigerant in a sinuous path throughout said sheet means, sump means formed in said sheet means adjacent said edges and connected to said tube means, said sump means being adapted to collect liquid refrigerant from said tube means, heater means in heat transferring relationship to said sump means adapted to heat said liquid refrigerant intermittently to cause it to evaporate and circulate in said tube means thereby defrosting said evaporator, and clamping means attached to said bracing means to hold said heater in place.

7. An evaporator comprised of a heat conducting body having a substantially upper continuous horizontal surface and integral vertically extending sides and lower horizontal surfaces extending inward from the sides with the

innermost edges in closely spaced relation to each other and with the portion adjacent the terminating part at a lower elevation than the remaining part, said evaporator being provided with refrigerant ducts distributed about the aforesaid surfaces including sumps adjacent the edges in said lower portions, ducts extending from said sumps across the lower portion and up the vertical side and across the top toward each other, most of said ducts terminating in headers at the upper surface near the medial portion.

8. An evaporator comprised of a heat conducting body having upper continuous horizontal surfaces and integral vertically extending sides and lower horizontal surfaces extending inward from the sides with the innermost edges in closely spaced relation to each other and with the portion adjacent the terminating part at a lower elevation than the remaining part, said evaporator being provided with refrigerant ducts distributed about the aforesaid surfaces including sumps adjacent the edges in said lower portions, ducts extending from said sumps across the lower portions and up the vertical side and across the top toward each other most of said ducts terminating in headers at the upper surfaces near the medial portion, a liquid refrigerant in said evaporator in sufficient quantity to maintain said sumps in a flooded condition and heater means secured in heat transfer relation to said sumps for heating and vaporizing the refrigerant in the sumps, said evaporator arranged to condense said vaporized refrigerant and conduct the liquid refrigerant back to said sumps the latent heat of vaporization causing the walls of the evaporator to be heated.

9. An evaporator comprised of a heat conducting body having upper continuous horizontal surfaces and integral vertically extending sides and lower horizontal surfaces extending inward from the sides with the innermost edges in closely spaced relation to each other and with the portion adjacent the terminating part at a lower elevation than the remaining part, said evaporator being provided with refrigerant ducts distributed about the aforesaid surfaces including sumps adjacent the edges in said lower portions, ducts extending from said sumps across the lower portion and up the vertical side and across the top toward each other, most of said ducts terminating in headers at the upper surface near the medial portion, a liquid refrigerant in said evaporator in sufficient quantity to maintain said sumps in a flooded conditions and heater means secured in heat transfer relation to said sumps for heating and vaporizing the refrigerant in the sumps, said evaporator arranged to condense said vaporized refrigerant and conduct the liquid refrigerant back to said

sumps, the latent heat of vaporization causing the walls of the evaporator to be heated, and thermostatic means in heat transfer relation to the evaporator to control the operation of said heater means.

10. An evaporator for a refrigerator comprising refrigerant tubes substantially enclosing a rectangular freezing compartment being formed with top, side and bottom sections, said tubes being connected together as a plurality of parallel connected groups of tubes, said groups being connected in series through a plurality of manifolds, a first of said groups extending from an inlet manifold around said compartment to a first sump manifold on the bottom of said compartment, a second group extending from said sump manifold in parallel spaced relation back to the first upper manifold atop said compartment, a third group extending from said upper manifold to a second sump manifold on the bottom of said compartment, a fourth group extending from said second sump manifold completely around said compartment to a third sump manifold adjacent said second sump manifold, a fifth group of tubes extending from said third sump manifold to a second upper manifold, adjacent said first upper manifold, a sixth group of tubes extending from said second upper manifold to a fourth sump manifold adjacent said first sump manifold, and a seventh group of tubes extending from said fourth sump manifold to an accumulator manifold means, said parallel groups of tubes being parallel to the longitudinal axis of said compartment on the top and bottom sections, and perpendicular to said axis on the side sections of said compartment, and outlet means from said accumulator means to conduct the refrigerant away from said evaporator.

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