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T. A. MCGREW

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DEFROST EVAPORATOR STRUCTURE

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FIG. 1

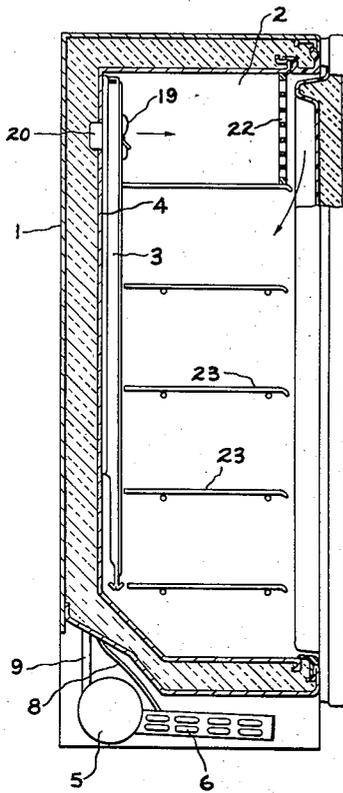


FIG. 2

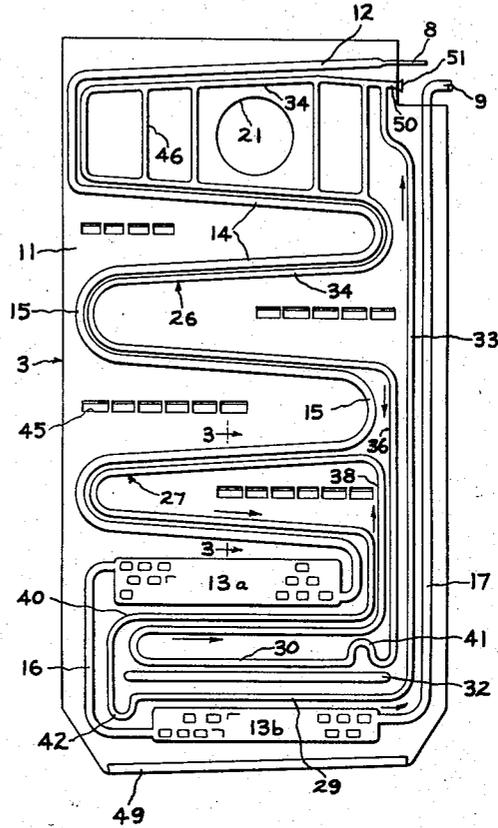


FIG. 3

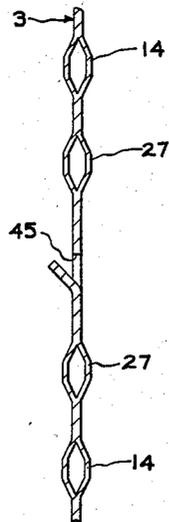
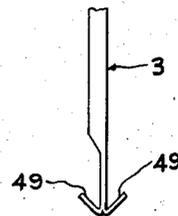


FIG. 4



INVENTOR  
THOMAS A. MCGREW

BY *Walter Hule*

HIS ATTORNEY

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## DEFROST EVAPORATOR STRUCTURE

Thomas A. McGrew, Fern Creek, Ky., assignor to General Electric Company, a corporation of New York

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2 Claims. (Cl. 62-276)

The present invention relates to an evaporator structure and is more particularly concerned with a roll-forged or roll-bonded evaporator including as an integral part thereof a closed liquid-vapor circuit and means for heating a portion of that circuit for the purpose of periodically removing frost from the evaporator structure.

A number of arrangements are known for employing what is sometimes called a secondary defrost circuit for defrosting a refrigerant evaporator. These arrangements comprise a closed circuit or passageway charged with a volatile liquid and including a section in heating relation with the frosting portions of the evaporator and a vaporizing section which when heated causes the hot vapors from the evaporating charge to circulate through the circuit and warm the evaporator to defrosting temperatures.

The application of this defrost scheme to a roll-forged or roll-bonded evaporator presents a number of problems in that the defrost circuit which must be separate from the refrigerant circuit, must nevertheless be in heating relation therewith for proper defrosting action. In addition the defrost circuit must be in the form of a closed or continuous passage for continuous circulation of the defrosting vapors and must be so constructed that the vapors formed in the vaporizing section will not interfere with the continuous circulation of vapors and liquid in the defrost circuit.

It is a primary object of the present invention to provide a roll-forged refrigerant evaporator structure including separate circuit means for uniformly heating the structure to defrosting temperatures.

Another object of the invention is to provide an evaporator structure including a roll-forged evaporator having a serpentine refrigerant circuit including a refrigerant accumulator and a separate defrost circuit in the form of a closed double loop passage for periodically heating the entire evaporator structure for the purpose of removing accumulator frost.

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

In accordance with the present invention, there is provided a refrigerant evaporator structure comprising a roll-forged evaporator having formed therein a refrigerant circuit comprising a serpentine portion having a refrigerant inlet adjacent the top of the evaporator and a refrigerant accumulator adjacent the lower portion. Since the evaporator structure is preferably of the roll-bonded or roll-forged construction, the accumulator portion conveniently consists of a plurality of vertically and horizontally extending intersecting tubular portions as is well known in the art.

As is well known, evaporator structures of this type can be formed by superimposing one metal plate on another with a predetermined pattern of stop-weld material on one of the sheets, roll-forging the sheets together and finally expanding by means of fluid pressure the portions

of the sheets which were prevented from welding by the stop-weld material, the pattern thereof being selected to form in the final roll-forged product the desired refrigerant and other passes or "tubes."

In order to provide means for periodically warming the roll-forged evaporator structure for the purpose of removing any accumulated frost therefrom there is provided a second or defrost circuit which is formed along with the refrigerant circuit during the roll-forging process.

A charge of volatile liquid, such as one of the well known refrigerants in an amount sufficient to fill the lower portion of the double loop defrost circuit arrangement and a heater for volatilizing the liquid are employed to heat the entire evaporator structure to defrosting temperatures.

Preferably, the heater is supported on the evaporator structure in heating relation with the accumulator and with each of the interconnected loops so that each loop comprises a first section in heat exchange relation with the heater and second or condensing section in heat exchange relationship with a portion of the refrigerant circuit.

By this arrangement the defrost circuit in effect comprises, in series connection, a first evaporator section in heat exchange with the heater, a condensing section in heat exchange with the upper portion of the refrigerant circuit comprising the serpentine passages, a second evaporator section in heat exchange with the heater and a second condensing section in heat exchange relationship with the remaining portions of the refrigerant circuit.

By providing suitable traps in the defrost circuit, circulation of the liquid and vapor therethrough upon energization of the heater can be controlled for flow in a predetermined direction to effect simultaneous heating of the evaporator structure at two different areas upon energization of the heater.

For a better understanding of the invention, reference may be had to the following description thereof when taken in connection with the accompanying drawing in which:

Fig. 1 is a side view partially in section of a refrigerator cabinet including the evaporator structure of the present invention;

Fig. 2 is an enlarged elevational view of the evaporator structure;

Fig. 3 is a sectional view along line 3-3 of Fig. 2; and

Fig. 4 is a detailed view of the lower portion of the evaporator structure of Fig. 2.

Referring now to Fig. 1 of the drawing, there is shown a refrigerated cabinet 1 including a food storage compartment 2 in which there is disposed the roll-forged evaporator structure 3 of the present invention, this evaporator structure being in a vertical position and spaced slightly from the rear wall 4 of the food storage compartment 2.

The refrigerated cabinet includes also a condensing unit comprising a compressor 5 and a condenser 6, the condenser being connected to the evaporator structure through a capillary tube 8 while the compressor 5 is connected through a suction line 9 to the outlet end of the evaporator.

As is best shown in Fig. 2 the evaporator 3 is in the form of a plate 11 made by the roll-forging method whereby the plate includes both refrigerant and defrost circuit passages.

In the illustrated embodiment of the invention, the refrigerant circuit includes an upper serpentine portion 12 extending from one edge of the plate where it is connected to the capillary 8 downwardly in serpentine configuration to an accumulator which preferably comprises an upper section 13a and a lower section 13b.

More specifically, the serpentine portion 12 of the refrigerant circuit comprises a plurality of downwardly sloping passes 14 extending substantially across the face of the sheet or plate 11 and connected by loop

15 so that refrigerant entering the serpentine portion of the circuit from the capillary 8 flows downwardly through the passes 14 and connecting loops 15 adjacent the edges of the plate 11 and into the first accumulator section 13a. This section is connected by a conduit 16 to the second accumulator section 13b which is in turn connected by means of a vertically extending suction gas passageway 17 to the suction line 9 at the upper portion of the plate 11. As illustrated, the accumulator sections 13a and 13b are preferably composed of a plurality of vertically and horizontally extending and intersecting tubular passageways in accordance with the usual practice in the roll-forged evaporator art.

Also in accordance with the illustrated embodiment of the invention, there is provided a fan 19 driven by a motor 20 for circulating air from within the storage compartment 2 upwardly between the evaporator 3 and the rear wall 4 of the cabinet for the purpose of cooling the contents of the cabinet by means of the circulating cooled air. The evaporator 3 is provided with an aperture 21 to receive the fan 19 whereby all of the air passing upwardly behind the evaporator structure 3 is directed upwardly through the opening 21 and into the upper section of the storage compartment 2 from which it flows through a louvered door 22 for circulation downwardly over the shelves 23 provided in the storage compartment 2.

During normal operation of the refrigerating system particularly when applied to a freezer structure, there is a gradual accumulation of frost on the evaporator structure which must be removed to maintain the desired operation efficiency of the system, and to eliminate manual defrosting.

In accordance with the preferred embodiment of the present invention, defrosting of the evaporator structure is accomplished by means of a closed double looped defrost circuit containing in the lower portion thereof a quantity of vaporizable liquid such as any of the well known refrigerants and means for heating the liquid to effect vaporization thereof so that circulation of the vapors through the defrost circuit warms the remaining portions of the evaporator structure to defrosting temperatures. More specifically, the defrost circuit which is in the form of a continuous or closed tubular passage formed during the roll-forging of the evaporator comprises a first loop 26 and a second loop 27 each of which have their lower or evaporator or vaporizing sections 29 and 30 in heat exchange relation with a heater 32.

More specifically, the defrost circuit comprises in closed series connection a first vaporizing section positioned below the heater 32, a vertical riser 33 extending up the right hand side of the evaporator structure, a condenser portion 34 comprising a plurality of downwardly sloping passages in parallel with the upper passes 14 of the serpentine refrigerant circuit, a vertical return line 36 which terminates in a connection to the second vaporizing section 30 disposed above the heater 32. This much of the defrost circuit up to the second evaporator section 30 comprises a first loop of the double loop defrost circuit, the second loop comprising the vaporizing section 30, a riser 38 and the second condenser portion 27 in parallel with the remaining serpentine passes 14, the second condenser section also including a conduit portion 40 extending below the accumulator 13a and connecting the condenser portion 27 to the first vaporizing section 29. Liquid traps 41 and 42 at the inlet ends of the two vaporizing sections 30, 29 prevent reverse flow of the volatile liquid within the defrost circuit when the heater 32 is energized.

From the above it will be seen that by the means of the present invention there is provided an evaporator structure of the roll-forged type in which the entire circuitry both for the refrigerant and for the defrost liquid can be formed readily by the roll-forging process since there is no overlap or crossing of the two circuits. A specific fea-

ture of the invention is the arrangement of the defrost circuit with reference to the main circuit such that there is provided a double loop defrost circuit with all of the connections between the vaporizing sections and the condenser sections of the loops arranged along one vertical edge of the evaporator structure leaving the remainder of the structure available for refrigerant circuit.

Upon energization of the heater 32 both of the evaporator sections 29 and 30 are warmed so that the volatile liquid contained therein is evaporated. Due to the presence of the traps 41 and 42 the vapor resulting from the evaporation flows from the evaporator sections 29 and 30 and rises through the risers 33 and 38 to the upper portions of the respective condensing sections 26 and 27. There the vapors condense, making available the heat of condensation for the melting of frost on the respective areas of the evaporator structure. The condensed refrigerant in section 27 flows downwardly into the evaporator section 29 and the condensed refrigerant in the condenser section 26 flows downwardly into the evaporator section 30 where the vaporization process is repeated. For the purpose of charging the defrost circuit an inlet 50 thereto is formed during the roll-forging process at one edge of the sheet. After the defrost liquid is introduced this inlet is suitably sealed as for example by means of a plug 51.

In those applications where the cabinet air is drawn over the evaporator surface by means of the fan 19 there may also be provided a plurality of apertures 45 at spaced points throughout the face of the plate whereby air from the cabinet can be drawn over the different shelves and through the openings and into the space between the evaporator and the rear wall 4 of the cabinet. Also in such an evaporator structure it may be found desirable to connect the upper passes of the defrost circuit condensing section 26 around the fan opening 21 by means of one or more vertically extending passageways 46 which will serve to defrost more quickly the areas of the evaporator adjacent the fan opening.

With reference to Fig. 4 there is shown a further detail of the evaporator structure in which the lower edge of the structure is formed into a pair of troughs 49 on opposite sides or faces of the evaporator structure to collect condensate flowing down the faces of the structure, it being understood that the water collecting in the troughs 49 is suitably disposed of outside the cabinet structure. This trough structure for the roll-forged evaporator is formed in the same manner as the tubular passages, that is by the use of a weld resistant material which will prevent welding in this area and provide separable portions forming the two side walls of the trough 49.

While there has been shown and described a particular embodiment of the present invention it will be understood that the invention is not limited thereto and it is intended by the appended claims to cover all modifications thereof within the true spirit and scope of the invention.

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

1. A defrostable refrigerant evaporator structure comprising a vertically arranged roll-forged evaporator having formed therein a refrigerant passage having an inlet and an outlet at the top thereof and a second passage separate from said refrigerant passage, said refrigerant passage including a serpentine conduit portion, an accumulator portion below said serpentine portion and a vertical passage adjacent one edge of said evaporator terminating in said refrigerant passage outlet, said second passage forming a double loop continuous tubular conduit and containing a charge of volatile liquid, one of said loops including a serpentine section in heating relation with a part of said refrigerant circuit serpentine portion the other of said loops including a serpentine section in heating relation with the remaining

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part of said refrigerant passage both of said loops including lower sections adjacent said accumulator and vertical risers connecting said serpentine sections and said lower sections disposed between said serpentine portion of said refrigerant passage and said vertical passage, a defrost heater supported on said structure in heating relation with said lower sections and said accumulator for heating said accumulator to defrosting temperatures and for causing said volatile liquid in said lower sections to vaporize and circulate through said serpentine sections to warm the remaining portions of said structure to defrost temperatures.

2. In a refrigerated cabinet, a defrostable evaporator structure comprising a vertically arranged roll-forged evaporator in spaced relation with one wall of said cabinet, said roll-forged evaporator comprising a refrigerant circuit and a second circuit separate from said refrigerant circuit, said refrigerant circuit including a serpentine portion having a refrigerant inlet thereto adjacent the top of said evaporator, first and second horizontally extending enlarged portions adjacent the bottom of said structure and spaced from one another, said enlarged portions forming refrigerant accumulator chambers, said first enlarged portion being connected to the outlet end of said serpentine portion, a passage extending along one vertical edge of said structure for connecting said first and second enlarged portions, an outlet passage connected to said second enlarged portion and extending

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vertically along the other vertical edge of said evaporator to the top of said evaporator, means for periodically heating said structure to melt accumulated frost thereon comprising a heating element secured to said structure between said enlarged portions, said second circuit being in the form of a closed double-loop continuous tubular passage substantially coextensive with said refrigerant circuit and partially filled with a volatile liquid, said second circuit including in series connection, a first substantially horizontal vaporizing section in heat exchange relation with said heater, a first condensing portion paralleling and in heat exchange relation with the upper part of said serpentine portion, a second substantially horizontal vaporizing portion in heat exchange relation with said heater and a second condensing portion in heat exchange with the remaining portion of said refrigerant circuit, said vaporizing sections being disposed between said heater and said enlarged portions and including traps to prevent reverse flow of vapor in said defrost circuit upon energization of said heater.

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