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REFRIGERATING APPARATUS WITH DEFROST MEANS

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2 Sheets-Sheet 1

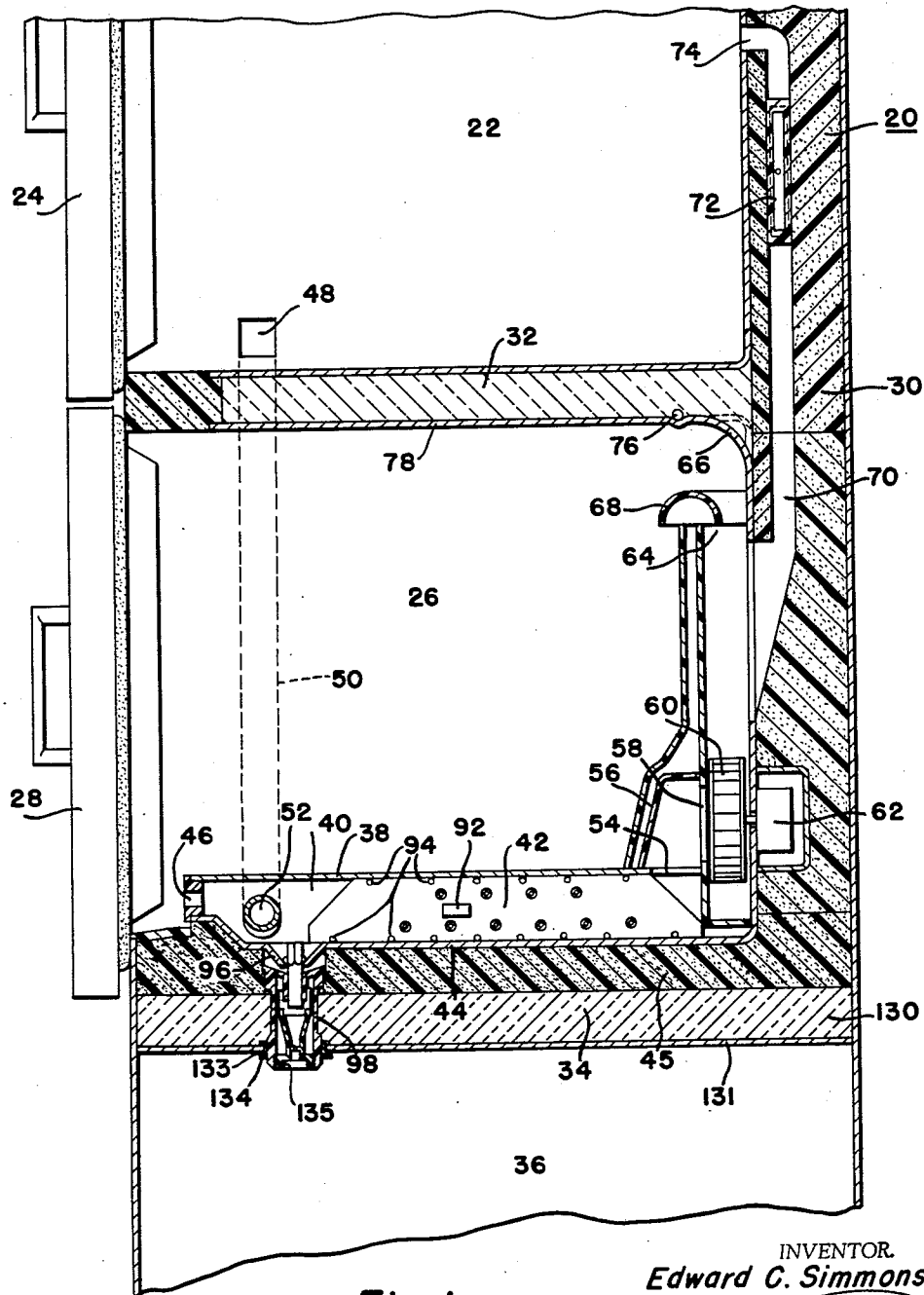


Fig. 1

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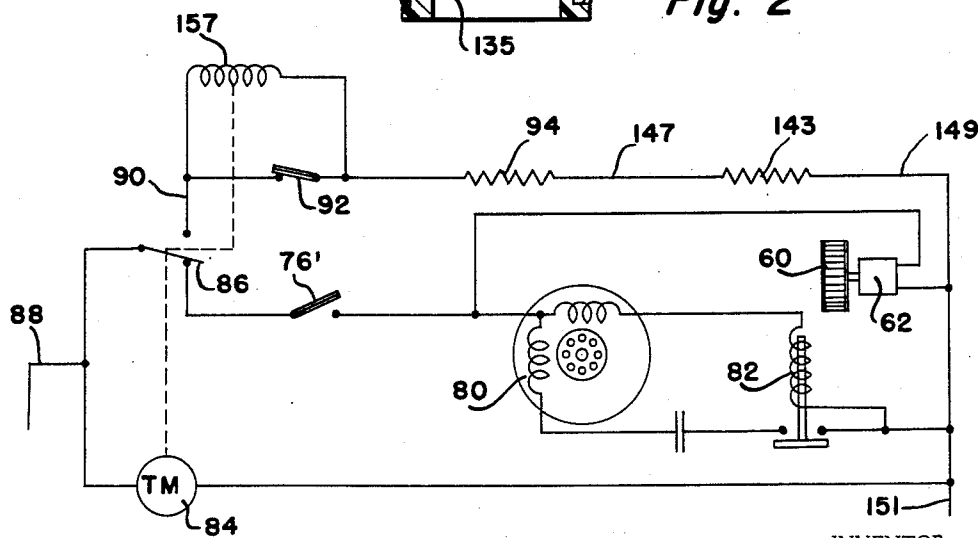
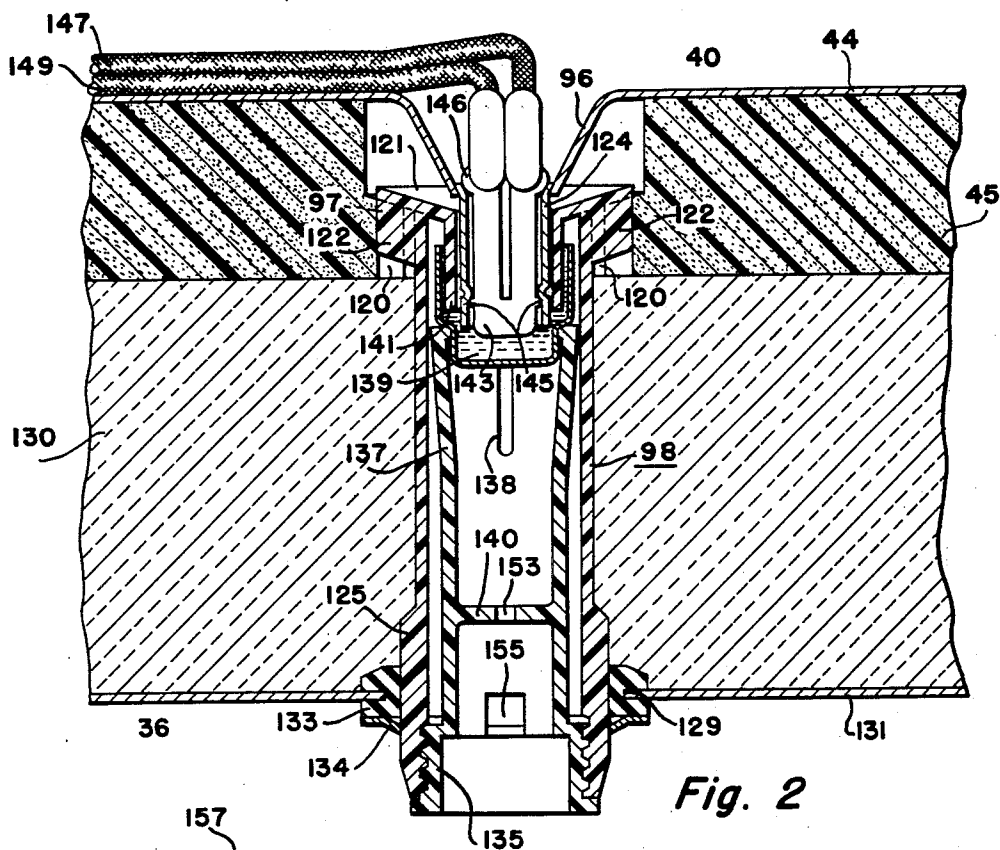
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2 Sheets-Sheet 2



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1

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REFRIGERATING APPARATUS WITH DEFROST MEANS

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This invention pertains to refrigerating apparatus and more particularly to means for carrying away melted frost from refrigerator cabinets without permitting the leakage of cold air therefrom.

Refrigerant evaporators when operated at below freezing temperatures in air gradually accumulate frost which acts as an insulator, gradually reducing the efficiency and capacity of the evaporator to cool the air. Consequently, it is necessary to defrost the evaporator from time to time to remove the frost and to convey the melted frost away from the refrigerator cabinet. It is customary to provide refrigerator cabinets with a water-sealed drain trap for carrying away the melted frost and for preventing the escape of the cold air from the cabinet. However, difficulties have been encountered when there is provided forced air circulation through the evaporator compartment. Under such circumstances, when frost accumulates upon the evaporator, the excessive vacuum created by the circulating fan may be sufficient to draw warm moist room air in through the water-sealed drain trap into the cabinet causing added frosting and an undesirable rise in temperature within the cabinet and possibly the unsealing of the trap. By the violent slamming of the refrigerator door, it may also be possible to force sufficient water out of the water sealed drain trap to unseal the trap.

It is an object of this invention to provide simple inexpensive means allowing the escape of the melted frost from the refrigerator cabinet during defrosting which will prevent the ingress of warm air, the loss of the cold air and the unsealing of the sealing trap under all conditions.

It is another object of this invention to provide a simple inexpensive water-sealed drain trap arrangement effective during defrosting to carry away the melted frost but which is arranged so that water in the trap is frozen during normal refrigerator operations to positively prevent the escape of cold air or the ingress of warm air into the cabinet.

It is another object of this invention to provide a simple inexpensive water-sealed drain trap which is arranged in sufficient proximity to the refrigerant evaporator to normally keep frozen the water in the trap which is also provided with a simple inexpensive means for melting the water in the trap at the beginning of the defrosting of the evaporator to quickly allow the melted frost to drain through the trap during the defrosting period.

These and other objects are attained in the form shown in the drawings in which the evaporator compartment is arranged at the bottom of the below freezing compartment. A fan at the rear draws air from both compartments through the evaporator compartment and the cross-finned evaporator and returns the air to the compartments to be cooled. A drain trap is arranged at the front of the evaporator compartment in close proximity to the front of the finned evaporator. This drain is provided with an upper water-sealed trap into which dips the copper outlet tube of the drain pan so that the water in the trap will be frozen during normal operation of the refrigerator. Periodically, refrigeration is stopped and the evaporator is electrically heated to melt the frost therefrom. The drain trap is provided with an electric heater which is immersed in the water seal and energized at the same time as the electrical heater for defrosting the evaporator. This melts

2

the ice or frozen defrost water in the drain trap seal so as to allow the melted frost from the evaporator to flow through the drain trap at the beginning of the defrost cycle to prevent any accumulation of melted frost within the evaporator compartment.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings wherein a preferred embodiment of the present invention is clearly shown.

In the drawings:

FIGURE 1 is a vertical side sectional device through a household two-compartment refrigerator having forced air circulation embodying one form of my invention;

FIGURE 2 is an enlarged sectional view through the drain trap shown in FIGURE 1; and

FIGURE 3 is a wiring diagram including a defrosting system for the refrigerator shown in FIGURE 1.

Referring now to the drawings and more particularly to FIGURE 1, there is shown, partly diagrammatically, an insulated refrigerator cabinet 20 provided with an upper above-freezing compartment 22 closed by the upper door 24 and a lower below-freezing compartment 26 closed by a lower insulated door 28. The compartments 22 and 26 have a common insulated rear wall 30 and a horizontal insulated wall 32 between them. There is also a thick insulated wall 34 between the bottom of the below-freezing compartment 26 and the machinery compartment 36 beneath the cabinet. The side walls and the top walls of the cabinet are also insulated.

At the lower portion of the below freezing compartment 26, there is provided a false bottom sheet metal wall 38 which separates the below-freezing compartment 26 from the evaporator compartment 40 beneath. This false bottom metal wall 38 rests on top of the transverse fins of the horizontally positioned refrigerant evaporator 42 which in turn rests upon the generally horizontal bottom sheet metal wall 44 forming a drain pan as well as the bottom of the below-freezing compartment 26 and resting upon the rigid insulation 45 of the bottom insulated wall 34. The evaporator compartment 40 is provided with an entrance 46 at the front which receives air from the below-freezing compartment 26. The above-freezing compartment 22 has an air outlet 48 connected by a passage 50 extending through the side insulated wall to an outlet 52 discharging into the front portion of the evaporator compartment 40. The false bottom metal wall 38 is provided with a notch 54 at the rear behind the evaporator 42.

Over the notch 54 there is provided an inlet shroud 56 connecting with the inlet 58 of a centrifugal fan 60 driven by an electric motor 62. This fan 60 discharges upwardly and has a discharge outlet 64 having a portion thereof directed onto the curved fillet 66 at the upper rear of the compartment 26 so as to distribute the air throughout the upper portion of the compartment 26. A second distributing collar 68 is provided above the outlet 64 for directing air to the lower portion of the compartment 26. The fan 60 is provided with a second discharge air passage 70 extending upwardly through the rear insulated wall 30 to a valve 72 which controls the discharge of air through the outlet 74 into the above-freezing compartment 22. The valve 72 may be either manual or thermostatic and throttles the flow of air sufficiently to maintain the temperature of the compartment 22 above water freezing temperatures.

A conventional compressing and condensing apparatus (not shown) is located in the machinery compartment 36 and connected operatively to the evaporator 42 for keeping the evaporator 42 at water freezing refrigerating temperatures. It is controlled in accordance with the

temperature of a thermostat bulb 76 located in heat transfer with the top of the liner 78 surrounding the compartment 26 to maintain the compartment 26 at suitable below-freezing temperatures, such as 0° to 10° F. The thermostat bulb and the switch operatively connected therewith is illustrated in FIGURE 3 diagrammatically by a switch 76'. As indicated diagrammatically in FIGURE 3, the switch 76' controls the operation of a capacitor start motor 80 which drives the compressor for supplying refrigerant to the evaporator 42. The starting winding is controlled by a starting relay 82 which energizes the capacitor and phase winding during the starting period. The fan motor 62 is connected in parallel with the compressor motor 80 so that both operate simultaneously and are both idle simultaneously.

The switch 76' normally operates to maintain the evaporator 42 at a temperature about 10° F. below the temperature of the compartment 26, for example, between -5° and -15° F. This causes the evaporator 42 to freeze out frost from the air circulating through the evaporator compartment 40. The frost gradually accumulates and acts as an insulator to reduce the capability of the evaporator 42 to cool the air. In addition, the frost tends to clog up the air passages through the evaporator 42 to cool the air. In addition, the frost tends to clog up the air passages through the evaporator 42 thereby reducing the air circulation. Both gradually reduce the efficiency of the refrigerating system. As indicated in FIGURE 3, a timing motor 84 is placed in parallel with the remainder of the electrical circuit including the compressor motor 80 and the switch 76'. Once a day, such as at 2 a.m., (or twice a day, if desired), this timer motor operates the double throw defrost switch 86 from the normal lower refrigerating position connecting the supply source 88 with the switch 76' to the upper defrost position in which it connects through the conductor 90, the defrost limiter switch 92 and the defrost heater 94. The defrost heater 94 is preferably of the sheathed tubular type and is lodged in notches provided in the upper and lower edges of the fins of the evaporator 42. The defrost heater 94 heats the evaporator 42 during the defrost period while refrigeration is prevented to melt the frost from the evaporator 42.

It has been customary to provide a water sealed drain outlet through insulated walls for draining away the melted frost from refrigerators. However, the water sealed traps are not capable of withstanding any appreciable difference in pressure. For example, if the water seal has an effective depth of an inch of water, such a seal can only withstand about 0.036 pound per square inch pressure. The fan 60 is capable of creating a suction of several inches on its inlet side and several pounds pressure on its discharge side. Even the slamming of one of the doors 24 or 28 is sufficient to create a pressure of several pounds within the compartments 22 and 26. Under such circumstances, the air from the compartments 22 and 26 will blow right through any water seal. When the doors 24 or 28 are open, they allow warm air to enter the compartments 22 and 26. If the doors are well sealed, this air will be cooled and will contract due to the cooling within the compartments 22 and 26, thereby drawing warm air from the machinery compartment upwardly into the evaporator compartment 40. Therefore, to provide a seal for the drain which will withstand such pressure differences, I arrange so that the water seal is located in a sufficiently cold environment to cause the water seal therein to be frozen during normal use of the refrigerator.

At the front of the evaporator compartment 40, there is provided a depression 96 within its bottom wall 44 containing a drain opening provided with a short copper drain tube 124. Surrounding this drain tube 124 and extending downwardly therefrom through the rigid insulation 45 and the bagged glass fiber insulation 130 is a generally cylindrical member 98 of a suitable plastic. This member

98 is provided with an upper flared rim 121 which seats upon the rim of an opening 97 in the rigid insulation 45. This rim 121 has a pair of ears 122 beneath it which fit within the notches 120 within the opening 97 to prevent the rotation of the member 98. The upper rim 121 has a downwardly extending cylindrical projection 141 which fits in between the copper tube 124 and a thin metal water seal container 139 having its upper rim extending substantially above the bottom of the copper tube 124 and the cylindrical extension 141 so as to form a water seal or trap whenever water flows downwardly through the copper tube 124.

This container 139 has an enlarged upper portion while its smaller lower cup-shaped portion fits within the upper portion of the inner plastic sleeve 137. This inner plastic sleeve 137 has diametrically opposite slots 138 so that the upper edge of the inner tube 137 will resiliently engage the lower cup-shaped portion of the water seal container 139. Provided between the enlarged upper portion and the cup-shaped smaller, lower portion is a shoulder which rests upon the upper rim of the inner tubular member 137. This inner tubular member 137 is provided with a lower externally threaded portion 135 which threads into the bottom of the internally threaded lower portion 125 of the outer tubular member 98. The ears 122 lodged in the notches 120 prevent the rotation of the member 98 whenever the inner tubular member 137 is threaded into its lower portion.

The inner tubular member 138 is provided with a transverse web 140 provided with a central aperture 153 for any drainage. The inner tubular member 137 is also provided with a pair of oppositely disposed openings 155 providing for the escape of any water which may overflow the container 139 during defrosting and flow downwardly between the inner and outer tubular members 137 and 98. The bottom portion 125 is surrounded by a grommet 133 which envelops the rim of the opening 129 in the bottom wall 131 and fits the portion 125 tightly enough to prevent air flow between the machinery compartment 36 beneath and the fibrous insulation 130. A sheet metal nut 134 is applied onto the lower end of the portion 125 of the outer tubular member 98 and forced into engagement with the grommet 133 so as to hold the member 98 from upward movement after it has been installed.

The drain pan 44 has a major portion of its upper face contacted by the bottom major face of the evaporator 42 and is cooled to a temperature between the temperature of the evaporator 42 and the temperature of the air within the compartment 40 during normal operation of the refrigerating system. Therefore, the temperature of this drain pan 44 can be expected to be maintained between -10° F. and -15° F. After any defrosting period, the water seal container 139 will be substantially filled with defrost water. The copper tube 124 is immersed in this water to a substantial depth. The copper tube 124 rapidly removes heat from and quickly freezes this water in the trap 139. This seals the trap provided by the seal container and the tube 124 so that no air movement can take place in either direction. The ice so formed in the trap cannot be displaced by any air pressure provided by the slamming of the door or by the fan 60. The suction provided by the fan 60 also cannot displace the ice. Although water in the water seal container 139 can evaporate readily because of the suction created by the fan 60, the ice formed is not readily affected thereby. In fact the sublimation rate of the ice would be less than one-seventh the rate of evaporation. The freezing of the ice in the seal trap container 139 will thereby prevent any leakage of air during the normal operation of the refrigerating system. Since the inner and outer tubular members 98 and 137 are of plastic, the transfer of heat by conduction through them is minimized.

To allow the flow of melted frost through and out of the drain during the defrost periods, I provide within the copper tube 124 an insulated electric resistance heater

5

143 of a U-shaped configuration. This heater 143 may be insulated with silicone rubber. It is provided with several spacing projections 145 in the lower portion so as to hold it substantially concentric within the tube 124. It is also provided with the upper projections 146 which limit its downward movement. This heater 143 is connected to a conductor 147 connecting with the heater 94 and a conductor 149 connecting with the second supply conductor 151.

The defrost period is terminated when the defrost limiter switch 92 mounted upon the evaporator 42 as shown in FIGURE 2 reaches a temperature of about 40° F. This thermostatically operable defrost limiter switch 92, when it reaches such a temperature as will assure the complete defrosting of the evaporator 42, opens to energize the electromagnet coil 157 to return the switch 86 to the lower normal refrigeration position and to de-energize the heaters 94 and 143 to resume normal refrigeration. The resumption of normal refrigeration through the cooling of the drain pan 44 and the copper tube 124 will refreeze the defrost water in the water seal receptacle 139 of the trap, thereby again preventing any movement of air through the drain outlet in either direction. The frozen defrost water cannot be dislodged by suction or pressure created by the fan 60 or pressure created by the slamming of the doors 24 or 28. In this way, heat leak through the trap during normal refrigeration operation is effectively prevented.

While the embodiment of the present invention as herein disclosed constitutes a preferred form, it is to be understood that other forms might be adopted.

What is claimed is as follows:

1. Refrigerating apparatus including an insulated cabinet having insulated walls enclosing a compartment to be cooled, refrigerant evaporating means normally operating at below water freezing temperatures for cooling said compartment and adapted to accumulate frost, a drain pan located beneath and adjacent to and cooled by said evaporating means and provided with a downwardly extending drain outlet tube of good heat conducting material, means for circulating air from said compartment to

6

be cooled in heat transfer with said evaporating means above said drain pan and outlet tube, a sealing container surrounding the bottom of said outlet tube beneath said drain pan and shielded thereby from the circulating air and provided with a rim higher than the bottom of said tube for collecting water and immersing the bottom of said tube in the water providing a sealing trap cooled below water freezing temperatures by said tube for freezing the collected water during the normal operation of said evaporating means, an electric heater extending into heat transfer relation with the frozen water for heating frozen water in said container, and means for defrosting said evaporating means to melt the frost therefrom and coincidentally energizing said electric heating means.

2. Refrigerating apparatus including an insulated cabinet having insulated walls enclosing a compartment to be cooled, horizontally positioned refrigerant evaporating means normally operating at below water freezing temperatures for cooling said compartment and adapted to accumulate frost, a generally horizontal drain pan located beneath and supported and having a major portion of its upper surface adjacent to and cooled by said evaporating means and provided with a drain outlet tube of good heat conducting material, a sealing container surrounding the bottom of said outlet tube provided with a rim higher than the bottom of said tube for collecting water and immersing the bottom of said tube in the water providing a sealing trap cooled below water freezing temperatures by said tube for freezing the collected water during the normal operation of said evaporating means, an electric heating means located within said tube and extending into contact with water collected in said container, and means for defrosting said evaporating means to melt the frost therefrom and coincidentally energizing said electric heating means for melting the frozen water in said container.

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