March 9, 1971 R. C. JUNG 3,568,465

SINGLE EVAPORATOR FOR COMBINATION REFRIGERATION APPARATUS

Filed June 5, 1969 2 Sheets-Sheet 1

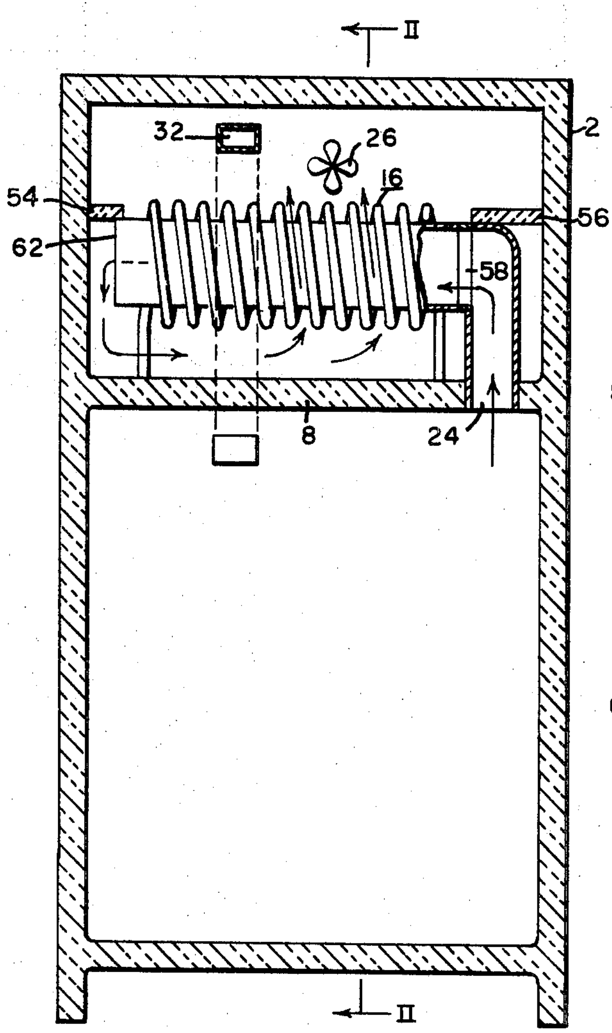

FIG.1

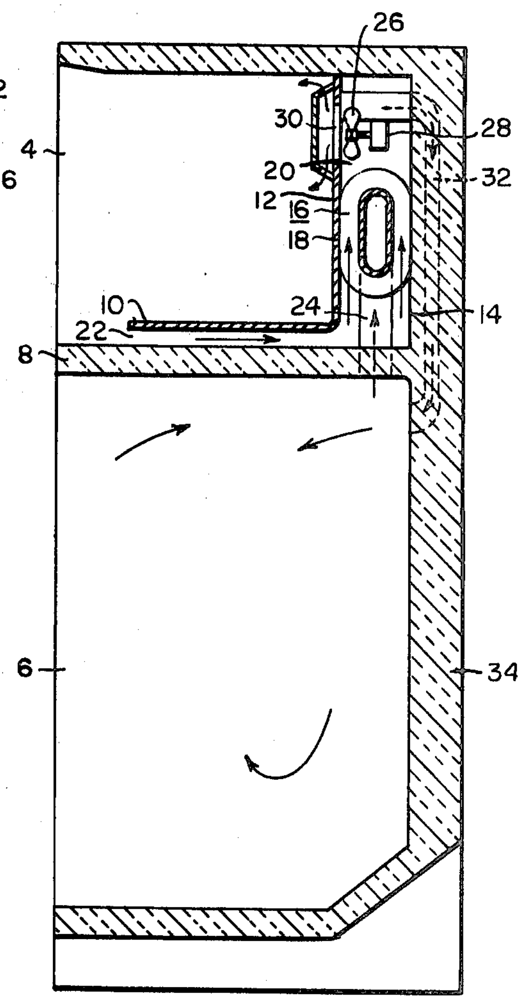

FIG.2

WITNESSES

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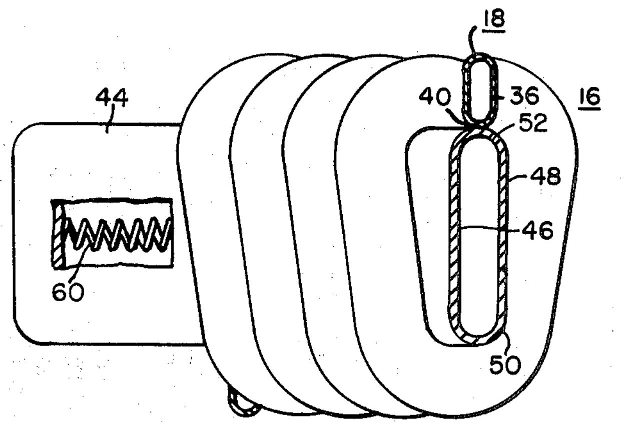
18
44
40
36
16
52
48
46
60
50

FIG. 3

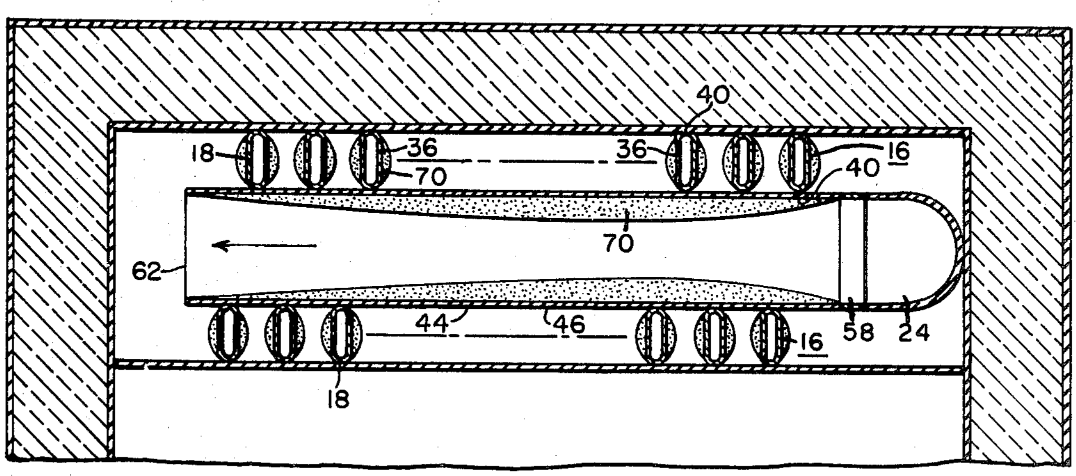
40
18
36
70
36
16
40
70
62
44
46
16
58
24
18

FIG. 4

3,568,465
SINGLE EVAPORATOR FOR COMBINATION REFRIGERATION APPARATUS

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U.S. Cl. 62—419 10 Claims

ABSTRACT OF THE DISCLOSURE

In evaporator is disclosed for use in a refrigerator of the type having both a frozen food compartment and a fresh food compartment in air flow communication with an evaporator chamber enclosing a single evaporator. The refrigerant tubing of the evaporator is flattened and spirally wound about, and in contact with, a metal cylinder through which the moisture laden return air from the fresh food compartment is initially directed for entry into the evaporator chamber. The moisture in the return air is deposited as frost on the internal walls of the cylinder, refrigerated by conductance through the tubing so that substantially dry, cool air exits from the cylinder to mix with the relatively dry return air of the frozen food compartment directed to the evaporator chamber. The mixed air is drawn over the exterior walls of the cylinder and in contact with the flattened walls of the closely spaced coils of the refrigerant tube, further cooling the air for return to the respective compartments. A defroster is also provided in the cylinder for periodic defrost of the frost accumulation.

BACKGROUND OF THE INVENTION

The present invention relates to a single evaporator in a refrigeration unit having separate compartments which are maintained at different temperatures. An example of such a refrigeration unit is a refrigerator having a freezer food compartment maintained at a temperature below freezing, and a fresh food compartment maintained at a temperature slightly above freezing. Although it has been found economically advantageous to provide a single evaporator in such a unit, this has given rise to other problems; one of which is the rapid frost buildup on the evaporator due to the moisture laden air returning to the evaporator chamber from the fresh food compartment. Such frost buildup requires frequent defrosting for efficient operation of the evaporator. However, frequent defrosting is costly to operate and reduces the refrigeration capacity of the unit since the temperature of the evaporator and associated parts must be raised sufficiently to defrost and then lowered again to refrigerate. The heat added during each defrost must be removed during the refrigeration cycle and requires lengthy operation of the initial refrigeration cycle after each defrost. Further, the heat added during defrost produces some surface thawing of refrigerated articles in the freezer compartment contributing to the shortening of food storage capabilities of the refrigerator.

The frost is deposited on the evaporator generally in the vicinity of initial contact with the moisture laden returned air on the air inlet side of the evaporator thereby decreasing the volume of air that can effectively flow through the evaporator, which in turn decreases the efficiency of the evaporator. In the well known fin-on-tube evaporators commonly employed in the refrigeration system of the present type, previous attempts have been made to decrease the necessary frequency of defrosting of the evaporator. Exemplary among such attempts are modifications of the evaporator by extending the leading edge of the fins beyond the refrigerant tubing so that more even distribution of ice buildup is possible before the frost restricts the air flow to an inefficient amount, such as is shown in U.S. Pat. No. 3,324,678, and also increasing the distance between the fins of the evaporator to permit greater accumulation before air flow becomes blocked such as is shown in U.S. Pat. No. 3,212,285. However, in these evaporators it is still apparent that frost will continue to buildup at the inlet side of the evaporator to such a degree that the evaporator will eventually become blocked to sufficient passage of air therethrough. For further efficient operation it is further apparent that in such illustrative evaporators the frost would still restrict the return air entrance of the evaporator although the remainder of the evaporator would provide sufficient cooling if accessible to the air flow.

SUMMARY OF THE INVENTION

The present invention relates to an evaporator for use in a refrigeration unit such as disclosed in the above-identified U.S. patents. The present evaporator comprises a flattened refrigerant tubing spirally wound about a central cylinder. The moisture laden return air from the fresh food compartment of a refrigeration unit is directed into the cylinder through a return air conduit where it is cooled and its moisture is deposited in the form of frost on the walls of the cylinder. The cylinder has a sufficiently large cross-sectional area so that the frost accumulation does not prevent efficient volumetric flow therethrough. The return air thus stripped of its moisture, exits at the opposite end of the cylinder where it is forced to mingle with the relatively dry return air from the freezer compartment. The mixed air is then drawn over the exterior walls of the cylinder and in contact with the flattened refrigerant tubing where it is further cooled prior to being returned to the respective compartments of the refrigerator. A defroster of any well known type is disposed within the cylinder so that when the frost accumulated therein acquires a sufficient thickness throughout the length of the cylinder such that the moisture is no longer stripped from the return air flowing therethrough, the cylinder can be defrosted.

DRAWING DESCRIPTION

FIG. 1 is a vertical front sectional schematic view of a refrigerator employing the evaporator of the present invention;

FIG. 2 is a vertical sectional view taken generally along line II—II of FIG. 1;

FIG. 3 is an isometric view of the refrigerant tubing and central cylinder of the present evaporator with a piece broken away to schematically show the internal defroster, and

FIG. 4 is an enlarged sectional view taken along line IV—IV of FIG. 1, showing typical frost accumulation of the evaporator.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIGS. 1 and 2 the present invention is shown as incorporated in a combination refrigerator unit **2** of well known construction having a single refrigerant evaporator **16** for maintaining freezing temperatures in a frozen food compartment **4** and temperatures in the range of 35° to 40° F. in a fresh food compartment **6**. The compartments **4** and **6** are thermally insulated from each other by a horizontal insulating partition **8**. The freezer compartment **6** has a bottom compartment liner **10** supported a short distance above the partition **8**, and a rear wall **12** spaced inwardly from the inner insulated rear wall **14** of the refrigerator cabinet **2**. A single evaporator **16** is disposed in the evaporator chamber **20** formed between walls **12** and **14**. Air from the freezer compartment **4** is returned to the evaporator chamber **20** through openings **22** in the forward portion of liner **10**, communicating with the space between liner **10** and partition **8** which terminate at the rear thereof into the evaporator chamber **20**. The return air from the fresh food compartment **6** is directed through a return air conduit **24** extending from the evaporator chamber **20**, through the insulating partition **8** and into the fresh food compartment **6**. A vent fan **26** is disposed in the upper portion of the evaporator chamber **20** and is actuated by an electric motor **28** connected in a common electric circuit with the motor driven refrigerant compressor so that the fan **26** runs simultaneously with the compressor as is well known in the art. The fan **26** draws the refrigerated air from the exit side of the evaporator and forces part of it through openings **30** in the rear wall **12** of the freezer compartment **4**, with the remaining portion of the refrigerated air being forced rearwardly through an air duct **32** in the rear wall insulation **34** which discharges into the fresh food compartment **6**. Thus, the evaporator chamber **20** is in air flow communication with both the freezer compartment **4** and fresh food compartment **6**.

Referring now to FIGS. 3 and 4, the evaporator **16** of the present invention, comprises an evaporator tube **18**, preferably of aluminum, having a generally flattened oval cross-section providing relatively wide side walls **36** and narrow end walls **40**. The flattened tube **18** is spirally wound about a central cylinder **44** also preferably of aluminum, and also having a substantially oval cross-section providing relatively wide side walls **46** and narrow end walls **50**. The evaporator tube **18**, as wound extends along substantially the full length of the cylinder **44** with the windings of the tube **18** spaced a short distance from each other to provide access for air to the space between adjacent windings as is shown in FIG. 4. As is also shown, evaporator tube **18** is wound in such a manner that one of its narrow end walls **40** is in contact with the exterior walls of the cylinder **44** so that the wide side walls **36** of adjacent windings of the tube **18** face each other. It is noted that no mechanical bonding between cylinder **44** and tube **18** is necessary as the cylinder **44**, having preferably been shaped from a round cylinder, would have sufficient natural resiliency so that after insertion in the center of the spirally wound tube **18** it would "spring-back" somewhat and provide sufficient contact between the wall **40** of tube **18** and the walls **46** and **50** of cylinder **44**.

The evaporator cylinder **44** with tube **18** spirally wound thereon is horizontally disposed and generally centrally located in the evaporator chamber **20**. Also, as is more clearly shown in FIGS. 2 and 4, the total width of the evaporator **16** corresponds generally to the width of the evaporator chamber **20** so that there is substantially no air flow over the relatively narrow end walls of the evaporator tube **18**. Air blocks **54** and **56** are placed in the evaporator compartment **20** adjacent each end thereof, above each end of the cylinder **44** and extend between the rear wall **12** of the freezer compartment and the rear wall **14** of the evaporator chamber to restrict upward air flow to the portion of the evaporator chamber **20** containing the refrigerant evaporator tube **18**.

The discharge end of the fresh food return air conduit **24** is connected to the inlet end of cylinder **44** through an insulated coupling member **58** providing a thermal break therebetween. The discharge end **62** of the cylinder **44** is spaced a short distance from the end of the evaporator chamber **20** and is open for discharge of the air to the chamber **20**.

A defroster of any of the well known types such as a heater wire **60**, shown in FIG. 3, or a radiant heat defrost means may be disposed within the cylinder **44** and electrically connected to be actuated under a predetermined condition as is well known in the art.

The advantages of the evaporator **16** operating in the

environment of a combination refrigeration unit having two separate compartments maintained at different temperatures can best be illustrated through the following description of typical air flow in the unit when the refrigerant compressor and vent fan **26** are operating in the normal manner providing the evaporator tube **18** with refrigerant and causing forced circulation of the air within the compartments **4** and **6** and chamber **20**.

The moisture laden air in the fresh food compartment **6** returns to the evaporator chamber **20** through return air conduit **24** and vents into cylinder **44**, the walls of which have been cooled through conductance by the surrounding evaporator tubing **18**. As the return air is cooled, moisture therein is deposited on the cold inner walls of the cylinder **44** in the form of frost. FIG. 4 illustrates a typical buildup of frost **70** in the evaporator cylinder **44** and on the tubing **18** and shows the accumulation at a period of heavy frost load just prior to defrost. Under such heavy frost conditions, cylinder **44** still has a sufficient open cross-sectional area to permit an efficient volume of air therethrough; however, the flow of air in the evaporator chamber **20** through the passages between consecutive windings of the evaporator tubing **18** has become restricted by frost accumulation on the tubing **18** prohibiting efficient volumetric flow thereby. Although the greater part of the moisture carried in the return air is deposited as frost on the inner walls of cylinder **44**, the frost buildup on which defrost initiation is dependent, namely the frost on the evaporator tube **18**, is due to the cooler surface of the evaporator tube **18** which is able to remove further moisture from the relatively dry cool air discharging from the cylinder **44**.

The return air from the fresh food compartment, after being pre-cooled and dried in the cylinder **44**, discharged therefrom where it is prevented from being immediately drawn upwards by virtue of the air block **54** above the discharged end **62**, and thus forced to mix with the relatively dry return air from the frozen food compartment **6** entering the evaporator chamber **20** below the evaporator **16**.

The mixed return air is then drawn upwards over the evaporator **16** by the vent fan **26**. The air is confined to flow through the narrow passages defined by walls **36** of the consecutive windings of the tube **18**, the outer walls **46** of the cylinder **44** and the walls **12** and **14** of the evaporator chamber **20**. The wide side walls **46** of the oval cylinder **44** provide sufficient height for the evaporator **16** so that the mixed air flowing through the passages between the windings of the evaporator tube **18** has a long vertical passage for efficient heat transfer between the air and the evaporator.

After thus being cooled, the air is returned to the respective compartments **4** and **6** of the refrigerator by vent fan **26** through vents **30** and conduit **32** as is well known in the art.

Thus, with the present evaporator, the critical area on which frost accumulates so as to require defrost operations is subjected to relatively dry cool air, substantially reducing the rate of frost buildup, prolonging the periods between necessary defrosting, and thereby reducing defrosting operations and unwanted effects therefrom. Also, the construction of the evaporator provides long narrow passageways to which the air flowing therethrough is confined, thereby exposing the air to sufficient cooling surfaces to provide the desired refrigerated air.

Further, the fabrication of such an evaporator having the flattened evaporator refrigerant tube wound in a helix about a central cylinder without any mechanical bonding necessary therebetween is obviously faster, less complex, and less expensive than the well known fin-on-tube type evaporator.

What is claimed is:

1. In a refrigeration unit having a plurality of cooling compartments maintained at different temperatures with

a single evaporator disposed in a chamber in the unit in air flow communication with said compartments, said evaporator comprising:

air passage means receiving moisture laden return air for initial cooling and drying;

cooling means encircling said central air passage means at spaced intervals substantially along its length for further cooling the return air from the said compartment as it passes over said cooling means.

2. The refrigeration unit of claim **1** wherein said air passage means comprises a metal cylinder connected at one end to a return air duct from one of said compartments and having the other end open to discharge air into the evaporator chamber.

3. The refrigeration unit of claim **2** wherein said cooling means comprises a flattened refrigerant evaporator tube having relatively wide side walls and relatively narrow end walls.

4. The refrigeration unit of claim **3** wherein said evaporator tube is spirally wound with one end wall in contact with said metal cylinder.

5. The refrigeration unit of claim **4** wherein the evaporator chamber has blocking means confining the discharged air to flow across said evaporator.

6. The refrigeration unit of claim **5** having means defining a plurality of passages for the flow of discharged air across said evaporator.

7. The refrigeration unit of claim **6** wherein the means defining passages comprises said evaporator chamber, said cylinder, and adjacent side walls of said spirally wound evaporator tube.

8. A single evaporator for a refrigeration unit having

separate compartments maintained at different temperatures, said evaporator comprising:

refrigerated evaporator tubing serially connected in a closed refrigeration circuit with compressor and condenser means;

air passage means for initially receiving moisture laden return air from at least one of said zones; and wherein

said evaporator tubing encircles said air passage means at relatively closely spaced intervals substantially along the length of said passage means.

9. The evaporator of claim **8** wherein the air passage means comprises a metal cylinder and said evaporator tubing is spirally wound about said cylinder.

10. The evaporator of claim **9** wherein the evaporator tubing and metal cylinder are in contact substantially along the length of said tubing.

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WILLIAM J. WYE, Primary Examiner

U.S. Cl. X.R.

62—407, 426, 272, 276