March 31, 1964 F. A. SCHUMACHER 3,126,717

FORCED AIR COOLED REFRIGERATOR

Filed Dec. 12, 1962

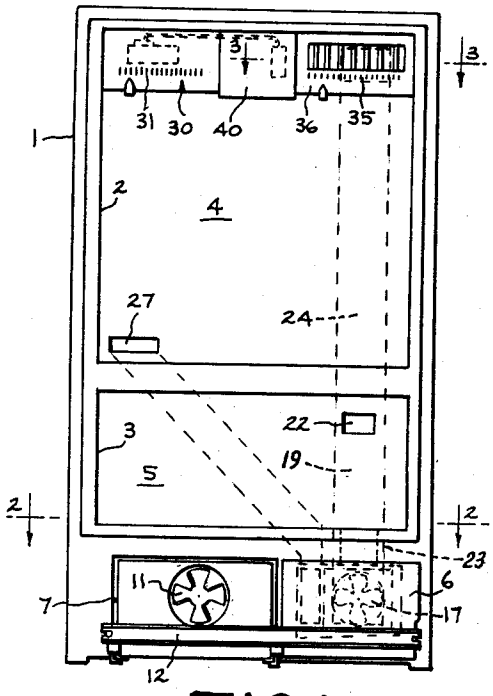

FIG. 1

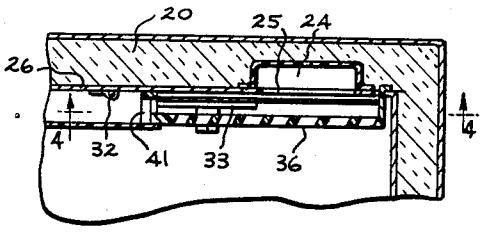

FIG. 3

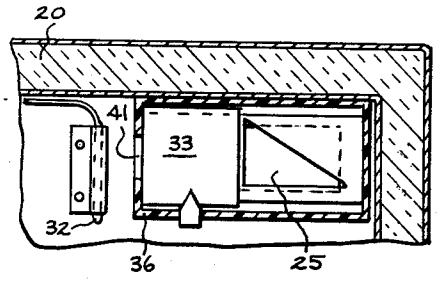

FIG. 4

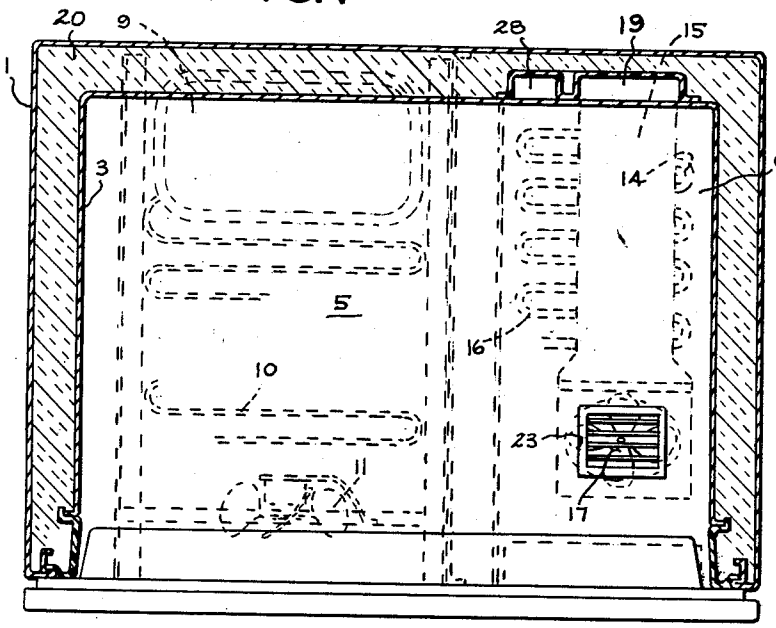

FIG. 2

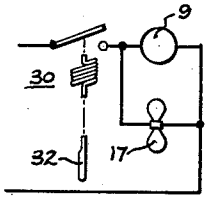

FIG. 5

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FORCED AIR COOLED REFRIGERATOR

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The present invention relates to household refrigerators of the type in which an above freezing and a below freezing storage compartment are cooled by air circulated over an evaporator positioned outside the compartments and is more particularly concerned with an improved air circulation and temperature control arrangement for such refrigerators.

When air circulated over a single evaporator is employed for cooling both an above freezing storage compartment and a below freezing storage compartment, it is necessary to operate the evaporator somewhat below the temperature desired in the lower temperature compartment. Since the air leaving the evaporator is at a much lower temperature than that desired in the higher temperature or above freezing compartment, means must be provided for so proportioning the air flow to the two compartments that the amount of air provided to the above freezing storage compartment is just sufficient to maintain the desired temperatures therein. In such refrigerators it is also desirable to provide means for separately controlling the temperatures in each of the two storage compartments so that the user has some flexibility in the temperatures at which the respective compartments operate.

The present invention has as its principal object the provision of a refrigerator in which separate storage compartments operating at different temperatures are cooled by air circulated over a single evaporator, the refrigerator including means providing for a limited change in the operating temperature of either compartment independent of the temperature maintained in the other compartment.

It is another object of the present invention to provide a two-temperature refrigerator cabinet including new and improved control and air circulating means.

A further object of the invention is to provide a household refrigerator comprising an above freezing storage compartment and a below freezing storage compartment in which the controls for regulating the temperatures in both compartments are positioned in a readily accessible position in the above freezing compartment.

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 a part of this specification.

In accordance with a preferred embodiment of the present invention, there is provided a household refrigerator including an above freezing storage compartment, a freezer or below freezing storage compartment and an insulated evaporator compartment below and separate from the two storage compartments. The evaporator compartment is designed to receive a single evaporator forming part of a refrigerating apparatus which also includes a condensing unit comprising a compressor and a condenser. Fan and air circulating means is provided for withdrawing air from both of the storage compartments and circulating it over the evaporator unit. Most of the cooled air circulated over the evaporator unit is conducted by means of a first supply duct to the below freezing compartment. A second supply duct connected to this first duct conducts a portion of the cooled air to the above freezing compartment. The operation of the compressor and the air circulating fan is controlled by a thermostat positioned in the above freezing compartment and including a control bulb responsive to a temperature condition in

that compartment. The thermostat is thus an above freezing compartment control and is designed to hold the temperature of that compartment within the desired operating limits. Variable air flow control means associated with the outlet from the second supply duct provides means for varying the amount of air flowing through the second supply duct to the above freezing compartment and thereby changing the proportion of cooled air circulated through the freezer compartment. Thus a decrease in the amount of air flowing to the above freezing compartment by adjustment of the air flow control means causes the compressor to run longer in order to satisfy the requirements of the above freezing storage compartment thermostat thereby causing the below freezing compartment to become colder. Conversely, adjustment of the variable air flow control means to a more open position thereby admitting more refrigerated air to the above freezing compartment causes the thermostat to reach the compressor cut off temperature sooner with the result that the freezer storage compartment runs at a somewhat higher temperature again without affecting the temperature maintained in the above freezing compartment. Preferably both the thermostat adjustment means and the air flow control means are placed adjacent one another on one wall of the above freezing storage compartment so that both are readily accessible to the user.

For a better understanding of the invention, reference may be had to the accompanying drawing in which:

FIGURE 1 is a front elevation, with the closure members removed, of a household refrigerator including what is presently considered to be a preferred embodiment of the present invention;

FIGURE 2 is a horizontal sectional view taken generally along line 2—2 of FIGURE 1;

FIGURE 3 is a vertical sectional view of a portion of the cabinet of FIGURE 1 taken generally along line 3—3 of FIGURE 1;

FIGURE 4 is a vertical sectional view taken along line 4—4 of FIGURE 3; and

FIGURE 5 is a diagram of a portion of an electrical control circuit for controlling the operation of the refrigerator.

Referring to FIGURE 1, there is shown a refrigerator cabinet including an outer shell 1 and upper liner 2 and a lower liner 3 spaced from the shell 1 and from one another, the space between these members being filled with suitable heat insulating material. The upper liner 2 forms a fresh food or above freezing storage compartment 4 while the lower liner 3 defines a below freezing or frozen food storage compartment 5. An evaporator compartment 6 and a condensing unit compartment 7 are positioned in side-by-side relationship along the bottom portion of the cabinet below the freezing compartment 5. For clarity the closure members for closing the access openings to the two storage compartments and to the evaporator and condensing unit compartments have been omitted from FIGURE 1. A removable unitary refrigerating apparatus for refrigerating the air supplied to the storage compartments 4 and 5 comprises a condensing unit which is positioned in the condensing unit compartment 7 and which includes a compressor 9, a condenser 10 and a fan 11 designed to pass a cooling stream of air over the condenser and the compressor. Connected to the condensing unit by means of a frame 12 is an evaporator unit disposed within the evaporator compartment 6 and including an evaporator 14 which comprises a length of tubing folded to provide a plurality of horizontal passes and a housing 15 which divides these passes into a frost collecting evaporator portion 16 and a cooling portion contained within the housing 15. A fan 17 mounted on the front of the housing 15 is adapted to draw air into the evaporator compartment from the stor-

age compartments and direct air over the cooling evaporator portion contained within the housing **15** after which the cooled air is returned by suitable ducts **19** and **24** to the two compartments **4** and **5**. It will be understood that means, not shown, are also provided for periodically defrosting the evaporator unit.

For the purpose of maintaining the freezer compartment **5** at desired sub-freezing temperature, there is provided means defining an air flow path which includes, in addition to the cooling portion of the evaporator **14**, the supply duct **19** extending from the rear of the housing **15** upwardly through the rear wall **20** of the cabinet and having an outlet **22** opening into the freezer compartment **5** and an air return passage **23**. The outlet **22** may be provided with suitable louvers for directing the flow of air through the compartment **5**. After passing through the freezer compartment **5**, the air is returned to the evaporator compartment through a return passage **23** provided in the bottom wall of the freezer compartment immediately above the fan **17** whereby the return air from the freezer compartment passes directly through the cooling portion of the evaporator contained within the housing **15** without passing over the defrost collecting portion **16**.

For the purpose of supplying cooled air to the above freezing storage compartment **4**, there is provided a second air flow path including the second supply duct **24** extending upwardly from the supply duct **19** to the top of the above freezing storage compartment **4**. This supply duct **24** which in the illustrated embodiment of the invention is a continuation of the duct **19** supplying air to the freezer compartment has its outlet **25** opening through the rear wall **26** of the liner **2** adjacent one top corner of the above freezing compartment **4**. Air is withdrawn from a lower portion of the above freezing storage compartment **4** through an opening **27** which is connected by means of duct **28** to the rear of the evaporator compartment **6**. The return air from the above freezing storage compartment **4** passes over the frost collecting portion **16** of the evaporator where the moisture contained therein is removed before it is again mingled with the air returning from the freezer compartment **5** through the opening **23**.

By this air flow system, it will be seen that the below freezing compartment **5** is cooled by air flowing in a closed circuit from the evaporator through the duct **20** out through the supply opening **22** and back to the cooling portion of the evaporator through the opening **23**. The above freezing compartment **4** is cooled by a portion of the air flowing from the evaporator into the duct **19** which is bypassed into the above freezing compartment **4** through the duct **24**.

In accordance with the present invention, the operation of the compressor **9** and the fan **17** is controlled by a thermostat **30** mounted in the above freezing storage compartment **4** and including a control dial **31** and a sensing bulb **32**. While the bulb **32** may be positioned at any point in the fresh food compartment where it will sense a temperature accurately reflecting the storage temperature conditions maintained in that compartment, it is preferably positioned on the rear wall **26** of the liner **2** adjacent air outlet **25**.

The amount or proportion of air flowing from the evaporator to the above freezing storage compartment **4** when fan **17** is running is regulated by means of a damper **33** slidably mounted on the rear wall **26** for varying the amount of refrigerated air supplied to the compartment **4** through opening **25**. As shown in FIGURE 4 of the drawing, the opening **25** is preferably triangular in shape so that there is obtained a rather linear control or proportioning of the air flowing to the fresh food compartment as the damper **33** is moved from its left hand or open position to its right hand position in which it partially closes the opening **25**. By this arrangement the indicia **35** on the face of the damper frame **36** can be linear and accurately reflect the change in temperatures obtained by movement of the damper **33** to its various positions.

Since air not permitted to flow into the above freezing compartment **4** through opening **25** circulates instead through the compartment **5**, it will be seen that when the damper **33** is in its fully open position a minimum amount of air will flow through the below freezing compartment **5** while movement of the damper **33** towards its closed position will increase the proportion of air flowing into the compartment **5**.

Thus independent control of the operating temperatures of the compartments **4** and **5** is obtained by means of the thermostat **30** and the damper **33**. Since the thermostat **30** is responsive to a temperature condition in the above freezing compartment **4**, the compressor will be cycled on and off in accordance with the temperatures sensed in that compartment. The desired temperature range within the compartment **4** will be maintained regardless of the setting of the damper **33**, the only difference being that the compressor will be run for a longer period of time to satisfy the requirements of the thermostat **30** when the damper is partially closed than when it is fully open. On the other hand, the setting of the damper **33** directly affects the temperature maintained in the freezer compartment **5**. When the damper **33** is opened so that the maximum amount of air possible is being supplied to the above freezing compartment **4**, a smaller proportion of the air will flow through the compartment **5** so that a higher temperature is maintained in that compartment although, of course, this temperature will still be below freezing due to the fact that the air supplied from the evaporator unit is at a below freezing temperature. Movement of damper **33** to a flow restricting position decreases the amount of air flowing to the compartment **4** and correspondingly increases the amount of air flowing from the evaporator through the freezer compartment **5**. The compressor then operates for a longer period of time to satisfy the requirements of the thermostat **30** with the result that the cooled air from the evaporator will be circulated for a longer period of time through the freezer compartment **5** and thereby cause this compartment to reach a somewhat lower temperature.

As is shown in FIGURE 1 of the drawing, this air flow and control means permits the positioning of both controls in the fresh food storage compartment where they are easily accessible for regulating the temperatures in either of the two storage compartments.

Preferably, the sensing bulb or capillary **32** is positioned on and in heat exchange relation with the rear wall **26** of the liner **2** to one side of the air delivery opening **25**. In this position, due to the heat leakage through the insulation adjacent the rear wall **26**, the sensing bulb will reflect the temperature of a part of the above freezing compartment which passes through a substantial temperature fluctuation during each cycle of operation of the compressor. During the compressor off period, the wall **26** will tend to warm to a greater extent than the shelves and other storage areas within the compartment **4** while during compressor on periods it will be cooled by the cold air entering the compartment. Thus the thermostat **30** can be of the less critical type permitting a greater temperature fluctuation between the on and off settings than would be the case if the bulb **32** were suspended directly in the air contained within the compartment **4**. Also by positioning the bulb on the rear wall **26** behind a shield **40** the bulb is protected from the warming effects of too many door openings.

In order that the bulb will anticipate the temperature at which the compressor should be turned off, a small portion of the air issuing through the inlet **25** is preferably directed through an opening **41** behind the grille or face plate **36** over that area of the wall **26** surrounding the bulb **32**. This portion of refrigerated air is just sufficient to cool the bulb **32** during a compressor on cycle to the point that the thermostat stops the compres-

sor at approximately the time that the main volume of air passing into the compartment 4 through the opening 25 has cooled the contents of that compartment to the desired temperature.

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 such changes and modifications as come 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 refrigerator including an above freezing compartment, a below freezing compartment and an evaporator compartment including an evaporator separate from said above and below freezing compartments,

a refrigerating system including a compressor and said evaporator,

means including a fan and a first supply duct connecting said evaporator compartment with said freezer compartment for circulating air in a first air flow path from said evaporator through said supply duct to said freezer compartment and back to said evaporator,

means including a second supply duct connected to said first supply duct having an outlet opening into said above freezing compartment for circulating a portion of the air flowing through said first supply duct to said above freezing compartment and back to said evaporator,

compressor and fan control means responsive only to a temperature in the above freezing compartment for controlling the operation of said compressor and fan to maintain a predetermined temperature in said above freezing compartment,

variable air flow control means associated with said outlet opening for varying the amount of air flowing from said second supply duct and thereby controlling the proportion of air circulated through said below freezing storage compartment to vary the temperature of said below freezing compartment,

said temperature sensing means being arranged to sense the temperature of a wall area of said above freezing compartment adjacent said opening,

and means for directing a portion of the air passing through said opening over said wall area.

2. A refrigerator including an above freezing compartment, a below freezing compartment and an evaporator compartment including an evaporator separate from said above and below freezing compartments,

a refrigerating system including a compressor and said evaporator,

means including a first supply duct connecting said evaporator compartment with said freezer compartment defining a first air flow path for circulating air from said evaporator through said supply duct to said freezer compartment and back to said evaporator,

means including a second supply duct having its inlet connected to said first supply duct and its outlet opening into said above freezing compartment for circulating a portion of the air flowing through said first supply duct to said above freezing compartment and back to said evaporator,

fan means for circulating said air,

compressor and fan control means including temperature sensing means responsive only to a temperature in the above freezing compartment for controlling the operation of said compressor to maintain a predetermined temperature in said above freezing compartment,

and variable air flow control means associated with said outlet opening for varying the amount of air flowing through said second supply duct and thereby controlling the proportion of air circulated through said below freezing storage compartment;

said temperature sensing means being arranged to sense the temperature of a wall area of said above freezing compartment adjacent said opening,

and means for directing a portion of the air passing through said opening over said wall area.

3. A refrigerator including an above freezing compartment, a below freezing compartment and an evaporator compartment including an evaporator separate from said above and below freezing compartments,

a refrigerating system including a compressor and said evaporator,

means including a first supply duct connecting said evaporator compartment with said freezer compartment defining a first air flow path for circulating air from said evaporator through said supply duct to said freezer compartment and back to said evaporator,

means includinga second supply duct connected to said first supply duct and having an outlet opening into said above freezing compartment for circulating a portion of the air flowing through said first supply duct to said above freezing compartment and back to said evaporator,

a fan for circulating said air over said evaporator and into said first supply duct,

compressor and fan control means including temperature sensing means responsive only to a temperature in the above freezing compartment for controlling the operation of said compressor to maintain a predetermined temperature in said above freezing compartment,

variable air flow control means associated with said outlet opening for varying the amount of air flowing through said second supply duct and thereby controlling the proportion of air circulated through said below freezing compartment to vary the temperature of the below freezing compartment,

said temperature sensing means being arranged to sense the temperature of a wall area of said above freezing compartment adjacent said outlet opening,

and means operable independent of said air flow control means for directing a fixed portion of the air passing through said outlet opening over said wall area.

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