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Gelbard

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[54] **REFRIGERATOR TEMPERATURE CONTROL**

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[52] **U.S. Cl.** **62/180,** 62/208, 62/187, 62/408, 62/157

[51] **Int. Cl.**.....**F25d 17/00**

[58] **Field of Search**.....62/161, 163, 267, 62/408, 187, 180

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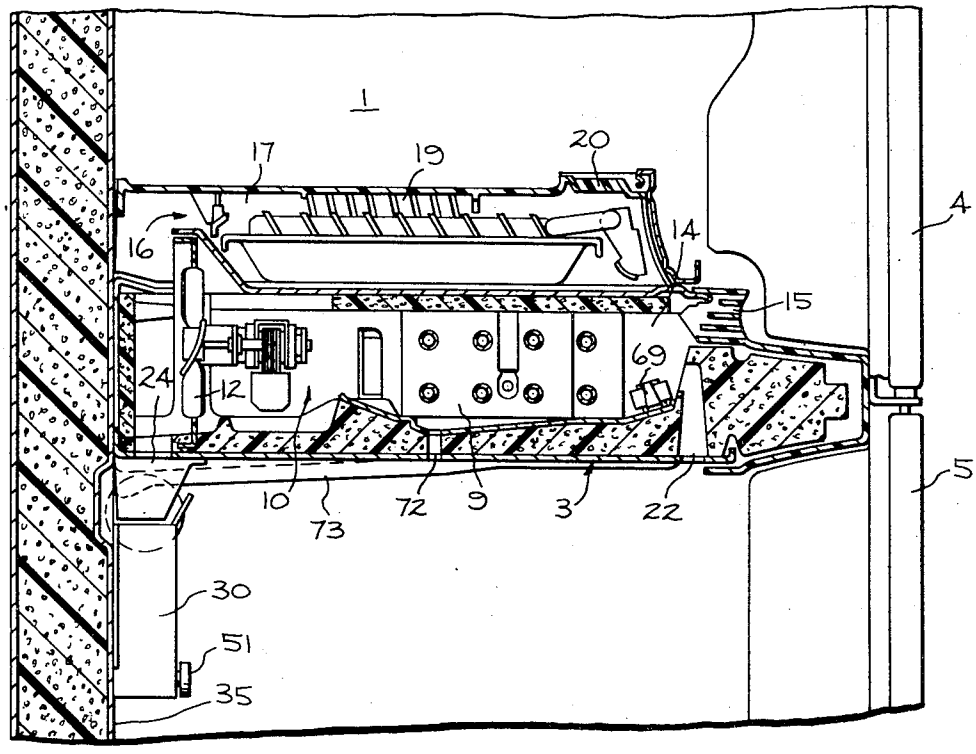
Primary Examiner—William J. Wye
Attorney—Frank L. Neuhauser et al.

[57] **ABSTRACT**

A refrigerator including a storage compartment cooled by forced circulation of air from the compartment over an evaporator and the return of cooled air to the compartment includes a fixed temperature control means for controlling the operation of the refrigeration system and means for varying the flow of cooled air over the fixed temperature control in order to control the operating temperature of the compartment.

4 Claims, 4 Drawing Figures



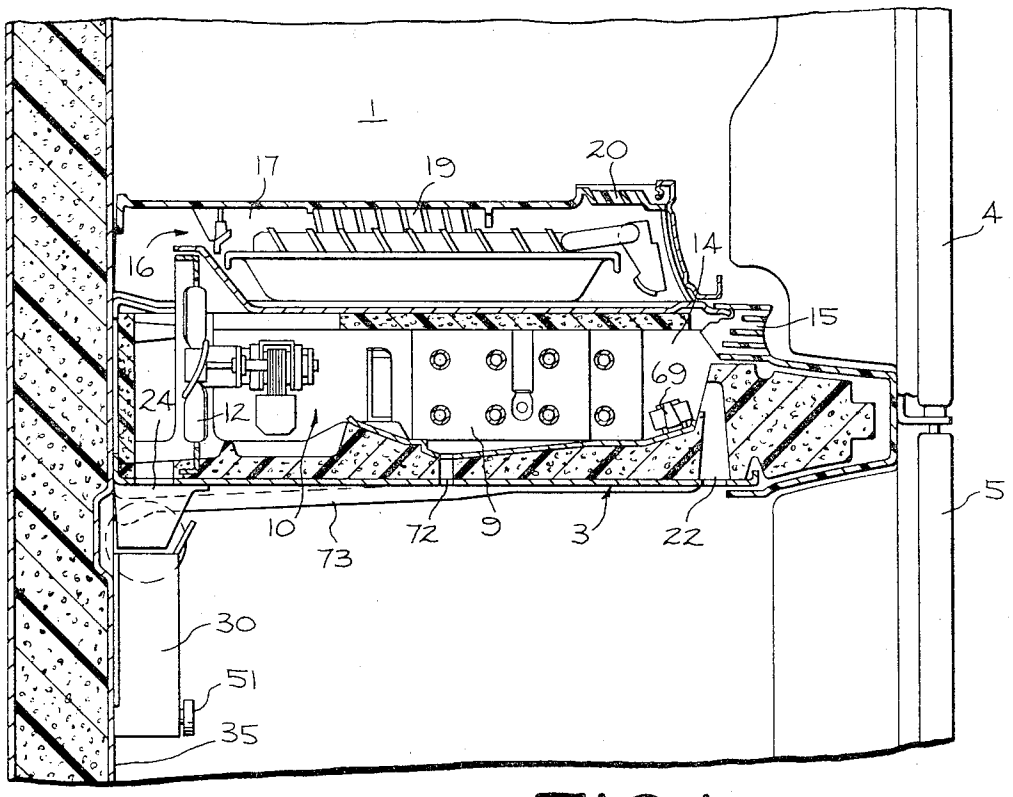

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FIG. 1

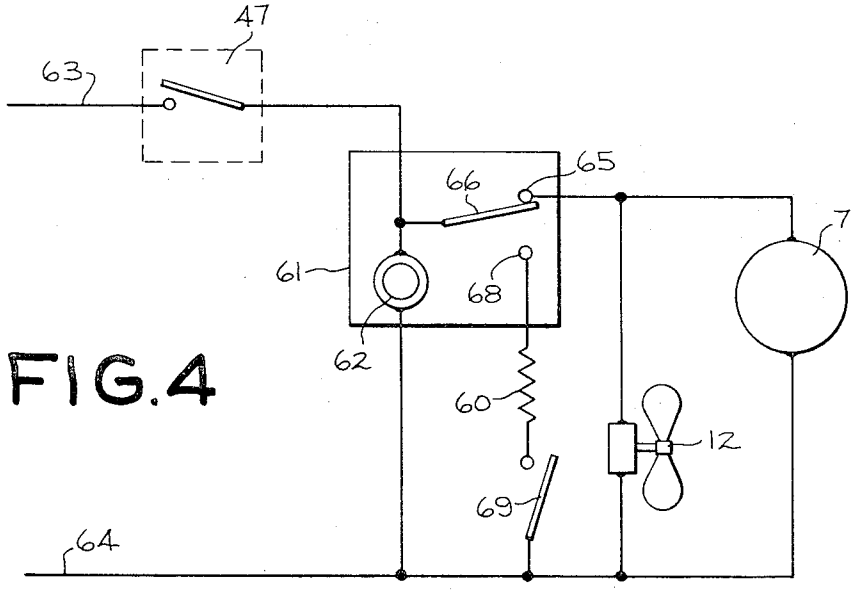
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FIG. 4

2 Sheets-Sheet 2

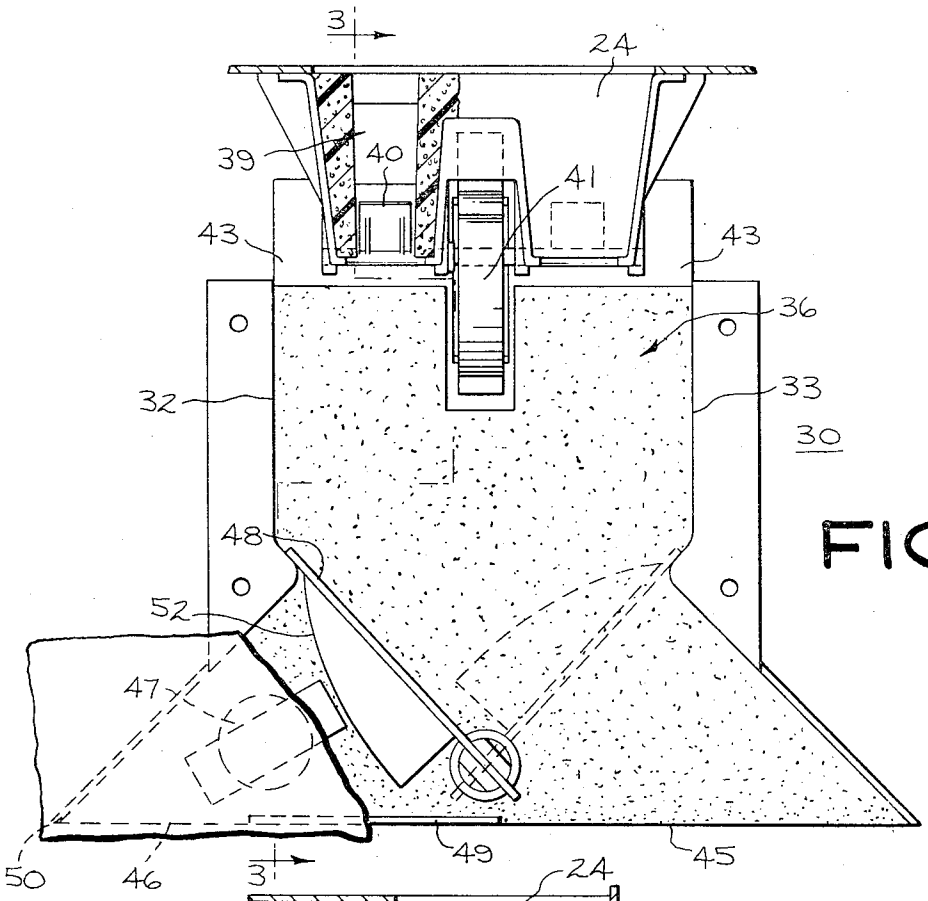

FIG. 2

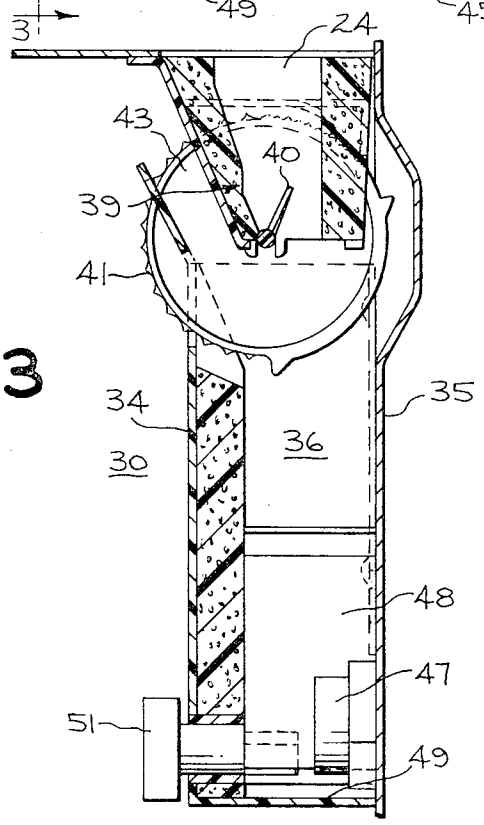

FIG. 3

REFRIGERATOR TEMPERATURE CONTROL

BACKGROUND OF THE INVENTION

Household refrigerators generally include control means whereby the user may, within limits, control the temperature in which a storage compartment or compartments operates. Such control means has generally included a thermostat having as part of its structure means for adjusting or selecting the temperature at which the thermostat operated switch means will function to energize a refrigeration system. By such adjustment of the thermostat, the user is able to select the desired operating temperature or temperatures within the storage compartment or compartments of the refrigerator. The adjusting mechanism for preselecting the temperature at which such thermostats operate adds to the cost of the thermostat.

An object of the present invention is to provide a refrigerator including a low cost temperature control component for selecting the operating temperature of a refrigerator storage compartment.

Another object of the invention is to provide a refrigerator including forced air circulating means, a fixed temperature control thermostat and means associated with the forced air circulating means for varying the operating temperature of the refrigerator.

SUMMARY OF THE INVENTION

In accordance with the preferred embodiment of the present invention, there is provided a refrigerator including at least one storage compartment, an evaporator separate from the compartment and forming part of the refrigeration system and air circulating means for circulating air from the compartment over the evaporator and returning cooled air to the compartment. Control means for controlling the operation of the refrigeration system and the air circulating means includes a fixed temperature sensing means in the path of the cooled air returned to the compartment and manually controlled means for varying the flow of cooled air relative to the fixed temperature control to thereby control the compartment operating temperature.

In accordance with the preferred embodiment of the present invention, the cooled air returned to the compartment is mixed with a proportionate amount of storage compartment air upstream from the fixed temperature control means, the means for effecting the mixture of the air also being so constructed and arranged that when the refrigerating system and air circulating fan are not operating, the fixed temperature sensing means will sense the temperature of the air within the storage compartment.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a vertical side elevational view through a portion of a refrigerator embodying the present invention;

FIG. 2 is an enlarged vertical sectional view of a portion of the refrigerator illustrated in FIG. 1;

FIG. 3 is a sectional view taken generally along lines 3—3 of FIG. 2; and

FIG. 4 is a wiring diagram for the refrigerator shown in the previous figures.

DESCRIPTION OF THE PREFERRED EMBODIMENT

While the invention is applicable to any of the forced air cooled refrigerators, including freezers having one or more storage compartments, it will be particularly described in its application to a combination refrigerator-freezer of the type described in U.S. Pat. No. 3,320,761-Gelbard.

With reference to the drawings, such a refrigerator comprises insulated walls defining an upper freezer compartment 1 intended to operate at a temperature below freezing and a lower fresh food compartment 2 adapted to operate at an above freezing temperature of about 35° to 40° F. The two compartments are separated by an insulated partition 3. The access opening to the freezer compartment 1 is closed by means of an insulated door 4 while the access opening to the fresh food compartment 2 is closed by means of door 5. A machinery compartment (not shown) in the lower portion of the cabinet contains the refrigerant condensing component of a refrigeration system including a hermetic motor-driven compressor 7 (FIG. 4) and a condenser.

In the illustrated embodiment of the invention, the single evaporator 9 for refrigerating the two compartments 1 and 2 is contained within an evaporator chamber 10 formed within the insulated partition 3. It is to be understood that the compressor 7, the condensor, suitable flow restricting means (not shown) and the evaporator 9 are connected in closed series flow relationship to form the usual closed refrigerant circuit.

For the purpose of cooling the two storage compartments 1 and 2 to the desired operating temperatures, air withdrawn from these two compartments is passed over the evaporator 9 and the refrigerated or cooled air returned to the compartments by means of a single fan generally indicated by the numeral 12. More specifically, the inlet portion or end 14 of the evpoarator chamber 10 is connected by means of a relatively large louvered inlet 15 at the forward end of the partition 3 to the freezer compartment 1 and the major portion of the air cooled or refrigerated by the evaporator 9 is returned to the freezer compartment through an air passage 16 connecting to the rear end of a tunnel 17 and a plurality of louvers 19 and 20 provided in the side walls and top wall of the tunnel.

Air from the fresh food compartment 2 enters the inlet end 14 of the evaporator chamber 10 through one or more passages or ducts 22 which are relatively small as compared with inlet 15. A relatively small portion of the refrigerated air flowing from the rear or outlet end of the chamber 10 is supplied through an outlet passage 24 to the fresh food compartment.

In the illustrated refrigerator, means are provided for automatically and continuously mixing the evaporator cooled air flowing through the outlet 24 with the warmer air from the storage compartment 2 before it is introduced into the compartment 2. This mixing is accomplished in a portion of a console member generally indicated by the numeral 30 and illustrated in greater detail in FIGS. 2 and 3 of the drawing. This console member is positioned adjacent the top and rear walls of the compartment 2 at the outlet end of the passage 24 and includes side wall portions 32 and 33 which along with the front wall 34 thereof and the rear wall 35 of the fresh food compartment 2 form a mixing chamber 36. Cooled or refrigerated air from the passage 24 is introduced into the upper portion of the chamber 36 through a nozzle member generally indicated by the numeral 39. In the illustrated embodiment

of the invention, the nozzle 39 is split into two portions and each portion includes a damper 40 for regulating the flow of air through the nozzle and thereby adjusting the relative proportions of the cooled air from the evaporator supplied to the two compartments. A control wheel 41 having a portion extending through the forward front wall 34 of the console provides means for manually adjusting the positions of the dampers 40.

The upper portion of the mixing chamber 36 is in communication with the fresh food compartment 2 through a plurality of inlet passages or openings 43 on three sides of nozzle 39 and the lower end has two outlet openings 45 and 46 leading to compartment 2. By aspirator action, the air flowing through the nozzle 39 and into the chamber 36 at a point intermediate draws a proportioned amount of fresh food cabinet air into the mixing chamber 36 through the passages 43. This air mixes with the cooled air from the nozzle before being discharged through one or both of the outlets 45 and 46.

In accordance with the present invention and as is shown in FIGS. 2 and 3 of the drawing, a fixed temperature control means such as a low cost fixed temperature bimetal thermostat generally indicated by the numeral 47 is positioned adjacent outlet 46, and an adjustable damper 48 is provided for controlling the flow of cooled air over the thermostat 47.

More specifically, one of the outlets, which in the illustrated embodiment of the invention is the outlet 46, is substantially smaller than the other outlet, this being accomplished by the provision of a wall portion 49 extending along the lower end of the console from a point just below the lower end of the damper 48 to a point spaced from the outer edge 50 of the console. The thermostat 47 is positioned with the console adjacent the outlet 46.

The baffle 48 is pivotally mounted within the console at a point near the bottom end thereof as indicated in FIGS. 2 and 3 of the drawing and is provided with a control dial 51 for moving the baffle 48 to any position between its solid line position as illustrated in FIG. 2 in which the air flow to the outlet 46 is substantially restricted and its dotted line position in which substantially all of the air flow is through the outlet 46. The side of the baffle 48 facing the outlet 46 may also be provided with an arcuate surface 52 adapted in various positions of the baffle to more lineally control the flow of air in the direction of the outlet 46, this surface 52 being so formed that when the baffle 48 is in its dotted line position the flow path adjacent the damper 48 is substantially the same size as the outlet 46.

The control circuitry for controlling the operation of a defrost heater 60 associated with the evaporator and both the normal and defrost operation of the refrigerator as illustrated in FIG. 4. The control circuit is designed to initiate a defrost cycle after a predetermined period of compressor operation. To this end, there is provided a defrost timer 61 including a timer motor 62 connected across the supply lines 63 and 64 through the thermostat 47. The timer 61 includes a double throw switch operated by the timer motor 62 and including a first contact 65 which is normally engaged by switch arm 66 to complete a circuit through the thermostat energizing both fan 12 and the compressor 7 when the thermostat calls for cooling. The timer 61 is designed so that at predetermined intervals the timer switch operates to move switch arm 66 from contact 65 into engagement with a contact 68 thereby opening the circuit to the fan 12 and the compressor 7 and closing a circuit including the defrost heater 60 for a period of time sufficient to assure defrosting of the evaporator 9. The energization of heater 60 is also under the control of a defrost control switch 69 sensing a temperature within the chamber 10 and designed to open the heater circuit at an above freezing ttemperature indicating complete defrosting action. After a suitable period, the timer 62 moves the switch arm 66 to open the heater circuit and close the fan and compressor circuit through the contact 65 thereby returning the refrigerator to a normal or cooling cycle of operation.

Defrost water collecting in a drain pan at the bottom of the chamber 10 during defrost flows downwardly through a drain opening 72 and into a trough 73 from which it is discharged onto the rear wall 35. This water flowing downwardly along the back wall 35 of the cabinet ultimately flows out of the fresh food compartment through a drain for evaporation in suitable means (not shown) in a lower portion of the cabinet.

When the compressor 7 is supplying condensed refrigerant to the evaporator 9 and the fan 12 is operating to circulate air from the two compartments 1 and 2 over the evaporator 9, the major portion of the air issuing from the chamber 10 passes upwardly into the freezer compartment 1 while a relatively smaller portion which depends on the position of damper 40 flows through the outlet passage 24 into the mixing chamber 36. The refrigerated air flowing through the passage 24 and the nozzle 39 into the chamber 36 becomes mixed with the fresh food cabinet air which is drawn into the chamber 36 through the passages 43. The thermostat 47 positioned in the chamber 36 senses the temperature of the air flowing through outlet 46 and when that temperature reaches the fixed minimum operating temperature of the thermostat, it operates to de-energize the timer motor 62, the fan 12 and the compressor 7.

The total air flow time required before operation of thermostat 47 is determined by the position of the damper 48. For example, if the damper 48 is in its full line position, only a small amount of cooled air leaking around damper 48 will flow through outlet 46, i.e., over the thermostat so that a longer flow time will be required to cool the thermostat to the fixed temperature at which it de-energizes the compressor and fan. Thus, during this time interval a larger total volume of cooled air is introduced into the compartment 2 to thereby cool this compartment to a lower temperature. On the other hand, if the damper is in its open, dotted line position, more cooled air flows through outlet 46 thereby more quickly cooling the thermostat to its operating temperature with the result that less refrigerated air is introduced into compartment 2. Compartment 2 then operates at a higher average temperature.

During the period that the compressor 7 and the fan 12 are "off", the temperature within the compartment 2 gradually increases. This increase in temperature is transmitted to the thermostat 47 by natural circulation of fresh food compartment air through the passage 46 and by conduction through wall 35 with the result that the thermostat ultimately senses the temperature of the fresh food compartment. When it is warmed to its fixed high operating temperature, the thermostat operates to again energize the fan, compressor 7 and timer motor, and this energization continues until it again senses its

lower operating temperature as a result of the cooling action of air flowing through passage **46**.

The proportioning of the amounts of air flowing to the fresh food compartment and to the freezer compartment is manually controlled by adjustment of the dampers **40** but once set this control need not be adjusted through most customer usage conditions. Also since the thermostat **47** is positioned within chamber **36**, it is shielded from momentary temperature fluctuations within the fresh food compartment **2** resulting, for example, from ambient air entering the compartment **2** during periods the door **5** is opened.

The specific manner in which the illustrated combination of damper **48** and the fixed thermostat **47** provide means for adjusting the operating temperature within the fresh food compartment will now be considered.

When the damper **48** is in its solid line position and the fan and compressor are operating, substantially all of the air flow from the chamber **36** is through the larger outlet **45**. This outlet as well as the cross sectional area of the air flow path through the chamber **36** is more than sufficient to accommodate the air flowing from the nozzle **39** so that maximum quantity of air is aspirated from the fresh food compartment and into the chamber through passages **43**. The result is a mixture of air having a higher temperature than the below freezing or evaporator air from the nozzle. Some of this air leaks around the damper **48** and flows over the thermostat. Since this air flow is relatively small and since its temperature is somewhat higher than the temperature of the air flowing from the nozzle **39**, a maximum time is required before the thermostat is cooled to its lower operating temperature. Hence more below-freezing or evaporator air will be introduced into the two compartments during the operating period to provide the lowest operating temperatures.

If the damper is in its fully opened or dotted line position, substantially all of the air flows through the smaller outlet **46** and as this outlet has a flow area closer to that of the nozzle, there is less aspiration of fresh food air into the chamber **36**. Under these conditions, substantially all of the air is flowing through the outlet **46** and the temperature of this air is below freezing. The thermostat is then quickly cooled to its minimum operating temperature with the result that the refrigeration cycle is shorter, less cooling of the compartment takes place and the compartment is maintained at a higher mean temperature.

Of course, intermediate positions of the damper vary the ratio of aspirated air to evaporator air and also vary the amount of air flowing through the outlet **46** in cooling engagement with the thermostat. The mean operating temperatures for the compartments will be between their highest and lowest possible temperatures. By a proper configuration of the slanting surface **52** on the one side of damper **48**, which surface in effect determines the proportion of air flowing through the outlet **46**, a linear control setting for the dial **51** can be provided. In other words, it is possible to provide a control in which movement of the damper through a given number of degrees from any position effects a temperature change of approximately the same number of degrees.

By the illustrated combination, it has been found possible to provide an accurate control of the temperature in the fresh food compartment over a range of approximately 10° to 15°.

From the foregoing it will be seen that for any given setting of damper **48**, the operating temperatures of the compartments **1** and **2** are controlled by the combination of the relatively low cost fixed temperature thermostat **47** and the adjustment of damper **48** which controls the rate of cooling of the thermostat during the operation of the refrigeration system and fan, and hence the total amount of refrigerated air supplied to the compartments during any "on" cycle.

While a change in the position of the thermostat **47** in the area between the damper and outlet **46** does not significantly affect the duration of an "on" cycle of operation of the refrigeration system and fan, it is preferably placed close to the outlet **46** in a position to more quickly sense an increase in the compartment air temperature during an "off" cycle.

While there has been shown and described a specific embodiment of the present invention, it will be obvious that it is not limited thereto. It is therefore intended by the appended claims to cover all such modifications as will occur to one skilled in the art to which the invention relates.

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

1. A refrigerator comprising insulated walls defining a cabinet and an insulated partition dividing the interior of said cabinet into a freezer compartment and a fresh food compartment having access openings at the front of said cabinet,

an evaporator chamber separate from said storage compartments,

said chamber having an inlet portion and an outlet portion and an evaporator positioned within said chamber between said portions,

air inlets respectively connecting said freezer compartment and said fresh food compartment to said inlet portion,

means for conducting air from the outlet portion of said evaporator chamber to said compartments comprising a fan means having an inlet connected to said outlet portion and an outlet discharging cooled air from said chamber into said fresh food compartment,

a mixing hood having an inlet passage communicating with said fresh food compartment and large and small outlet passages spaced from said inlet passage and communicating with said fresh food compartment,

said outlet duct opening into said hood between said inlet and outlet passages whereby discharge of air from said outlet duct into said mixing hood induces air from said fresh food compartment to flow through said inlet passage into said hood to mix with said cooled air,

a refrigerant condensing means for supplying refrigerant to said evaporator,

fixed temperature responsive means including a sensing element positioned between said outlet duct and said small outlet passage for controlling the operation of said refrigerant condensing means; and

manually controlled means for varying the flow of mixed air over said sensing element and to said small outlet passage to thereby control the temperature maintained in said fresh food compartment.

2. A refrigerator comprising:

a freezer compartment,
a fresh food compartment,
an evaporator chamber having an evaporator therein,
air outlets connecting each of said compartments to said chamber,
air supply conduits connecting said chamber with each of said compartments,
a fan means for circulating air from said compartments over said evaporator,
means for mixing the air supplied to said fresh food compartment with fresh food compartment air and introducing the mixed air into said fresh food compartment comprising:
a mixing chamber including an inlet passage and two outlet passages connecting said chamber to said fresh food compartment,
a nozzle connected to the supply conduit to said fresh food compartment, said nozzle having its outlet end positioned within said mixing chamber between said inlet and outlet passages whereby the flow of air through said nozzle induces circulation of fresh food compartment air through said mixing chamber and the mixing thereof with the air from said nozzle,
refrigerant condensing means for supplying condensed refrigerant to said evaporator,
a fixed temperature bimetal thermostat for controlling the operation of said condensing means and said fan means including a temperature sensing means positioned in said mixing chamber adjacent one of said outlet passages and responsive to the temperature of the air flowing through said one of said passages; and
manually adjustable means in said chamber for varying the portion of mixed air flowing over said thermostat means.

3. A refrigerator according to claim **2** in which said manually adjustable means includes a damper between said inlet passage and said thermostat.

4. A refrigerator according to claim **2** in which said temperature sensing means is positioned to also be sensitive to the temperature of the air in said fresh food compartment when said fan means is not operating.

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