United States Patent

Jung

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[54] CONTROL APPARATUS FOR A TWO TEMPERATURE REFRIGERATOR

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[52] **U.S. Cl.** **62/97,** 62/408, 62/419, 62/223

[51] **Int. Cl.** **F25d 17/06**

[58] **Field of Search** 62/408, 187, 419, 97, 223

[56] **References Cited**

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[57] **ABSTRACT**

A refrigerator is disclosed which is provided with two separate compartments, one being a freezing compartment and the other being a fresh food compartment and with a single thermostat and damper arrangement to provide two temperature control within the refrigerator enclosure. The air distribution system includes a conduit disposed in the divider between the freezing compartment and the fresh food compartment and in which the evaporator is situated. Air inlets at the front of the refrigerator provide for the entrance of air from the fresh food and freezer compartment to this evaporator. At the rear of the refrigerator, a fan is disposed for providing for forced circulation of the air flow through the evaporator. A large portion of the air coming off the evaporator is directed through a conduit arrangement back to the freezer compartment to furnish cooling for it, with this compartment receiving approximately 90 percent of the air through the evaporator. Joined to the conduit providing cold air to the freezer is a conduit which leads down through the rearward portion of the refrigerator and discharges an air flow around a meat keeper or vegetable crisper contained in the fresh food compartment. A second conduit is also joined to the conduit supplying cooled air to the freezer, with this conduit being provided with a damper arrangement to adjustably maintain the air flow therethrough to the fresh food compartment. A thermostat is disposed adjacent the juncture of the last two mentioned conduits, with this thermostat controlling the operation of the evaporator so as to maintain a substantially uniform cooling temperature in the freezer. The temperature in the fresh food compartment, of course, may be adjustably maintained based on the setting of the aforementioned damper.

11 Claims, 4 Drawing Figures

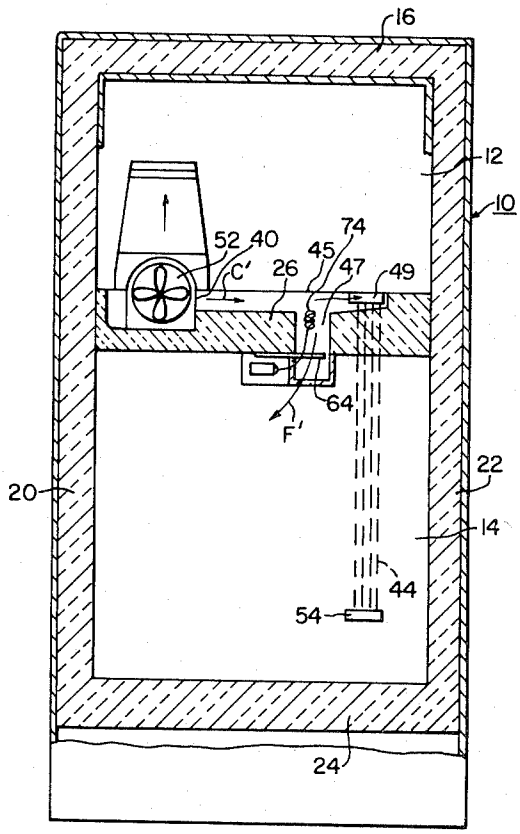


FIG. 1.

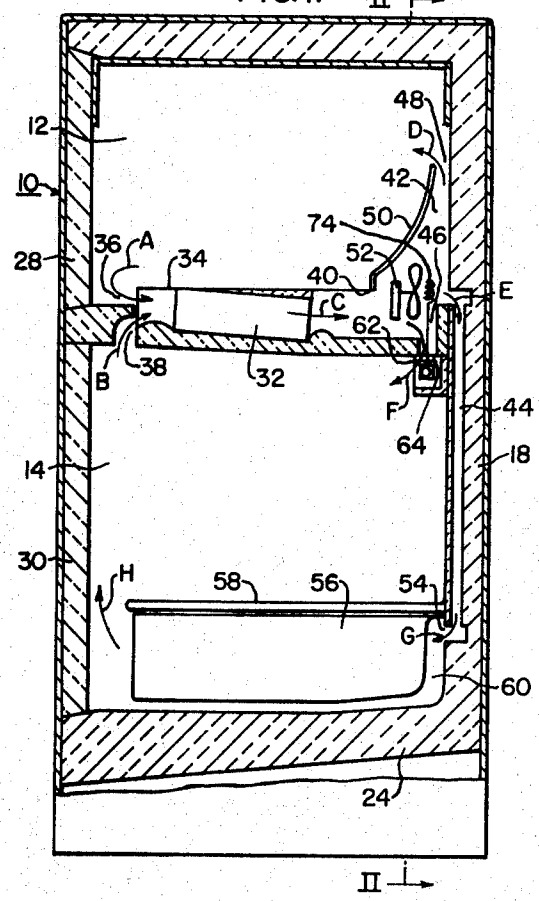


FIG. 2.

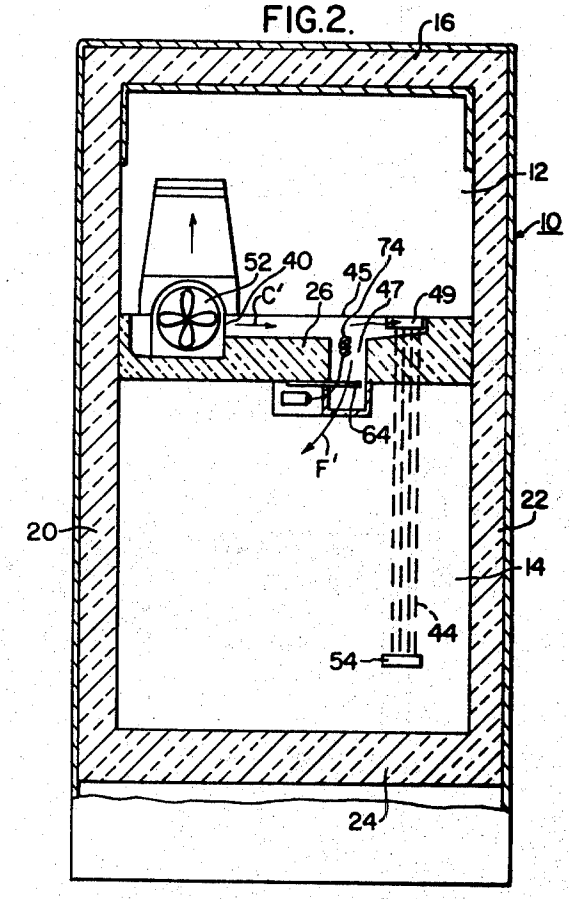


FIG. 3.

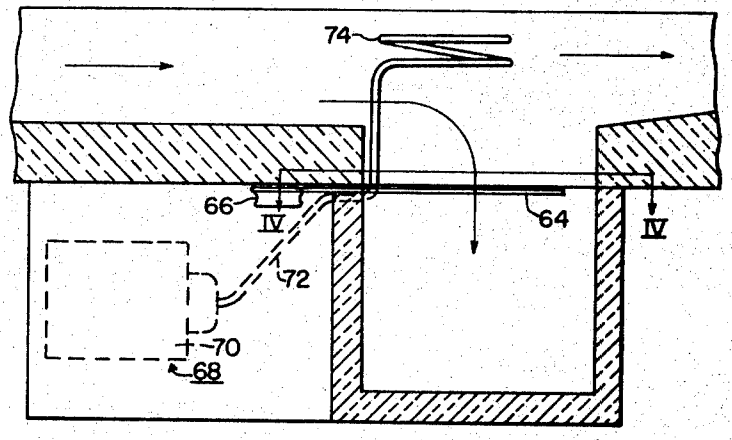
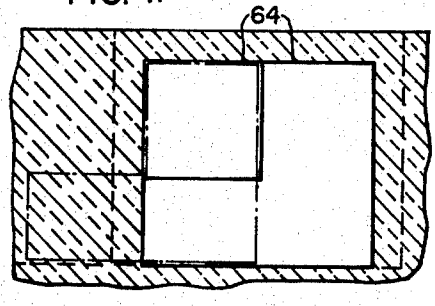


FIG. 4.



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CONTROL APPARATUS FOR A TWO TEMPERATURE REFRIGERATOR

BACKGROUND OF THE INVENTION

1. Field of The Invention

This invention relates to a control system for a two temperature refrigerator and, more specifically, relates to a temperature control for a two temperature refrigerator wherein the temperature of the freezer compartment is maintained substantially uniform throughout the refrigerator's operation.

2. Description of The Prior Art

Although prior art two temperature refrigerators are known which utilize a series of delivery ports to the fresh and frozen food spaces with these delivery ports and the volume of air passing therethrough governed at least partially by a damper, no known refrigerator in the prior art can provide the uniform temperature control to the frozen food compartment as is yielded by the instant apparatus.

Exemplary of the prior art is U.S. Pat. No. 3,403,533, issued Oct. 1, 1968, which discloses a side-by-side two temperature refrigerator wherein two separate flow paths of air are provided, one in the fresh food space and the other in the frozen food space. A damper arrangement is provided in the conduit leading to the fresh food space with this damper manually controlled so as to moderate the amount of cooling air passing into the fresh food space directly or passing into the fresh food space by being discharged over a meat keeper. In the apparatus of this patent the damper modulates the quantity of both these air flows since it is disposed upstream in the main supply conduit. A thermostat is provided at the discharge area of the air directly discharged to the fresh food space, with this thermostat controlling the operation of an evaporator and thereby providing a temperature maintenance of the air discharged over it. Since this air flow volume varies rather significantly the thermostat's response also varies because of the differing heat transfer coefficients of it with differing air velocities.

U.S. Pat. No. 3,126,717, issued Mar. 31, 1964, illustrates another air distribution system for a two temperature refrigerator. In this refrigerator the frozen food space is disposed directly above the fresh food space with the evaporator positioned beneath it. A main supply conduit provides for a flow of air which is distributed first to the frozen food space through a discharge in this area and secondly to the fresh food space through a discharge arrangement which may be modulated by a damper so as to modify the amount of air flowing to the fresh food space. Control of the evaporator for the refrigerator disclosed in this patent is obtained by the use of a thermostat which is mounted within the fresh food space and thereby subject to the precise temperature in this space as modified by the direct flow of air into the space so that frozen food space temperature is extremely variable.

Thus, in both of these patents, the actual reading thermostat does not closely reflect the temperature of the frozen food space closely enough to maintain its temperature at a substantially uniform rate throughout the operational modes of the refrigerator. In U.S. Pat. No. 3,403,533 the air flow across the sensing thermostat is substantially modified, dependent upon the desired temperature within the fresh food space and thereby the setting on the damper. The changing heat transfer characteristics of the changeable volume (velocity) of the air across the thermostat in this refrigerator provides what can be considered at certain operational times a false or at least an inaccurate reading when its signal is passed back to the evaporator to control its operation system. Since the entire refrigeration system of this patent is never in complete equilibrium, due to the opening of the doors, the changing refrigerant load of the food, etc., the particular temperature reading sensed by the thermostat is always, at least, partially dependent upon the velocity of the air stream flow across it. The refrigerator of U.S. Pat. No. 3,126,717 suffers even more relative to close control of the frozen food space. The thermostat in this

refrigerator is located in the fresh food space so that it monitors the temperature of this space which varies based on the setting on the manually controlled damper. The actuation of it substantially modifies the air flow to both the frozen food and fresh food spaces so that the temperature in the frozen food space is relatively uncontrolled, operating between the parameters set by the varying air temperature in the fresh food space.

Accordingly, it would be advantageous to provide a two temperature refrigerator wherein the temperature of frozen food space could be accurately maintained at a substantially uniform condition, and at the same time, the temperature of the fresh food space adjustably set, dependent upon the conditions required or desired by the housewife.

SUMMARY OF THE INVENTION

The invention comprises a two temperature refrigerator with the freezing compartment of the refrigerator disposed above the fresh food compartment and separated therefrom by an insulating panel or the like. The evaporator for the refrigerator is disposed at the bottom portion of the freezer compartment in a conduit formed in the insulating panel, with entrance openings provided to this evaporator from both the below freezing compartment and the fresh food compartment. At the discharge side of the conduit containing the evaporator, the conduit separates into two air passageways, with a fan providing for circulation of air in the refrigerator positioned substantially at the location of the entrance to these two air passageways. One of these air passageways has a fixed cross-sectional area and leads upwardly to discharge air into the freezer compartment. The other air passageway leads sidewardly to provide a junction for two air ducts that lead downwardly so as to provide a forced air circulation into the fresh food compartment. One of these two ducts comprises a passageway which leads air to the lower portion of the fresh food space and discharges it around the meat keeper or vegetable crisper contained in the fresh food compartment to maintain this meat keeper or vegetable crisper at a slightly lower temperature condition than the remainder of the fresh food compartment. The second air passageway also leads into the fresh food compartment, but it is provided with a damper arrangement so that the amount of air passing into the fresh food compartment through this passageway may be controlled to maintain the overall temperature of the fresh food compartment adjustable so that a proper temperature may be selected which is desired or required for the proper refrigeration of the food contained in this compartment. A thermostat element is disposed substantially at the junction of the branching of these two air passageways for the fresh food compartment and rearwardly of the fan so that the fan discharge provides a flow of air across it. Because of the arrangement of the thermostat and its disposition relative to the air passageways for the freezer and fresh food compartments, a substantially constant temperature can be maintained in the freezer compartment which is independent of the temperature in the fresh food compartment to thereby maintain frozen food products at precisely their desired temperature.

DRAWING DESCRIPTION

For a better understanding of the invention, reference may be had to the preferred embodiment, exemplary of the invention, shown in the accompanying drawings, in which:

FIG. 1 is a sectional side view in elevation of the refrigerator somewhat schematically illustrating the principles of this invention;

FIG. 2 is a sectional view taken on line II—II of FIG. 1 with the meat keeper removed and showing the arrangement of the ducting and damper mechanism of the instant invention;

FIG. 3 is a detailed enlarged view of the damper arrangement and the air passageways adjacent to it as seen in FIG. 2; and

FIG. 4 is a fragmentary view taken on line IV—IV of FIG. 3 and showing the damper shutter of the fresh food space discharge passageway.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now specifically to FIGS. 1 and 2, it can be seen that a refrigerator 10 is shown having a freezer food space 12 and a fresh food space 14. These two spaces are bounded by a top wall 16, back wall 18, sidewalls 20 and 22 and a bottom wall 24 so that the walls just related generally outline the space which undergoes refrigeration. A dividing wall 26 is disposed approximately two-thirds of the way vertically upwardly from the bottom wall 24 to provide a separation for dividing the refrigerator into the frozen food and fresh food spaces 12, 14, respectively. The refrigeration enclosure is completed by upper and lower doors 28 and 30 that close the forward portion of the freezer and fresh food spaces, respectively.

An evaporator 32 is disposed in a conduit 34 formed in dividing wall 26 and extends therealong substantially from front to back. Intake air to the evaporator 32 flows into the conduit 34 from the freezer space 12 by means of an opening 36 and from the fresh food space 14 by means of an opening 38, with both of these openings communicating with conduit 34 forwardly of the evaporator 32 and with each of these openings being disposed in their respective compartments substantially at the front of the refrigerator 10. These air flows are indicated by the arrows A and B which schematically illustrate the flow of these air streams into the evaporator 32. The air flows from these two openings into the conduit 34 and through the evaporator and its cooling coils (not shown) and is discharged from the rear of the evaporator into the rearward extent of the conduit 34 as indicated by the arrow C.

Conduit 34 terminates at a junction 40 where it branches into an air passageway 42. Passageway 42 leads upwardly into and discharges directly into the freezer food space 12 at an exit 48 as indicated by the arrow D. This passageway is formed by the front face of the rear wall 18 and a wall 50 tapering upwardly and rearwardly to provide a tapered cross-section to the passageway 42 towards the opening 48. Thus, a streamlined flow of air is assured in the passageway 42 to encourage freedom of flow into the freezer compartment 12 by a larger amount of cooling air. Disposed slightly rearwardly of the junction 40, a fan 52 is provided so as to insure that a forced flow of air is supplied to both the freezer and fresh food spaces 12 and 14. This fan, of course, discharges into the passageway 42 and a pair of passageways 44 (arrow E) and 46 (arrow F) disposed downstream through a connecting passageway 45 (arrow C') which leads from the junction 40.

As set out, the passageway 44 opens downstream of the fan 52 into a passageway 45 and sidewardly of junction area 40. This passageway extends therefrom vertically downwardly in the back wall 18 being formed therein, and terminates adjacent to the bottom of the fresh food space 14 by means of a discharge 54, with this discharge located behind a meat keeper or vegetable crisper 56. The meat keeper 56 is disposed on runners (not shown) or some other equivalent supporting means (not shown) which maintain it slightly spaced above the bottom wall 24 of the refrigerator 10. Meat keeper 56 includes a cover 58 to prevent any circulation of air within the fresh food space 14 from tending to dry out the food items maintained in the meat keeper 56.

As is shown in FIG. 1, meat keeper 56 is also spaced slightly forwardly of rear wall 18 so that a variable cross-section passageway 60 is provided between the rear wall 18 and it and between the bottom wall 24 and it to lead the flow of air from the discharge 54 downwardly around (arrow G) and then forwardly around (arrow H) the meat keeper 56. By this direct impingement of air on the meat keeper, the temperature of the meat keeper is maintained at a slightly lower temperature than the remainder of the fresh food space 14, since the volume of air directed around it is not subject to heating by the remainder of the volume of food disposed in and the sidewalls, etc., of the fresh food space 14.

The third passageway 46 extends from the passageway 45 slightly forwardly of the passageway 44 to also provide a flow of cooling air to the fresh food space 14 as is indicated by the arrow F. This air is discharged outwardly into the fresh food space 14 through an opening 62 formed slightly below the bottom surface of the dividing wall 26 of the refrigerator 10. The volume of air flow through the passageway 46, however, has means so that its flow may be varied by the operator, depending entirely upon that temperature at which he desires the fresh food space 14 to be maintained.

More specifically, and now directing your attention to FIGS. 3 and 4, a damper taking the form of a shutter 64 can be seen to be disposed in the air passageway 46 so as to adjustably moderate the amount of air flowing through this passageway. Damper 64 includes a manipulating knob 66 mating with a shutter extension which the operator of the refrigerator may grasp to move the said damper sidewardly for opening and closing the air passageway 46. This damper is disposed on the bottom surface of the dividing wall 26 with the manipulating knob 66 disposed on the front face of the damper housing so as to facilitate its handling by the housewife or the like. As shown in FIG. 4, the shutter 64 comprises a thin, shutter-like element which reciprocates sidewardly thereby closing off a greater or lesser portion of the flow area of air passageway 46. As seen in this figure, the full line position of the shutter 64 is the position where the largest amount of the flow area of passageway 46 is shut off and the dashed line position of the shutter 64 is that position where the largest amount of flow area of passageway 46 is opened for air flow. Because of the large amount of area which can be proportionately closed off for the passage of air flow through passageway 46, a large range of adjustments of temperature within the fresh food space 14 is afforded to the user by mere manipulation of the knob 66. It should be noted that, no matter what the position of the shutter 64, a certain portion of air is still capable of flowing through the passageway 46 to provide supplementary cooling for the fresh food space 14 over that afforded by the flow of cooling air to the meat keeper 56.

Mounted at the side of or beside the passageway 46 is a thermostat 68 which controls the temperature at which the evaporator 32 provides a refrigerating effect to provide cooling for the flow of air through the evaporator coils. Thermostat 68 includes the usual and conventional housing 70 and a sensing element 72 which extends upwardly into the conduit 45. The sensing element 72 terminates with a coil 74, with the actual temperature reading done by this coil element. It is located in the conduit 45 proximate a junction 47 of this conduit with the passageway 46 and directly aligned with the air flow through an opening 49 (FIG. 2) that serves as the inlet for the passageway 44. Thus, a large percentage of the air flow into passage 44 and a smaller percentage of the air flow into passageway 46 contributes to the velocity of air across the coil sensing element 74.

With the shutter 64 in a full open position (dashed line position of FIG. 4), it is considered that approximately 30 percent of the air flow to the fresh food compartment comes through the passageway 44 while 70 percent of the air to this compartment is provided through the passageway 46 and the air flow through these two passageways represents 10 percent of the total flow through evaporator 32. When the damper member 64 is placed in a full closed position (a portion of the flow area of the passageway 46 still available for the passage of cooling air), it is considered that approximately 60 percent of the air flow available to the fresh food compartment 14 is provided by the passageway 46 and 40 percent is provided by the flow of air through the passageway 44. Since the increasing percentage (10 percent) provided through flow passageway 44 compensates, at least partially, for the decrease of air flow through passageway 46 and since the thermostatic sensing ele-

ment 74 is located directly in the flow path of air to passageway 44 and slightly removed from the direct flow of air into flow passageway 46, the velocity of air across the element remains substantially constant.

Then, although the closing down of the shutter 64 modulates the total air flow to the fresh food compartment to provide a higher temperature therein, the temperature of the frozen food compartment 24 remains substantially at a steady, uniform condition because the air flow across the coil element 74 is not significantly different with the shutter closed than with the damper open. Thus, placing of this damper downstream of the thermostat 68 and, with this thermostat situated generally in the total flow of the passageway 44 and indirectly in the total flow of the passageway 46, provides a fairly constant volume of air flow past it so that its heat transfer characteristics are not substantially changed by a changing volume to the fresh food space 14 and the temperature sensed by it, then, depends solely upon the temperature of the air coming off the evaporator 32.

It should be clear from the foregoing description that the invention disclosed has all the attendant advantages suggested for it including the maintenance of a nearly constant uniform temperature in the freezer compartment. It should also be clear to one skilled in the art that many minor variations can be made to the disclosed invention without departing from the scope and spirit of it.

I claim as my invention:

1. In a two temperature refrigerator, the combination comprising;
   a. a plurality of food compartments, at least one of said food compartments being an above freezing food compartment,
   b. air cooling means for providing cooling for said compartments,
   c. conduit means for circulating cooled air to said compartments,
   d. said conduit means including branches, said branches leading to and being in communication with said above freezing food compartment and each providing a separate cooling air discharge to it,
   e. damper means in one of said branches, and
   f. temperature sensing means disposed in said conduit means for controlling said air cooling means, said temperature sensing means being disposed upstream of said damper means.

2. In a two temperature refrigerator, the combination comprising;
   a. a plurality of food compartments,
   b. air cooling means for providing cooling for said compartments,
   c. conduit means for circulating cooled air to said compartments,
   d. said conduit means including branches,
   e. damper means in one of said branches,
   f. temperature sensing means disposed in said conduit means for controlling said air cooling means, said temperature sensing means being disposed upstream of said damper means,
   g. one of said branches is provided for cooling a food retaining drawer means contained in a first one of said food compartments, by providing a discharge of cooling air thereto, and
   h. a second of said branches is provided for discharging air directly into said first one of said food compartments.

3. The two temperature refrigerators of claim 2 wherein;
   a. said damper is positioned in said second of said branches.

4. The two temperature refrigerator of claim 2 wherein;
   a. said temperature sensing means is disposed in said conduit means so as to have impinged directly thereon the main flow of said one of said branches.

5. In a two temperature refrigerator, the combination comprising;
   a. a plurality of food compartments,
   b. air cooling means for providing cooling for said compartments,
   c. conduit means for circulating cooled air to said compartments,
   d. said conduit means including branches,
   e. damper means in one of said branches,
   f. temperature sensing means disposed in said conduit means for controlling said air cooling means, said temperature sensing means being disposed upstream of said damper means,
   g. one of said branches provided for cooling a food retaining drawer means contained in a first one of said food compartments,
   h. a second of said branches provided for discharging air directly into said first one of said food compartments,
   i. a third branch of said conduit means provides a flow of cooling air to a second one of said food compartments, and
   j. said third branch is disposed upstream from said damper means.

6. The two temperature refrigerator of claim 2 wherein;
   a. said one of said branches has a flow that varies between approximately 30 to 40 percent of the total flow of said one branch and said second branch and said second of said branches has a flow that varies between approximately 60 to 70 percent of the total flow of said one branch and said second branch.

7. The two temperature refrigerator of claim 5 wherein;
   a. the flow of cooling air to the second one of said compartments is approximately 90 percent of the total flow to the first and second compartments when said damper means is at its full open position.

8. The two temperature refrigerator of claim 7 wherein;
   a. said temperature sensing means is disposed directly in the flow path of cooling air for said one of said branches, and
   b. said temperature sensing means is disposed offset from the direct, main flow of cooling air to said second branch.

9. In a refrigerator having two temperatures, the combination including;
   a. a fresh food compartment,
   b. a frozen food compartment,
   c. an evaporator disposed in a conduit means,
   d. openings in said fresh food compartment and said frozen food compartment in confluent relationship with said conduit means,
   e. forced air circulating means for moving air to be cooled across said evaporator,
   f. a temperature sensing means,
   g. a first air passageway means for providing cooling air to said fresh food compartment,
   h. a second air passageway means for providing cooling air to a food retaining drawer-means disposed in said fresh food compartment,
   i. conduit means for providing air flow to said first and second air passageways,
   j. damper means for closing off a portion of said first air passageway means,
   k. said temperature sensing means being upstream of said damper and disposed directly in the air flow to the second air passageway means and having a portion of the air flow to said first passageway means impinging thereon,
   1. whereby the velocity of air across said temperature sensing means remains substantially constant independent of any particular setting of said damper means.

10. A method of providing a uniform temperature in one compartment of a two temperature refrigerator while varying the other including;
   a. directing a relatively large portion of a total flow of cooled air to one compartment of said refrigerator,
   b. directing the remainder of the total flow of cooled air to another compartment of said refrigerator,
   c. splitting the said remainder of the total flow of cooled air into two flow paths prior to its discharge into said another compartment of said refrigerator,

d. damping one of said two flow paths for said remainder air flow to thereby alter the temperature in said another compartment,

e. disposing a temperature sensing element adjacent said area of splitting so that the main flow stream of said undamped flow path impinges thereon and a portion of the flow stream of said damped flow path impinges thereon, and

f. controlling the cooling effect by said temperature sensing element of a cooling means over which the total flow of air to be cooled flows so that the temperature in the compartment to which said relatively large portion of cooled air is directed is substantially uniform.

11. The method set out in claim **10** wherein;

a. said relatively large portion of cooled air represents approximately 90 percent of total flow.

* * * * *