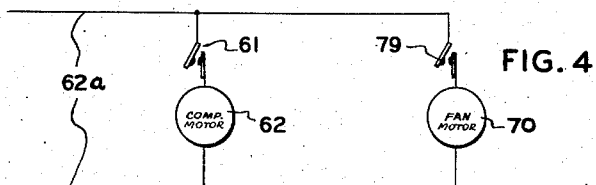
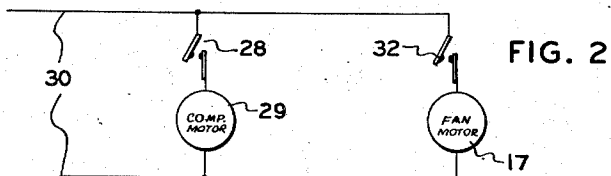
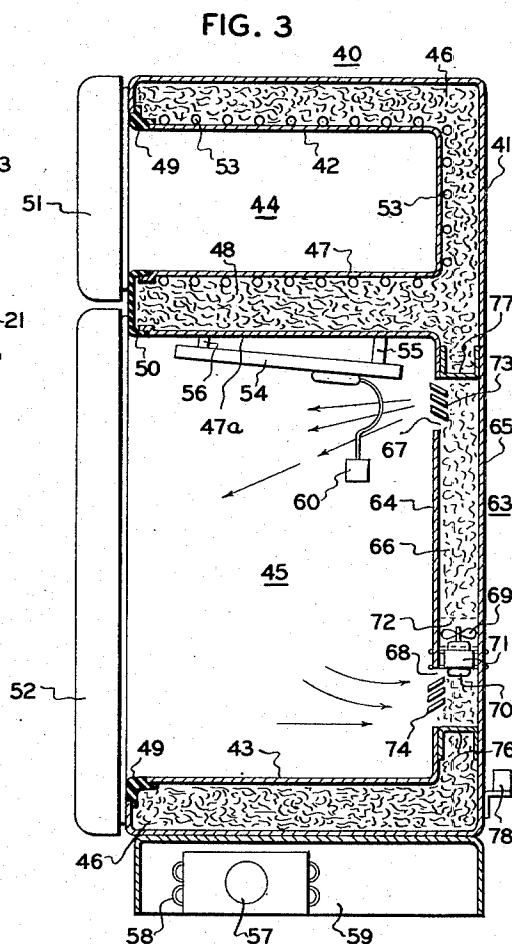
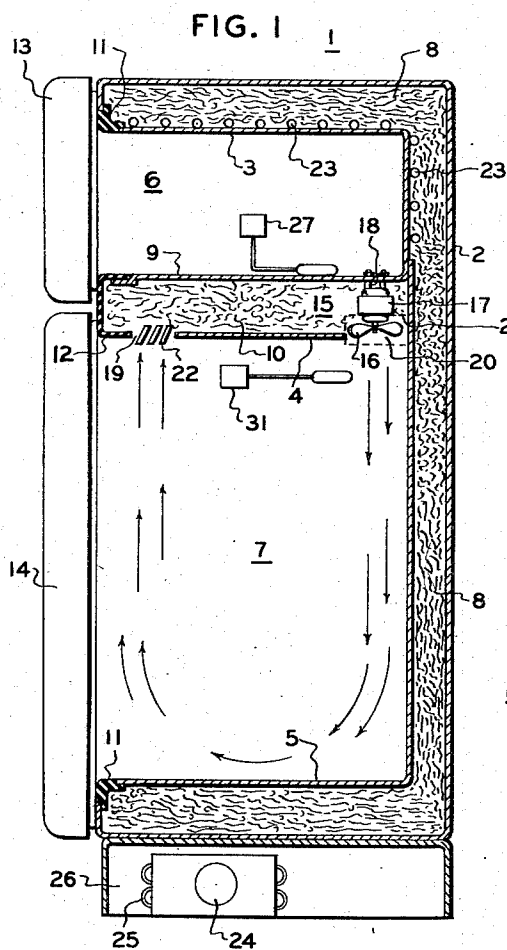


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REFRIGERATOR CABINET STRUCTURE HAVING A VARIABLE
THERMAL CONDUCTIVITY INSULATING WALL
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REFRIGERATOR CABINET STRUCTURE HAVING A VARIABLE THERMAL CONDUCTIVITY INSULATING WALL

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7 Claims. (Cl. 62—6)

My invention relates to refrigerator cabinets and more particularly to the insulating wall structures utilized in such cabinets.

It is an object of my invention to provide a new and improved insulating wall structure having a variable thermal conductivity.

It is another object of my invention to provide improved refrigerator cabinets including a variable thermal conductivity insulating wall.

It is a further object of my invention to provide improved refrigerator cabinets in which a variable thermal conductivity insulating wall is used to affect the storage temperatures.

Another object of my invention is to provide an improved refrigerator cabinet having two diverse temperature compartments, in which a variable thermal conductivity insulating wall is employed to regulate the temperature of the higher temperature compartment.

A further object of my invention is to provide an improved refrigerator cabinet having two diverse temperature compartments, in which a variable thermal conductivity insulating wall is utilized to prevent an over-temperature condition from occurring in the lower temperature compartment.

In carrying out my invention I provide a variable thermal conductivity insulating wall particularly adapted for use in a refrigerator cabinet. This wall includes a pair of spaced apart panels, a body of fibrous insulating material positioned between the panels, and means for setting in motion the air or gas contained within the insulating material. When the air moving means are not in operation, a more or less normal rate of heat transfer occurs through the wall. However, when the air moving means are put in operation, the gas normally trapped within the fibrous insulating material is set in motion; and this movement of the gas reduces the insulating effect of the wall so that the rate of heat transfer therethrough is increased. When incorporated in refrigerator cabinets the wall may thus be employed to control the temperatures of the storage compartments thereof.

The novel features which I believe to be characteristic of my invention are set forth with particularity in the appended claims. The invention itself, however, both as to its organization and mode of operation may be best understood by reference to the following description taken in conjunction with the accompanying drawing in which:

Fig. 1 is a vertical sectional view of a two-compartment refrigerator in which my new and improved variable thermal conductivity insulating wall is incorporated for the purpose of regulating the temperature of the fresh food compartment;

Fig. 2 is a schematic circuit diagram of the electrical components included in the refrigerator of Fig. 1;

Fig. 3 is a vertical sectional view of a two-compartment refrigerator in which my new and improved variable thermal conductivity insulating wall is incorporated for the purpose of preventing an over-temperature condition from occurring in the frozen food compartment; and,

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Fig. 4 is a schematic circuit diagram of the electrical components included in the refrigerator of Fig. 3.

Referring now to Fig. 1 I have shown therein a household refrigerator 1 having an outer case 2. Positioned within the outer case 2 and spaced therefrom are a plurality of inner liner members 3, 4, and 5. The liner 3, a tub-shaped member, defines a low temperature or frozen food compartment 6, and the liners 4 and 5 together define a higher temperature or fresh food compartment 7. The spaces between the outer case 2 and the liners 3 and 5 respectively are filled with suitable thermal insulating material 8 so that the compartments 6 and 7 are insulated from the surrounding atmosphere. Similarly the space between the horizontal liner member 4 and the horizontal bottom portion 9 of the liner 3 is filled with insulating material 10 so that the compartments 6 and 7 are insulated from one another. At the front of the cabinet an insulating breaker strip 11 is provided between the outer case 2 and the liners 3 and 5 and another insulating breaker strip 12 is mounted between the liners 3 and 4. Access is provided to the compartments 6 and 7, respectively, by means of upper and lower insulated doors 13 and 14. These doors which may be insulated in any suitable manner swing outward on vertical pivots (not shown) to open the fronts of their respective compartments.

In the refrigerator 1 the partition or common wall formed between the compartments 6 and 7 by the spaced apart panels 3 and 9 and generally designated as the wall 15 comprises one form of my novel variable thermal conductivity insulating wall. As above mentioned, the space between these panels is filled with a body of fibrous insulating material 10. This insulation 10 may be any of the fibrous materials such as glass wool, mineral wool, metal wool, etc. which depend on the gas entrapped therein for their resistance to thermal conductivity. This insulation 10 has a certain insulating value so that for a predetermined temperature differential between the compartments 6 and 7 a predetermined rate of heat transfer will occur through the wall 15. In other words the wall 15 due to the insulating value of the material 10 normally presents a certain insulating effect between the compartments 6 and 7.

But by my invention the wall 15 is so constructed and arranged that its insulating effect may be varied from this normal value. In other words, the wall 15 is so constructed that it has a variable thermal conductivity. To accomplish this result I have provided means whereby the gas entrapped within the body of insulation 10 may be set in motion. When the gas or more exactly the air contained within the insulation is set in motion, the conductivity of the insulation is increased. In fact the greater is the flow rate of the gas, the greater is the conductivity within normal limits.

In Fig. 1 the means for setting in motion the air within the insulation 10 of wall 15 comprises a fan 16. This fan is driven by a motor 17 which is supported from the panel 9 by means of suitable mounting brackets 18. Upon rotation of the fan 16 it draws air into the body of insulation 10 through one aperture 19 provided in the liner member 4 and discharges this air back into the liner through a second aperture 20. The apertures 19 and 20 are disposed at opposite ends of the wall 15 so that upon operation of the fan a flow of air is set up through the insulation 10 across practically the length of the wall. As a result when the fan is running, the insulating effect of wall 15 is materially lessened. A screen 21 surrounding the fan blades is provided to prevent any of the insulation 10 from being drawn into the fan, and a grill 22 is mounted in the aperture 19 to prevent the insulation from falling therethrough.

In the embodiment of Fig. 1 the variable thermal capacity insulating wall 15 is utilized to regulate the tem-

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perature within the fresh food compartment 7. The refrigerator 1 includes only a single evaporator 23 which is disposed to cool the frozen food compartment 6. For example, the various tubing passes of the evaporator 23 may be placed in intimate thermal contact with the freezer liner 3. This evaporator 23 is supplied with condensed expanded refrigerant from a condensing unit comprising a compressor 24 and a condenser 25 which is mounted within a machinery compartment 26 at the base of the refrigerator. A thermostatic control 27 having a pair of contacts 28 which are opened and closed in response to the temperature within the freezer compartment 6 cycles the compressor 24 on and off so as to maintain a predetermined temperature within the freezer compartment for example a temperature of 0° F. As shown in Fig. 2 the driving motor 29 of compressor 24 is connected in series with the contacts 28 of the control 27 across a suitable power supply 30. Thus whenever the contacts 28 are closed the compressor will operate to refrigerate the compartment 6 and whenever the contacts are open the compressor will be inoperative.

The fresh food compartment 7 is refrigerated by means of heat transfer occurring between it and the freezer compartment 6. In other words, the fresh food compartment 7 is cooled by means of heat flowing from it to the freezer compartment 6 where the heat is picked up by the evaporator 23. This heat transfer, of course, occurs through the wall 15 separating the compartments, and the amount of heat transferred to the freezer compartment 6 and thus the temperature of the fresh food compartment 7 is controlled by the insulating effect of the wall 15. The greater the resistance this wall presents to the flow of heat, the less heat is transferred out of the fresh food compartment 7. Conversely the lower the resistance of the wall, the more heat is transferred out of the compartment. When the fan 16 is inoperative, the insulating effect of the wall 15 is at its maximum value, and under normal conditions the rate of heat flow into the compartment 7 from the surrounding atmosphere is greater than the heat transferred therefrom through the wall 15. As a result a gradual rise in the temperature of compartment 7 occurs. On the other hand when the fan 16 is placed in operation so that the insulating effect of the wall 15 is lowered, a greater rate of heat transfer is set up through the wall 15 than normally exists between compartment 7 and the surrounding atmosphere. Consequently with the fan in operation the temperature of the fresh food compartment 7 is lowered.

In order to regulate the temperature of the fresh food compartment, i. e. hold it at a desired mean temperature, for example 40°, I have provided means whereby the fan 16 is turned on and off in response to the temperature of the fresh food compartment 7. This means comprises a thermostatic control 31 which is positioned in the fresh food compartment and which includes a pair of contacts 32. The contacts are closed whenever the fresh food compartment temperature rises above a certain predetermined value and are opened whenever the temperature of the fresh food compartment falls below a second predetermined value. The driving motor 17 of the fan 16 is connected in series with these contacts 32 across the power supply 30 and thus the fan is put in operation whenever the contacts 32 are closed and remains inoperative whenever the contacts 32 are opened.

With the fan motor so controlled, whenever the fresh food compartment temperature rises above the first predetermined value the fan is placed in operation. The fan by drawing air longitudinally between the panels 4 and 9 and through the body of insulating material 10 lowers the insulating effect of wall 15. The increased heat transfer then occurring through the wall 15 lowers the temperature of the fresh food compartment 7 until the second predetermined temperature is reached. At that point the contacts 32 are opened so as to deenergize the fan. The air movement through the insulation 10

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ceases and the wall 15 regains its maximum insulating effect. The heat transfer through the wall is thus diminished and the compartment temperature begins a gradual rise. The rise continues until the upper temperature is reached at which the fan is once again set in operation. The same cycle is then repeated. The fan is intermittently turned on and off so as to hold the fresh food compartment between the two predetermined temperatures, which of course lie on opposite sides of the desired mean temperature; and in this manner my new and improved variable thermal capacity insulating wall is utilized in the embodiment of Fig. 1 to regulate the temperature of the fresh food compartment of a refrigerator having a pair of diverse temperature compartments.

Referring now to Fig. 3 I have shown therein a two-compartment refrigerator 40 including a second embodiment of my novel variable thermal conductivity insulating wall. In this refrigerator 40 I utilize my new and improved insulating wall to prevent over-temperature conditions from occurring in the freezer compartment. The refrigerator 40 includes an outer case 41 and a pair of inner liner members 42 and 43. The uppermost liner member 42 defines a low temperature or freezer compartment 44 and the lower liner member 43 defines a higher temperature or fresh food compartment 45. The spaces between the outer case 41 and the inner liners 42 and 43 are filled with suitable heat insulating material 46 to insulate the two compartments 44 and 45 from the surrounding atmosphere; and the space between the bottom panel 47 of liner 42 and the top panel 47a of liner 43 is filled with similar insulating material 48 to insulate the compartments one from the other. At the front of the cabinet a suitable insulating breaker strip 49 is provided to connect the outer case to the liners 42 and 43 respectively, and a second U-shaped insulating breaker strip 50 is provided to connect together the panels 47 and 47a of liners 42 and 43, respectively. The front of the freezer compartment 44 is closed by a suitable insulated door 51 and the front of the fresh food compartment 45 by an insulated door 52. These doors are both mounted on vertical pivots (not shown) and when swung open provide access to their respective compartments.

In the refrigerator 40 a separate evaporator is provided for cooling each of the compartments 44 and 45. Thus an evaporator 53 is disposed to cool the freezer compartment 44 and an evaporator 54 to cool the fresh food compartment 45. Specifically the various tubing passes of the evaporator 53 are disposed in intimate thermal contact with the liner 42 of freezer compartment 44, and the evaporator 54, which comprises a serpentine finned tube or plate-like member, is mounted in the upper portion of the fresh food compartment 45 by brackets 55 and 56 attached to the liner panel 47a. Refrigerant is supplied to these evaporators from a condensing unit comprising a compressor 57 and a condenser 58. This condensing unit is positioned in a machinery compartment 59 at the base of the refrigerator and is connected to the evaporators through suitable conduit and expansion means.

The operation of the compressor 57 and thus the refrigerating effect applied to the two compartments 53 and 54 is controlled by means of a thermostatic control 60 positioned in the fresh food compartment 45. This control 60 includes a pair of contacts 61 which are opened and closed in response to the temperature of the fresh food compartment 45 or, more specifically, in response to the temperature of the evaporator 54. As shown in Fig. 4 the contacts 61 are connected in series with the driving motor 62 of the compressor 57 across a power supply 62a and thus the compressor is placed in operation whenever the contacts are closed and rendered inoperative whenever they are opened.

Normally with the compressor 57 so cycled on and off by the thermostatic control 60 in response to the tempera-

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ture of the fresh food evaporator 54, the freezer compartment 44 will also be maintained at a satisfactory temperature, for example 0° F. The freezer compartment 44 is, of course, refrigerated by the evaporator 53 whenever the fresh food compartment 45 is refrigerated by the evaporator 54. However, when the ambient temperature surrounding the refrigerator drops to a very low value, as for example 50° F. the temperature differential between the fresh food compartment and the surrounding atmosphere is very low. At such times the periods between the operation of the compressor are quite long, since the heat leakage into the fresh food compartment is smaller than under normal conditions. It takes a relatively long time for the fresh food compartment to warm up from the temperature at which the compressor is shut off to the temperature at which it is turned on. Further, because the refrigerating system is more efficient in low ambient temperature and because less heat is leaking into the fresh food compartment during low ambient operation, the compressor will only operate for a relatively short time before lowering the fresh food compartment and evaporator to the temperature at which the control opens the contacts 61 to stop the compressor.

At such a time with the compressor running so little, insufficient refrigerating effect is applied to the evaporator 53 to hold the freezer compartment 44 at the desired temperature. Even though the temperature of the surrounding atmosphere is quite low, a considerable temperature differential still exists between it and the freezer compartment. Thus the flow of heat into the freezer compartment is not decreased nearly so much as that into the fresh food compartment, and as a result the freezer compartment heats up at a faster rate relative to fresh food compartment than it should. In fact, unless some means are provided for cycling the compressor more frequently when the ambient temperature falls to a low temperature, an over-temperature condition of the freezer compartment 44 is very likely to result.

By my invention I have provided means in the refrigerator 40 which will prevent an over-temperature condition from occurring in the freezer compartment 44. As will now be explained, these means include an embodiment of my novel variable thermal capacity insulating wall. To cause the compressor to operate more frequently upon the ambient temperature dropping to a low value I have provided means which cause a higher than normal heat transfer into the fresh food compartment upon such a condition, and this means comprises an embodiment of my novel variable thermal capacity insulating wall. Thus in the refrigerator 40 the rear wall 63 of the fresh food compartment is so constructed and arranged that it has a variable thermal insulating capacity. The wall 63 includes the rear panel 64 of the liner 43, the rear panel 65 of the outer case 41 and a body of fibrous insulating material 66 which is positioned between the two panels. The fibrous insulating material 66 may be any of the fibrous materials such as glass, mineral wool, metal wool, etc. which depend upon the gas trapped therein for their resistance to thermal conductivity. Normally the wall 63 has a certain insulating effect impeding heat transfer between the surrounding atmosphere and the fresh food compartment 45. However, in order to increase the heat transfer through the wall 63 I have provided means whereby the gas entrapped within the insulation 66 may be set in motion. Since this fibrous insulating material depends upon entrapped gas for its resistance to thermal conductivity, the setting in motion of this gas increases the thermal conductivity through the insulation and thus through the wall itself.

In order to set in motion the gas contained within the insulation of wall 63 the panel 64 is provided with spaced apart upper and lower apertures 67 and 68. Further a fan 69 and its driving motor 70 are mounted between the panels 64 and 65 and intermediate the apertures 67 and 68. The fan and its driving motor may be mounted by

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any suitable means, as by the brackets 71. A screen 72 is provided around the fan to prevent the insulation 66 from being drawn into it and suitable decorative grills 73 and 74 are provided in front of the apertures 67 and 68.

Whenever the fan 69 is placed in operation it draws air in through the aperture 68, causes it to flow longitudinally between the panels 64 and 65 through the insulation 66 and then outwardly through the aperture 67. This, of course, decreases the insulating effect of the wall 63. Suitable blocking members 76 and 77 are provided for preventing any air flow being set up by the fan in the other walls of the refrigerator. More specifically the member 76 prevents any air from being drawn out of the bottom wall of the refrigerator and the member 77 prevents any of the fan discharge from entering the upper walls of the refrigerator. Thus when the fan is in operation only the air or gas within the rear wall 63 of the fresh food compartment is set in motion, and thus only the heat transfer through that wall is increased. As a result only the heat transfer between the fresh food compartment 45 and the outside atmosphere is increased. The heat transfer into the freezer compartment 44 remains the same.

In the refrigerator 40 the operation of the fan 69 is controlled by means of a thermostatic control 78 which is mounted on the outer case of the refrigerator and is responsive to outside temperature. This control 78 includes a pair of contacts 79 which are closed whenever the outside ambient temperature falls below a certain value. As shown in Fig. 4 these contacts are connected in series with the fan motor 70 across the power supply 62a and thus whenever the contacts 79 are closed the fan is set in motion.

Due to the action of the control 78 the fan 69 is operated whenever the outside temperature drops to a certain predetermined value, as for example 50° F. When the fan is placed in operation the insulating capacity or effect of the wall 63 is lowered and therefore the heat transfer into the fresh food compartment is increased. With the heat transfer into the fresh food compartment increased the compressor 57 is then cycled on and off more frequently by the control 60 with approximately normal lengths of "on" time in order to maintain the desired temperature within the fresh food compartment, for example 40° F. This more frequent operation of the compressor also causes the freezer compartment 44 to be refrigerated more frequently and for longer durations of time; and since the heat transfer into the freezer compartment is not increased by the change on the insulating effect of wall 63, the increased operation of the compressor results in a lowering of the freezer compartment temperature. That is, it reduces the freezer compartment temperature below that which would be held in the absence of the increased heat transfer into the fresh food compartment. As a result and as contemplated by my invention, the freezer compartment temperature is held at or near its desired value, for example 0° F., even though the outside ambient temperature drops to a low value. In this manner through the operation of my improved variable thermal conductivity insulating wall the temperature of the fresh food compartment and thus the operation of the refrigerating means are so controlled that the freezer compartment temperature does not rise above the desired value even though the outside ambient temperature should drop to quite a low value.

In summary, in both the illustrated embodiments I have incorporated my novel variable thermal conductivity wall in two-compartment refrigerators which themselves form further aspects of my invention. In these refrigerators the wall is disposed to form one of the walls of the higher temperature compartment so that by varying the rate of heat transfer through the wall, the temperature of the higher temperature compartment is affected. The air moving means are set in operation to change the insulating effect of the wall and thus the heat transfer

rate therethrough in response to predetermined temperatures on a selected side of the wall, whereby in accordance with my invention a change in the temperature of the higher temperature compartment is effected upon the occurrence of those predetermined temperatures. The location of the variable thermal conductivity wall varies with the result it is desired to accomplish by increasing the heat transfer rate therethrough. If it is desired to decrease the compartment temperature by the use of the wall, it is included at a different position within the refrigerator than it is when it is desired to increase the compartment temperature by its use. But in both of the illustrated embodiments the variable thermal conductivity wall through its operation varies the heat transfer rate of the higher temperature compartment to produce the desired result. It should be understood though that my invention is not limited to these embodiments.

I have shown the air moving means in both the illustrated embodiments as causing a flow of air from the fresh food compartment through the insulation of the variable thermal conductivity wall. In other words, the air within the insulation of the wall is set in motion by bringing air from the storage compartment into the wall, causing it to flow longitudinally between the panels and through the insulation of the wall, and then discharging it outwardly back into the compartment. However, although such an arrangement provides very desirable results it should be understood that my invention is not limited to such a structure. For example, I contemplate a variable thermal conductivity insulating wall in which the gas entrapped within the insulation is itself caused to flow through the insulation without any air being brought in from the storage compartment or from the outside atmosphere. In other words according to my invention the insulating effect of the wall may be varied by setting in motion only the gas contained within the insulation of the wall, as well as by forcing outside air through the insulation in manner shown in the illustrated embodiments. For example the variable thermal capacity wall may comprise a completely enclosed structure through which the entrapped gas is caused to flow in continuous path upon the operation of the air moving means, baffle means being incorporated within the wall to define the path.

In accordance with the patent statutes, I have described what at present are considered to be the preferred embodiments of my invention; however, it should be obvious to those skilled in the art that various changes and modifications may be made therein without departing from my invention, and I, therefore, aim in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of my invention.

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

1. In a refrigerator having a food storage compartment, a variable thermal conductivity insulating wall forming one of the walls of said compartment and comprising a pair of spaced apart panels, a body of fibrous insulating material positioned between said panels, and means responsive to a predetermined controlling condition for moving air from said storage compartment between said panels through said insulating material and back into said compartment thereby to increase the thermal conductivity of said wall and increase the heat transfer between said compartment and the space on the other side of said wall.

2. A refrigerator cabinet having insulated walls defining a low temperature compartment and a higher temperature compartment, an evaporator for cooling at least one of said compartments, fan means for setting in motion the gas contained within the insulation of one of the walls of said higher temperature compartment to increase the thermal conductivity thereof and increase heat transfer therethrough, and means for operating said fan means in response to predetermined conditions on a

selected side of said one wall, thereby to increase the heat transfer rate through said one wall upon the occurrence of said predetermined conditions and effect a change in the temperature of said higher temperature compartment.

3. A refrigerator cabinet having insulated walls defining a low temperature compartment and a higher temperature compartment, an evaporator for cooling at least one of said compartments, means for moving air from said higher temperature compartment through one of the walls of said compartment to increase the thermal conductivity thereof and increase the heat transfer therethrough, and means for operating said air moving means in response to predetermined temperatures on a selected side of one wall thereby to increase the heat transfer rate through said one wall upon the occurrence of said predetermined temperatures and effect a change in the temperature of said higher temperature compartment.

4. A refrigerator cabinet having insulated walls defining a low temperature compartment and a higher temperature compartment, one of said walls comprising a partition separating said compartments, an evaporator for cooling said low temperature compartment, said higher temperature compartment being cooled by heat transferred through said partition to said low temperature compartment, means for setting in motion the gas contained within the insulation of said partition to increase the thermal conductivity thereof and facilitate heat transfer between said compartments, and temperature responsive means for operating the gas moving means in response to predetermined temperatures of said higher temperature compartment thereby to regulate said heat transfer between said compartments and maintain a desired temperature in said higher temperature compartment.

5. A refrigerator cabinet having insulated walls defining a low temperature compartment and a higher temperature compartment, one of said walls comprising a partition separating said compartments, an evaporator for cooling said low temperature compartment, said higher temperature compartment being cooled by heat transferred through said partition to said low temperature compartment, means for moving air from said higher temperature compartment through the insulation of said partition to increase the thermal conductivity thereof and facilitate heat transfer between said compartments, and temperature responsive means for operating the air moving means in response to predetermined temperatures of said higher temperature compartment, thereby to regulate said heat transfer between said compartments and maintain a desired temperature in said higher temperature compartment.

6. A refrigerator cabinet having insulated walls defining a low temperature compartment and a higher temperature compartment, a separate evaporator for cooling each of said compartments, a condensing unit for supplying refrigerant to said evaporators, means responsive to the temperature of said higher temperature compartment evaporator for cycling said condensing unit to maintain a predetermined temperature in said higher temperature compartment, means for setting in motion the gas contained within the insulation of one of the walls of said higher temperature compartment to increase the thermal conductivity thereof and facilitate heat transfer between said higher temperature compartment and the warmer surrounding atmosphere, and temperature responsive means for operating the gas moving means in response to predetermined low ambient temperatures of said surrounding atmosphere thereby to increase the heat transfer through said wall at said low ambient temperatures and raise the temperature of said higher temperature compartment to cause operation of said condensing unit before the temperature of said low temperature compartment rises to an undesirable level.

7. A refrigerator cabinet having insulated walls defining a low temperature compartment and a higher temperature

compartment, a separate evaporator for cooling each of said compartments, a condensing unit for supplying refrigerant to said evaporators, means responsive to the temperature of said higher temperature compartment evaporator for cycling said condensing unit to maintain a predetermined temperature in said higher temperature compartment, means for moving air from said higher temperature compartment through one of the insulated walls thereof to increase the thermal conductivity thereof and facilitate heat transfer between said higher temperature compartment and the warmer surrounding atmosphere, and temperature responsive means for operating said air moving means in response to predetermined low ambient temperatures of said outside atmosphere, thereby to in-

crease the heat transfer through said wall at said low ambient temperatures and raise the temperature of said higher temperature compartment to cause operation of said condensing unit before the temperature of said low temperature compartment rises to an undesirable level.

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