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REFRIGERATOR TEMPERATURE CONTROLLING DEVICE

The present invention relates to a refrigerating temperature control, in particular to a refrigerator temperature controlling device capable of improving temperature distribution.

A conventional refrigerator temperature controlling device as disclosed in Japanese Unexamined Utility Model Publication No. 57679/1983 will be explained in reference to Figure 9, which is a vertical cross sectional view showing a refrigerator with the temperature controlling device.

A refrigerator main body 1 includes an insulating partition wall 2 and a detachable compartment wall 3, which serve to divide the inside of the refrigerator main body. A reference numeral 4 designates a frozen food compartment which is suitable for keeping food in a frozen state. A reference numeral 5 designates a refrigerating compartment which is suitable for keeping food in a refrigerated state. A reference numeral 6 designates a salad compartment for vegetables. The

compartments are separated from each other by the insulating partition wall 2, the compartment walls 3 and so on. A door is attached to the open end of each compartment so as to be capable of opening and closing.

5 A reference numeral 7 designates a cooling chamber which is arranged at a deep position in the frozen food compartment 4. A reference numeral 8 designates a condenser which is placed in the cooling chamber 7. A reference numeral 9 designates a fan for circulating
10 cooled air produced in the cooling chamber 7, which is placed above the condenser. A reference numeral 10 designates a rear duct which is provided behind the cooling chamber 7, and through which the cooled air passes to be directed into the refrigerating chamber 5
15 through an outlet 10a.

A damper unit 11 for controlling blowoff of the cooled air is arranged at an upper rear portion in the refrigerating compartment 5. The damper unit 11 comprises a temperature controller 11a and a damper 11b.

20 A reference numeral 12 designates a cooled air intake duct, through which the cooled air that has circulated in the refrigerating compartment 5 and the salad compartment 6 comes back to the cooling chamber 7. The intake duct 12 is formed in the partition wall 2 so as to open in the
25 undersurface of the partition wall. A reference numeral 13 designates a rear aperture which is formed at a deep position in the compartment wall 3 so as to allow the cooled air to come from the refrigerating compartment 5

into the salad compartment 6. A reference numeral 14 designates a return duct through which the cooled air having circulated in the salad compartment 6 comes back into the refrigerating compartment 5. A reference numeral 15 designate shelves which are arranged at suitable levels in the refrigerating compartment 5 to put food etc. on them. A reference numeral 16 designates a cooled air passage which is formed in respective rear ends of the shelves 15 and through which the cooled air moves down.

A reference numeral 17 designates a cover which serves to protect the damper unit 11. The cover has an upper outlet 17a formed in its upper portion and a lower outlet 17b formed in its lower portion.

A reference numeral 18 designates an outlet grill which blows off the cooled air from the cooling chamber 7 into the frozen food compartment 4. A reference numeral 19 designates an intake grill which sucks part of the cooled air having circulated in the frozen food compartment 4.

A reference numeral 20 designates a front intake port which sucks the remaining part of the cooled air having circulated in the frozen food compartment 4. The front intake port is formed in the upper surface of a front portion of the partition wall 2.

In the refrigerator having the conventional refrigerator temperature control device as explained, the cooled air which has been produced in the cooling chamber

7 is forcibly fed in the respective compartments in the refrigerator so that each compartment becomes at a suitable temperature.

Now, cooling operation of each compartment will be explained.

The frozen food compartment 4 is cooled directly by the cooled air which is produced by the condenser 8.

The refrigerating chamber 5 is cooled as follows: The cooled air in the cooling chamber 7 is forcibly fed into the rear duct 10 by the action of the fan 9 and moves behind the cover 17 through the outlet 10a of the rear duct 10. The cooled air is blown off from the upper outlet 17a and the lower outlet 17b into the refrigerating compartment 5, and circulates in the refrigerating compartment 5 to cool the inside of it. In addition, part of the cooled air blown off into the refrigerating compartment 5 flows into the salad compartment 6 through the cooled air passages 16 and the rear aperture 13 to cool the inside of the salad compartment 6 while circulating in it. The cooled air, the temperature of which has slightly increased after the circulation in the salad compartment, passes through the return duct 14 and come back into the cooling chamber 7 through the cooled air intake duct 12 to be cooled in the cooling chamber again.

Since the cooled air circulates in the refrigerator as explained, when the temperatures in the refrigerating compartment 5 and in the salad compartment 6 are lowered

to a predetermined low temperature, the damper unit 11 closes the outlet 10a of the rear duct 10 by the damper 11b to control the blowoff of the cooled air so as to prevent the inside of the refrigerating chamber 5 from being cooled too much. On the other hand, when the temperatures in the compartments have been increased to higher than a predetermined temperature, the damper unit 11 opens the outlet to allow the cooled air to circulate in the compartments in order to adjust the temperature in the compartments.

Now, a circuit diagram in the conventional refrigerator temperature controlling device, as disclosed in Japanese Unexamined Patent Publication No. 134564/1986, will be explained in reference to Figure 10.

In Figure 10, a reference numeral 21 designates a temperature detecting element such as a thermistor, which is placed in the frozen food compartment. A comparator (voltage comparing IC) 25 compares a voltage at A determined according to the voltage dividing ratio between the temperature detecting element 21 and a resistor 22, to a voltage (corresponding to a set temperature in the frozen food compartment) at B determined according to the voltage dividing ratio between a resistor 23 and a resistor 24. The output of the comparator is input to a transistor 26 for energizing a relay 27 for a compressor 41, and an OR gate 28.

A reference numeral 29 designates a temperature detecting element such as a thermistor, which is placed

in the refrigerating compartment. A comparator (voltage
comparing IC) 33 compares a voltage at C determined
according to the voltage dividing ratio between the
temperature detecting element 29 and a resistor 30, to a
5 voltage (corresponding to a set temperature in the
refrigerating compartment) at D according to the voltage
dividing ratio between a resistor 31 and a resistor 32.
The output of the comparator is input to a transistor 34
for energizing a relay 35 for the damper unit 39, and the
10 OR gate 28.

The OR gate 28 receives the outputs of the
comparators 25 and 33, and its output is transmitted to a
transistor 36 for energizing a relay 37 for a fan motor
40.

15 A reference numeral 38 designates an AC power which
drives the compressor 41, the fan motor 40 and the damper
unit 39 through contacts 44, 43 and 42, respectively.

When the temperature in the frozen food compartment
becomes higher than the set temperature, the resistance
20 value of the temperature detecting element 21 becomes
decreased and the voltage at A becomes higher than the
voltage at B. As a result, the comparator 25 produces
high output so that the transistor 26 conducts to
energize the relay 37 so as to close the contact 44 for
25 driving the compressor 41.

On the other hand, when the temperature in the frozen
food compartment becomes lower than the set temperature,
the resistance value of the temperature detecting element

21 becomes increased and the comparator 25 produces low output. As a result, the transistor 26 ceases to conduct and the relay 27 is deenergized. So, the contact 44 opens to stop the operation of the compressor.

5 Since the output from the comparator 25 is input into one of the terminals of the OR gate 28, when the output of the comparator is high, the output of the OR gate 28 is also high to make a transistor 36 conduct. As a result, the relay 37 for the fan motor 40 is energized to
10 close the contact 43 so as to start the operation of the fan motor 40. In other words, while the output of the comparator 25 is high, the fan motor 40 and the compressor 41 carry out the refrigerating operation.

 The temperature control in the inside of the
15 refrigerating compartment is similar to that of the frozen food compartment. That is to say, a change in resistance value of the temperature detecting element 29 in the refrigerating compartment, which is dependent on a change in temperature in the compartment, is detected.
20 When the temperature in the refrigerating compartment becomes higher than the set temperature, a voltage at C becomes higher than a voltage at D. As a result, the comparator 33 produces high output to make the transistor 34 conduct so as to energize the relay 35 for the damper
25 unit 39. So, the contact 42 is closed by the relay to energize the damper unit 39 so as to open the damper for cooling the inside of the refrigerating compartment. In this time, since the OR gate 28 also receives the high

input from the comparator 33, the OR gate 28 produces high output to start the operation of the fan motor 40.

On the other hand, when the temperature in the refrigerating compartment becomes lower than the set temperature, the contact 42 is opened to deenergize the damper unit 39 to close the damper.

As explained, in the conventional refrigerator, when the temperature in the frozen food compartment becomes higher than the set temperature, the compressor and the fan motor are driven to refrigerate the inside of the frozen food compartment. When the temperature in the refrigerating compartment becomes higher than the set temperature, the damper is opened and the fan motor is driven to cool the inside of the refrigerating compartment.

It is a disadvantage of the conventional temperature controlling device that if good circulation of the cooled air is obstructed due to volumes of food or the arrangement of food in the refrigerating compartment, the temperature distribution in the refrigerating compartment becomes uneven. It is because there is provided only a single temperature detecting element in the refrigerating compartment.

In the conventional refrigerator, even when only the refrigerating compartment is cooled, the cooled air is also fed into the frozen food compartment because the fan motor is driven. While the compressor is not driven, the temperature of the cooled air is higher than the

temperature in the frozen food compartment. As a result, an increase in temperature in the frozen food compartment is accelerated. For the reasons, the conventional refrigerator has problems that the compressor is
5 frequently driven and much power consumption is required.

It is an object of the present invention to eliminate the problems as stated above, and provide a refrigerator temperature control device capable of uniforming the temperature distribution in the refrigerating compartment
10 and of decreasing power consumption.

It is another object of the present invention to overcome a problem in a conventional multi door type of large sized refrigerator that the inside of the refrigerating compartment is divided by a plurality of
15 shelves, is full of volume of food on the shelves, and the food stored in the refrigerating chamber covers the cooled air passages in the rear end of the shelves to prevent the cooled air from coming into the refrigerating compartment to cool the entire inside of the
20 refrigerating compartment, and to provide a refrigerator temperature controlling device capable of uniforming the temperature distribution in the refrigerating compartment, irrespective of the storage arrangement of the food stored in the refrigerating compartment.

25 In drawings:

Figure 1 is a diagram showing the whole structure of a refrigerator of a first embodiment according to the present invention;

Figure 2 is a block diagram showing the controller as shown in Figure 1;

Figures 3 through 5 are flow charts showing how the controller as shown in Figure 1 operates;

5 Figure 6 is a vertical cross sectional view showing a refrigerator with a refrigerator temperature controlling device of a second embodiment according to the present invention;

Figure 7 is a block diagram showing the refrigerator
10 temperature controlling device of the second embodiment;

Figure 8 is a flow chart showing how the temperature controlling device operates;

Figure 9 is a cross sectional view showing a refrigerator with the conventional refrigerator
15 temperature controlling device; and

Figure 10 is a circuit diagram showing the conventional temperature controlling device.

Now, a first embodiment of a refrigerator temperature controlling device according to the present invention
20 will be explained in reference to Figures 1 through 5.

A refrigerator main body 1 includes a frozen food compartment 4 and a refrigerating compartment 5. In the frozen food compartment 4, a temperature detecting element (hereinbelow, referred to as "F-thermistor") 45
25 such as a thermistor is placed and its output is input into refrigerator temperature detecting means 46. A condenser 8 and a fan motor 9 are placed at a deep position in the frozen food compartment 4. The fan motor

9 forcibly feeds cooled air produced by the condenser 8, into the frozen food compartment 4 directly, and the refrigerating compartment 5 through a rear duct 10 which is provided behind the condenser. A damper unit 11 which
5 has a damper 11b placed in the outlet of the duct 10 controls the blowoff of the cooled air into the refrigerating compartment 5. When the damper 11b is opened, the cooled air is blown off into the refrigerating compartment 5. When the damper 11b is
10 closed, it shuts the outlet of the duct 10. The opening and closing operation of the damper 11b is electrically control.

In the refrigerating compartment 5, a first temperature detecting element (hereibelow referred to as
15 "R₁-thermistor") 47 such as a thermistor and a second temperature detecting element (hereinbelow, referred to as "R₂-thermistor") 48 such as a thermistor are arranged at different levels. The output of each temperature detecting element is input into the refrigerator
20 temperature detecting means 46.

A console panel 49 for setting predetermined temperatures in the refrigerator is attached to a front surface of a door. The set temperatures are input into set temperature detecting means 50.

25 Control means 51 includes a control unit 52, compressor controlling means 53 for controlling a compressor 56, damper controlling means 54 for controlling the damper unit 11 and fan motor controlling

means 55 for controlling the fan motor 9. Signals output from the refrigerator temperature detecting means 46 and the set temperature detecting means 50 are input into the control unit 52. The control unit 52 gives control
5 signals the compressor controlling means 53, the damper controlling means 54 and the fan motor controlling means 55, respectively.

The control means 51 will be explained in more detail, referring to Figure 2.

10 A refrigerator temperature detecting circuit 57 corresponding to the refrigerator temperature detecting means 46 as shown in Figure 1 detects refrigerator temperatures (temperature in the frozen food compartment 4 and temperature in the refrigerating compartment 5)
15 based on the input signals from the F-thermistor 45, the R_1 -thermistor 47 and the R_2 -thermistor 48. The temperature data are transmitted to a control circuit 59 corresponding to the control unit 52 as shown in Figure 1. A refrigerator temperature setting circuit 58
20 corresponding to the set temperature detecting means 50 as shown in Figure 1 transmits the set temperatures for the frozen food compartment 4 and the refrigerating compartment 5 to the control circuit 59.

The control circuit 59 determines operation modes
25 based on the data from the refrigerator temperature detecting circuit 57 and the refrigerator temperature setting circuit 58 to control the operations of the compressor 56, the fan motor 9 and the damper unit 11

through a compressor driving circuit 60 corresponding to the compressor controlling means 53 in Figure 1, a fan motor driving circuit 61 corresponding to the fan motor controlling means 50 in Figure 1 and a damper driving circuit 62 corresponding to the damper controlling means 54 in Figure 1, respectively.

The operation of the refrigerator temperature controlling device as constructed above will be explained in reference to Figure 3, which is a schematic flow chart shown in the whole program stored in the controlling circuit 59.

After the controlling circuit is initialized at a step 100, a main routine starts. At a step 200, data from the thermistors 45, 47 and 48 are converted into refrigerator temperature representations based on data from the refrigerator temperature detecting circuit 57. At a step 300, data from the refrigerator temperature setting circuit 58 are converted into set temperature representations. At a step 400, temperature judgement is made based on the converted temperature data on the temperature in the inside of the refrigerator and the converted set temperature data to determine the operation mode. At a step 500, the determined operation mode is output.

The temperature judgement routine at the step 400 will be explained in more detail, referring to Figure 4.

In an F-temperature judgement wherein the temperature in the frozen food compartment is checked, a temperature

T_{Fa} detected by the F-thermistor is compared to a set temperature T_{Fs} for the frozen food compartment at steps 401 and 402. If the temperature T_{Fa} is higher than the temperature T_{Fs} , a memory "COMP F" in the control circuit is set to 1 at a step 404. If negative, the memory "COMP F" is reset to 0 at a step 403.

In an R-temperature judgement wherein refrigerating temperature control is checked, an average thermistor temperature T_{Ra} obtained by averaging the value of an R_1 -thermistor temperature T_{Ra1} and that of an R_2 -thermistor temperature T_{Ra2} is compared to a set temperature T_{Rs} at steps 410-415. If the average thermistor temperature T_{Ra} is higher than the set temperature T_{Rs} , a memory "DAMP F" in the control circuit is set to 1 at a step 417. If negative, the memory "DAMP F" is reset 0 at a step 416. Then, at steps 418, 419 and 422, if the R_1 -thermistor temperature T_{Ra1} or the R_2 -thermistor temperature T_{Ra2} is lower than the value given by subtracting T_1 (upper allowable temperature deviation) from the set temperature T_{Rs} , the memory "DAMP F" is reset to 0. If negative, the R_1 -thermistor temperature T_{Ra1} and the R_2 -thermistor temperature T_{Ra2} are compared to the value given by adding T_2 to the set temperature T_{Rs} , respectively. If the R_1 -thermistor temperature T_{Ra1} or the R_2 -thermistor temperature T_{Ra2} is higher than the value, the memory "DAMP F" and a memory "FAN F" in the control circuit are set to 1, respectively, at steps 420, 421 and 424. If not, the

memory "FAN F" is reset to 0 at a step 423.

Now, the output routine at the step 500 as shown in Figure 3 will be described referring to Figure 5.

At a step 501, the data stored in the memory "DAMP F" is inspected. If the data is 1, an output signal indicative of opening the damper is produced at a step 503. If the data is 0, an output signal indicative of closing the damper is produced at a step 502. Then, the data stored in the memory "COMP F" is inspected at a step 504. If the data is 1, an output signal indicating to drive the compressor is produced at a step 506 and an output signal indicating to drive the fan is also produced at a step 509. If the data stored in the memory "COMP F" is 0, an output signal indicating to stop the compressor is produced at a step 505. Then, the data stored in the memory "FAN F" is inspected at a step 507. If the data is 1, an output signal indicating to drive the fan is produced at a step 509. If the data is 0, an output signal indicating to stop the fan is produced at a step 508.

Since the control circuit carries out the temperature control in the sequential order as described above, when the difference between the R_1 -thermistor temperature R_{a1} and the R_2 -thermistor temperature T_{Ra2} is a small (it means that the refrigeration load in the refrigerator is stable and the temperature in the refrigerator is under normal condition), the average value of the thermistor temperatures T_{Ra1} and T_{Ra2} is used as the temperature in

the refrigerator. And, based on that temperature, the opening and closing operation of the damper is made to control the temperature in the refrigerator. When the damper is opened and the compressor is off, an increase
5 in temperature in the frozen food compartment can be minimized because the fan motor is not driven. That can prevent the compressor from being frequently driven, and obtain save energy.

In addition, when the refrigerator is full of food
10 stock and the temperature has been raised to more than a temperature determined based on the set temperature and the temperature T_1 , the fan motor is driven even when the compressor is off. As a result, it is possible to cool the inside of the refrigerator at once.

15 When the food stored in the refrigerator prevents good circulation of the cooled air and the stored food is partially cooled (the temperature in the refrigerator is lower than a temperature determined based on the set temperature and temperature T_2 which is lower allowable
20 temperature deviation), it is dominant to close the damper to prevent the food from being frozen in the refrigerating compartment.

Although, in the first embodiment, there are two temperature detecting elements in the refrigerator, there
25 can be provided more than two temperature detecting elements.

Although, in the embodiment, the average value of the two temperature detecting elements in the refrigerator is

used as the temperature in the refrigerator to carry out the temperature control, it is possible to obtain a similar effect even if one of the temperature detecting elements is used as an exclusive temperature detecting element for normal conditions only, and the other is used to detect only abnormal conditions.

As explained, in accordance with the first embodiment, at least two temperature detecting elements are arranged in the refrigerator to control the opening and closing operation of the damper based on the temperatures detected by the elements. If one of the temperature detecting elements detects that the temperature in the refrigerator is higher than a predetermined temperature, the damper is opened and the fan motor is driven. On the other hand, if one of the temperature detecting elements detects that the temperature in the refrigerator is lower than a predetermined temperature, it is dominant to close the damper. As a result, it becomes possible to uniform the temperature distribution in the refrigerator, to establish the cooling operation matching refrigerating load and to minimize power consumption.

Now, a second embodiment according to the present invention, wherein uniform temperature distribution in the refrigerator can be obtained irrespective of the storage arrangement of food stored in the refrigerator, will be described in reference to Figures 6 through 8.

Figure 6 is a vertical cross sectional view showing a

refrigerator with a refrigerator temperature controlling device of the second embodiment. Figure 7 is a block diagram showing a circuit for the temperature controlling device. Figure 8 is a flow chart showing how the temperature controlling device operates. In Figure 6, reference numerals 1 through 14 and 17 through 20 designate parts indential or similar to those of the conventional refrigerator as shown in Figure 9.

Referring to Figure 6, a communicating duct 63 for feeding the cooled air is arranged at a deep position in the refrigerating compartment so as to connect to the lower end of the cover 17 for covering the damper unit 11. The communicating duct 63 extends, along the rear surface of the refrigerating compartment 5, to the rear aperture 13 in the compartment wall 3 which serves to separate the salad compartment 6 from the refrigerating compartment 5. In the refrigerating compartment 5, there are provided a plurality of compartment shelves 64, 65 and 66 to divide the refrigerating compartment into a plurality of spaces 78, 79, 80 and 81. The communicating duct 63 has outlets for blowing off the cooled air, formed therein to face the spaces 78, 79, 80 and 81. Temperature detecting elements 70, 71 and 72, such as thermistors, for detecting the temperature in the refrigerating compartment are arranged in the spaces 79, 80 and 81, respectively. Among the temperature detecting elements, the elements indicated by 70 is used as a representative temperature detecting element.

The inside of the refrigerating compartment are divided by the three shelves 64, 65 and 66 and a partition wall 3 into the spaces 78, 79, 80 and 81, and a space 82 for storage of food. A reference numeral 83
5 designates an outlet for blowing off the cooled air into the space 78. A reference numeral 84 designates an outlet for blowing off the cooled air into the space 84.

In Figure 7, there are shown temperature detecting means 73, 74 and 75, which are connected to the
10 temperature detecting elements 70, 74 and 72, respectively. The temperature detecting means 73 connected to the representative temperature detecting element 70 is used as a representative temperature detecting means. In Figure 7, there are also shown a
15 variable resistor 76 which is placed at the door for the frozen food compartment 4, the door for the refrigerating compartment 5 or other member. The variable resistor 76 is connected to a set temperature detecting means 77. The representative temperature detecting means 73, the
20 temperature detecting means 74 and 75, and the set temperature detecting means 77 are connected to control means 78 comprising a microcomputer and so on, to control the opening and closing operation of the damper unit 11, comparing output signals from the temperature detecting
25 means with those from the set temperature detecting means.

In the refrigerator temperature controlling device according to the second embodiment, cooled air feeding

operation and cooled air circulation wherein the cooled
air produced in the cooling chamber 7 is fed throughout
the inside of the refrigerator main body 1 by the fan 9
are basically similar to the conventional temperature
controlling device. Hereafter, differences between the
5 second embodiment and the conventional device will be
mainly explained.

Firstly, the blowoff of the cooled air into the
refrigerating compartment 5 will be described.

10 The cooled air produced in the cooling chamber 7
passes through the rear duct 10 and comes into the
communicating duct 63 through the back of the cover 17
because the communicating duct 63 is arranged so as to
connect to the lower end of the cover 17 for covering the
15 damper unit 11. Since the communicating duct 63 has the
outlets 67, 68 and 69 formed for the spaces 79, 80 and
81, most of the cooled air blows off from the outlets 67,
68 and 69 simultaneously. The remaining cooled air which
has flowed into the communication duct 63 blows off into
20 the salad compartment 6.

As a result, a refrigerator with the temperature
controlling device of the second invention can distribute
the cooled air rapidly into both refrigerating
compartments 5 and salad compartment 6, which is
25 different from the conventional refrigerator as shown in
Figure 9 wherein the cooled air is blown off only from
the upper outlet 17a and the lower outlet 17b formed in
the cover 17. In addition, the cooled air is widely and

uniformly blown off into the entire refrigerating compartment 5 because the outlets 67, 68 and 69 are formed to face the spaces 79, 80 and 81. The cooled air is usually a downward flow and is fed from the cooling chamber 7 which is positioned at an upper portion in the refrigerator main body 1. For these reasons, it becomes possible to obtain more effective circulation of the cooled air by forming the outlets 67, 68 and 69 in the communicating duct at positions adjacent the lower surfaces of the shelves 15 for dividing the inside of the refrigerating compartment 5 in the spaces 78, 79, 80 and 81. Such arrangement of the outlets prevents the food stored in the refrigerating compartment from covering the outlets 67, 68 and 69 and from obstructing the blowoff of the cooled air even if the refrigerating compartment 5 is full of stored food.

In addition, since the communicating duct 63 which is arranged at the rear ends of the shelves 15 insures a passage for feeding the cooled air, there is no possibility of preventing the cooled air from being fed even if food is put in the deepest position on the shelves 15. As a result, it is possible to put food or other things into the refrigerating compartment 5 effectively.

Now, the temperature control means for the inside of the refrigerating compartment 5 will be explained.

In the refrigerating compartment 5, there are the temperature detecting elements 70, 71 and 72 to detect

the temperatures in the refrigerating compartment 5 a
to control the temperature in the refrigerating
compartment, comparing the detected temperatures with the
set temperature. The reason why a plurality of the
5 temperature detecting elements are arranged is that the
temperature distribution is unapt to be uniform in the
refrigerating compartment 5 having great volume and that
the temperature distribution is affected by the storage
arrangement of the stored food or other things. For this
10 reason, it is preferable to arrange the temperature
detecting means in each space which is divided by the
shelves 15. Temperatures detected by the temperature
detecting elements 70, 71 and 72 through the temperautre
detecting means 73, 74 and 75 are compared to the set
15 temperature (which is given by the variable resistor 76
through the set temperature detecting means 77) in the
control means 78 to control the opening and closing
operation of the damper unit 11.

Now, it is explained how the control is carried out.
20 One of the temperature detecting elements is selected
as the representative temperature detecting elements
(e.g. the element 70 as shown in Figures 6 and 7) to use
the temperature detected by that element as a
representative value to be compared to the set
25 temperature. If the representative value is higher than
the set temperature, the damper 11b is opened. On the
other hand, if the representative value is lower than the
set temperature, the damper 11b is closed. Even if the

blowoff of the cooled air is controlled only by the opening and closing operation of the damper, it is possible to adequately control the temperature in the refrigerating compartment 5 on condition that the temperature distribution in the spaces 79, 80 and 81 is always uniform.

However, if the temperature distribution is not uniform, such control is insufficient. For this reason, the temperature control is carried out so as to control the opening and closing operation of the damper unit 11 if, irrespective of the representative value and the set temperature, one of the temperature detecting elements 70, 71 and 72 detects a temperature that is out of a predetermined temperature range defined by the upper and lower allowable temperature deviations in respect to the set temperature. That is to say, if the lowest temperature among the temperatures detected by the temperature detecting elements 71 and 72 except the representative temperature detecting element 70 is below the predetermined temperature range (e.g. the set temperature -3°C), the damper 11b is closed. On the other hand, if the highest temperature among the temperatures detected by the temperature detecting elements 71 and 72 is above the predetermined temperature range (e.g. the set temperature $+3^{\circ}\text{C}$), the damper 11b is opened. According to such control, it is possible to control the opening and closing operation of the damper

unit 11 according to the temperature in the space 79, or 81 that is the furthest from the set temperature, among the temperatures in the spaces 79, 80 and 81 in the refrigerating compartment 5. That control helps the temperature distribution in the refrigerating compartment 5 to be uniform and enables a certain level of unification in the temperature distribution.

Accordingly, even if food having a higher temperature is put on one of the shelves 64, 65 and 66, or even if the temperature in the refrigerator is unapt to be uniform due to the storage arrangement of the stored food, it is possible to prevent the food from rotting or being frozen.

Now, the control of the blowoff of the cooled air according to the second embodiment will be described in more detail, referring to Figure 8.

In Figure 8, a symbol T_A is used to refer to a temperature detected by the representative temperature detecting element 70. A symbol T_{BH} is used to refer to the highest temperature among temperatures detected by the temperature detecting elements 71 and 72 except the representative temperature detecting element. A symbol T_{BL} is used to refer to the lowest temperature among the detected temperatures by the temperature detecting elements 71 and 72. A symbol T_S is used to refer to the set temperature. The upper allowable temperature deviation in reference to the set temperature T_S is indicated by a symbol T_1 (e.g. 3°C). The lower allowable

temperature deviation is indicated by a symbol T_2 (-3°C).

At a step S_1 , the temperature T_A detected by the representative temperature detecting element 70 is compared to the highest temperature T_{BH} detected by one of the temperature detecting elements 71 and 72. The value obtained by subtracting T_A from T_{BH} is not smaller than T_1 (e.g. 3°C), the damper 11b is opened at a step S4. If smaller, the lowest temperature T_{BL} among the temperatures detected by the temperature detecting elements 71 and 72 is compared to the representative detected temperature T_A at a step S2. If the value obtained by subtracting T_{BL} from T_A is not smaller than the absolute value of T_2 (e.g. -3°C), the damper 11b is closed at a step S5. If smaller, the temperature T_A detected by the representative temperature detecting element 70 is compared to the set temperature T_S at a step S3. If the representative detected temperature T_A is not greater than the set temperature T_S , the damper 11b is closed at the step S5. If positive, the damper 11b is opened at the step S4.

As explained, the opening and closing operation of the damper unit 11 is carried out based on the temperature in the space 79, 80 or 81 that has the most deviated temperature, so as to uniform the temperature distribution in the refrigerating compartment 5. If variation in the temperature in the spaces 79, 80, and 81 are within the predetermined range, the temperature in the refrigerator is controlled only by comparing the

representative value given by representative temperature detecting element 70 to the set temperature.

Such the cooled air blowoff control is repeatedly carried out at intervals of a predetermined time. The temperature control in the refrigerating compartment 5 is carried out while uniforming the temperature distribution in the refrigerating compartment 5.

Although, in the second embodiment, the temperature detected by the temperature detecting element 70 is used as the representative value, the temperature detecting element 71 or 72 can be used as a representative temperature detecting element, instead of the temperature detecting element 70. It is preferable to choose the location of each temperature detecting element, which facilitates to detect the temperatures in the spaces 78, 79, 80 and 81. The number of the temperature detecting elements can be increased according to an increase in volume in the refrigerating compartment 5.

In addition, the temperatures detected by the temperature detecting elements are averaged and the averaged value can be used as a representative value. Such control is particularly excellent in terms of the unification of the temperature distribution in the refrigerating compartment 5.

By the way, although, in the second embodiment, the temperature detecting elements are arranged in the three spaces 79, 80 and 81, additional temperature detecting elements can be arranged in the top space 78 and the

bottom space 82. In this case, the opening and closing control of the damper unit 11 is done by the control means 78 based on detected signals from the five temperature detecting elements in the five spaces 78, 79, 80, 81 and 82 so as to adjust the blowoff of the cooled air from the outlets 83, 67, 68, 69 and 84 into the five spaces 78, 79, 80, 81 and 82.

Further, in the second embodiment, the arrangement of the temperature detecting elements and the temperature control can be done like the first embodiment as shown in Figures 1 through 5.

As explained, the refrigerator temperature controlling device of the second embodiment can detect the temperature at different positions in the refrigerating compartment to control the opening and closing operation of the damper by the temperature control means for controlling the damper unit so as to adjust the blowoff of the cooled air. As a result, the temperature distribution in the entire refrigerating compartment can be uniformed within a certain range and the temperature control in the refrigerator can be done while effectively carrying out uniform cooling. In addition, since the communicating duct is arranged so as to connect to the lower end of the cover for covering the damper unit and the communicating duct has the cooled air outlet formed therein so as to face the spaces divided by the shelves, the cooled air produced in the cooling

chamber passes through the communicating duct and is blown off into the spaces through the outlets simultaneously. As a result, it is possible to rapidly spread the cooled air in the entire refrigerating compartment.

CLAIMS:

1. A refrigerator having a temperature controlling device comprising:

a fan motor for feeding cooled air into a refrigerating compartment;

a damper unit having a damper for controlling blowoff of the cooled air into the refrigerating compartment;

temperature detecting elements arranged at a plurality of positions in the refrigerating compartment, and

control means for controlling the damper based on temperatures detected by the temperature detecting elements so as to carry out the temperature control in response to the overall temperature of the refrigerating compartment, and any local variations in temperature within the refrigerating compartment.

2. The device according to Claim 1 wherein the control means calculates an average temperature of the temperatures detected by the temperature detecting elements, and regards the average temperature as the temperature in the refrigerating compartment so as to carry out the temperature control in the refrigerating compartment.

3. The device according to Claim 1, wherein the control means opens the damper and continuously drives the fan motor when the temperature detected by one of the temperature detecting elements is higher than a set temperature for the refrigerating compartment by more than a predetermined upper allowable deviation; and wherein the control means has a mode of closing the damper when the temperature detected by one of the temperature detecting elements is lower than a set temperature by more than a predetermined lower allowable deviation, this mode being dominant over a mode of opening the damper which is done when the temperature in the refrigerating compartment is higher than the set temperature by the predetermined upper allowable deviation.

4. A refrigerator controlling device comprising:

a damper unit having a damper for controlling blowoff of cooled air into a refrigerating compartment,
partitions for dividing the inside of the refrigerating



compartment into a plurality of spaces,

a communicating duct having an inlet facing the damper and having outlets formed at positions in the refrigeration compartment;

5 temperature detecting elements arranged at a plurality of positions in the refrigerating compartment, and

control means for controlling the damper based on the temperatures detected by the temperature detecting elements so as to carry out the temperature control in response to
10 the overall temperature in the refrigerating compartment, and any local variations in temperature within the refrigerating compartment.

5. The device according to Claim 4, wherein the temperature detecting elements are arranged so that there
15 are one or more temperature detecting elements in each of the spaces divided by the partitions.

6. The device according to Claim 4, wherein the damper unit is placed at an upper rear portion in the refrigerating compartment.

20 7. The device according to Claim 4 wherein the outlets are formed in the communicating duct at positions adjacent the undersurfaces of the partitions.

8. The device according to Claim 4 wherein the control means compares the temperatures detected by the temperature
25 detecting elements with a set temperature so as to control the opening and closing operation of the damper in the damper unit.

9. The device according to Claim 8 wherein the opening and closing operation control of the damper by the control
30 means is carried out so that a representative value is chosen based on the temperatures detected by the temperature detecting elements, the representative value is compared to the set temperature, the damper is opened when the representative value is higher than the set temperature, the
35 damper is closed when the representative temperature is lower than the set temperature, and if the temperature detected by one of the temperature detecting elements is out of a predetermined range with respect to the set temperature



the operation of opening and closing the damper is determined based on the detected temperature which is out of the predetermined temperature range, irrespective of the representative value and the set temperature.

5 10. The device according to Claim 9, wherein the representative value chosen among the detected temperatures is a temperature detected by one of the temperature detecting elements which is chosen as a representative temperature detecting element among the temperature
10 detecting elements.

11. The device according to Claim 9 wherein value obtained by averaging the temperatures detected from the temperatures detecting elements is determined as the representative value.

15 12. The device according to Claim 9 wherein the operation of opening and closing the damper which is done, irrespective of the representative value and the set temperature, when one of the temperatures detected by the temperature detecting elements is out of the predetermined
20 temperature range with respect to the set temperature is carried out so that the damper is closed when the lowest temperature among the detected temperatures is lower than the set temperature by more than the predetermined lower allowable temperature deviation.

25 13. The device according to Claim 9, wherein the operation of opening and closing the damper which is done, irrespective of the representative value and the set temperature, when the temperature detected by one of the temperature detecting elements is out of the predetermined
30 range with respect to the set temperature is carried out so that the damper is opened when the highest temperature among the detected temperatures is higher than the set temperature by more than the predetermined upper allowable deviation.

