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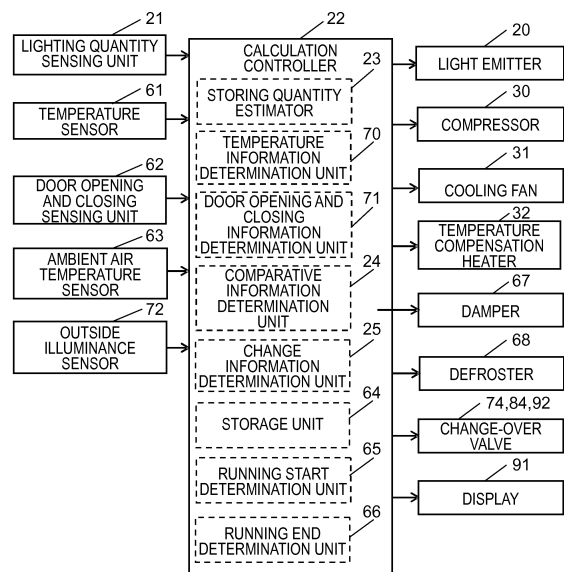
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(54) **REFRIGERATOR**

(57) A refrigerator according to an aspect of the present invention includes a refrigeration device that cools an inside of each of compartments, a damper (67) that corresponds to each of the compartments to control a supply quantity of cold air generated by the refrigeration device, and calculation controller (22) that performs calculation based on input data of storing quantity estimator (23) and storage unit (64) to control the refrigeration device. Usually, energy-saving running is performed by the control of damper (67) corresponding to each of the compartments. In the case where the storing quantity changes largely due to a bulk purchase, a cooling quantity in each of the compartments in which the storing quantity changes is intensively cooled by the control of damper (67), and an input object to be stored is cooled to an optimum storage temperature in a short time.

FIG. 3



Description

TECHNICAL FIELD

[0001] The present invention relates to a refrigerator provided with a unit sensing a storage situation of a compartment, particularly to a refrigerator that can adjust a cooling quantity according to a change of the storage situation to perform rapid cooling or automatic power saving.

BACKGROUND ART

[0002] Nowadays, in a household refrigerator, a plurality of compartments, such as a refrigerating compartment and a freezing compartment, which have different temperature ranges in order to preserve various foods are provided, each of the compartments includes an inside temperature sensor that senses a temperature at the compartment, and a cooling quantity is adjusted to perform temperature control according to a sensing result of output.

[0003] As to the refrigerator in which the cooling quantity in each of the compartments is adjusted, for example, there is a refrigerator in which a damper that opens or closes supply of cold air is provided at an ejection port to each of the compartments (for example, see PTL 1).

[0004] FIG. 24 is a configuration diagram of a refrigerating compartment of a conventional refrigerator, and FIG. 25 is a view schematically illustrating a temperature behavior of a temperature sensor of the conventional refrigerator.

[0005] Refrigerator body 101 has heat insulating box body 102 filled with a heat insulating material. Refrigerating compartment 107 and temperature selecting compartment 108 are provided in refrigerator body 101. Refrigerating compartment 107 is provided in an upper portion of refrigerator body 101. Temperature selecting compartment 108 is provided below refrigerating compartment 107, and is switchable in wide temperature range from a vegetable to a frozen food. Vegetable compartment 109 and freezing compartment 110 are also provided in refrigerator body 101. Vegetable compartment 109 is provided below temperature selecting compartment 108 to preserve the vegetable and the like. Freezing compartment 110 is provided below vegetable compartment 109 to preserve the frozen food and the like.

[0006] Opening and closing type refrigerating compartment door 103 is provided in a front surface of refrigerating compartment 107, and drawer type temperature selecting compartment door 104 is provided in a front surface of temperature selecting compartment 108. Drawer type vegetable compartment door 105 is provided in a front surface of vegetable compartment 109, and drawer type freezing compartment door 106 is provided in a front surface of freezing compartment 110. Compressor 111 is installed in machine compartment 111a provided in a rear and lower portion of refrigerator body 101,

cooler 113 is disposed in a cooler compartment provided in the rear portion of refrigerator body 101, and defrosting heater 112 is disposed below cooler 113 in order to melt frost.

[0007] The cold air cooled by cooler 113 is forcedly blown by cooling fan 114 to compartments such as refrigerating compartment 107 and freezing compartment 110 in refrigerator body 101. The cold air sent from cooling fan 114 flows as cold air 116 into refrigerating compartment 107 through refrigerating compartment draft air duct 119A, and flows as cold air 118 into freezing compartment 110 through freezing compartment draft air duct 120A. Refrigerating compartment damper 115A that adjusts a quantity of cold air supplied to refrigerating compartment 107 is provided in refrigerating compartment draft air duct 119A. Temperature selecting compartment damper 115B that adjusts a quantity of cold air 117 supplied to temperature selecting compartment 108 is provided in temperature selecting compartment draft air duct 123A provided in a rear surface of temperature selecting compartment 108. Freezing compartment damper 115C that adjusts the quantity of cold air supplied to freezing compartment 110 is provided in freezing compartment draft air duct 120A.

[0008] In the conventional refrigerator, deodorizing device 122 is installed in bypass passage 121. When all refrigerating compartment damper 115A, temperature selecting compartment damper 115B, and freezing compartment damper 115C are closed, the cold air is not supplied to refrigerating compartment draft air duct 119A, freezing compartment draft air duct 120A, and temperature selecting compartment draft air duct 123A, which have very few air resistances. Because almost the cold air is supplied to bypass passage 121 having a large air resistance, a short cycle is generated, and the whole cold air in a closed space of heat insulating box body 102 is forcedly passed through deodorizing device 122 by cooling fan 114. Therefore, an inside of heat insulating box body 102 is deodorized.

[0009] As illustrated in FIG. 25, when a temperature sensed by a freezing compartment temperature sensor rises to a predetermined temperature (ON temperature), compressor 111 is driven to perform an operation of "closed → opened" of freezing compartment damper 115C, and then cooling fan 114 is driven. When a temperature sensed by a refrigerating compartment temperature sensor is greater than or equal to a predetermined temperature (opened temperature), an operation of "closed → opened" of refrigerating compartment damper 115A is performed (hereinafter, the operation is referred to as "refrigerating compartment and freezing compartment simultaneous cooling (a)").

[0010] When the temperature sensed by the refrigerating compartment temperature sensor reaches the predetermined temperature (closed temperature), an operation of "opened → closed" of refrigerating compartment damper 115A is performed, and cooling running is performed only on the side of freezing compartment 110

(hereinafter, the operation is referred to as "freezing compartment single cooling (b)").

[0011] When the temperature sensed by the freezing compartment temperature sensor reaches a predetermined temperature (OFF temperature), compressor 111 is stopped (hereinafter, the operation is referred to as "cooling stopping (c)"). In the conventional refrigerator, as illustrated in FIG. 25, a string of operations, namely, the refrigerating compartment freezing compartment simultaneous cooling (a), the freezing compartment single cooling (b), and the cooling stopping (c) are sequentially repeated.

[0012] An operation, in which refrigerating compartment damper 115A is set to "opened" while freezing compartment damper 115C is set to "closed" and compressor 111 and cooling fan 114 are driven, may be added to the string of operations (hereinafter, the operation is referred to as "refrigerating compartment single cooling (d)").

[0013] However, the conventional refrigerator performs sensing control of an atmospheric temperature in the refrigerator or a returning air temperature using the temperature sensor, but the refrigerator does not have a function of directly sensing a temperature at an object to be stored. Therefore, there is generated a difference between the atmospheric temperature in the refrigerator and the actual temperature at the object to be stored.

[0014] For example, a shift period until the inside of the refrigerator is cooled to reach a setting temperature since the temperature in the refrigerator rises immediately after the object to be stored is input, after a door is opened for a long time, and immediately after defrosting running is performed will be described below. In this case, time to an optimum storage temperature changes depending on a storing quantity because a difference between the temperature sensed by the temperature sensor disposed in the refrigerator and the temperature at the object to be stored is generated according to the quantity of object to be stored and specific heat or heat capacity of the object to be stored. Specifically, for the large storing quantity, the time to the optimum storage temperature is generally lengthened, and therefore sometimes supercooling running is performed.

[0015] After time elapses sufficiently to stabilize the temperature at the object to be stored to a low temperature, the object to be stored is maintained at the temperature by an own heat capacity. On the other hand, for the large storing quantity, a possibility of placing the object to be stored in a neighborhood of an ejection port of the cold air is increased to directly expose the object to be stored to the cold air, and the object to be stored tends to be excessively cooled. Because the heat capacity increases with increasing storing quantity, the temperature difference between the air and the food decreases compared with the case of the normal storing quantity, whereby the object to be stored tends to be excessively cooled. Therefore, in the conventional cooling control, the object to be stored becomes an "overcooled" state and the object to be stored can hardly be cooled at the optimum

temperature. Additionally, in this period, the refrigerator performs the cooling running while consuming excess energy in this period.

[0016] Particularly, nowadays a work arrangement changes to increase a dual-income household, and a purchase at a large grocery store increases. Therefore, a bulk purchase tends to increase. An opportunity to purchase the food and the like of one week at once increases and the storing quantity of the refrigerator tends to largely increase than ever. On the other hand, frequently the object to be stored such as the food is not added to the refrigerator on weekdays, and a life pattern of a standard home is changing.

[0017] In the conventional refrigerator, for example, in the case where the storing quantity increases largely, the time difference is generated until the temperature sensor in the refrigerator senses the temperature rise since the object to be stored is input, because the temperature control is performed according to the sensing result of the temperature sensor. This is attributed to the fact that the temperature sensor is usually molded by resin to hardly follow a rapid temperature change. Therefore, it takes a time to perform such rapid cooling running that a rotating speed of compressor 111 or cooling fan 114 increases.

[0018] The damper (refrigerating compartment damper 115A, temperature selecting compartment damper 115B, and freezing compartment damper 115C in FIG. 24) that opens or closes the supply of the cold air is provided at the ejection port of each of the compartments, and sometimes the cooling is performed while the plurality of dampers of the compartments are simultaneously opened. For example, it is assumed that refrigerating compartment damper 115A is set to "opened", that freezing compartment damper 115C is set to "opened", and that the object to be stored is input to refrigerating compartment 107. The air warmed by the increase in storing quantity of refrigerating compartment 107 flows into freezing compartment 110 through cooler 113 and freezing compartment damper 115C, and the temperature at freezing compartment 110 possibly rises in addition to refrigerating compartment 107, which results in a problem in that freshness of the food degrades.

Citation List

Patent Literature

[0019] PTL 1: Unexamined Japanese Patent Publication No. 2003-42646

SUMMARY OF THE INVENTION

[0020] A refrigerator according to the present invention includes compartments, each being partitioned by a heat insulating wall and a heat insulating door to store an object to be stored, a storing quantity estimator that estimates a storing quantity in each of the compartments, a

storage unit that stores an estimation result of the storing quantity estimator, and a refrigeration device that cools an inside of each of the compartments. The refrigerator also includes a damper device that corresponds to each of the compartments and controls a supply quantity of cold air generated by the refrigeration device, and a calculation controller that performs calculation based on input data from the storing quantity estimator and the storage unit to control the refrigeration device and the damper device.

[0021] In the configuration of the present invention, energy-saving running is usually performed, and a cooling quantity in each of the compartments in which the storing quantity changes is adjusted in the case where the storing quantity changes largely due to a bulk purchase, so that the object to be stored can properly be cooled to achieve energy saving.

[0022] A refrigerator according to the present invention includes compartments, each being partitioned by a heat insulating wall and a heat insulating door to store an object to be stored, a storing quantity estimator that estimates a storing quantity in each of the compartments, a storage unit that stores an estimation result of the storing quantity estimator, and a refrigeration device that cools an inside of each of the compartments. The refrigerator also includes a switchable radiator that constitutes the refrigeration device, and a calculation controller that performs calculation based on input data from the storing quantity estimator and the storage unit to control the refrigeration device. In the refrigerator, the calculation controller performs control by switching the radiator of the refrigeration device based on a calculation result of the storing quantity.

[0023] In the configuration of the present invention, the energy-saving running can usually be performed, and the cooling quantity of the compartment in which the storing quantity changes can be increased to cool the input object to be stored to an optimum storage temperature in a short time in the case where the storing quantity changes largely due to the bulk purchase. Additionally, enhancement of a radiation capacity can be achieved according to the increase in cooling capacity.

[0024] A refrigerator according to the present invention includes compartments, each being partitioned by a heat insulating wall and a heat insulating door to store an object to be stored, a storing quantity estimator that estimates a storing quantity in each of the compartments, a storage unit that stores an estimation result of the storing quantity estimator, and a refrigeration device that cools an inside of each of the compartments. The refrigerator also includes a refrigerant circulating quantity adjuster that constitutes the refrigeration device, and a calculation controller that performs calculation based on input data from the storing quantity estimator and the storage unit to control the refrigeration device. In the refrigerator, the calculation controller adjusts a refrigerant circulating quantity using the refrigerant circulating quantity adjuster based on a calculation result of the storing quantity.

[0025] In the configuration of the present invention, the energy-saving running can usually be performed, the cooling quantity in each of the compartments in which the storing quantity changes can be increased to cool the input object to be stored to the optimum storage temperature in a short time in the case where the storing quantity changes largely due to the bulk purchase. Additionally, a refrigerant circulating quantity can be ensured according to the increase in cooling capacity.

[0026] A refrigerator according to the present invention includes compartments, each being partitioned by a heat insulating wall and a heat insulating door to store an object to be stored, a storing quantity estimator that estimates a storing quantity in each of the compartments, a storage unit that stores an estimation result of the storing quantity estimator, and a cooling device that cools an inside of each of the compartments. The refrigerator also includes a draft air device that independently circulates cold air in each of the compartments, and a calculation controller that performs calculation based on input data from the storing quantity estimator and the storage unit to control the cooling device and the draft air. Additionally, when it is determined that the storing quantity in each of the compartments changes, the calculation controller controls the draft air device of each of the compartments in which the storing quantity changes.

[0027] In the configuration of the present invention, the energy-saving running can usually be performed, and a cold air convection quantity in each of the compartments in which the storing quantity changes can be increased to cool the input object to be stored to the optimum storage temperature in a short time in the case where the storing quantity changes largely due to the bulk purchase.

[0028] A refrigerator according to the present invention includes compartments, each being partitioned by a heat insulating wall and a heat insulating door to store an object to be stored, a storing quantity estimator that estimates a storing quantity in each of the compartments, a storage unit that stores an estimation result of the storing quantity estimator, and a refrigeration device that cools an inside of each of the compartments. The refrigerator also includes a plurality of switchable coolers that constitute the refrigeration device, and a calculation controller that performs calculation based on input data from the storing quantity estimator and the storage unit to control the refrigeration device. In the refrigerator, the calculation controller performs control by switching the plurality of coolers of the refrigeration device based on a calculation result of the storing quantity.

[0029] In the configuration of the present invention, the energy-saving running can usually be performed, and the cooling quantity in each of the compartments in which the storing quantity changes can be increased to cool the input object to be stored to the optimum storage temperature in a short time in the case where the storing quantity changes largely due to the bulk purchase.

BRIEF DESCRIPTION OF DRAWINGS

[0030]

FIG. 1 is a front view illustrating a refrigerator according to a first exemplary embodiment of the present invention.

FIG. 2 is a sectional view taken along a line 2-2 of FIG. 1 illustrating the refrigerator according to the first exemplary embodiment of the present invention.

FIG. 3 is a control block diagram of the refrigerator according to the first exemplary embodiment of the present invention.

FIG. 4 is an explanatory view illustrating light quantity sensing operation of the refrigerator according to the first exemplary embodiment of the present invention.

FIG. 5A is a view illustrating a temperature change to time indicating operation of the refrigerator according to the first exemplary embodiment of the present invention.

FIG. 5B is a view illustrating the temperature change to the time indicating the operation of the refrigerator according to the first exemplary embodiment of the present invention.

FIG. 6 is a control flowchart illustrating storing quantity sensing control of the refrigerator according to the first exemplary embodiment of the present invention.

FIG. 7 is a control flowchart illustrating cooling running determination in which the storing quantity sensing control is used in the refrigerator according to the first exemplary embodiment of the present invention.

FIG. 8 is a control flowchart illustrating the cooling running determination in which the storing quantity sensing control is used in the refrigerator according to the first exemplary embodiment of the present invention.

FIG. 9 is a control flowchart illustrating the cooling running determination in which the storing quantity sensing control is used in the refrigerator according to the first exemplary embodiment of the present invention.

FIG. 10 is a control flowchart illustrating temperature sensing control after the storing quantity sensing control in the refrigerator according to the first exemplary embodiment of the present invention.

FIG. 11A is a view illustrating a relationship between a storing quantity change and a temperature change and the cooling running determination in the refrigerator according to the first exemplary embodiment of the present invention.

FIG. 11B is a view illustrating the relationship between the storing quantity change and the temperature change and the cooling running determination in the refrigerator according to the first exemplary embodiment of the present invention.

FIG. 12 is a view schematically illustrating a temper-

ature behavior of a temperature sensor, when an object to be stored is input while a refrigerating compartment and a freezing compartment are simultaneously cooled in the refrigerator according to the first exemplary embodiment of the present invention.

FIG. 13 is a view schematically illustrating the temperature behavior of the temperature sensor, when the object to be stored is input while the freezing compartment is singularly cooled in the refrigerator according to the first exemplary embodiment of the present invention.

FIG. 14 is a view schematically illustrating the temperature behavior of the temperature sensor, when the object to be stored is input while cooling of the refrigerator according to the first exemplary embodiment of the present invention is stopped.

FIG. 15 is a control flowchart illustrating rapid cooling and energy-saving running in the refrigerator according to the first exemplary embodiment of the present invention.

FIG. 16 is a view schematically illustrating a refrigerant circuit of the refrigerator according to the first exemplary embodiment of the present invention.

FIG. 17 is a view schematically illustrating a refrigerant circuit of a refrigerator according to a second exemplary embodiment of the present invention.

FIG. 18 is a view schematically illustrating a refrigerant circuit of a refrigerator according to a third exemplary embodiment of the present invention.

FIG. 19 is a view schematically illustrating a modification of the refrigerant circuit of the refrigerator according to the third exemplary embodiment of the present invention.

FIG. 20 is a sectional view illustrating a main part of a refrigerator according to a sixth exemplary embodiment of the present invention.

FIG. 21 is a sectional view illustrating a main part of a refrigerator according to a seventh exemplary embodiment of the present invention.

FIG. 22 is a sectional view illustrating a main part of a refrigerator according to an eighth exemplary embodiment of the present invention.

FIG. 23 is a front projection of the refrigerator according to the eighth exemplary embodiment of the present invention.

FIG. 24 is a configuration diagram of a conventional refrigerator.

FIG. 25 is a view schematically illustrating a temperature behavior of a temperature sensor of the conventional refrigerator.

DESCRIPTION OF EMBODIMENTS

[0031] Hereinafter, exemplary embodiments of the present invention will be described below with reference to the drawings. However, the present invention is not limited to the exemplary embodiments.

(FIRST EXEMPLARY EMBODIMENT)

[0032] FIG. 1 is a front view illustrating refrigerator 50 according to a first exemplary embodiment of the present invention.

[0033] As illustrated in FIG. 1, refrigerator 50 includes refrigerator body 11. Refrigerator body 11 is a heat insulating box body. A structure of refrigerator body 11 includes an outer casing mainly made of a steel plate, an inner casing molded using resin such as ABS, and a heat insulating material, such as urethane, which is provided in a space between the outer casing and the inner casing. The heat insulating box body insulates an inside of refrigerator body 11 from an environment.

[0034] Refrigerator body 11 is partitioned into a plurality of compartments in a heat insulating manner. Refrigerating compartment 12 is provided in an uppermost portion of refrigerator body 11, and ice-making compartment 13 and temperature selecting compartment 14 are provided in parallel below refrigerating compartment 12. Freezing compartment 15 is disposed below ice-making compartment 13 and temperature selecting compartment 14, and vegetable compartment 16 is disposed in a lowermost portion.

[0035] A door is openably and closably provided in a front opening of refrigerator body 11 in order to separate each of the compartments from ambient air. Operating unit 17 and display 91 are disposed near a central portion of refrigerating compartment door 12a of refrigerating compartment 12. Operating unit 17 sets an inside temperature of each of the compartments, and sets ice making or rapid cooling. Display 91 is an example of an information unit that informs a user of various pieces of information.

[0036] FIG. 2 is a sectional view taken along a line 2-2 of FIG. 1 illustrating refrigerator 50 according to the first exemplary embodiment of the present invention.

[0037] As illustrated in FIG. 2, a plurality of storing shelves 18 are provided in refrigerating compartment 12, and some of storing shelves 18 can vertically be moved.

[0038] A storage situation sensing unit is provided in refrigerating compartment 12. The storage situation sensing unit includes lighting unit 19 constructed with a lamp or a plurality of LEDs, light emitter 20 such as an LED, and light quantity sensor 21 such as an illuminance (light) sensor). When refrigerating compartment door 12a is opened, lighting unit 19 irradiates the inside of refrigerating compartment 12 such that the user easily sees the inside of refrigerating compartment 12. Light emitter 20 irradiates the inside of refrigerating compartment 12 while refrigerating compartment door 12a is closed, light quantity sensor 21 measures a light quantity of light emitter 20, and measurement information of light quantity sensor 21 is sent to the storage situation sensing unit.

[0039] When viewed from a front surface on a door opening side of refrigerator 50, lighting units 19 are vertically disposed in right and left wall surfaces so as to be located in front of a half of a depth size in the inside of

refrigerator 50 and so as to be located in front of a leading end of storing shelf 18. Light emitter 20 is disposed adjacent to lighting unit 19, and light quantity sensor 21 is disposed at a rear portion in refrigerating compartment 12.

[0040] The disposition of light quantity sensor 21 is not limited to the first exemplary embodiment, and light quantity sensor 21 may be disposed at any position as long as light quantity sensor 21 can receive the light emitted from light emitter 20 through object to be stored 33 in FIG. 4 and a structure in refrigerator 50.

[0041] Compressor 30 and refrigerating cycle high-pressure-side components such as a dryer removing moisture are accommodated in machine compartment 11a formed in a rear area in the uppermost portion of refrigerating compartment 12.

[0042] A cooling compartment (not illustrated) generating cold air is provided at the back of freezing compartment 15, and a cooler and cooling fan 31 (see FIG. 3) are disposed in the cooling compartment. Cooling fan 31 blasts the cold air cooled by the cooler to refrigerating compartment 12, temperature selecting compartment 14, ice-making compartment 13, vegetable compartment 16, and freezing compartment 15. Defroster 68 (see FIG. 3), a drain pan, and a drain tube evaporation pan are disposed in the cooling compartment in order to defrost frost and ice that adhere to cooler and the neighborhood of cooler.

[0043] In order to perform refrigerated storage, refrigerating compartment 12 is usually controlled in a temperature range of 1°C to 5°C with a not-frozen temperature as a lower limit, and vegetable compartment 16 in the lower most portion is controlled in a temperature range of 2°C to 7°C equal to or slightly higher than that of refrigerating compartment 12.

[0044] Freezing compartment 15 is set to a freezing temperature range, and usually controlled in a temperature range of -22°C to -15°C for the purpose of frozen storage. Sometimes freezing compartment 15 is set to a lower temperature of, for example, -30°C or -25°C in order to improve the frozen storage state.

[0045] Ice-making compartment 13 makes ice using an automatic ice maker (not illustrated) provided in an upper portion of ice-making compartment 13 from water delivered from a water tank (not illustrated) in refrigerating compartment 12, and stores the ice in an ice storing container (not illustrated) disposed in a lower portion of ice-making compartment 13.

[0046] Temperature selecting compartment 14 can be switched to a previously-set temperature range between a cooling temperature range and a freezing temperature range in addition to the refrigerated storage temperature range of 1°C to 5°C, the vegetable storage temperature range of 2°C to 7°C, and the frozen storage temperature range of -22°C to -15°C. Temperature selecting compartment 14 is a compartment, which is provided in parallel to ice-making compartment 13 while including an independent door. Temperature selecting compartment 14

frequently includes a drawer type door.

[0047] In the first exemplary embodiment, temperature selecting compartment 14 is used as the compartment that can be adjusted to temperatures including the refrigeration and freezing temperature ranges. Alternatively, the refrigeration function is entrusted to refrigerating compartment 12 and vegetable compartment 16, the freezing function is entrusted to freezing compartment 15, and temperature selecting compartment 14 may be used as the compartment specializing in the switching only of an intermediate temperature range between the refrigeration and the freezing. For example, because nowadays a demand for a frozen food increases, temperature selecting compartment 14 may be used as the compartment fixed to the frozen storage temperature range.

[0048] Operation and action of refrigerator 50 having the above configuration will be described below.

[0049] FIG. 3 is a control block diagram of refrigerator 50 according to the first exemplary embodiment of the present invention.

[0050] As illustrated in FIG. 3, refrigerator 50 includes light quantity sensor 21, temperature sensor 61, door opening and closing sensing unit 62, calculation controller 22, light emitter 20, compressor 30, cooling fan 31, temperature compensation heater 32, damper 67, defroster 68, and display 91.

[0051] Refrigerator 50 may include, but not necessarily include, ambient air temperature sensor 63 and outside illuminance sensor 72 in order to measure an external environment.

[0052] In the first exemplary embodiment, damper 67 includes a refrigerating compartment damper, a temperature selecting compartment damper, a freezing compartment damper, and a vegetable compartment damper, and each of the dampers independently controls the temperature based on a temperature sensor included in any of the compartments.

[0053] Calculation controller 22 includes storing quantity estimator 23, temperature information determination unit 70, door opening and closing information determination unit 71, comparative information determination unit 24, change information determination unit 25, storage unit 64, running start determination unit 65, and running end determination unit 66.

[0054] In refrigerator 50 of the first exemplary embodiment, when door opening and closing operation is performed, door opening and closing sensing unit 62 senses opening operation or closing operation, a sensing signal is input to calculation controller 22 constructed with a microcomputer or the like, and door opening and closing information determination unit 71 determines the door opening and closing operation. When the door is determined to be closed, calculation controller 22 sequentially operates light emitters 20 using a predetermined program.

[0055] Light quantity sensor 21 senses a light quantity in a neighborhood, and inputs the light quantity informa-

tion to calculation controller 22, and storing quantity estimator 23 obtains storage information such as a storing quantity and a position of the object to be stored.

[0056] For example, comparative information determination unit 24 compares the obtained storage information to the storage information before the door opening and closing operation, thereby obtaining comparative information.

[0057] Then, change information determination unit 25 compares the comparative information to a predetermined threshold to obtain change information on the storage information such as the storing quantity and the position of the object to be stored.

[0058] Based on the obtained change information, running start determination unit 65 of calculation controller 22 determines whether energy-saving running or rapid cooling running is started, and decides cooling-running-related operations of compressor 30, cooling fan 31, temperature compensation heater 32, damper 67, defroster 68, and display 91, thereby starting the energy-saving running or rapid cooling running. Running end determination unit 66 of calculation controller 22 determines whether the energy-saving running or rapid cooling running is ended, and ends the running of each of the above constituents.

[0059] The operations of light emitter 20 and light quantity sensor 21, which constitute the storage situation sensing unit, will be described in detail.

[0060] FIG. 4 is a view illustrating a storage situation detecting operation of refrigerator 50 according to the first exemplary embodiment of the present invention.

[0061] The inside of refrigerating compartment 12 and object to be stored 33, which is stored in refrigerating compartment 12, are irradiated with irradiation light beams 34a output from light emitter 20 disposed in the right and left wall surface of refrigerator 50. Part of irradiation light beam 34a is incident on light quantity sensor 21 disposed in refrigerating compartment 12. FIG. 4 illustrates a state in which area X, area Y, and area Z are generated due to existence of object to be stored 33 in the case where object to be stored 33 is stored in refrigerating compartment 12. Both irradiation light beams 34a from the right and left wall surfaces are blocked in area X. One of irradiation light beams 34a is blocked in area Y. Both irradiation light beams 34a are not blocked in area Z.

[0062] In the case of FIG. 4, light quantity sensor 21 is located in area Y where one of irradiation light beams 34a is blocked, and light quantity sensor 21 senses and inputs the corresponding light quantity. For the large quantity of object to be stored 33, the light quantity sensed by light quantity sensor 21 decreases due to the increase of area X where both irradiation light beams 34a are blocked.

[0063] For the small quantity of storing quantity, the light quantity sensed by light quantity sensor 21 increases due to the increase of area Z where both irradiation light beams 34a are not blocked.

[0064] Thus, light quantity sensor 21 senses the change in light quantity caused by the existence of object to be stored 33, and the quantity (for example, a large or small quantity) of object to be stored 33 can be classified by determining a difference in quantity of object to be stored 33 using a predetermined threshold previously set.

[0065] Light emitter 20 is also used as lighting unit 19 provided in refrigerator 50, or a board for light emitter 20 is also used as a board for lighting unit 19, which allows a storage state to be sensed by a simpler configuration without providing a new light source or material.

[0066] A temperature control operation of the compartment of refrigerator 50 will be described below.

[0067] FIGS. 5A and 5B are views illustrating a temperature change to the time indicating the operation of the refrigerator according to the first exemplary embodiment of the present invention.

[0068] FIG. 5A illustrates the temperature change of the refrigerator in the case where the increase in storing quantity is larger than a standard, and FIG. 5B illustrates the temperature change of the refrigerator in the case where the increase in storing quantity is smaller than the standard. In FIGS. 5A and 5B, a solid line indicates the temperature at object to be stored 33 (see FIG. 4) and a representative temperature at the compartment in the refrigerator of the first exemplary embodiment, and a broken line indicates time dependence of the temperature at object to be stored 33 and the representative temperature in the case where control is performed in the conventional refrigerator.

[0069] Setting temperature K_o is a previously-set storage temperature of object to be stored 33. In the case where the increase in storing quantity is larger and smaller than the standard, calculation controller 22 switches a running state of refrigerator 50 based on a storing quantity determination result of storing quantity estimator 23 in FIG. 3. For the sake of convenience, it is assumed that kinds of objects to be stored 33 are identical to each other. A criterion of "large, standard, small" of the increase in storing quantity depends on a size, configuration, or control method of the refrigerator. Therefore, the criterion is not limited to the example of the description.

[0070] In FIG. 5A, it is assumed that, in order to store object to be stored 33 in the compartment, the door of refrigerator 50 is opened, object to be stored 33 such as a food is input to compartment, and the door is closed. In the case where the quantity of the identical kind of object to be stored 33 is stored larger than the standard, the light quantity sensed by light quantity sensor 21 decreases compared with the standard case. According to a degree of the decrease in sensed light quantity, change information determination unit 25 in FIG. 3 determines that the increase in storing quantity in the refrigerator is larger than the standard. In this case, as illustrated in FIG. 5A, in the conventional cooling running (broken line), the object to be stored retains a large heat capacity, and a time delay is generated in the conventional temperature

sensing unit. Therefore, a cooling quantity cannot rapidly be increased. For this reason, temperature rise is generated to some extent, the cooling quantity increases to shift to the cooling, and the temperature in the refrigerator comes close to setting temperature K_o . However, a supercooling state is generated (a state in which the temperature in the refrigerator becomes a temperature lower than setting temperature K_o in FIG. 5A) to some extent because the cooling quantity increases, and then the refrigerator is stabilized at setting temperature K_o .

[0071] On the other hand, in refrigerator 50 of the first exemplary embodiment, the food input quantity can quickly be sensed during the closing of the door. Therefore, for example, when the increase larger than a certain increase in storing quantity is sensed, the cooling quantity is rapidly increased, input object to be stored 33 can rapidly be cooled while the temperature rise is suppressed in the refrigerator. When the temperature in the refrigerator reaches the neighborhood of setting temperature K_o , the cooling quantity can also be decreased in order to prevent the supercooling state. Therefore, the supercooling state can be prevented to achieve power saving.

[0072] In the case where the increase in storing quantity is smaller than the standard, the light quantity sensed by light quantity sensor 21 in FIG. 4 increases compared with the standard case. According to the degree of the increase in sensed light quantity, change information determination unit 25 in FIG. 3 determines that the increase in storing quantity in the refrigerator is smaller than the standard.

[0073] In this case, as illustrated in FIG. 5B, in the conventional cooling running (broken line), because object to be stored 33 reaches a setting temperature in a short time, sometimes the cooling running is performed while power is consumed beyond necessity. Additionally, sometimes the cooling quantity is increased by the door opening and closing signal or the like to generate the supercooling state.

[0074] Therefore, in order that the temperature in the refrigerator reaches the setting temperature within already-decided time, calculation controller 22 switches a refrigerant passage onto thin capillary 83b side (see FIG. 16) using change-over valve 84 (see FIG. 16), and the refrigerator is automatically switched to the energy-saving running by suppressing a rotating speed of compressor 30 or decreasing a circulating quantity of cold air. This operation loosens a temperature behavior in the refrigerator to obtain an energy-saving effect, and suppresses the rotating speed of cooling fan 31 to achieve the quiet refrigerator. In a refrigerating cycle of FIG. 16, the refrigerant passage is switched to one of thin capillary 83b and thick capillary 83a by change-over valve 84.

[0075] Storing quantity sensing control in which light emitter 20 and light quantity sensor 21 are used will be described below. FIG. 6 is a flowchart illustrating the storing quantity sensing control of refrigerator 50 according to the first exemplary embodiment of the present inven-

tion.

[0076] Referring to FIG. 6, in the case where the door opening and closing operation is sensed (Step S101) from normal main control (Step S100), calculation controller 22 checks whether the door is in the closed state (Step S102). When the door is in the closed state, calculation controller 22 starts the storing quantity sensing control (Step S103).

[0077] In the storing quantity sensing control (Step S103), the plurality of light emitters 20 are sequentially lit (Step S104), and light quantity sensor 21 senses the light quantity or illuminance every time light emitters 20 are lit, and outputs the light quantity or illuminance to calculation controller 22 (Step S105).

[0078] Storing quantity estimator 23 obtains the storage information on the compartment (Step S106). Comparative information determination unit 24 compares the storage information before and after the door opening and closing operation, before and after the door opening and closing operations of a plurality of times in the past, or before and after a constant time to each other, thereby obtaining the comparative information (Step S107).

[0079] Change information determination unit 25 obtains the change information on the storage situation based on the storage information obtained in Step S106 and the comparative information obtained in Step S107 (Step S108). The obtained change information on the storage situation is stored in storage unit 64 (Step S109), and a database is constructed for a certain period.

[0080] Calculation controller 22 performs cooling running determination control based on the database (Step S110).

[0081] A specific example of the cooling running control based on the storing quantity sensing control will be described below with reference to FIGS. 7 to 9.

[0082] FIG. 7 is a flowchart illustrating the cooling running determination control in which the storing quantity sensing control is used in refrigerator 50 according to the first exemplary embodiment of the present invention. In the example of FIG. 7, the quantity of object to be stored 33 is relatively evaluated.

[0083] Referring to FIG. 7, when the door opening and closing operation is sensed (Step S111) during the main control (Step S110), the storing quantity sensing control is started (Step S112).

[0084] Specifically, as illustrated in Steps S104 to S109 of FIG. 6, the change information on the storage situation is obtained based on the storage information and the comparative information.

[0085] Calculation controller 22 determines a threshold to storage change quantity data A obtained from the change information (Step S113). When storage change quantity data A is determined to be greater than previously-set reference storage change quantity B (YES in Step S114), running start determination unit 65 performs the rapid cooling running (Step S116). In the rapid cooling running, for example, as illustrated in FIG. 16, a refrigerant passage is switched from the side of thin capillary

83b to the side of thick capillary 83a, or the rotating speed of compressor 30 is enhanced, whereby a refrigerant circulating quantity is increased to increase the cooling quantity. An operation to enhance rotating speed of cooling fan 31 to increase an air volume, or an operation to increase an opening degree of the refrigerating compartment damper (not illustrated) is also performed.

[0086] On the other hand, when storage change quantity data A is determined to be less than or equal to previously-set reference storage change quantity B (NO in Step S114), calculation controller 22 determines whether storage change quantity data A is less than previously-set reference storage change quantity C ($C < B$). When storage change quantity data A is determined to be less than previously-set reference storage change quantity C (YES in Step S115), running start determination unit 65 performs the energy-saving running (Step S117). In the energy-saving running, for example, as illustrated in FIG. 16, the refrigerant passage is switched from the side of thick capillary 83a to the side of thin capillary 83b, or the rotating speed of compressor 30 is reduced, whereby the refrigerant circulating quantity is decreased to decrease the cooling quantity. An operation to reduce the rotating speed of cooling fan 31 to narrow down the air volume, or an operation to decrease the opening degree of the refrigerating compartment damper (not illustrated) is also performed. In other cases (NO in Step S115), normal running is continued (Step S118). As used herein, the normal running means control in which the cooling quantity is increased compared with the energy-saving running by one of the rotating speed of compressor 30, the rotating speed of cooling fan 31, and the switching of change-over valve 84. Damper 67 performs normal control (control by opening and closing temperatures or ON and OFF temperatures).

[0087] When the flow goes to Step S117 or S118, the cooling running determination control shifts to temperature sensing control (Step S119). Reference storage change quantity B and reference storage change quantity C satisfy a relationship ($C < B$).

[0088] An absolute change quantity, a relative change quantity, a change rate, or a change pattern of a lighting reception quantity related to an illuminance attenuation at light quantity sensor 21 before and after the door opening and closing operation can be used as storage change quantity data A obtained from the change information on the storing quantity. In the case where the determination is made using the change pattern, for example, the storing quantity is classified into a plurality of stages such as "large, medium, and small", the determination that the storing quantity changes "small \rightarrow large" or "small \rightarrow medium" before and after the door opening and closing operation is made, and calculation controller 22 adjusts the cooling quantity according to the storing quantity change pattern.

[0089] In the above example, refrigerator 50 is partitioned by the heat insulating wall and the heat insulating door, and includes refrigerating compartment 12 that is

of the compartment in which object to be stored 33 is stored. Refrigerator 50 includes storing quantity estimator 23 that estimates the storing quantity in the compartment and storage unit 64 that stores an estimation result of storing quantity estimator 23. Refrigerator 50 also includes calculation controller 22. Calculation controller 22 calculates a storage change quantity based on the previous estimation result of the storing quantity stored in storage unit 64 and the estimation result of storing quantity estimator 23, and controls an electric functional component output operation. Calculation controller 22 compares a predetermined threshold to the storage change quantity, determines that the storing quantity changes when the storage change quantity is greater than the threshold, and controls the electric functional component output operation.

[0090] In the first exemplary embodiment, when the storage change quantity (relative value) is greater than the threshold, the determination that the storing quantity changes is made to perform the output control. Therefore, a running rate is increased in consideration of the energy saving (in other words, for the small change in storing quantity, energy-saving running state is maintained while the setting temperature rises), and the energy saving can be achieved during practical use. The use of the threshold can prevent chattering of the electric functional component output operation by the frequent on and off running or a tripping phenomenon of compressor 30. The predetermined threshold and the storage change quantity are compared to each other, and the determination that the storing quantity changes is made when the storage change quantity is greater than the threshold, so that a unique variation potentially owned by storing quantity estimator 23 can be absorbed to properly control the output side.

[0091] Calculation controller 22 may be configured not to change the electric functional component output operation when the storage change quantity is less than or equal to the threshold. In this configuration, when the storage change quantity is less than or equal to the threshold, the determination that the storing quantity does not change is made, and the storing quantity of storage unit 64 before the estimation result of storing quantity estimator 23 can be maintained to correspond properly to a small change (separated storage).

[0092] The electric functional component can include at least one of cooling fan 31, damper 67, and compressor 30 that change the cooling quantity in the compartment. Therefore, the energy saving can be achieved during practical use while the running rate is increased in consideration of the energy saving, a need for the cooling capacity due to the increase in storing quantity can quickly be caught in real time compared with in-refrigerator temperature rise sensing, and the temperature rise of the food can be suppressed by the quick increase in cooling capacity. Additionally, overshoot (overcool) can be suppressed to improve the energy saving during the decrease in load.

[0093] As to the specific increase in cooling capacity, the refrigerant passage is switched from the side of thin capillary 83b to the side of thick capillary 83a by change-over valve 84 in FIG. 16, the rotating speed of compressor 30 is increased, the rotating speed of cooling fan 31 is increased, or the opening degree of damper 67 in the duct is increased.

[0094] In the case where the storing quantity increases, a condensing capacity of the refrigerating cycle needs to be enhanced according to the increase in cooling capacity, and desirably the rotating speed of a condenser fan is also increased.

[0095] In the case where the storing quantity increases, because the temperature in the refrigerator rises temporarily, a heat generation quantity of a sweating prevention heater included in the front opening of the refrigerator may be decreased according to the increase in storing quantity. In this case, the energy saving can further be achieved.

[0096] FIG. 8 is a flowchart illustrating another example of the cooling running determination control in which the storing quantity sensing control is used in refrigerator 50 of the first exemplary embodiment.

[0097] In the example of FIG. 8, the storing quantity of object to be stored 33 is absolutely evaluated.

[0098] Referring to FIG. 8, when the door opening and closing operation is sensed (Step S121) during the main control (Step S120), the storing quantity sensing control is started (Step S122). In the storing quantity sensing control, the storage information is obtained by storing quantity estimator 23. In this example, the comparative information and the change information are not calculated. Therefore, in the example of FIG. 8, comparative information determination unit 24 and change information determination unit 25 are not necessarily provided.

[0099] Calculation controller 22 determines the threshold to storing quantity data G obtained from the storage information (Step S123). When storing quantity data G is determined to be greater than previously-set reference storing quantity H (YES in Step S124), running start determination unit 65 performs the rapid cooling running (Step S126).

[0100] On the other hand, when storing quantity data G is determined to be less than or equal to previously-set reference storing quantity H (NO in Step S124), and when storing quantity data G is determined to be less than previously-set reference storing quantity I (YES in Step S125), running start determination unit 65 performs the energy-saving running (Step S127). In other cases (NO in Step S125), the normal running is continued (Step S128). When the flow goes to Step S127 or S128, the cooling running determination control shifts to the temperature sensing control (Step S129). It is assumed that reference storing quantity H and reference storing quantity I satisfy a relationship of $I < H$.

[0101] FIG. 9 is a flowchart illustrating still another example of the cooling running determination control in which the storing quantity sensing control is used in re-

frigerator 50 of the first exemplary embodiment.

[0102] FIG. 9 also illustrates an example in which the storing quantity of object to be stored 33 is absolutely evaluated.

[0103] Referring to FIG. 9, when the door opening and closing operation is sensed (Step S131) during the main control (Step S130), reference storing quantity data J is stored in storage unit 64 (Step S132).

[0104] At this point, it is assumed that storing quantity data during a certain period (for example, three weeks) is stored in storage unit 64. The storing quantity data is calculated to obtain reference storing quantity data J.

[0105] Then the storing quantity sensing control is started (Step S133) to determine the storage information. The threshold is determined to storing quantity data K obtained from the storage information (Step S134). When storing quantity data K is greater than a value in which reference storing quantity data J is multiplied by coefficient p (for example, 1.15) (YES in Step S135), running start determination unit 65 performs the rapid cooling running (Step S137). On the other hand, when storing quantity data K is less than or equal to the value in which reference storing quantity data J is multiplied by coefficient p (NO in Step S135), and when storage change quantity data K is less than a value in which reference storing quantity data J is multiplied by a coefficient q (for example, 1.05) (YES in Step S136), running start determination unit 65 performs the energy-saving running (Step S138). In other cases (NO in Step S135), the normal running is continued (Step S139). When the flow goes to Step S138 or S139, the cooling running determination control shifts to temperature sensing control (Step S140).

[0106] At this point, the coefficient p and the coefficient q satisfy a relationship of $q < p$.

[0107] In the above example, refrigerator 50 includes the compartment that is partitioned by the heat insulating wall and the heat insulating door to store the object to be stored and storing quantity estimator 23 that estimates the storing quantity in the compartment based on a previously-held reference value. Refrigerator 50 also includes calculation controller 22. Calculation controller 22 calculates the storing quantity in the compartment based on the estimation result of storing quantity estimator 23, and controls the electric functional component output operation. Calculation controller 22 controls the electric functional component output operation based on the predetermined threshold and the storing quantity.

[0108] Therefore, only a portion suitable to the estimation of the storing quantity can be used in the calculation, and the output operation can be adjusted. Because the absolute quantity can be output, it is not necessary to consider a variation generated in time series or by relative comparison.

[0109] A plurality of thresholds are provided, the storing quantity in the compartment is divided into a plurality of groups based on the plurality of thresholds, and the electric functional component output operation may be

controlled.

[0110] Therefore, based on the plurality of thresholds, the storing quantity in the compartment can be output while divided into the plurality of groups; therefore, the control can be simplified, and user-friendliness such as a display function can be improved.

[0111] The temperature sensing control in Steps S119, S129, and S140 of FIGS. 7 to 9 will be described below.

[0112] FIG. 10 is a flowchart illustrating the cooling running determination control after the temperature sensing control in refrigerator 50 of the first exemplary embodiment.

[0113] Referring to FIG. 10, when the temperature sensing control is started (Step S141), whether a predetermined time elapses is checked (Step S142). When the predetermined time does not elapse (NO in Step S142), the flow waits until the predetermined time elapses.

[0114] When the predetermined time elapses (YES in Step S142), temperature sensor 61 (see FIG. 3) senses the temperature in the refrigerator (Steps S143 and S144). Temperature information determination unit 70 determines the temperature information (Step S145), the determined information is stored in storage unit 64, and a database during a certain period is constructed (Step S146).

[0115] Then, the threshold is determined to temperature information data D obtained from the temperature information (Step S147). When temperature information data D is higher than previously-set reference temperature E (YES in Step S148), running start determination unit 65 performs the rapid cooling running (Step S150). On the other hand, when temperature information data D is lower than or equal to previously-set reference temperature E (NO in Step S148), and when temperature information data D is lower than previously set reference temperature F (YES in Step S149), running start determination unit 65 performs the energy-saving running (Step S151). In other cases (NO in Step S149), the normal running is continued (Step S152). It is assumed that reference temperature E and reference temperature F satisfy a relationship of $E > F$.

[0116] Through the above operation, the automatic rapid cooling running and the automatic energy-saving cooling running can be performed according to the change in food storing quantity at the purchase and the use situation of the refrigerator.

[0117] The cooling running determination by the determination result of the change in storing quantity and the temperature change will be described below.

[0118] FIGS. 11A and 11B are views illustrating the relationship between the storing quantity change and the temperature change and the cooling running determination in refrigerator 50 of the first exemplary embodiment.

[0119] In FIGS. 11A and 11B, the period between reference storage change quantity B and reference storage change quantity C in FIG. 7 and the period between reference temperature E and reference temperature F in FIG. 10 are not illustrated because the normal running

is performed in the period between reference storage change quantity B and reference storage change quantity C and the period between reference temperature E and reference temperature F.

[0120] As illustrated in FIG. 11A, the change in storing quantity is sensed and determined before and after the door opening and closing operation, and the rapid cooling running is performed, for example, in the case where obtained storage change quantity data A is greater than previously set reference storage change quantity B.

[0121] On the other hand, in the case where obtained storage change quantity data A is less than previously-set reference storage change quantity B and previously-set reference storage change quantity C, basically the energy-saving running is performed.

[0122] As illustrated in FIG. 11A, the temperature information obtained by temperature sensor 61 is sensed and determined, and the rapid cooling running is performed, for example, in the case where obtained temperature information data D is higher than previously-set reference temperature E. On the other hand, the energy-saving running is performed in the case where obtained temperature information data D is lower than previously-set reference temperature E and previously-set reference temperature F.

[0123] Reference storage change quantity B and reference storage change quantity C in FIG. 7 and reference temperature E and reference temperature F in FIG. 10 may be set depending on the ambient temperature or the storing quantity. For example, for the low ambient temperature, the temperature in the refrigerator hardly rises even if the door opening and closing operation or the food input is performed. In order to easily enter the energy-saving running, reference temperature E or reference temperature F is set higher, and reference storage change quantity B or reference storage change quantity C is set larger, which allows the energy saving to be achieved. On the other hand, for the high ambient temperature, the temperature in the refrigerator rises by the door opening and closing operation or the food input. In order to easily enter the rapid cooling running, reference temperature E or reference temperature F is set lower, and reference storage change quantity B or reference storage change quantity C is set smaller, which allows the freshness of the food to be maintained.

[0124] For the large storing quantity in refrigerator 50, the temperature in the refrigerator hardly rises because of a cold accumulation effect of the food even if the door opening and closing operation or the food input is performed. In order to easily enter the energy-saving running, reference temperature E or reference temperature F is set higher, and reference storage change quantity B or reference storage change quantity C is set larger, which allows the energy saving to be achieved. On the other hand, for the small storing quantity in refrigerator 50, the temperature in the refrigerator rises by the door opening and closing operation or the food input. In order to easily enter the rapid cooling running, reference tem-

perature E or reference temperature F is set lower, and reference storage change quantity B or reference storage change quantity C is set smaller, which allows the freshness of the food to be maintained.

[0125] As illustrated in FIG. 11B, the settings of reference temperatures E and F in FIG. 7 may be changed according to the storage change quantity, and the settings of reference storage change quantities B and C in FIG. 10 may be changed according to the temperature rise in the refrigerator.

[0126] For example, the rapid cooling running is performed in the case where the storing quantity increases largely because of the bulk purchase, or in the case where the heated cooking food, which largely influences the temperature in refrigerator 50 although the storing quantity does not largely increase, is preserved in refrigerator 50. The rapid cooling running is also performed in the case where the temperature in refrigerator 50 changes gradually although the storing quantity does not largely increase before and after the one-time door opening and closing operation such that the food is stored in refrigerator 50 while separated, or in the case where the temperature in refrigerator 50 changes largely by opening the door of refrigerator 50 in half or full for a long time. Therefore, object to be stored 33 is cooled to the optimum storage temperature in a short time, so that the freshness of object to be stored 33 can highly be achieved.

[0127] On the other hand, for example, in the case where only the object to be stored in refrigerator 50 is checked, or in the case where the change in storing quantity and the temperature change in the refrigerator are small such that drink is taken out or returned, the "over-cool" is prevented by performing the energy-saving running, and the optimum cooling running can be implemented according to a life pattern of each home.

[0128] In the above example, refrigerator 50 includes the compartment that is partitioned by the heat insulating wall and the heat insulating door to store the object to be stored, temperature sensor 61 that is of the temperature sensing unit sensing the temperature in the compartment, and storing quantity estimator 23 that estimates the storing quantity in the compartment. Refrigerator 50 also includes storage unit 64 that stores the estimation result of storing quantity estimator 23, a cooling unit that cools the inside of the compartment, and calculation controller 22 that performs the calculation based on the input data of temperature sensor 61, storing quantity estimator 23, and storage unit 64 to control the cooling unit. Calculation controller 22 controls a cooling unit output operation based on the temperature of temperature sensor 61 during the normal running, and controls the cooling unit in preference to the temperature change when it is determined that the storing quantity changes in the compartment.

[0129] Therefore, compared with the case that the change in storing quantity is sensed by a thermistor, the change in storing quantity can quickly be sensed in real time, and the temperature rise of the food can be sup-

pressed by the quick cooling capacity control. Additionally, the overshoot (overcool) can be suppressed to improve the energy saving during the decrease in load.

[0130] The rapid cooling running and the energy-saving running will be described in detail with reference to FIGS. 12 to 14.

[0131] FIG. 12 is a view schematically illustrating a temperature behavior of temperature sensor 61 when the object to be stored is input while the refrigerating compartment and the freezing compartment are simultaneously cooled in refrigerator 50 of the first exemplary embodiment. FIG. 13 is a view schematically illustrating the temperature behavior of temperature sensor 61 when the object to be stored is input while the freezing compartment is singularly cooled in refrigerator 50 of the first exemplary embodiment. FIG. 14 is a view schematically illustrating the temperature behavior of temperature sensor 61 when the object to be stored is input while the cooling of refrigerator 50 of the first exemplary embodiment is stopped.

[0132] There are two rapid cooling running methods. One is a method for increasing the air volume to the refrigerating compartment, and the other is a method for decreasing an ejection air temperature of the refrigerating compartment. The rotating speed of cooling fan 31 in FIG. 3 can be cited as a specific example of the former. Alternatively, the opening degree of damper 67 of refrigerating compartment 12 is increased to increase the air volume of refrigerating compartment 12, and the rapid cooling running is performed. Therefore, the rotating speed of cooling fan 31 is optimized according to the storage situation of each home, so that consumed power can be suppressed. On the other hand, as to the specific method of the latter, the refrigerant passage is switched from the side of thin capillary 83b to the side of thick capillary 83a. Alternatively, the rotating speed of compressor 30 is increased to increase the refrigerant circulating quantity, the ejection air temperature of the refrigerating compartment is lowered, and the rapid cooling running is performed.

[0133] In the energy-saving running, as illustrated in FIG. 16, the refrigerant passage is switched from the side of thick capillary 83a to the side of thin capillary 83b, or the rotating speed of compressor 30 is decreased, whereby the refrigerant circulating quantity is decreased to raise the ejection air temperature into the refrigerator. Therefore, the rotating speed of compressor 30 is optimized according to the storage situation of each home, so that the consumed power can be suppressed.

[0134] As illustrated in FIG. 12, in the case where the object to be stored is input during refrigerating compartment freezing compartment simultaneous cooling (a), a time difference is generated in the conventional refrigerator (broken line) until temperature sensor 61 senses the temperature rise since the object to be stored is input. Because the rotating speed of compressor 30 is gradually enhanced after the temperature rise is sensed, it takes a time to cool the input object to be stored to a target

temperature.

[0135] In the conventional refrigerator, return air (warm air) of refrigerating compartment 12 returns to the cooler to raise the temperature of the cooler, and the ejection air temperature thermally exchanged by the cooler rises to raise the temperature in freezing compartment 15, which results in a problem in that the freshness of the object to be stored degrades.

[0136] In refrigerator 50 of the first exemplary embodiment, the change in storing quantity is calculated before and after the door opening and closing operation, a cooling pattern identification unit of calculation controller 22 identifies that the cooling pattern at that time is refrigerating compartment freezing compartment simultaneous cooling (a) when the increase in storing quantity is greater than the predetermined threshold, and then the refrigerant passage is switched from the side of thin capillary 83b to the side of thick capillary 83a to increase the rotating speed of compressor 30. Therefore, the refrigerant circulating quantity increases to increase the cooling capacity, and the ejection air temperature of the refrigerating compartment 12 is lowered immediately after object to be stored 33 is input, so that input object to be stored 33 can be cooled to the optimum storage temperature in a short time compared with the conventional refrigerator.

[0137] Because damper 67 of freezing compartment 15 performs the operation of "opened → closed" at the time point when the increase in storing quantity is sensed, the warm air caused by the input of the object to be stored can be prevented from flowing in freezing compartment 15 from refrigerating compartment 12, and refrigerating compartment 12 in which the storing quantity increases can intensively be cooled. Damper 67 of freezing compartment 15 performs the operation of "closed → opened" after a constant time elapses, at the time point when the temperature sensed by temperature sensor 61 of refrigerating compartment 12 becomes a predetermined temperature or less, or at the time point when the temperature sensed by the temperature sensor 61 of freezing compartment 15 becomes a predetermined temperature or more.

[0138] As illustrated in FIG. 13, in the case where object to be stored 33 is input during freezing compartment single cooling (b), the time difference is generated in the conventional refrigerator until temperature sensor 61 senses the temperature rise since the object to be stored is input. Sometimes the temperature sensed by temperature sensor 61 of freezing compartment 15 reaches an OFF temperature of a predetermined value to stop compressor 30 until temperature sensor 61 of refrigerating compartment 12 senses the temperature rise. Then, damper 67 of refrigerating compartment 12 performs the operation of "closed → opened" at the time point when the temperature sensed by temperature sensor 61 of refrigerating compartment 12 reaches the opened temperature. Therefore, it takes a time to cool input object to be stored 33 to the target temperature because compressor 30 or cooling fan 31 is driven to cool input object to be

stored 33.

[0139] On the other hand, in refrigerator 50 of the first exemplary embodiment, the change in storing quantity is calculated before and after the door opening and closing operation, and the cooling pattern identification unit of calculation controller 22 identifies that the cooling pattern at that time is freezing compartment single cooling (b) when the increase in storing quantity is greater than the predetermined threshold. Then, the refrigerant passage is immediately switched from the side of thin capillary 83b to the side of thick capillary 83a, and the control is performed such that damper 67 of refrigerating compartment 12 performs the operation of "closed → opened", thereby increasing the rotating speed of compressor 30. Because the ejection air flows in refrigerating compartment 12, input object to be stored 33 can be cooled to the optimum storage temperature in a short time compared with conventional refrigerator 60.

[0140] Damper 67 of freezing compartment 15 performs the operation of "opened → closed" at the time point when the increase in storing quantity is sensed, so that the warm air caused by the input of object to be stored 33 can be prevented from flowing in freezing compartment 15 from refrigerating compartment 12. Damper 67 of freezing compartment 15 performs the operation of "closed → opened" after the constant time elapses, at the time point when the temperature sensed by temperature sensor 61 of refrigerating compartment 12 becomes the predetermined temperature or less, or at the time point when the temperature sensed by temperature sensor 61 of freezing compartment 15 becomes a predetermined temperature or more.

[0141] As illustrated in FIG. 14, in the case where object to be stored 33 is input during cooling stopping (c), compressor 30 is not driven in the conventional refrigerator until the temperature sensed by temperature sensor 61 of freezing compartment 15 reaches the ON temperature. Then, the control is performed such that damper 67 of refrigerating compartment 12 performs the operation of "closed → opened" at the time point when the temperature sensed by temperature sensor 61 of refrigerating compartment 12 reaches the opened temperature, and compressor 30 or cooling fan 31 is driven to cool the input object to be stored. Therefore, it takes a time to cool input object to be stored 33 to the target temperature.

[0142] On the other hand, in refrigerator 50 of the first exemplary embodiment, the change in storing quantity is calculated before and after the door opening and closing operation, the cooling pattern identification unit of calculation controller 22 identifies that the cooling pattern at that time is cooling stopping (c) when the increase in storing quantity is greater than the predetermined threshold, and then the refrigerant passage is switched from the side of thin capillary 83b to the side of thick capillary 83a irrespective of the temperature sensed by temperature sensor 61 when compressor 30 is stopped for a constant time (for example, 10 minutes), compressor 30 is

driven at a high rotating speed, and damper 67 of refrigerating compartment 12 performs the operation of "closed → opened". Because refrigerating compartment 12 can quickly be cooled while a starting property of compressor 30 is ensured, input object to be stored 33 can be cooled to the optimum storage temperature in a short time compared with conventional refrigerator.

[0143] During the stopping of compressor 30, sometimes damper 67 of refrigerating compartment 12 is set to "opened", damper 67 of freezing compartment 15 is set to "closed", and the cooling is performed using the frost adhering to cooler 85. At this point, at the time point when the increase in storing quantity is sensed, damper 67 of freezing compartment 15 is maintained at "closed", compressor 30 is started while the starting property is ensured, and the single running of refrigerating compartment 12 is performed, so that input object to be stored 33 can be cooled to the optimum storage temperature in a short time compared with the conventional refrigerator. However, damper 67 of freezing compartment 15 performs the operation of "closed → opened" at the time point when the temperature sensed by temperature sensor 61 of freezing compartment 15 becomes a predetermined temperature or more.

[0144] In refrigerator 50 of the first exemplary embodiment, in the case where the object to be stored is input to refrigerating compartment 12 during refrigerating compartment single cooling (d), the change in storing quantity is calculated before and after the door opening and closing operation. The cooling pattern identification unit of calculation controller 22 identifies that the cooling pattern at that time is refrigerating compartment single cooling (d) when the increase in storing quantity is greater than the predetermined threshold. Then, the refrigerant passage is immediately switched from the side of thin capillary 83b to the side of thick capillary 83a to increase the rotating speed of compressor 30. Therefore, the refrigerant circulating quantity increases to increase the cooling capacity, and the ejection air temperature of the refrigerating compartment 12 is lowered immediately after object to be stored 33 is input, so that the input object to be stored can be cooled to the optimum storage temperature in a short time compared with the conventional refrigerator. Because damper 67 of freezing compartment 15 is maintained in the "closed" state even after the rotating speed of compressor 30 increases, the warm air caused by the input of the object to be stored from refrigerating compartment 12 can be prevented from flowing in freezing compartment 15 from refrigerating compartment 12, and refrigerating compartment 12 in which the storing quantity increases can intensively be cooled.

[0145] FIG. 15 is a control flowchart illustrating the rapid cooling and energy-saving running in the refrigerator of the first exemplary embodiment. The increase in storing quantity of refrigerating compartment 12 is sensed (Step S161), and the rapid cooling running is started (Step S162). When the temperature sensed by temperature sensor 61 of refrigerating compartment 12 is lower

than a predetermined temperature (for example, opened temperature) (NO in Step S163), damper 67 of freezing compartment 15 performs the operation of "closed → opened" (Step S166). Alternatively, when the temperature sensed by temperature sensor 61 of freezing compartment 15 is higher than a predetermined temperature (for example, ON temperature) (NO in Step S164), damper 67 of freezing compartment 15 performs the operation of "closed → opened" (Step S166). At the time point at least a constant time elapses (for example, 30 minutes elapses since the rapid cooling running is started) (NO in Step S165), damper 67 of freezing compartment 15 performs the operation of "closed → opened" (Step S166). This is because the temperature at freezing compartment 15 is prevented from being raised beyond necessity by maintaining damper 67 of freezing compartment 15 in the "closed" state.

[0146] After damper 67 of freezing compartment 15 performs the operation of "closed → opened" (Step S166), the temperature sensed by temperature sensor 61 of freezing compartment 15 reaches the OFF temperature, and damper 67 of freezing compartment 15 performs the operation of "opened → closed". At this point an operation that is not illustrated in FIG. 15 may be performed. That is, when the temperature sensed by temperature sensor 61 of refrigerating compartment 12 is greater than or equal to the predetermined temperature (for example, opened temperature), the flow may return to Step S162 to intensively cool refrigerating compartment 12 again.

[0147] After damper 67 of freezing compartment 15 performs the operation of "closed → opened" (Step S166), when the temperature sensed by temperature sensor 61 of refrigerating compartment 12 is lower than the predetermined temperature (for example, closed temperature) (NO in Step S167), the rapid cooling running is ended to start the normal running or automatic power saving cooling running (Step S170). When the temperature sensed by temperature sensor 61 of freezing compartment 15 is lower than the predetermined temperature (for example, OFF temperature) (NO in Step S168), the rapid cooling running is ended to start the normal running or the automatic power saving cooling running (Step S170). When the constant time elapses (for example, 60 minutes) (NO in Step S169), the rapid cooling running is ended to start the normal running or the automatic power saving cooling running (Step S170).

[0148] FIG. 16 is a schematic diagram illustrating a refrigerant circuit of the refrigerator of the first exemplary embodiment. The cooling cycle in FIG. 16 includes compressor 30 that compresses the refrigerant, condenser 81 that condenses a high-temperature, high-pressure refrigerant gas, capillary 83 (thick capillary 83a and thin capillary 83b are disposed in parallel) that is of refrigerant quantity adjuster 82, change-over valve 84, and cooler 85.

[0149] Specifically, the refrigerant gas ejected from compressor 30 is condensed by condenser 81, change-

over valve 84 is switched to thick capillary 83a or thin capillary 83b according to the ambient temperature or the load quantity in the refrigerator air, thereby adjusting a quantity of refrigerant flowing in cooler 85.

[0150] In the case where the object to be stored is input to refrigerating compartment 12, the time difference is generated in the conventional refrigerator until temperature sensor 61 senses the temperature rise since the object to be stored is input. Because refrigerant quantity adjuster 82 increases the refrigerant circulating quantity after the temperature rise is sensed, the refrigerant quantity is temporarily lacked in cooler 85, the cooling quantity is insufficiently obtained, and it takes a time to cool the input object to be stored to the target temperature.

[0151] In the refrigerator of the first exemplary embodiment, the storage change quantity is calculated before and after the door opening and closing operation, and a shift to the next operation is made at the time point when the increase in storing quantity is determined to be greater than reference storage change quantity B. Change-over valve 84 switches the refrigerant passage from the side of thin capillary 83b to the side of thick capillary 83a to increase the refrigerant circulating quantity in preference to the temperature sensing of temperature sensor 61, so that the optimum refrigerant quantity can be supplied to cooler 85.

[0152] In the cooling running, change-over valve 84 switches the refrigerant passage from the side of thick capillary 83a to the side of thin capillary 83b at the time point when the temperature sensed by temperature sensor 61 of refrigerating compartment 12 is lower than or equal to the predetermined temperature (for example, closed temperature). Change-over valve 84 switches the refrigerant passage from the side of thick capillary 83a to the side of thin capillary 83b at the time point when the temperature sensed by temperature sensor 61 of freezing compartment 15 is lower than or equal to the predetermined temperature (for example, OFF temperature). Change-over valve 84 switches the refrigerant passage from the side of thick capillary 83a to the side of thin capillary 83b at the time point when the constant time elapses (for example, 60 minutes).

[0153] The description is made based on the specific examples, and the cooling control based on the cooling pattern in sensing the increase in the object to be stored of refrigerating compartment 12 is summarized as follows.

[0154] For refrigerating compartment freezing compartment simultaneous cooling (a), other compartment dampers except the refrigerating compartment are closed to intensively cool the refrigerating compartment, and the warm air is prevented from flowing in other compartments from the object to be stored, which is stored in the refrigerating compartment, through the cooling compartment. Then, change-over valve 84 switches the refrigerant passage from the side of thin capillary 83b to the side of thick capillary 83a, and the rotating speeds of compressor 30 and the cooling fan are enhanced. The

shift to the normal running or energy-saving running is made after the temperature in the refrigerator is lowered to a predetermined temperature (for example, closed temperature of refrigerating compartment) or after the predetermined time (for example, 30 minutes elapse since the rapid cooling is started).

[0155] For freezing compartment single cooling (b), other compartment dampers except the refrigerating compartment are closed, the refrigerating compartment damper is opened to intensively cool the refrigerating compartment, and the warm air is prevented from flowing in other compartments from the object to be stored, which is stored in the refrigerating compartment, through the cooling compartment. Then, change-over valve 84 switches the refrigerant passage from the side of thin capillary 83b to the side of thick capillary 83a, and the rotating speeds of compressor 30 and the cooling fan are enhanced. The shift to the normal running or energy-saving running is made after the temperature in the refrigerator is lowered to a predetermined temperature (for example, closed temperature of refrigerating compartment) or after the predetermined time (for example, 30 minutes elapse since the rapid cooling is started).

[0156] For cooling stopping (c), when OFF time of compressor 30 is longer than a predetermined period (time for protecting the compressor), irrespective of the refrigerating compartment and freezing compartment temperatures, other compartment dampers are closed, and the refrigerating compartment damper is opened to start the running of the compressor. Therefore, the refrigerating compartment is intensively cooled, and the warm air is prevented from flowing in other compartments from the object to be stored, which is stored in the refrigerating compartment, through the cooling compartment. Then, change-over valve 84 switches the refrigerant passage from the side of thin capillary 83b to the side of thick capillary 83a, and the rotating speeds of compressor 30 and the cooling fan are enhanced.

[0157] For refrigerating compartment single cooling (d), the control is performed similar to refrigerating compartment freezing compartment simultaneous cooling (a).

[0158] When the increase in the object to be stored of refrigerating compartment 12 is sensed, the finely efficient refrigerator can be made by performing the cooling control in consideration of the load situations of other compartments sensed by the load sensing unit (temperature sensor) in addition to the cooling pattern.

[0159] Specifically, in the case where the cooling pattern of the compartment is refrigerating compartment freezing compartment simultaneous cooling (a), change-over valve 84 switches the refrigerant passage from the side of thin capillary 83b to the side of thick capillary 83a in preference to the temperature control of the refrigerating compartment temperature sensing unit when the increase in the object to be stored of refrigerating compartment 12 is sensed. Additionally, the rotating speeds of compressor 30 and the cooling fan are enhanced.

[0160] At this point, in the case where the sensing result of the freezing compartment load sensing unit is less than or equal to the predetermined threshold, only the refrigerating compartment damper is opened, and the refrigerating compartment is intensively cooled. In the case where the sensing result of the freezing compartment load sensing unit is greater than the predetermined threshold, the compartment dampers except the refrigerating compartment and freezing compartment are closed, and the refrigerating compartment and the freezing compartment are intensively cooled. In the case where the freezing compartment temperature is higher than or equal to the predetermined temperature (for example, ON temperature + 3°C: an overload state is assumed), only the freezing compartment is intensively cooled to preferentially prevent ice melting.

[0161] Then, each of the dampers is controlled in a similar manner when the freezing compartment temperature becomes the above state during the rapid cooling control to be performed in consideration of the increase in storing quantity of the refrigerating compartment and the load on the freezing compartment. In the case where the freezing compartment is cooled to the predetermined temperature to relatively decrease the load on the freezing compartment, the control may be performed similarly to the refrigerating compartment freezing compartment simultaneous cooling (a) in which the load situation is not considered. The shift to the normal running or energy-saving running is made after the temperature in the refrigerator is lowered to a predetermined temperature (for example, closed temperature of refrigerating compartment) or after the predetermined time (for example, 30 minutes elapse since the rapid cooling is started).

[0162] In the case where the cooling pattern of the compartment is freezing compartment single cooling (b), basically similarly to refrigerating compartment freezing compartment simultaneous cooling (a), change-over valve 84 switches the refrigerant passage from the side of thin capillary 83b to the side of thick capillary 83a in preference to the temperature control of the refrigerating compartment temperature sensing unit when the increase in the object to be stored of refrigerating compartment 12 is sensed. Additionally, the rotating speeds of compressor 30 and the cooling fan are enhanced.

[0163] At this point, in the case where the sensing result of the freezing compartment load sensing unit is less than or equal to the predetermined threshold, only the refrigerating compartment damper is opened, and the refrigerating compartment is intensively cooled. In the case where the sensing result of the freezing compartment load sensing unit is greater than the predetermined threshold, the compartment dampers except the refrigerating compartment and freezing compartment are closed, and the refrigerating compartment and the freezing compartment are intensively cooled. In the case where the freezing compartment temperature is higher than or equal to the predetermined temperature (for ex-

ample, ON temperature + 3°C: an overload state is assumed), only the freezing compartment is intensively cooled to preferentially prevent ice melting.

[0164] Then, each of the dampers is controlled in a similar manner when the freezing compartment temperature becomes the above state during the rapid cooling running, which allows the optimum cooling running control to be performed in consideration of the increase in storing quantity of the refrigerating compartment and the load on the freezing compartment.

[0165] In the case where the freezing compartment is cooled to the predetermined temperature to relatively decrease the load on the freezing compartment, the control may be performed similarly to refrigerating compartment freezing compartment simultaneous cooling (a) in which the load situation is not considered. The shift to the normal running or energy-saving running is made after the temperature in the refrigerator is lowered to a predetermined temperature (for example, closed temperature of refrigerating compartment) or after the predetermined time (for example, 30 minutes elapse since the rapid cooling is started).

[0166] In the case where the cooling pattern of the compartment is cooling stopping (c), the shift to the next operation is made when the increase in the object to be stored of refrigerating compartment 12 is sensed. When the OFF time of compressor 30 is longer than the predetermined period (time for protecting the compressor), in preference to the temperature control of the refrigerating compartment temperature sensing unit, the refrigerating compartment damper is opened to start the running of the compressor, and the refrigerating compartment is intensively cooled. Then, change-over valve 84 switches the refrigerant passage from the side of thin capillary 83b to the side of thick capillary 83a, and the rotating speeds of compressor 30 and the cooling fan are enhanced.

[0167] In the case where the sensing result of the freezing compartment load sensing unit is greater than the predetermined threshold during the rapid cooling running, the compartment dampers except the refrigerating compartment and freezing compartment are closed, and the refrigerating compartment and the freezing compartment are intensively cooled. In the case where the freezing compartment temperature is higher than or equal to the predetermined temperature (for example, ON temperature + 3°C: an overload state is assumed), only the freezing compartment is intensively cooled to preferentially prevent ice melting.

[0168] Therefore, the optimum cooling running control can be performed in consideration of the increase in storing quantity of the refrigerating compartment and the load on the freezing compartment. In the case where the freezing compartment is cooled to the predetermined temperature to relatively decrease the load on the freezing compartment, the control may be performed similarly to cooling stopping (c) in which the load situation is not considered. The shift to the normal running or energy-saving running is made after the temperature in the refrigerator

is lowered to a predetermined temperature (for example, closed temperature of refrigerating compartment) or after the predetermined time (for example, 30 minutes elapse since the rapid cooling is started).

[0169] In the case where the cooling pattern of the compartment is refrigerating compartment single cooling (d), the shift to the next operation is made when the increase in the object to be stored of refrigerating compartment 12 is sensed. That is, in preference to the temperature control of the refrigerating compartment temperature sensing unit, the compartment dampers except the refrigerating compartment are closed to intensively cool the refrigerating compartment, and the rotating speeds of compressor 30 and the cooling fan are enhanced while change-over valve 84 switches the refrigerant passage from the side of thin capillary 83b to the side of thick capillary 83a.

[0170] In the case where the sensing result of the freezing compartment load sensing unit is greater than the predetermined threshold during the rapid cooling running, the compartment dampers except the refrigerating compartment and freezing compartment are closed, and the refrigerating compartment and the freezing compartment are intensively cooled. In the case where the freezing compartment temperature is higher than or equal to the predetermined temperature (for example, ON temperature + 3°C: an overload state is assumed), only the freezing compartment is intensively cooled to preferentially prevent ice melting.

[0171] Therefore, the optimum cooling running control can be performed in consideration of the increase in storing quantity of the refrigerating compartment and the load on the freezing compartment. In the case where the freezing compartment is cooled to the predetermined temperature to relatively decrease the load on the freezing compartment, the control may be performed similarly to refrigerating compartment single cooling (d) in which the load situation is not considered. The shift to the normal running or energy-saving running is made after the temperature in the refrigerator is lowered to a predetermined temperature (for example, closed temperature of refrigerating compartment) or after the predetermined time (for example, 30 minutes elapse since the rapid cooling is started).

[0172] Although refrigerant quantity adjuster 82 of the first exemplary embodiment is constructed with different-diameter capillaries 83 disposed in parallel (thick capillary 83a and thin capillary 83b are disposed in parallel) and change-over valve 84, the refrigerant quantity may be adjusted by changing a decompression quantity using an expansion valve instead of the capillary.

(SECOND EXEMPLARY EMBODIMENT)

[0173] FIG. 17 is a view illustrating a refrigerant circuit of a refrigerator according to a second exemplary embodiment of the present invention. In the refrigerator of the second exemplary embodiment, it is assumed that a

portion except the configuration identical to that of the first exemplary embodiment and a portion in which a failure is generated even if the same technical thought is applied can be combined with the second exemplary embodiment, and the detailed description is not given.

[0174] Referring to FIG. 17, the high-temperature, high-pressure refrigerant compressed by compressor 30 is condensed by condenser 81, and switched by change-over valve 74 located on a downstream side of condenser 81. One route of change-over valve 74 communicates with sweating prevention radiation pipe 75 disposed at a peripheral edge of the front opening of the refrigerator, is decompressed by capillary 83, is evaporated by cooler 85, and returns to compressor 30. The other route of change-over valve 74 merges with the one route of change-over valve 74 on an upstream side of capillary 83 through bypass pipe 76.

[0175] That is, sweating prevention radiation pipe 75 disposed at the peripheral edge of the front opening can be switched to the refrigerant passage, the side of bypass pipe 76 is opened by change-over valve 74 during the normal running such that the refrigerant does not flow onto the side of radiation pipe 75, thereby reducing the heat generation load progressing into the refrigerator from the peripheral edge of the front opening of the refrigerator. In the case where the load increases to require the improvement of a condensing capacity, or in the case where the inside of the refrigerator becomes a high-humidity state to generate a sweating risk, characteristically the refrigerant flows from change-over valve 74 to radiation pipe 75.

[0176] In the above configuration, the cooling control based on the cooling pattern in sensing the increase in the object to be stored of refrigerating compartment 12 similarly to the first exemplary embodiment will be described below.

[0177] For refrigerating compartment freezing compartment simultaneous cooling (a), the rotating speeds of compressor 30 and the cooling fan are enhanced while change-over valve 74 switches the refrigerant passage to the side of radiation pipe 75, thereby improving a refrigeration capacity. The shift to the normal running or energy-saving running is made after the temperature in the refrigerator is lowered to a predetermined temperature (for example, closed temperature of refrigerating compartment) or after the predetermined time (for example, 30 minutes elapse since the rapid cooling is started). In the refrigerator including each compartment damper, other storing compartment dampers except the refrigerating compartment are closed to intensively cool the refrigerating compartment, and the warm air can be prevented from flowing in other compartments from the object to be stored, which is stored in the refrigerating compartment, through the cooling compartment.

[0178] For freezing compartment single cooling (b), the rotating speeds of compressor 30 and the cooling fan are enhanced while change-over valve 74 switches the refrigerant passage to the side of radiation pipe 75, thereby

improving the refrigeration capacity. The shift to the normal running or energy-saving running is made after the temperature in the refrigerator is lowered to a predetermined temperature (for example, closed temperature of refrigerating compartment) or after the predetermined time (for example, 30 minutes elapse since the rapid cooling is started). In the refrigerator including each compartment damper, other compartment dampers except the refrigerating compartment are closed, and the refrigerating compartment damper is opened to intensively cool the refrigerating compartment, and the warm air can be prevented from flowing in other compartments from the object to be stored, which is stored in the refrigerating compartment, through the cooling compartment.

[0179] For cooling stopping (c), when the OFF time of compressor 30 is longer than the predetermined period (time for protecting the compressor), the rotating speeds of compressor 30 and the cooling fan are enhanced while change-over valve 74 switches the refrigerant passage to the side of radiation pipe 75, thereby improving the refrigeration capacity. The shift to the normal running or energy-saving running is made after the temperature in the refrigerator is lowered to a predetermined temperature (for example, closed temperature of refrigerating compartment) or after the predetermined time (for example, 30 minutes elapse since the rapid cooling is started). In the refrigerator including each compartment damper, other compartment dampers except the refrigerating compartment are closed, and the refrigerating compartment damper is opened to intensively cool the refrigerating compartment, and the warm air can be prevented from flowing in other storing compartments from the object to be stored, which is stored in the refrigerating compartment, through the cooling compartment.

[0180] For refrigerating compartment single cooling (d), the control is performed similar to refrigerating compartment freezing compartment simultaneous cooling (a).

[0181] When the increase in the object to be stored of refrigerating compartment 12 is sensed, the finely efficient refrigerator can be made by performing the cooling control in consideration of the load situations of other compartments sensed by the load sensing unit (temperature sensor) in addition to the cooling pattern.

[0182] Specifically, in the case where the cooling pattern of the compartment is refrigerating compartment freezing compartment simultaneous cooling (a), when the increase in the object to be stored of refrigerating compartment 12 is sensed, in preference to the temperature control of the refrigerating compartment temperature sensing unit, the rotating speeds of compressor 30 and the cooling fan are enhanced while change-over valve 74 switches the refrigerant passage to the side of radiation pipe 75.

[0183] At this point, in the refrigerator including each compartment damper, only the refrigerating compartment damper is opened to intensively cool the refrigerating compartment in the case where the sensing result

of the freezing compartment load sensing unit is less than or equal to the predetermined threshold. In the case where the sensing result of the freezing compartment load sensing unit is greater than the predetermined threshold, the compartment dampers except the refrigerating compartment and freezing compartment are closed, and the refrigerating compartment and the freezing compartment are intensively cooled. In the case where the freezing compartment temperature is higher than or equal to the predetermined temperature (for example, ON temperature + 3°C: an overload state is assumed), only the freezing compartment is intensively cooled to preferentially prevent ice melting.

[0184] Then, each of the dampers is controlled in a similar manner when the freezing compartment temperature becomes the above state during the rapid cooling running, which allows the optimum cooling running control to be performed in consideration of the increase in storing quantity of the refrigerating compartment and the load on the freezing compartment.

[0185] In the case where the freezing compartment is cooled to the predetermined temperature to relatively decrease the load on the freezing compartment, the control may be performed similarly to refrigerating compartment freezing compartment simultaneous cooling (a) in which the load situation is not considered. The shift to the normal running or energy-saving running is made after the temperature in the refrigerator is lowered to a predetermined temperature (for example, closed temperature of refrigerating compartment) or after the predetermined time (for example, 30 minutes elapse since the rapid cooling is started).

[0186] In the case where the cooling pattern of the compartment is freezing compartment single cooling (b), basically similarly to refrigerating compartment freezing compartment simultaneous cooling (a), when the increase in the object to be stored of refrigerating compartment 12 is sensed, in preference to the temperature control of the refrigerating compartment temperature sensing unit, the rotating speeds of compressor 30 and the cooling fan are enhanced while change-over valve 74 switches the refrigerant passage to the side of radiation pipe 75.

[0187] At this point, in the refrigerator including each of the compartment dampers, only the refrigerating compartment damper is opened to intensively cool the refrigerating compartment in the case where the sensing result of the freezing compartment load sensing unit is less than or equal to the predetermined threshold. In the case where the sensing result of the freezing compartment load sensing unit is greater than the predetermined threshold, the compartment dampers except the refrigerating compartment and freezing compartment are closed, and the refrigerating compartment and the freezing compartment are intensively cooled. In the case where the freezing compartment temperature is higher than or equal to the predetermined temperature (for example, ON temperature + 3°C: an overload state is as-

sumed), only the freezing compartment is intensively cooled to preferentially prevent ice melting.

[0188] Then, each of the dampers is controlled in a similar manner when the freezing compartment temperature becomes the above state during the rapid cooling running, which allows the optimum cooling running control to be performed in consideration of the increase in storing quantity of the refrigerating compartment and the load on the freezing compartment. In the case where the freezing compartment is cooled to the predetermined temperature to relatively decrease the load on the freezing compartment, the control may be performed similarly to refrigerating compartment freezing compartment simultaneous cooling (a) in which the load situation is not considered. The shift to the normal running or energy-saving running is made after the temperature in the refrigerator is lowered to a predetermined temperature (for example, closed temperature of refrigerating compartment) or after the predetermined time (for example, 30 minutes elapse since the rapid cooling is started).

[0189] In the case where the cooling pattern of the compartment is cooling stopping (c), the shift to the next operation is made when the increase in the object to be stored of refrigerating compartment 12 is sensed. When the OFF time of compressor 30 is longer than the predetermined period (time for protecting the compressor), in preference to the temperature control of the refrigerating compartment temperature sensing unit, the refrigerating compartment damper is opened to start the running of the compressor, and the refrigerating compartment is intensively cooled. Then, the rotating speeds of compressor 30 and the cooling fan are enhanced while change-over valve 74 switches the refrigerant passage to the side of radiation pipe 75.

[0190] In the refrigerator including each compartment damper, in the case where the sensing result of the freezing compartment load sensing unit is greater than the predetermined threshold during the rapid cooling running, the storing chamber dampers except the refrigerating compartment and freezing compartment are closed, and the refrigerating compartment and the freezing compartment are intensively cooled. In the case where the freezing compartment temperature is higher than or equal to the predetermined temperature (for example, ON temperature + 3°C: an overload state is assumed), only the freezing compartment is intensively cooled to preferentially prevent ice melting.

[0191] Therefore, the optimum cooling running control can be performed in consideration of the increase in storing quantity of the refrigerating compartment and the load on the freezing compartment. In the case where the freezing compartment is cooled to the predetermined temperature to relatively decrease the load on the freezing compartment, the control may be performed similarly to cooling stopping (c) in which the load situation is not considered. The shift to the normal running or energy-saving running is made after the temperature in the refrigerator is lowered to a predetermined temperature (for example,

closed temperature of refrigerating compartment) or after the predetermined time (for example, 30 minutes elapse since the rapid cooling is started).

[0192] In the case where the cooling pattern of the compartment is refrigerating compartment single cooling (d), the shift to the next operation is made when the increase in the object to be stored of refrigerating compartment 12 is sensed. That is, in preference to the temperature control of the refrigerating compartment temperature sensing unit, the rotating speeds of compressor 30 and the cooling fan are enhanced while change-over valve 74 switches the refrigerant passage to the side of radiation pipe 75. In the refrigerator including each compartment damper, the compartment dampers except the refrigerating compartment are closed to intensively cool the refrigerating compartment.

[0193] In the case where the sensing result of the freezing compartment load sensing unit is greater than the predetermined threshold during the rapid cooling running, the compartment dampers except the refrigerating compartment and freezing compartment are closed, and the refrigerating compartment and the freezing compartment are intensively cooled. In the case where the freezing compartment temperature is higher than or equal to the predetermined temperature (for example, ON temperature + 3°C: an overload state is assumed), only the freezing compartment is intensively cooled to preferentially prevent ice melting.

[0194] Therefore, the optimum cooling running control can be performed in consideration of the increase in storing quantity of the refrigerating compartment and the load on the freezing compartment. In the case where the freezing compartment is cooled to the predetermined temperature to relatively decrease the load on the freezing compartment, the control may be performed similarly to refrigerating compartment single cooling (d) in which the load situation is not considered. The shift to the normal running or energy-saving running is made after the temperature in the refrigerator is lowered to a predetermined temperature (for example, closed temperature of refrigerating compartment) or after the predetermined time (for example, 30 minutes elapse since the rapid cooling is started).

[0195] Radiation pipe 75 of the second exemplary embodiment is disposed at the peripheral end of the front opening of the refrigerator to prevent the sweating, and bypass pipe 76 may be disposed so as to bypass a part of radiation pipe 75.

[0196] The rotating speed or running rate of the radiation fan disposed near condenser 81 may be controlled so as to be able to vary the radiation capacity of condenser 81 that is of a main part of the radiator.

[0197] The damper devices of the second exemplary embodiment are disposed in at least the compartment of the cooling temperature range and the compartment of the freezing temperature range. Specifically, the damper includes the refrigerating compartment damper (not illustrated), the temperature selecting compartment damper

(not illustrated), the freezing compartment damper (not illustrated), and the vegetable compartment damper (not illustrated), and each of the dampers independently controls the temperature based on the temperature sensor included in each compartment. Therefore, the temperature control can finely be performed in each of the compartments, the cold air can intensively be ejected to the compartment in which the cooling capacity is required, and the freshness of the stored food can be maintained.

[0198] Although the combination of the switching control of radiation pipe 75 and the control of the damper included in each of the compartments is described in the second exemplary embodiment, the refrigerator may include the damper corresponding to each of the compartments without the switching control of radiation pipe 75. In this case, the second exemplary embodiment can be described while the switching control of radiation pipe 75 is not given.

20 (THIRD EXEMPLARY EMBODIMENT)

[0199] FIG. 18 is a view illustrating a refrigerant circuit of a refrigerator according to a third exemplary embodiment of the present invention. In the refrigerator of the third exemplary embodiment, it is assumed that a portion except the configuration identical to that of the first and second exemplary embodiments and a portion in which a failure is generated even if the same technical thought is applied can be combined with the third exemplary embodiment, and the detailed description is not given.

[0200] Referring to FIG. 18, the high-temperature, high-pressure refrigerant compressed by compressor 30 is condensed by condenser 81, and switched by change-over valve 92 located on the downstream side of condenser 81. One route of change-over valve 92 is connected to freezing compartment cooler 94 through capillary 93a, and the other route of change-over valve 92 is connected to refrigerating compartment cooler 95 through capillary 93b.

[0201] That is, characteristically the refrigerant circuit includes freezing compartment cooler 94 and refrigerating compartment cooler 95, the refrigerant passage is switched as needed basis to enable the cooling suitable to the freezing temperature range and the cooling temperature range. Change-over valve 74 also includes a mode in which the refrigerant flows in both freezing compartment cooler 94 and refrigerating compartment cooler 95.

[0202] In the above configuration, the cooling control based on the cooling pattern in sensing the increase in the object to be stored of refrigerating compartment 12 similarly to the first exemplary embodiment will be described below.

[0203] For refrigerating compartment freezing compartment simultaneous cooling (a) (in the third exemplary embodiment, the state in which the refrigerant flows in both freezing compartment cooler 94 and refrigerating compartment cooler 95), the shift to the next operation

is made. The side of freezing compartment cooler 94 is closed using change-over valve 74, the side of refrigerating compartment cooler 95 is opened, and the rotating speeds of compressor 30 and the cooling fan are enhanced while the refrigerating compartment is intensively cooled. The shift to the normal running or energy-saving running is made after the temperature in the refrigerator is lowered to a predetermined temperature (for example, closed temperature of refrigerating compartment) or after the predetermined time (for example, 30 minutes elapse since the rapid cooling is started).

[0204] For freezing compartment single cooling (b) (in the third exemplary embodiment, the state in which the refrigerant flows only in freezing compartment cooler 94), the shift to the next operation is made. The side of freezing compartment cooler 94 is closed using change-over valve 74, the side of refrigerating compartment cooler 95 is opened, and the rotating speeds of compressor 30 and the cooling fan are enhanced while the refrigerating compartment is intensively cooled. The shift to the normal running or energy-saving running is made after the temperature in the refrigerator is lowered to a predetermined temperature (for example, closed temperature of refrigerating compartment) or after the predetermined time (for example, 30 minutes elapse since the rapid cooling is started).

[0205] For cooling stopping (c) (the state in which the refrigerant does not flow in both freezing compartment cooler 94 and refrigerating compartment cooler 95), the shift to the next operation is made. When the OFF time of compressor 30 is longer than the predetermined period (time for protecting the compressor), irrespective of the refrigerating compartment and freezing compartment temperatures, the side of freezing compartment cooler 94 is closed using change-over valve 74, and the side of refrigerating compartment cooler 95 is opened to start the running of the compressor. Therefore, the refrigerating compartment can intensively be cooled. Then the rotating speeds of compressor 30 and the cooling fan are enhanced.

[0206] For refrigerating compartment single cooling (d) (in the third exemplary embodiment, the state in which the refrigerant flows only in refrigerating compartment cooler 95), the state is maintained to perform the control similar to refrigerating compartment freezing compartment simultaneous cooling (a).

[0207] When the increase in the object to be stored of refrigerating compartment 12 is sensed, the finely efficient refrigerator can be made by performing the cooling control in consideration of the load situations of other compartments sensed by the load sensing unit (temperature sensor) in addition to the cooling pattern.

[0208] Specifically, in the case where the cooling pattern of the storing compartment is refrigerating compartment freezing compartment simultaneous cooling (a), the shift to the next operation is made when the increase in the object to be stored of refrigerating compartment 12 is sensed. In preference to the temperature control of the

refrigerating compartment temperature sensing unit, the side of freezing compartment cooler 94 is closed using change-over valve 74, the side of refrigerating compartment cooler 95 is opened, and the rotating speeds of compressor 30 and the cooling fan are enhanced.

[0209] At this point, in the case where the sensing result of the freezing compartment load sensing unit is less than or equal to the predetermined threshold, the state is maintained to intensively cool the refrigerating compartment. In the case where the sensing result of the freezing compartment load sensing unit is greater than the predetermined threshold, the refrigerant flows in both freezing compartment cooler 94 and refrigerating compartment cooler 95 using change-over valve 74, and the refrigerating compartment and the freezing compartment are intensively cooled. In the case where the freezing compartment temperature is higher than or equal to the predetermined temperature (for example, ON temperature + 3°C: the overload state is assumed), only the side of freezing compartment cooler 94 is opened using change-over valve 74, and the freezing compartment may intensively be cooled to preferentially prevent ice melting.

[0210] Then, change-over valve 74 is controlled in a similar manner when the freezing compartment temperature becomes the above state during the rapid cooling running, which allows the optimum cooling running control to be performed in consideration of the increase in storing quantity of the refrigerating compartment and the load on the freezing compartment.

[0211] In the case where the freezing compartment is cooled to the predetermined temperature to relatively decrease the load on the freezing compartment, the control may be performed similarly to refrigerating compartment freezing compartment simultaneous cooling (a) in which the load situation is not considered. The shift to the normal running or energy-saving running is made after the temperature in the refrigerator is lowered to a predetermined temperature (for example, closed temperature of refrigerating compartment) or after the predetermined time (for example, 30 minutes elapse since the rapid cooling is started).

[0212] In the case where the cooling pattern of the compartment is freezing compartment single cooling (b), basically similarly to refrigerating compartment freezing compartment simultaneous cooling (a), the shift to the next operation is made when the increase in the object to be stored of refrigerating compartment 12 is sensed. In preference to the temperature control of the refrigerating compartment temperature sensing unit, the side of freezing compartment cooler 94 is closed using change-over valve 74, the side of refrigerating compartment cooler 95 is opened, and the rotating speeds of compressor 30 and the cooling fan are enhanced.

[0213] At this point, in the case where the sensing result of the freezing compartment load sensing unit is less than or equal to the predetermined threshold, the state is maintained to intensively cool the refrigerating com-

partment. In the case where the sensing result of the freezing compartment load sensing unit is greater than the predetermined threshold, the refrigerant flows in both freezing compartment cooler 94 and refrigerating compartment cooler 95 using change-over valve 74, and the refrigerating compartment and the freezing compartment are intensively cooled. In the case where the freezing compartment temperature is higher than or equal to the predetermined temperature (for example, ON temperature + 3°C: the overload state is assumed), only the side of freezing compartment cooler 94 is opened using change-over valve 74, and the freezing compartment may intensively be cooled to preferentially prevent ice melting.

[0214] Then, change-over valve 74 is controlled in a similar manner when the freezing compartment temperature becomes the above state during the rapid cooling running, which allows the optimum cooling running control to be performed in consideration of the increase in storing quantity of the refrigerating compartment and the load on the freezing compartment.

[0215] In the case where the freezing compartment is cooled to the predetermined temperature to relatively decrease the load on the freezing compartment, the control may be performed similarly to refrigerating compartment freezing compartment simultaneous cooling (a) in which the load situation is not considered. The shift to the normal running or energy-saving running is made after the temperature in the refrigerator is lowered to a predetermined temperature (for example, closed temperature of refrigerating compartment) or after the predetermined time (for example, 30 minutes elapse since the rapid cooling is started).

[0216] In the case where the cooling pattern of the compartment is cooling stopping (c), the shift to the next operation is made when the increase in the object to be stored of refrigerating compartment 12 is sensed. When the OFF time of compressor 30 is longer than the predetermined period (time for protecting the compressor), in preference to the temperature control of the refrigerating compartment temperature sensing unit, the side of refrigerating compartment cooler 95 is opened using change-over valve 74, and the running of the compressor is started to intensively cool the refrigerating compartment. Then the rotating speeds of compressor 30 and the cooling fan are enhanced.

[0217] In the case where the sensing result of the freezing compartment load sensing unit is greater than the predetermined threshold during the rapid cooling running, the refrigerant flows in both freezing compartment cooler 94 and refrigerating compartment cooler 95 using change-over valve 74, and the refrigerating compartment and the freezing compartment are intensively cooled. In the case where the freezing compartment temperature is higher than or equal to the predetermined temperature (for example, ON temperature + 3°C: the overload state is assumed), only the side of freezing compartment cooler 94 is opened using change-over valve 74, and the

freezing compartment may intensively be cooled to preferentially prevent ice melting.

[0218] Therefore, the optimum cooling running control can be performed in consideration of the increase in storing quantity of the refrigerating compartment and the load on the freezing compartment. In the case where the freezing compartment is cooled to the predetermined temperature to relatively decrease the load on the freezing compartment, the control may be performed similarly to cooling stopping (c) in which the load situation is not considered. The shift to the normal running or energy-saving running is made after the temperature in the refrigerator is lowered to a predetermined temperature (for example, closed temperature of refrigerating compartment) or after the predetermined time (for example, 30 minutes elapse since the rapid cooling is started).

[0219] In the case where the cooling pattern of the compartment is refrigerating compartment single cooling (d), when the increase in the object to be stored of refrigerating compartment 12 is sensed, in preference to the temperature control of the refrigerating compartment temperature sensing unit, the side of freezing compartment cooler 94 is closed using change-over valve 74, the side of refrigerating compartment cooler 95 is opened, and the rotating speeds of compressor 30 and the cooling fan are enhanced.

[0220] In the case where the sensing result of the freezing compartment load sensing unit is greater than the predetermined threshold during the rapid cooling running, the refrigerant flows in both freezing compartment cooler 94 and refrigerating compartment cooler 95 using change-over valve 74, and the refrigerating compartment and the freezing compartment are intensively cooled. In the case where the freezing compartment temperature is higher than or equal to the predetermined temperature (for example, ON temperature + 3°C: the overload state is assumed), only the side of freezing compartment cooler 94 is opened using change-over valve 74, and the freezing compartment may intensively be cooled to preferentially prevent ice melting.

[0221] Therefore, the optimum cooling running control can be performed in consideration of the increase in storing quantity of the refrigerating compartment and the load on the freezing compartment. In the case where the freezing compartment is cooled to the predetermined temperature to relatively decrease the load on the freezing compartment, the control may be performed similarly to refrigerating compartment single cooling (d) in which the load situation is not considered. The shift to the normal running or energy-saving running is made after the temperature in the refrigerator is lowered to a predetermined temperature (for example, closed temperature of refrigerating compartment) or after the predetermined time (for example, 30 minutes elapse since the rapid cooling is started).

[0222] In the third exemplary embodiment, freezing compartment cooler 94 and refrigerating compartment cooler 95 are disposed in parallel. Alternatively, as illus-

trated in a cooling circuit of FIG. 19, freezing compartment cooler 94 and refrigerating compartment cooler 95 are connected in series through capillary 93a and capillary 93b, one route of change-over valve 92 is connected to freezing compartment cooler 94, and the other route of change-over valve 92 is connected to an upstream portion of capillary 93b from bypass pipe 96. In this case, the refrigerating compartment freezing compartment simultaneous cooling can be implemented by a simple structure, and the change-over valve can be simplified.

(FOURTH EXEMPLARY EMBODIMENT)

[0223] A fourth exemplary embodiment of the present invention has a feature that a refrigerating compartment stirring fan (not illustrated) that can independently be controlled is provided in refrigerating compartment 12. In the refrigerator of the second exemplary embodiment, it is assumed that a portion except the configuration identical to that of the first to third exemplary embodiments and a portion in which a failure is generated even if the same technical thought is applied can be combined with the fourth exemplary embodiment, and the detailed description is not given.

[0224] The refrigerating compartment stirring fan is provided in refrigerating compartment 12, the storage change quantity is calculated before and after the door opening and closing operation, and the shift to the next operation is made at the time point when the increase in storing quantity is determined to be greater than reference storage change quantity B in FIG. 7. The refrigerating compartment stirring fan (not illustrated) is driven in preference to the temperature control of the refrigerating compartment temperature sensing unit. Therefore, a temperature distribution difference in refrigerating compartment 12 can be minimized, and the freshness of the food can be improved.

[0225] Through the above operation, the optimum automatic rapid cooling and the automatic power saving cooling running can be performed according to the change in storing quantity of the compartment.

[0226] In addition to the improvement of the cooling capacity of the refrigerating compartment, an effect of a sterilizing or deodorizing function can be enhanced by providing a sterilizing or deodorizing device near the refrigerating compartment stirring fan.

(FIFTH EXEMPLARY EMBODIMENT)

[0227] A fifth exemplary embodiment of the present invention will be described below.

[0228] In the fifth exemplary embodiment, only a configuration and a technical thought, which are different from the first to fourth exemplary embodiments, will be described in detail. In the refrigerator of the fifth exemplary embodiment, it is assumed that a portion except the configuration identical to that of the first to fourth exemplary embodiments and a portion in which a failure is

generated even if the same technical thought is applied can be combined with the fifth exemplary embodiment, and the detailed description is not given.

[0229] As illustrated in FIG. 3, refrigerator 50 of the fifth exemplary embodiment includes door opening and closing sensing unit 62 that senses the opened and closed states of the door of refrigerator 50. In a period during which the closed state of the door is sensed, the string of operations of light emitter 20, light quantity sensor 21, calculation controller 22, and storing quantity estimator 23, which are described in the first exemplary embodiment, is started.

[0230] Through the string of operations, the door opened and closed states of refrigerator 50 are sensed, and light emitter 20 and light quantity sensor 21 are operated after constant time elapses since the door is closed, which allows an influence of background light or afterglow to be easily avoided.

[0231] When the storing quantity changes, a user performs a string of operations, namely, the user opens the door to store or take out the food, and closes the door. Therefore, the storing quantity is sensed after the door opening and closing operation. That is, refrigerator 50 includes door opening and closing sensing unit 62 to perform the minimum sensing operation, thereby reducing the consumed power of light emitter 20 and the like.

[0232] In the household refrigerator, the sensing of the door opening and closing and the lighting in the refrigerator are correlated with each other, and turn-on and -off control of lighting unit 19 in the refrigerator is performed according to the door opening and closing. When a door opening and closing sensing function in this control is shared, door opening and closing sensing unit 62 can be made by the simple configuration.

[0233] In the fifth exemplary embodiment, after predetermined time elapses since door opening and closing sensing unit 62 senses the closing operation of the heat insulating door, calculation controller 22 performs the calculation to control the electric functional component output operation.

[0234] Therefore, the comparison is stably performed after the door is closed, so that the change in storing quantity can securely be understood.

(SIXTH EXEMPLARY EMBODIMENT)

[0235] A sixth exemplary embodiment of the present disclosure will be described below.

[0236] FIGS. 20 and 21 are explanatory views (sectional views corresponding to FIG. 2) of a storing quantity detecting operation in the third exemplary embodiment of the present invention.

[0237] In the sixth exemplary embodiment, only a configuration and a technical thought, which are different from the configuration of refrigerator 50 of the first to fifth exemplary embodiments, will be described in detail. The configurations of the first to fifth exemplary embodiments of the present invention can be implemented while com-

bined with the sixth exemplary embodiment.

[0238] Referring to FIG. 20, when viewed from the front surface on the door opening side of refrigerator, lighting units 19 are vertically disposed in the right and left wall surfaces so as to be located in front of a half of the depth size in the inside of refrigerator and so as to be located in front of the leading end of storing shelf 18.

[0239] In lighting unit 19, light emitters 20a to 20d are vertically disposed at equal interval such that the inside of refrigerating compartment 12 can evenly be irradiated from the top to the bottom. Light quantity sensors 21a to 21d are disposed in the rear portion inside refrigerating compartment 12, and sense a light quantity attenuation caused by the light blocking of object to be stored 33. Light quantity sensor 21e is disposed in a ceiling surface of refrigerating compartment 12, and senses the light quantity attenuation caused by the light reflection of object to be stored 33. An illuminance sensor and a chromaticity sensor that can identify chromaticity (RGB) in addition to the illuminance can be used as light quantity sensors 21a to 21e.

[0240] As illustrated in FIG. 21, when light quantity sensor 21f is provided in a lower portion of the refrigerator while light emitter 20e is provided in the ceiling surface, the storing quantity can be sensed with high accuracy. When viewed from the door opening side of refrigerator 50, light emitter 20e in the ceiling surface is installed in front of a half of the depth size in the refrigerator. In the sixth exemplary embodiment, light emitter 20e in the ceiling surface is disposed on the door side with respect to the leading end of storing shelf 18, and on the depth sides of the door shelves 27a to 27c attached to the door. Therefore, the front surface (optical axis direction) of light emitter 20e in the ceiling surface is not blocked by storing shelf 18 or objects to be stored 33 for door shelves 27a to 27c.

[0241] For the similar reason, light quantity sensor 21f in the lower portion is disposed on the door side with respect to the leading end of storing shelf 18, and on the depth sides of door shelves 27a to 27c attached to the door. Additionally, light quantity sensor 21f is disposed at a level lower than or equal to the lowermost storing shelf 18. The surface in which light quantity sensor 21f is installed may be a side surface or a lower surface inside the refrigerator. A positional relationship between light emitter 20e in the ceiling surface and light quantity sensor 21f in the lower portion may be reversed.

[0242] The inside of the refrigerator is irradiated from the ceiling surface, and the light quantity is sensed in the lower portion. Therefore, storing shelf 18 and door shelves 27a to 27c are evenly irradiated with the light, so that the storing quantity can correctly be sensed.

[0243] In the compartment that is long in the height direction like refrigerating compartment 12, because the light from light emitter 20e in the ceiling surface hardly reaches the object to be stored in the lower portion, desirably the inside of the refrigerator is evenly irradiated using the light emitters, such as light emitter 20d, which

are located in the lower portion.

[0244] The dispositions of light quantity sensors 21a to 21f may be disposed at any position as long as light quantity sensors 21a to 21f can receive the light emitted from light emitters 20a to 20d through object to be stored 33 and the structure in the refrigerator. In the case where the storing quantity can roughly be estimated, the plurality of light quantity sensor 21 are not necessarily disposed, and one light quantity sensor 21 may be disposed.

(SEVENTH EXEMPLARY EMBODIMENT)

[0245] A seventh exemplary embodiment of the present disclosure will be described below.

[0246] FIG. 22 is an explanatory view illustrating a light quantity sensing operation in the seventh exemplary embodiment of the present invention.

[0247] In the seventh exemplary embodiment, only a configuration and a technical thought, which are different from the configuration of refrigerator 50 of the first to sixth exemplary embodiments, will be described in detail. The configurations of the first to sixth exemplary embodiments of the present invention can be implemented while combined with the seventh exemplary embodiment.

[0248] As illustrated in FIG. 22, in the seventh exemplary embodiment, air quantity adjusters 28a to 28d are disposed in rear portions of refrigerating compartment 12. Refrigerating compartment 12 and object to be stored 33, which is stored in refrigerating compartment 12, are irradiated with irradiation light beams 34a output from light emitters 20a to 20d.

[0249] Irradiation light beam 34b that is a part of the output light is incident on light quantity sensors 21a to 21e disposed in refrigerating compartment 12, and the quantity of object to be stored 33 in the refrigerator can be classified by identifying the light quantity sensing result using a previously-set predetermined threshold.

[0250] At this point, the light quantities sensed by light quantity sensors 21a to 21e vary according to the storage situation. For example, in the case where object to be stored 33 is input to storing shelf 18b as illustrated in FIG. 22, the light quantity sensed by light quantity sensor 21a is smaller than the light quantities sensed by light quantity sensors 21b to 21e before and after object to be stored 33 is input. Therefore, the input of object to be stored 33 to storing shelf 18b is sensed to classify the quantity of object to be stored 33. Then, air quantity adjuster 28a adjusts the air volume according to the sensed increase in storing quantity to perform the rapid cooling running.

[0251] The rapid cooling running is released after the constant time elapses, after the compressor is stopped, or at the time point when the temperature sensed by the refrigerating compartment sensor becomes lower than or equal to the predetermined temperature, and the normal running or the automatic power saving cooling running is started.

[0252] As described above, in the seventh exemplary embodiment, air quantity adjusters 28a to 28d are pro-

vided to efficiently cool the surroundings of the input object to be stored, so that the cooling running of the optimum automatic rapid cooling can be performed.

[0253] The positions of air quantity adjusters 28a to 28d are not limited to the seventh exemplary embodiment, but air quantity adjusters 28a to 28d may be disposed at any position in the refrigerator.

(EIGHTH EXEMPLARY EMBODIMENT 8)

[0254] An eighth exemplary embodiment of the present disclosure will be described below.

[0255] FIG. 23 is a front view illustrating refrigerator 50 according to the eighth exemplary embodiment of the present invention.

[0256] In the eighth exemplary embodiment, only a configuration and a technical thought, which are different from the configuration of refrigerator 50 of the first to seventh exemplary embodiments, will be described in detail. The configurations of the first to seventh exemplary embodiments of the present invention can be implemented while combined with the eighth exemplary embodiment.

[0257] Referring to FIG. 23, in refrigerator body 11 constructed with inner casing 11b and outer casing 11c, refrigerating compartment 12, ice-making compartment 13, freezing compartment 15, and vegetable compartment 16 are disposed from above in inner casing 11b that is provided in outer casing 11c with the heat insulating wall interposed therebetween, and temperature selecting compartment 14 that can switch the compartment to various temperatures is provided on the side of ice-making compartment 13.

[0258] The front opening of largest refrigerating compartment 12 in which the object to be stored is frequently stored and taken out is closed by hinged double refrigerating compartment doors 12a that is a rotating door. A drawer type door is provided in each of ice-making compartment 13, temperature selecting compartment 14, vegetable compartment 16, and freezing compartment 15.

[0259] In refrigerating compartment 12, the compartment held at the refrigeration temperature is vertically partitioned by the plurality of storing shelves 18 provided at proper intervals, and a feed-water tank supplying ice making water to refrigerating compartment 12 and low-temperature compartment 12b maintained at a chilled temperature are provided in the bottom portion.

[0260] Specifically, the upper spaces of storing shelves 18a to 18c are the space in which the food is preserved. In the eighth exemplary embodiment, storing shelf 18a that is formed at the uppermost stage to store the food, storing shelf 18b that is formed in the second stage to store the food, and storing shelf 18c that is located immediately below storing shelf 18b to store the food are provided, and the feed-water tank and low-temperature compartment 12b maintained at the chilled temperature are disposed in the lowermost storing partition.

[0261] Lighting units 19 are installed in refrigerating

compartment 12. In lighting unit 19, the plurality of LEDs are vertically incorporated at equal intervals on the front side of the inside surface of the compartment. Light quantity sensors 21a and 21b constructed with the illuminance sensors are installed on the rear surface side in the compartment. Light quantity sensor 21a is provided above storing shelf 18a that is formed at the uppermost stage to store the food and in the rear surface wall below inner casing 11b on the ceiling surface side. Light quantity sensor 21b is provided above storing shelf 18b that is formed at the second stage to store the food and in the rear surface wall below storing shelf 18a.

[0262] In the eighth exemplary embodiment, object to be stored 33 that is of the food is placed on storing shelf 18b.

[0263] Cold air ejection ports 4a and 4b are provided above light quantity sensors 21a and 21b, cold air ejection port 4a is provided near storage situation sensor 21a on the upper side, and cold air ejection port 4b is provided near storage situation sensor 21b on the lower side.

[0264] The operation of refrigerator 50 having the above configuration will be described below.

[0265] Lighting unit 19 is lit while refrigerating compartment door 12a is closed. In the refrigerator, the light from lighting unit 19 reaches light quantity sensor 21a that senses the illuminance of the storing space at the uppermost stage through air. In storing shelf 18b at the intermediate stage, the light from lighting unit 19 partially reaches storage situation sensing unit 21b that senses the illuminance of the storing space at the second stage through a gap between objects to be stored 33. The light strikes partially on object to be stored 33, and the light is partially absorbed by object to be stored 33 and partially reflected and scattered. For this reason, the light quantity is decreased to become dark on the opposite side to lighting unit 19 of object to be stored 33, namely, the rear surface side of object to be stored 33.

[0266] With increasing height of object to be stored 33, or with increasing storing quantity of object to be stored 33, the light from lighting unit 19 is blocked to decrease the quantity of light reaching light quantity sensors 21a and 21b located in the rear portion.

[0267] Therefore, light quantity sensors 21a and 21b constructed with the illuminance sensors act as a sensing unit that senses the empty space in the compartment in a non-contact manner.

[0268] Light quantity sensors 21a and 21b sense the light quantity, and display 91 (see FIG. 1) located in the outer surface of refrigerating compartment door 12a displays the empty space at the intermediate stage of storing shelf 18.

[0269] That is, the user can be informed of the state of the object to be stored in refrigerating compartment 12 by display 91 that is of a perception unit. The perception unit displays the state of the object to be stored in the outer surface of refrigerating compartment door 12a provided on the front surface side of refrigerating compartment 12 that is of the compartment including light quantity

sensors 21a and 21b.

[0270] The user checks the display indicated by display 91 that is of the perception unit, opens refrigerating compartment door 12a to place the food on storing shelf 18a that is of the uppermost storing space where small storing quantity of object to be stored 33 is displayed without hesitation, and quickly closes refrigerating compartment door 12a.

[0271] As illustrated by storing shelf 18b, it is assumed that object to be stored 33 that is of the food is stored on the front side of cold air ejection port 4b, or that object to be stored 33 is excessively stored. In such cases, in the case where the light quantities sensed by light quantity sensors 21a and 21b located near cold air ejection ports 4a and 4b are less than a predetermined value, power increasing running caused by the excessive storage of the storing space sensed by the illuminance sensor is displayed on display 91 located in the outer surface of refrigerating compartment door 12a.

[0272] In the case where object to be stored 33 is excessively stored, or in the case where object to be stored 33 is stored near cold air ejection ports 4a and 4b, object to be stored 33 becomes a draft resistance of the cold air, and a cold air circulating quantity per unit time decreases to lengthen the cooling time. When the cold air circulating quantity decreases, the air volume of the evaporator decreases, and a heat exchange quantity decreases. Therefore, the evaporation temperature is lowered, and compressor input also increases due to the increase in pressure difference between the high and low pressures of the refrigerating cycle.

[0273] In order to maintain the cooling time, it is necessary to increase the rotating speed of the fan that circulates the cold air or the rotating speed of compressor 30, which results in the increased power.

[0274] The user is informed of a tendency of the increased power and encourage to dispose optimum object to be stored 33. Therefore, in the practical use of refrigerator 50, the energy saving can be achieved, and refrigerator 50 in which the energy saving is achieved can be provided to a consumer to contribute to the reduction of CO₂.

[0275] Thus, the opening time of refrigerating compartment door 12a is shortened, the high-temperature ambient air is prevented from flowing through refrigerating compartment door 12a, and the energy saving can be achieved. The temporary temperature rise in refrigerating compartment 12 is also suppressed, so that the temperature rise of the food that is of object to be stored 33 can be suppressed to reduce quality degradation.

[0276] The user is informed of the increased power running by display 91 that is of the perception unit, so that user's attention is invited to energy-saving running. The perception unit is not limited to display 91. Alternatively, for example, the user's attention is called by sound.

[0277] Compared with the conventional refrigerator, the configuration of the eighth exemplary embodiment has the higher effect in the case where various kinds of

foods are possibly stored like the household refrigerator.

[0278] Refrigerator 50 of the eighth exemplary embodiment includes the compartment that is partitioned by the heat insulating wall and the heat insulating door to store a object to be stored, storing quantity estimator 23 that estimates the storing quantity in the compartment, and storage unit 64 that stores the estimation result of storing quantity estimator 23. Refrigerator 50 also includes calculation controller 22. Calculation controller 22 calculates the storage change quantity based on the previous estimation result of storage unit 64 and the estimation result of storing quantity estimator 23, and controls the electric functional component output operation. Calculation controller 22 informs the user of the running state of refrigerator 50 using an information unit when it is determined that the storing quantity in the compartment changes.

[0279] Therefore, based on the storing quantity estimation, user's consciousness of the power saving can be enhanced by informing the user of the state in which, for example, the energy-saving running (the running state of the refrigerator) is performed.

[0280] Storing quantity information such as the excessive storage may be displayed on display 91 using an indicator. Storing quantity absolute value estimation of storing quantity estimator 23 is suitable in the case where the storing quantity in the refrigerator is displayed.

[0281] Storing quantity relative value estimation of storing quantity estimator 23 is suitable in the case where the change in storing quantity in the refrigerator is displayed. Therefore, the user-friendliness can be improved.

[0282] As described above, the refrigerator of the present invention includes the compartment that is partitioned by the heat insulating wall and the heat insulating door to store the object to be stored, the storing quantity estimator that estimates the storing quantity in the compartment, and the storage unit that stores the estimation result of storing quantity estimator. The refrigerator also includes the refrigeration device that cools the compartment, the damper device that corresponds to each compartment to control the supply quantity of the cold air generated by the refrigeration device, and the calculation controller that performs the calculation based on the input data of the storing quantity estimator and the storage unit to control the refrigeration device and the damper device.

[0283] In the configuration of the present invention, usually the energy-saving running can be performed by the control of the damper device corresponding to each of the compartments. Additionally, in the case where the storing quantity changes largely due to the bulk purchase, the compartment in which the storing quantity changes is intensively cooled, and the input object to be stored can be cooled to the optimum storage temperature in a short time.

[0284] The refrigerator of the present invention also includes the temperature detector that senses the temperature in the compartment, and the calculation controller controls the refrigeration device and the damper de-

vice based on the change information on the storing quantity of the compartment and the temperature information in the compartment.

[0285] In the configuration of the present invention, the change in storing quantity is sensed with high accuracy, the high freshness of the object to be stored is implemented, and the cooling quantity is adjusted according to the storage situation or the use situation, so that the "overcool" can be prevented to further achieve the energy saving.

[0286] In the present invention, the damper device is disposed in at least the compartment of the cooling temperature range and the compartment of the freezing temperature range.

[0287] In the configuration of the present invention, the storing compartments of the cooling temperature range and the freezing temperature range can independently be controlled to enhance the cooling efficiency, and the cooling quantity in each compartment can be adjusted according to the storage situation or the use situation.

[0288] The refrigerator of the present invention includes the light emitter and the light quantity sensor in the compartment, and the storing quantity estimator estimates the storing quantity based on the sensing result of the light quantity sensor.

[0289] In the configuration of the present invention, the irradiation light beam of the light source is repeatedly reflected in the compartment, the whole inside of the refrigerator is evenly irradiated with the irradiation light beam, and the irradiation light beam is incident on the optical sensor, so that the storing quantity can be estimated with the simple configuration in which the number of component is decreased.

[0290] The refrigerator of the present invention includes the compartment that is partitioned by the heat insulating wall and the heat insulating door to store the object to be stored, the storing quantity estimator that estimates the storing quantity in the compartment, and the storage unit that stores the estimation result of storing quantity estimator. The refrigerator also includes the refrigeration device that cools the compartment, the switchable radiator that constitutes the refrigeration device, and the calculation controller that performs the calculation based on the input data of the storing quantity estimator and the storage unit to control the refrigeration device. In the refrigerator, the calculation controller performs the control by switching the radiator of the refrigeration device based on the calculation result of the storing quantity.

[0291] Therefore, in the present invention, usually the energy-saving running can be performed. Additionally, the cooling quantity of the compartment in which the storing quantity changes can be increased to cool the input object to be stored to an optimum storage temperature in a short time in the case where the storing quantity changes largely due to the bulk purchase, and the enhancement of the radiation capacity can be achieved according to the increase in cooling capacity.

[0292] The refrigerator of the present invention in-

cludes the temperature detector that senses the temperature in the compartment, and the calculation controller changes the radiation quantity of the radiator of the refrigeration device based on the change information on the storing quantity of the compartment and the temperature information in the compartment.

[0293] In the configuration of the present invention, the change in storing quantity is sensed with high accuracy, the high freshness of the object to be stored is implemented, and the cooling quantity is adjusted according to the storage situation or the use situation, so that the "overcool" can be prevented to further achieve the energy saving.

[0294] In the present invention, the radiator is used as the sweating prevention radiation pipe that is disposed at the peripheral edge in the front opening of the refrigerator.

[0295] In the configuration, the heat absorption from the front opening can be reduced to achieve the energy saving, and the sweating at the peripheral edge in the front opening can properly be prevented.

[0296] The refrigerator of the present invention includes the light emitter and the light quantity sensor in the compartment, and the storing quantity estimator estimates the storing quantity based on the sensing result of the light quantity sensor.

[0297] In the configuration of the present invention, the irradiation light beam of the light source is repeatedly reflected in the compartment, the whole inside of the refrigerator is evenly irradiated with the irradiation light beam, and the irradiation light beam is incident on the optical sensor, so that the storing quantity can be estimated with the simple configuration in which the number of component is decreased.

[0298] The refrigerator of the present invention includes the compartment that is partitioned by the heat insulating wall and the heat insulating door to store the object to be stored, the storing quantity estimator that estimates the storing quantity in the compartment, and the storage unit that stores the estimation result of storing quantity estimator. The refrigerator also includes the refrigeration device that cools the compartment, the refrigerant circulating quantity adjuster that constitutes the refrigeration device, and the calculation controller that performs the calculation based on the input data of the storing quantity estimator and the storage unit to control the refrigeration device. The calculation controller adjusts the refrigerant circulating quantity using the refrigerant circulating quantity adjuster based on the calculation result of the storing quantity.

[0299] Therefore, in the present invention, usually the energy-saving running can be performed. Additionally, the cooling quantity of the compartment in which the storing quantity changes can be increased to cool the input object to be stored to the optimum storage temperature in a short time in the case where the storing quantity changes largely due to the bulk purchase, and the enhancement of the radiation capacity can be achieved ac-

ording to the increase in cooling capacity.

[0300] The refrigerator of the present invention includes the temperature detector that senses the temperature in the compartment, and the calculation controller changes the refrigerant circulating quantity of the refrigeration device based on the change information on the storing quantity of the compartment and the temperature information in the compartment.

[0301] In the configuration of the present invention, the change in storing quantity is sensed with high accuracy, the high freshness of the object to be stored is implemented, and the cooling quantity is adjusted according to the storage situation or the use situation, so that the "overcool" can be prevented to further achieve the energy saving.

[0302] In the refrigerant quantity adjuster of the present invention, the capillaries having the different diameters are disposed in parallel, the two-way change-over valve is provided on the upstream side of the capillary, and the refrigerant passage is switched when the increase in storing quantity of the compartment is greater than or equal to the predetermined threshold.

[0303] In the configuration of the present invention, the refrigerant circulating quantity can be switched by the simple structure.

[0304] The refrigerator of the present invention includes the light emitter and the light quantity sensor in the compartment, and the storing quantity estimator estimates the storing quantity based on the sensing result of the light quantity sensor.

[0305] In the configuration of the present invention, the irradiation light beam of the light source is repeatedly reflected in the compartment, the whole inside of the refrigerator is evenly irradiated with the irradiation light beam, and the irradiation light beam is incident on the optical sensor, so that the storing quantity can be estimated with the simple configuration in which the number of component is decreased.

[0306] The refrigerator of the present invention includes the compartment that is partitioned by the heat insulating wall and the heat insulating door to store the object to be stored, the storing quantity estimator that estimates the storing quantity in the compartment, and the storage unit that stores the estimation result of storing quantity estimator. The refrigerator also includes the cooling unit that cools the compartment, the draft air device that independently circulates the cold air in the compartment, and the calculation controller that performs the calculation based on the input data of the storing quantity estimator and the storage unit to control the cooling unit and the draft air. Additionally, when it is determined that the storing quantity in the compartment changes, the calculation controller controls the draft air device of the compartment in which the storing quantity changes.

[0307] Therefore, in the present invention, usually the energy-saving running can be performed. Additionally, in the case where the storing quantity changes largely due to the bulk purchase, the cold air convection quantity

of the compartment in which the storing quantity changes can be increased, to cool the input object to be stored to the optimum storage temperature in a short time.

[0308] The refrigerator of the present invention includes the temperature detector that senses the temperature in the storing compartment, and the calculation controller controls the draft air unit based on the change information on the storing quantity of the storing compartment and the temperature information in the storing compartment. In the configuration of the present invention, the change in storing quantity is sensed with high accuracy, the high freshness of the object to be stored is implemented, and the cooling quantity is adjusted according to the storage situation or the use situation, so that the "overcool" can be prevented to further achieve the energy saving.

[0309] The refrigerator of the present invention also includes sterilizing or deodorizing device near the draft air unit.

[0310] In the configuration of the present invention, the effect of the sterilizing or deodorizing function can be enhanced in addition to the improvement of the cooling capacity of the refrigerating compartment.

[0311] The refrigerator of the present invention includes the light emitter and the light quantity sensor in the storing compartment, and the storing quantity estimator estimates the storing quantity based on the sensing result of the light quantity sensor.

[0312] In the configuration of the present invention, the irradiation light beam of the light source is repeatedly reflected in the storing compartment, the whole inside of the refrigerator is evenly irradiated with the irradiation light beam, and the irradiation light beam is incident on the optical sensor, so that the storing quantity can be estimated with the simple configuration in which the number of component is decreased.

[0313] The refrigerator of the present invention includes the storing compartment that is partitioned by the heat insulating wall and the heat insulating door to store the object to be stored, the storing quantity estimator that estimates the storing quantity in the storing compartment, and the storage unit that stores the estimation result of storing quantity estimator. The refrigerator also includes the refrigeration device that cools the storing compartment, the plurality of switchable coolers that constitute the refrigeration device, and the calculation controller that performs the calculation based on the input data of the storing quantity estimator and the storage unit to control the refrigeration device. The calculation controller performs the control by switching the plurality of coolers of the refrigeration device based on the calculation result of the storing quantity.

[0314] Therefore, in the present invention, usually the energy-saving running can be performed. Additionally, in the case where the storing quantity changes largely due to the bulk purchase, the storing compartment in which the storing quantity changes is intensively cooled, and the input object to be stored can be cooled to the

optimum storage temperature in a short time.

[0315] The refrigerator of the present invention includes the temperature detector that senses the temperature in the storing compartment, and the calculation controller performs the control by switching the plurality of coolers of the refrigeration device based on the change information on the storing quantity of the storing compartment and the temperature information in the storing compartment.

[0316] In the configuration of the present invention, the change in storing quantity is sensed with high accuracy, the high freshness of the object to be stored is implemented, and the cooling quantity is adjusted according to the storage situation or the use situation, so that the "overcool" can be prevented to further achieve the energy saving.

[0317] In the present invention, the cooler is disposed so as to cool at least the storing compartment of the cooling temperature range and the storing compartment of the freezing temperature range.

[0318] In the configuration of the present invention, the plurality of coolers can be cooled at the evaporation temperature suitable to the cooling temperature range and the freezing temperature range, and the cooling quantity can be adjusted according to the storage situation or the use situation while the cooling efficiency is enhanced.

[0319] The refrigerator of the present invention includes the light emitter and the light quantity sensor in the storing compartment, and the storing quantity estimator estimates the storing quantity based on the sensing result of the light quantity sensor.

[0320] In the configuration of the present invention, the irradiation light beam of the light source is repeatedly reflected in the storing compartment, the whole inside of the refrigerator is evenly irradiated with the irradiation light beam, and the irradiation light beam is incident on the optical sensor, so that the storing quantity can be estimated with the simple configuration in which the number of component is decreased.

INDUSTRIAL APPLICABILITY

[0321] The refrigerator of the present invention can be applied to the control in which the storing quantity sensing function is provided in the household or professional-use refrigerator to switch a running mode to the energy-saving running using the storing quantity sensing result.

REFERENCE MARKS IN THE DRAWINGS

[0322]

- 4a,4b cold air ejection port
- 11,101 refrigerator body
- 11a,111a machine compartment
- 11b inner casing
- 11c outer casing
- 12,107 refrigerating chamber

- 12a refrigerating compartment door
- 12b low-temperature compartment
- 13 ice-making compartment
- 14,108 temperature selecting compartment
- 5 15,110 freezing compartment
- 16,109 vegetable compartment
- 17 operating unit
- 18a to c storing shelf
- 19 lighting unit
- 10 20a to e light emitter
- 21,21a to f light quantity sensor
- 22 calculation controller
- 23 storing quantity estimator
- 24 comparative information determination unit
- 15 25 change information determination unit
- 27a to c door shelf
- 28a to d air quantity adjuster
- 30,111 compressor
- 20 31,114 cooling fan
- 33 object to be stored
- 34a,34b irradiation light beam
- 61 temperature sensor
- 62 door opening and closing sensing unit
- 25 64 storage unit
- 67 damper
- 74,84,92 change-over valve
- 75 radiation pipe
- 81 condenser
- 30 82 refrigerant quantity adjuster
- 83,93a,93b capillary
- 85,113 cooler
- 87 refrigerating compartment stirring fan
- 91 display
- 35 115A refrigerating compartment damper
- 115B temperature selecting compartment damper
- 115C freezing compartment damper
- 116,117,118 cold air
- 40 119A refrigerating-compartment draft air duct
- 120A freezing-compartment draft air duct
- 121 bypass passage
- 123A temperature-selecting-compartment draft air duct
- 45

Claims

1. A refrigerator comprising:

- 50 compartments, each being partitioned by a heat insulating wall and a heat insulating door to store an object to be stored ;
- 55 a storing quantity estimator that estimates a storing quantity in each of the compartments;
- a storage unit that stores an estimation result of the storing quantity estimator;
- a refrigeration device that cools an inside of each

of the compartments;
 a damper device that corresponds to each of the compartments and controls a supply quantity of cold air generated by the refrigeration device;
 and
 a calculation controller that performs calculation based on input data from the storing quantity estimator and the storage unit to control the refrigeration device and the damper device.

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2. The refrigerator according to claim 1 further comprising a temperature detector that senses a temperature in any of the compartments, wherein the calculation controller controls the refrigeration device and the damper device based on change information on a storing quantity and temperature information in any of the compartments.

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3. The refrigerator according to claim 1, wherein the damper device is disposed in each of at least one of the storing compartments in a cooling temperature range and one of the storing compartments in a freezing temperature range.

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4. The refrigerator according to any one of claims 1 to 3 further comprising a light emitter and a light quantity sensor in any of the compartments, wherein the storing quantity estimator estimates the storing quantity based on a sensing result of the light quantity sensor.

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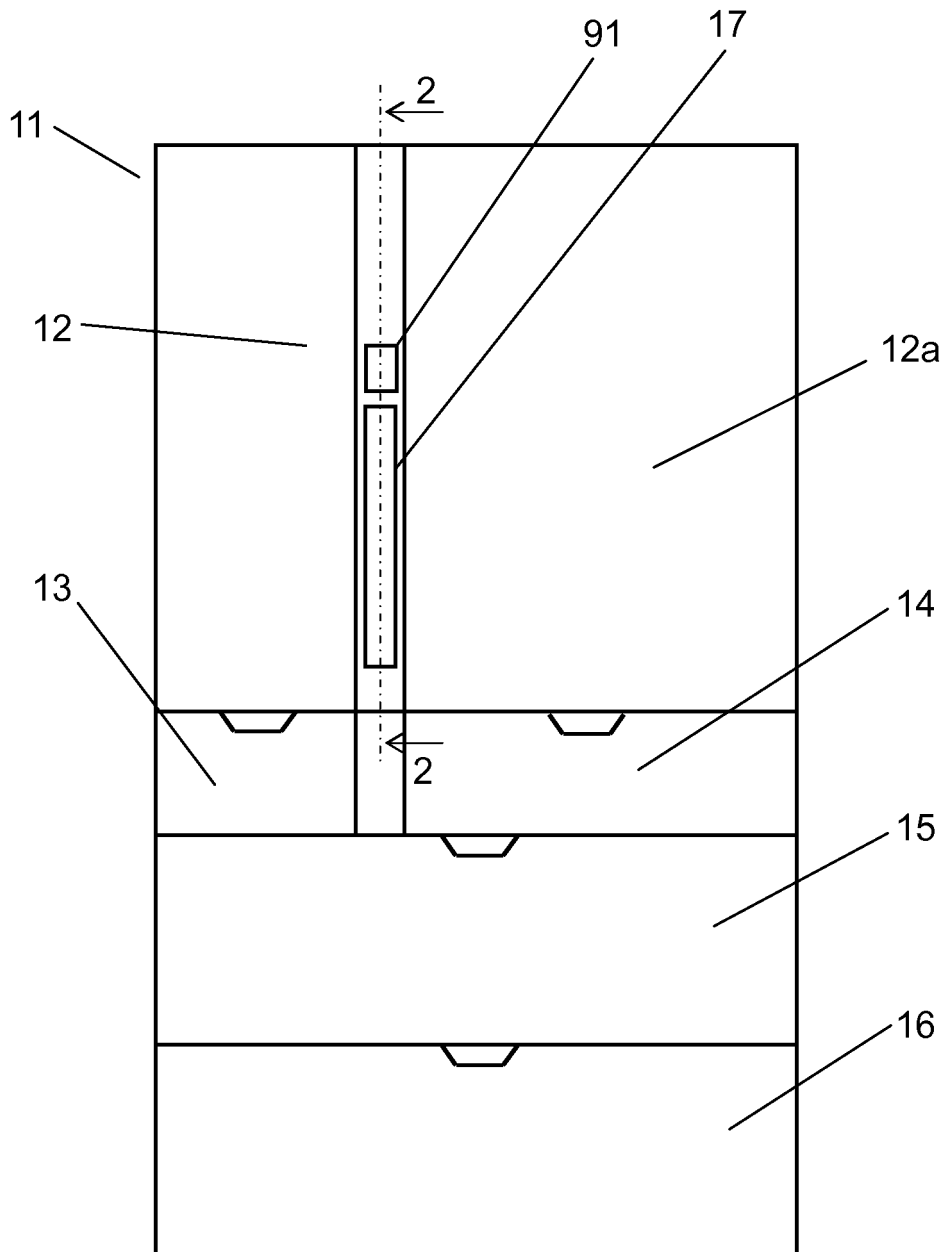
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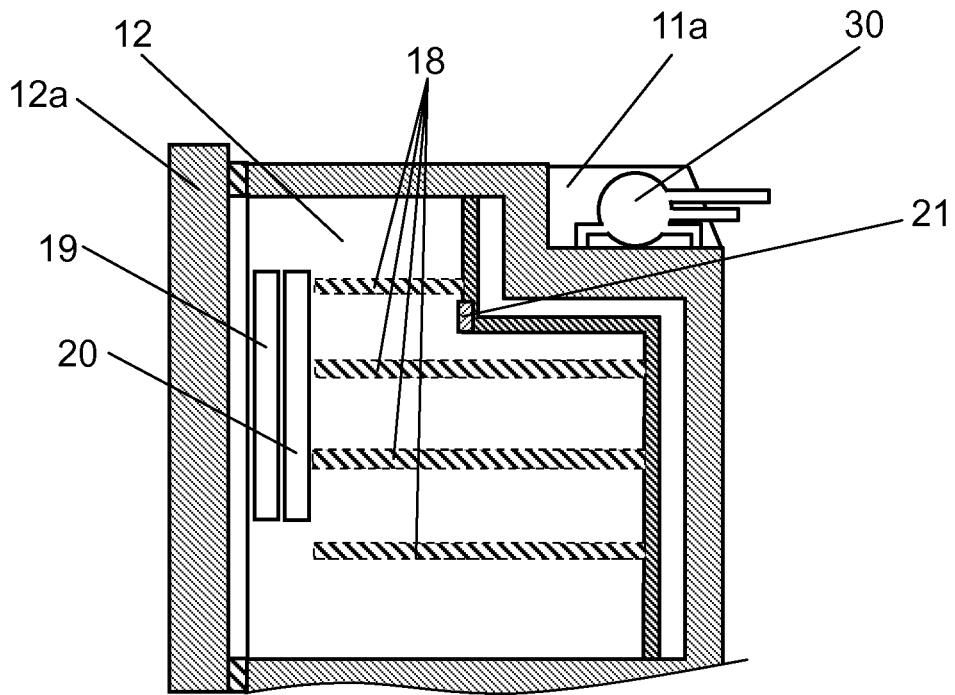
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FIG. 1



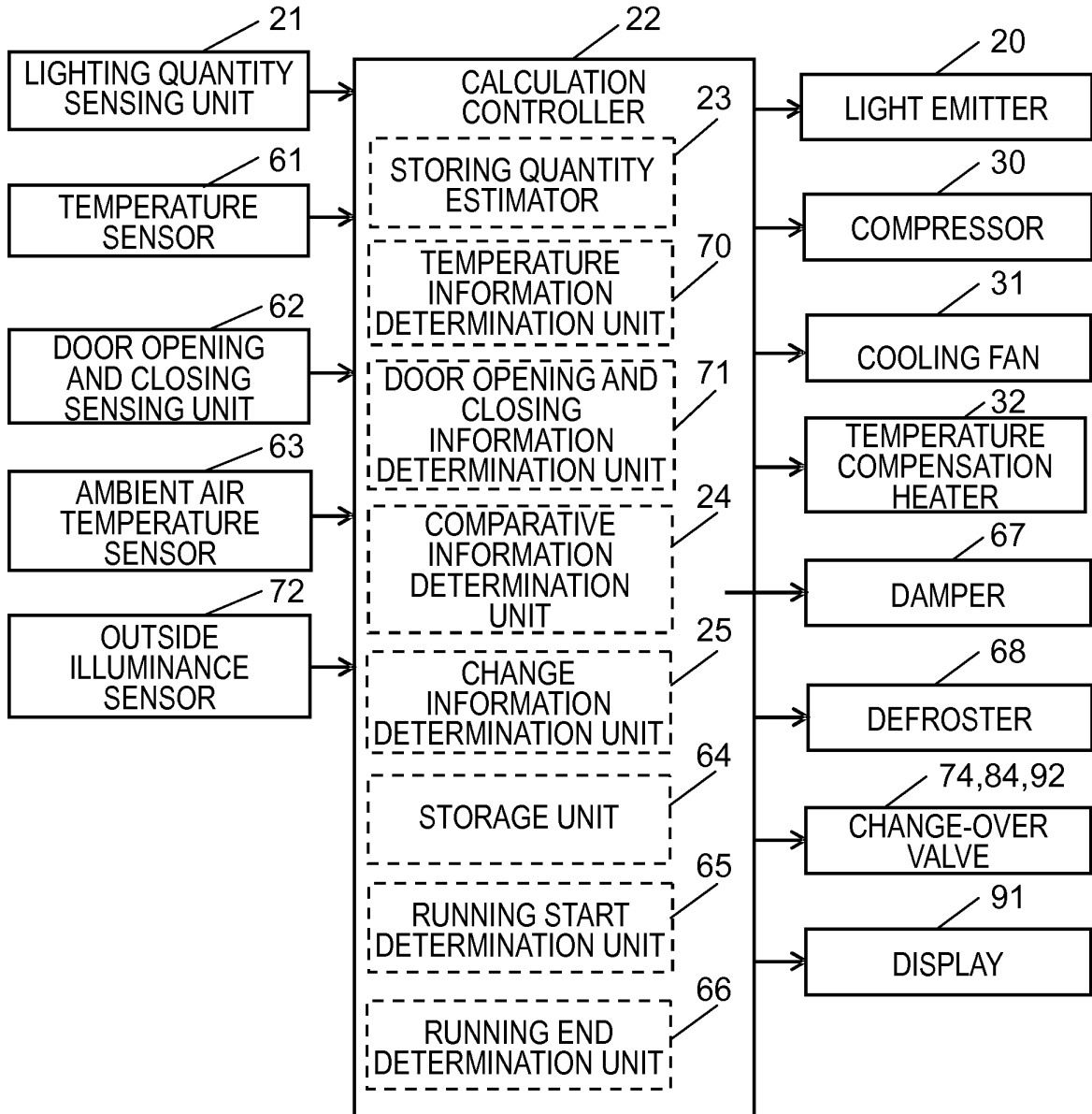
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FIG. 2



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FIG. 3



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FIG. 4

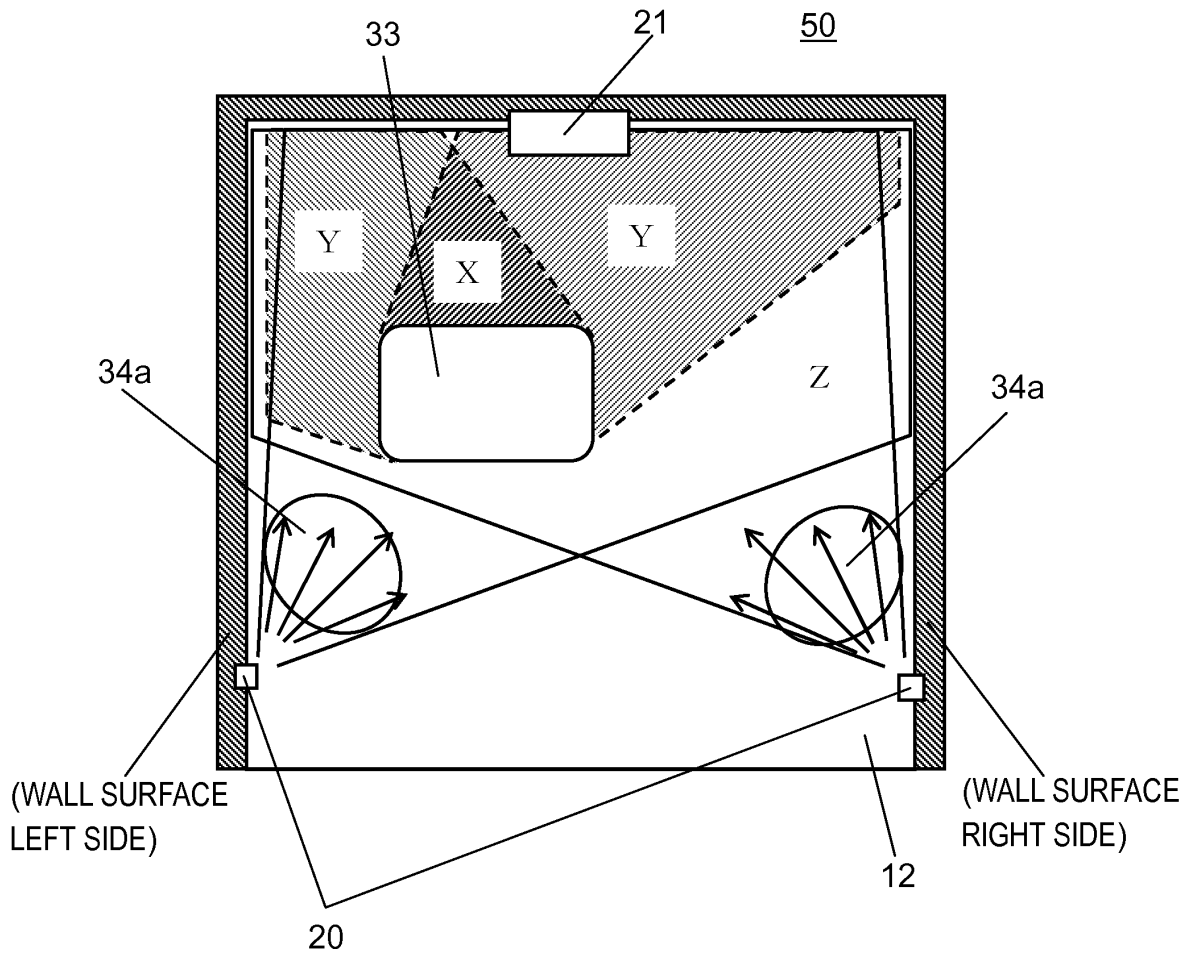


FIG. 5A

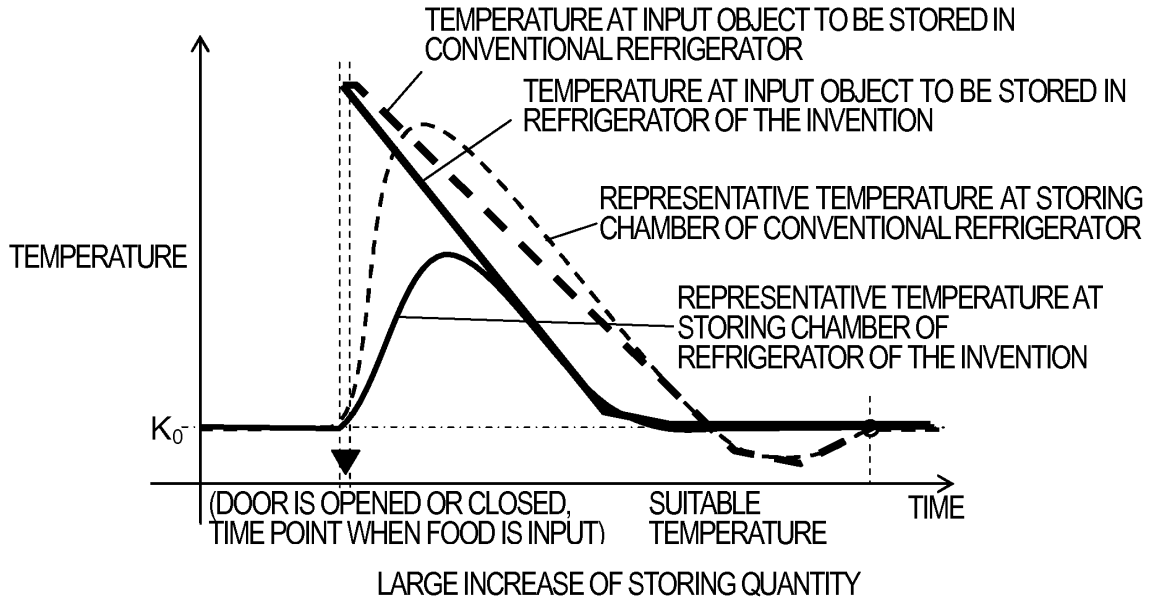


FIG. 5B

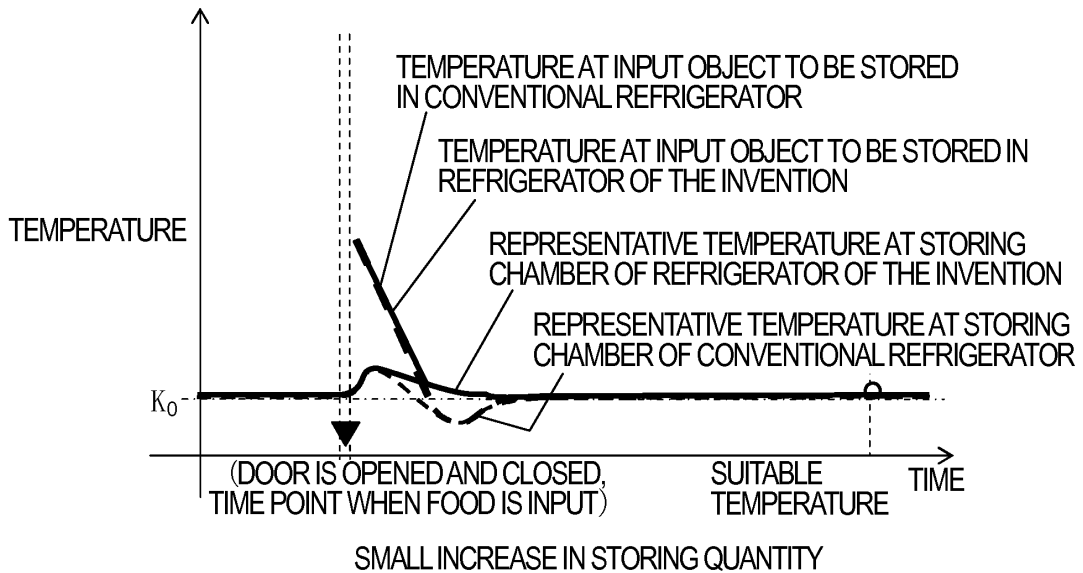


FIG. 6

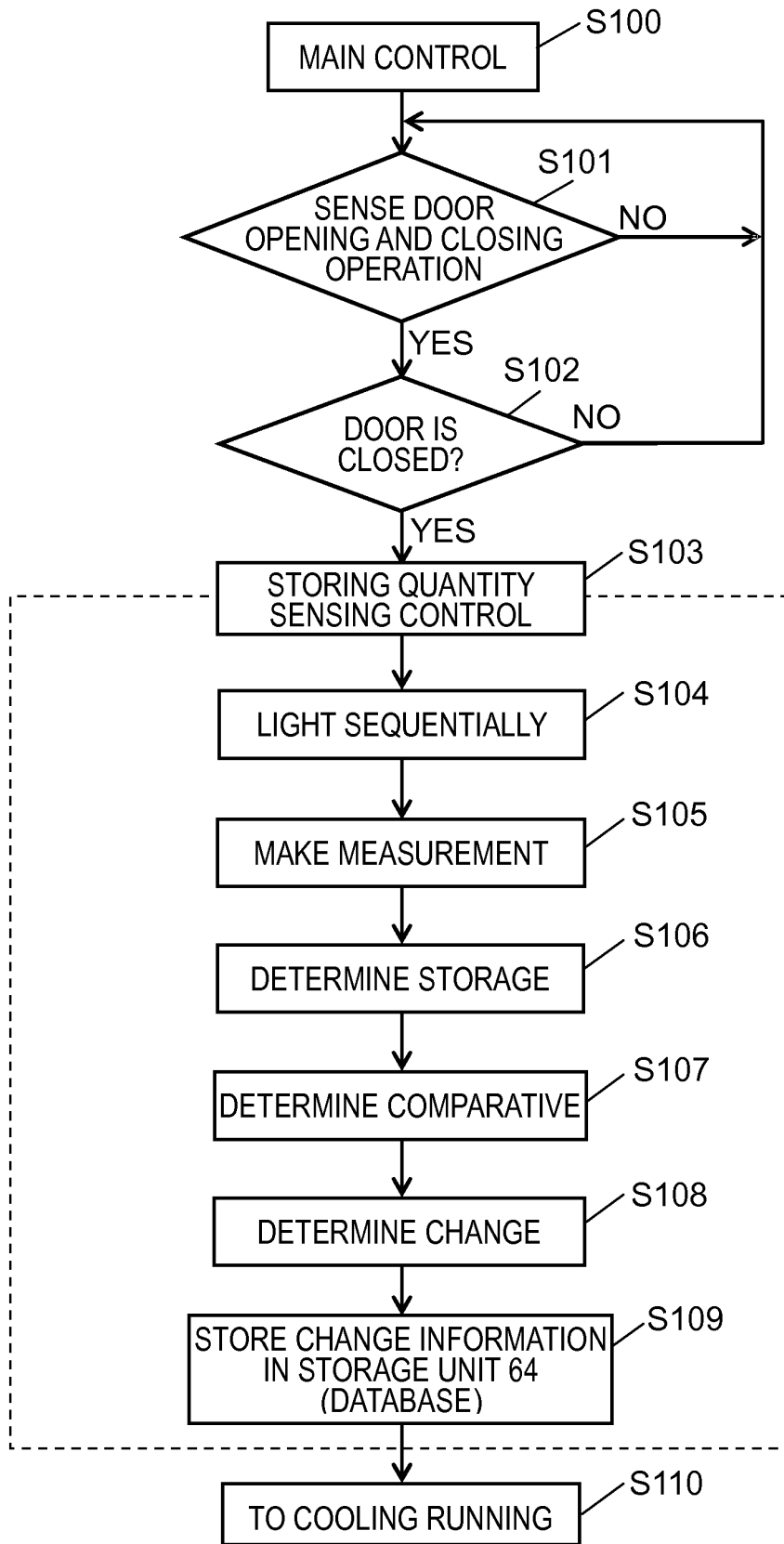


FIG. 7

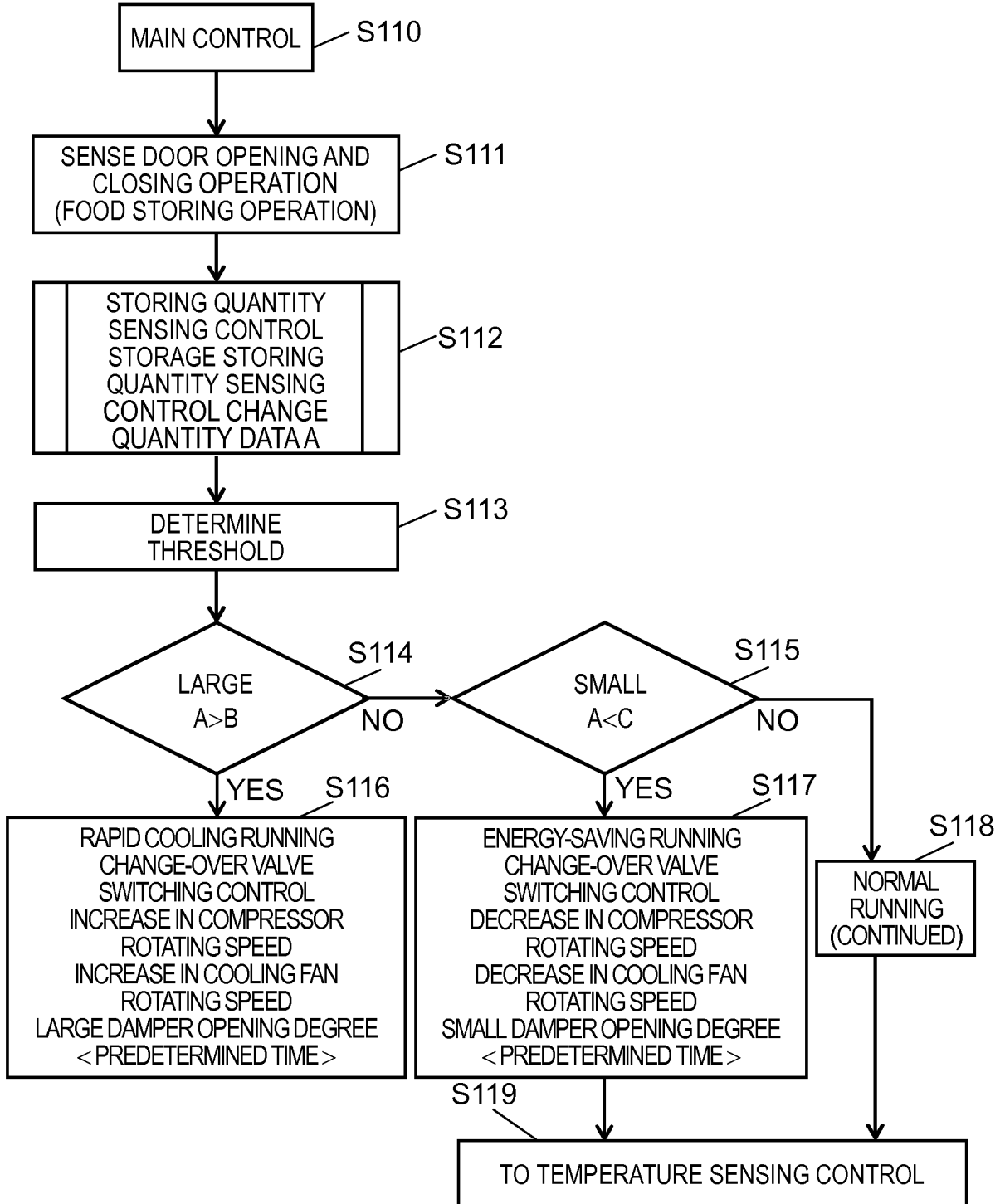


FIG. 8

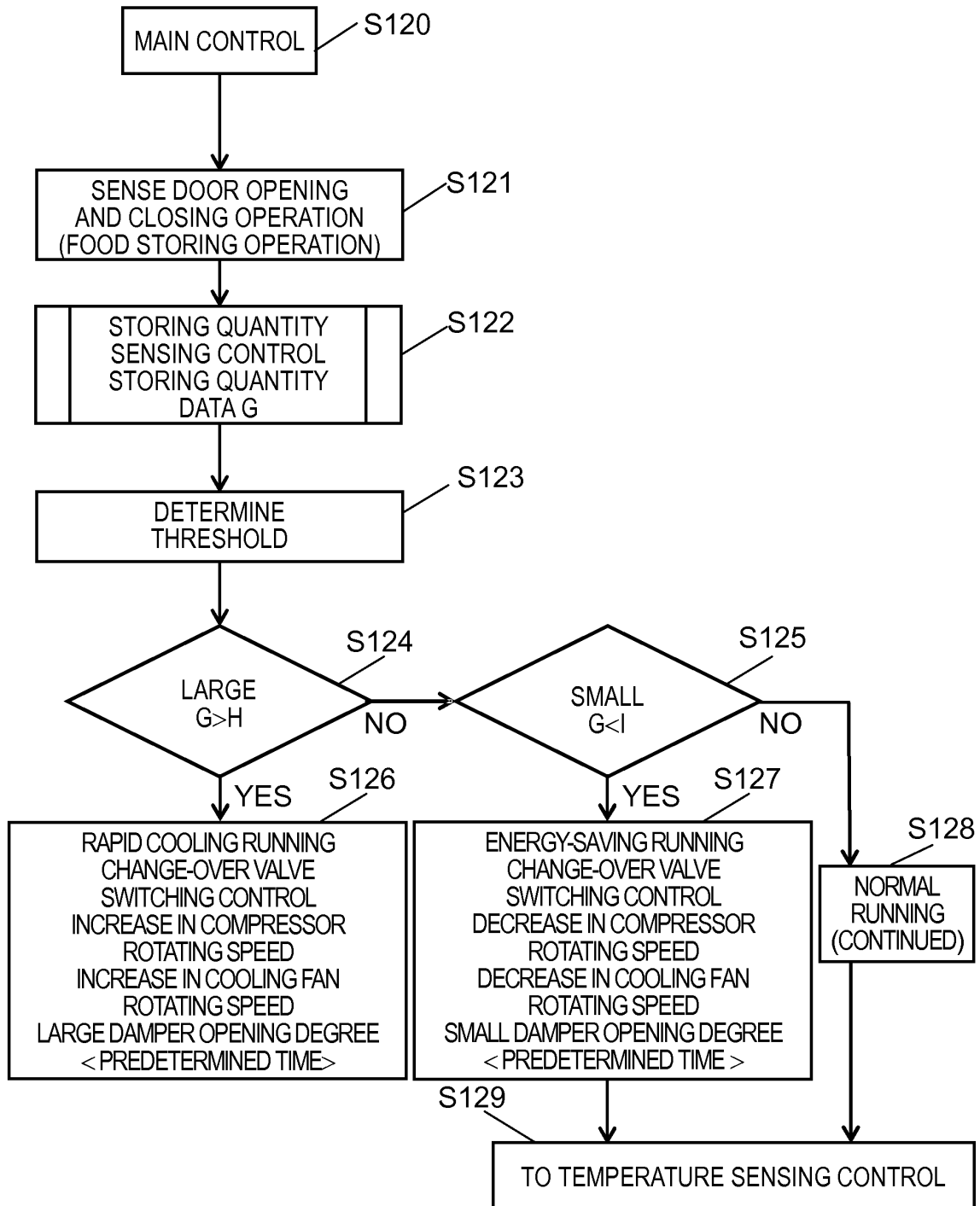


FIG. 9

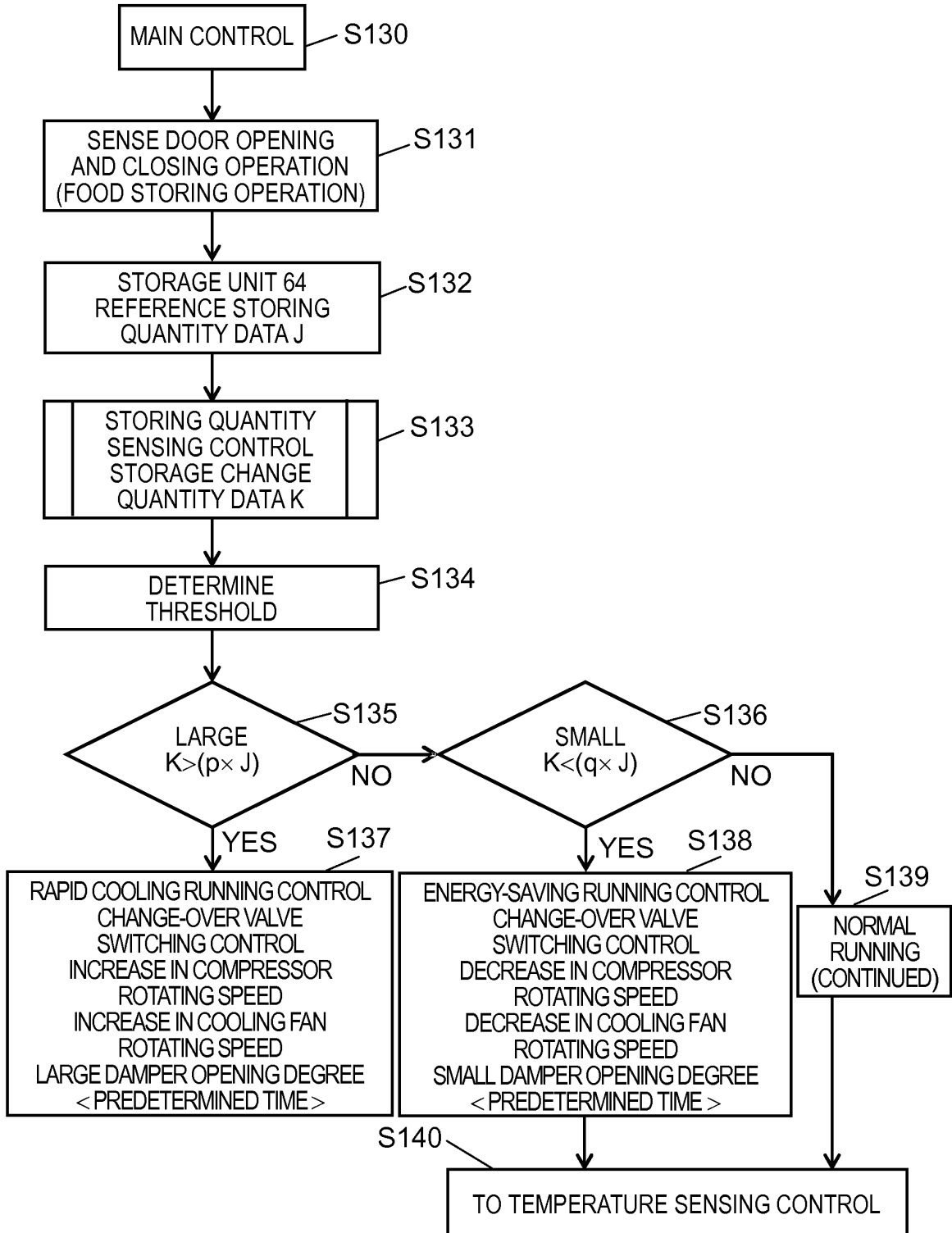


FIG. 10

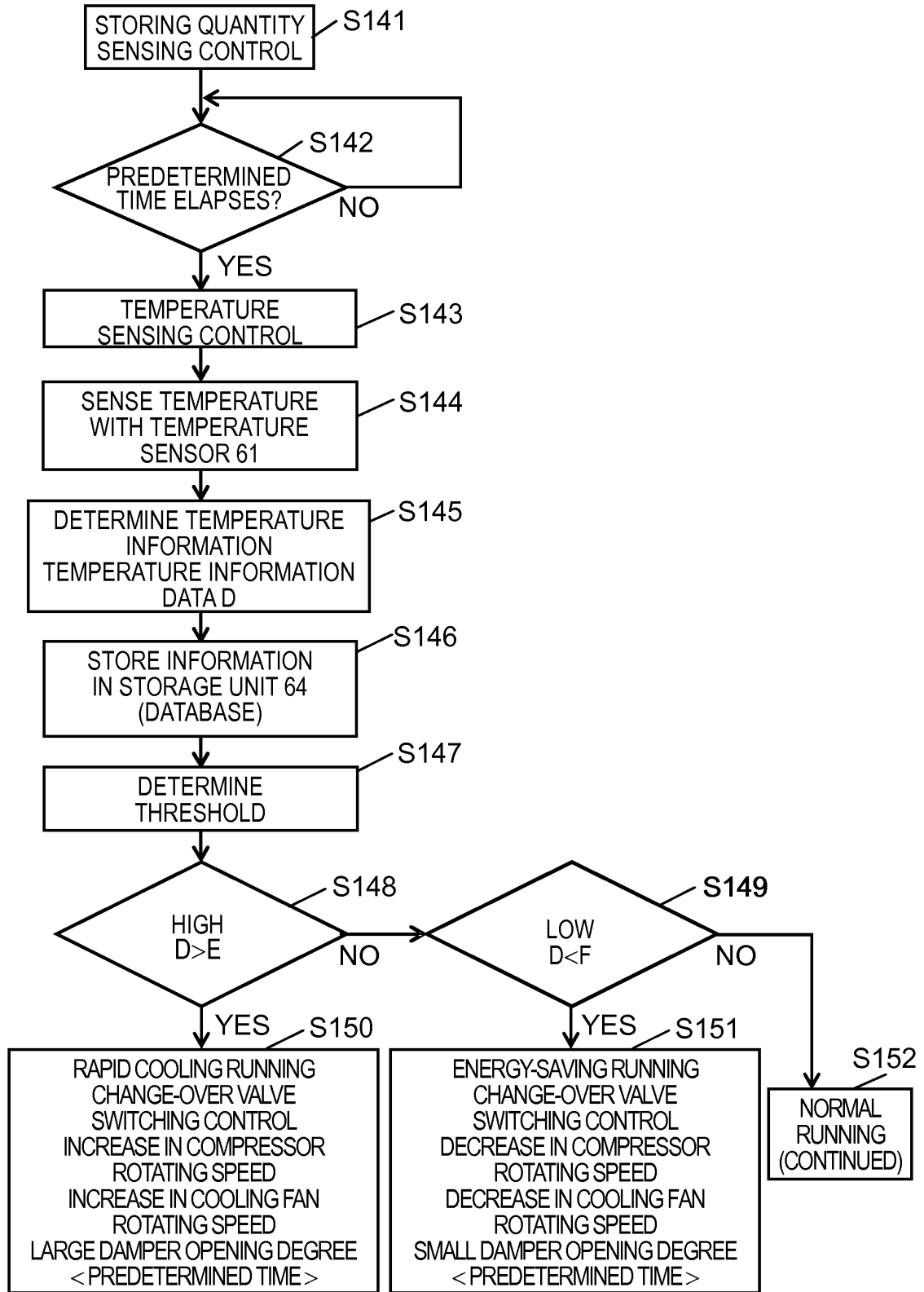


FIG. 11A

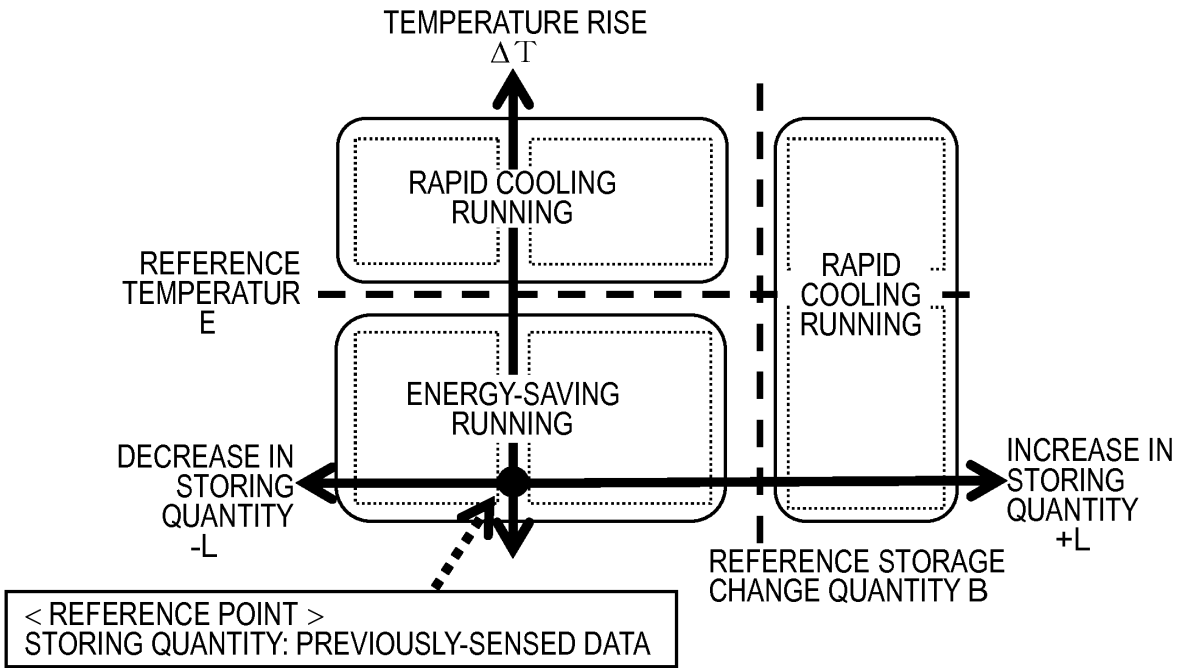


FIG. 11B

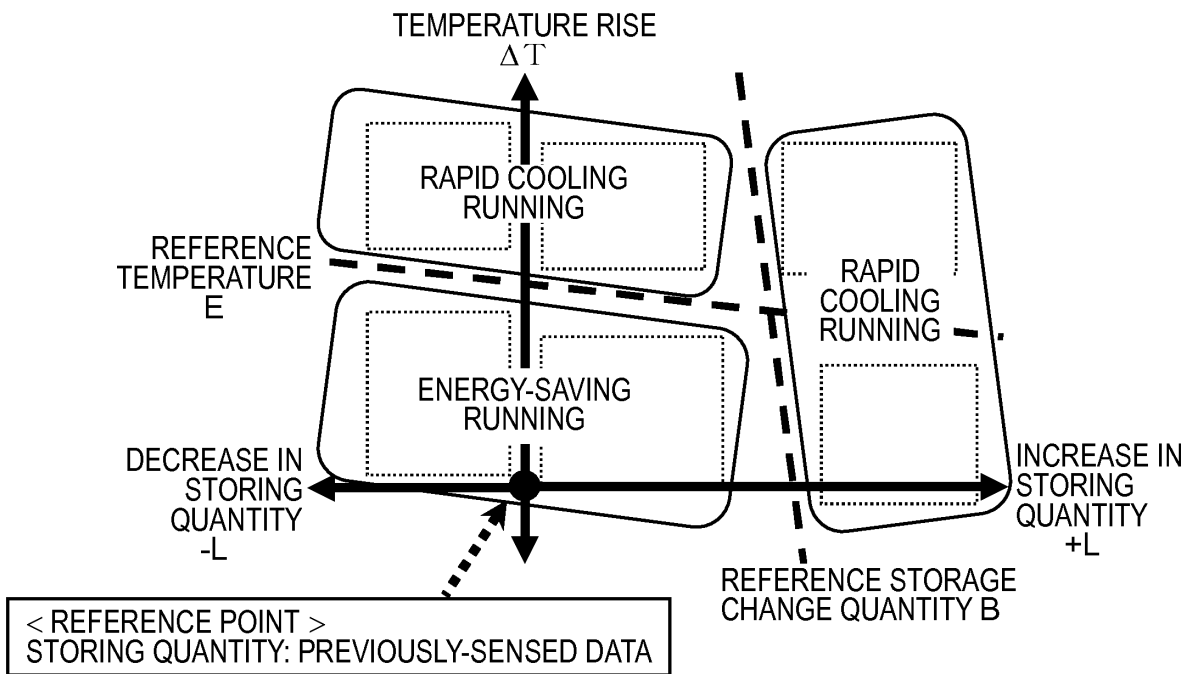


FIG. 12

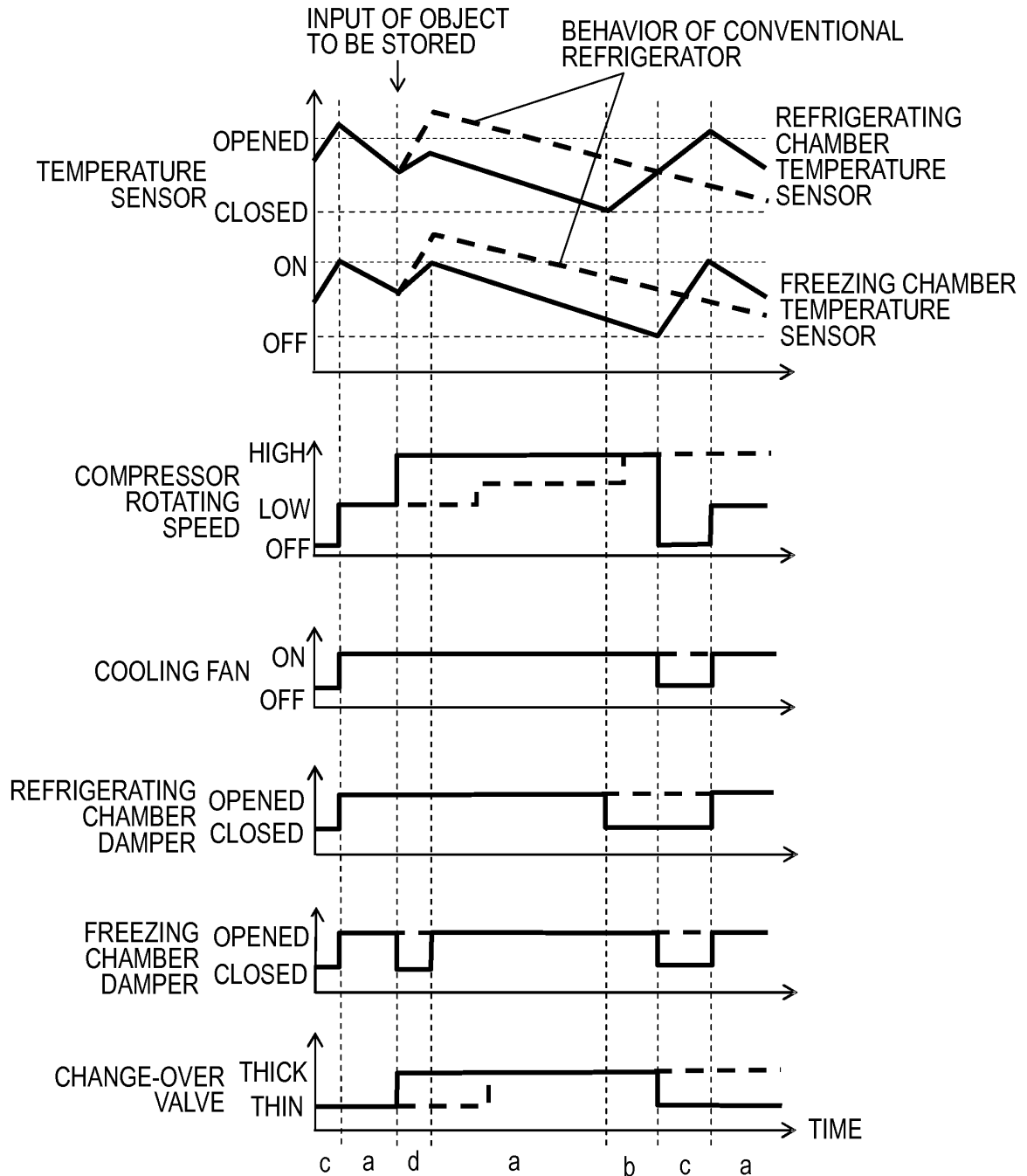


FIG. 13

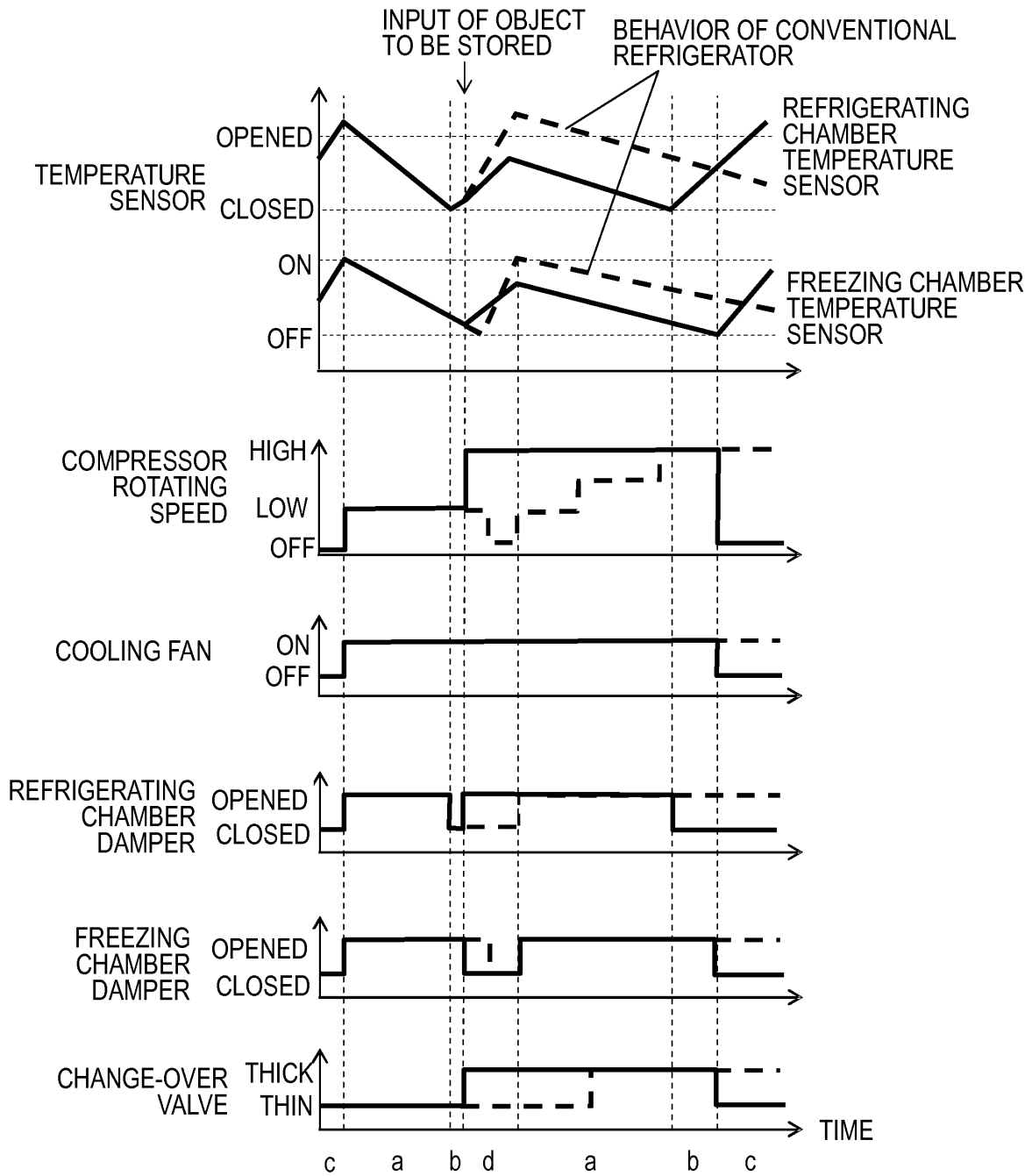


FIG. 14

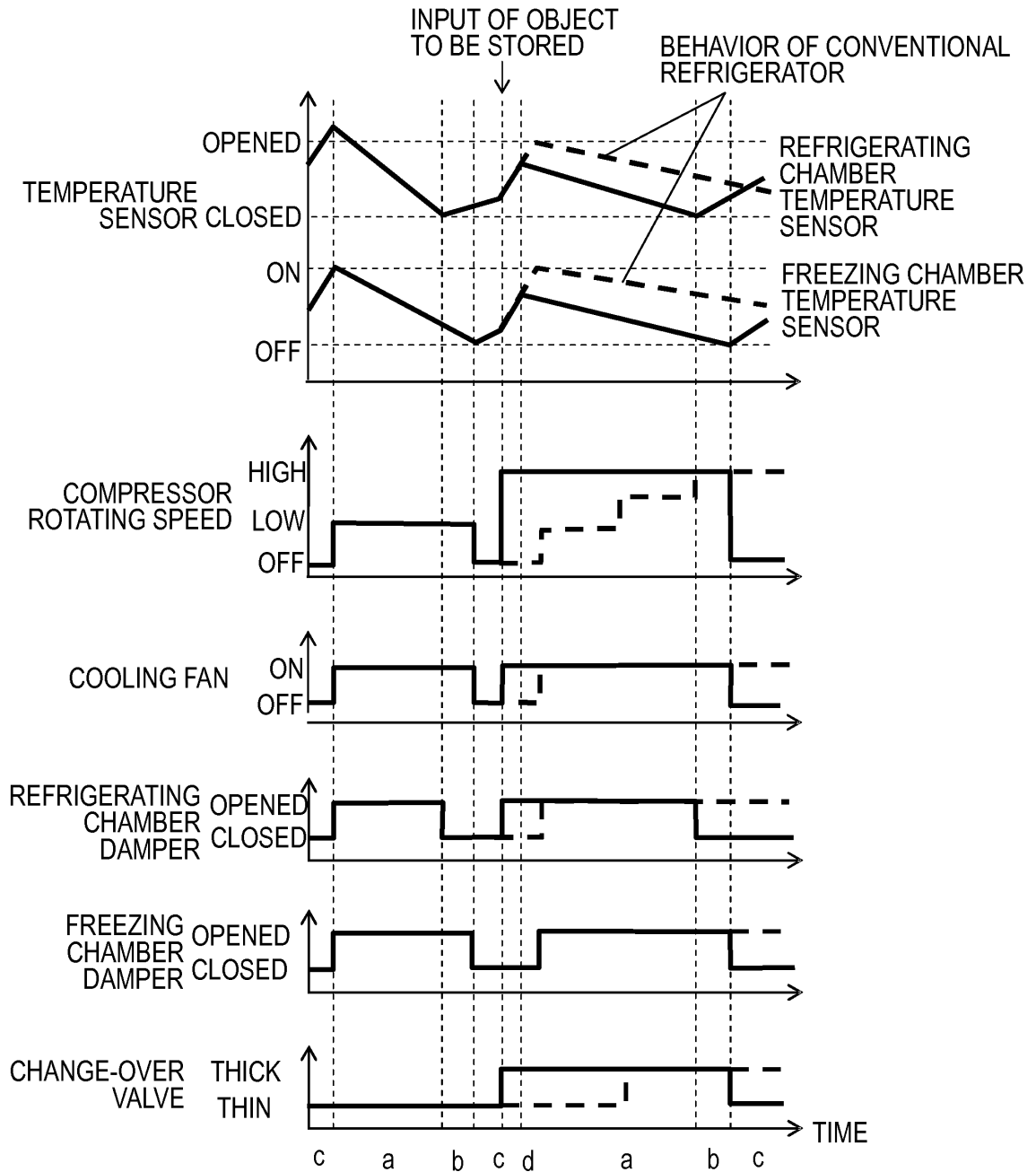


FIG. 15

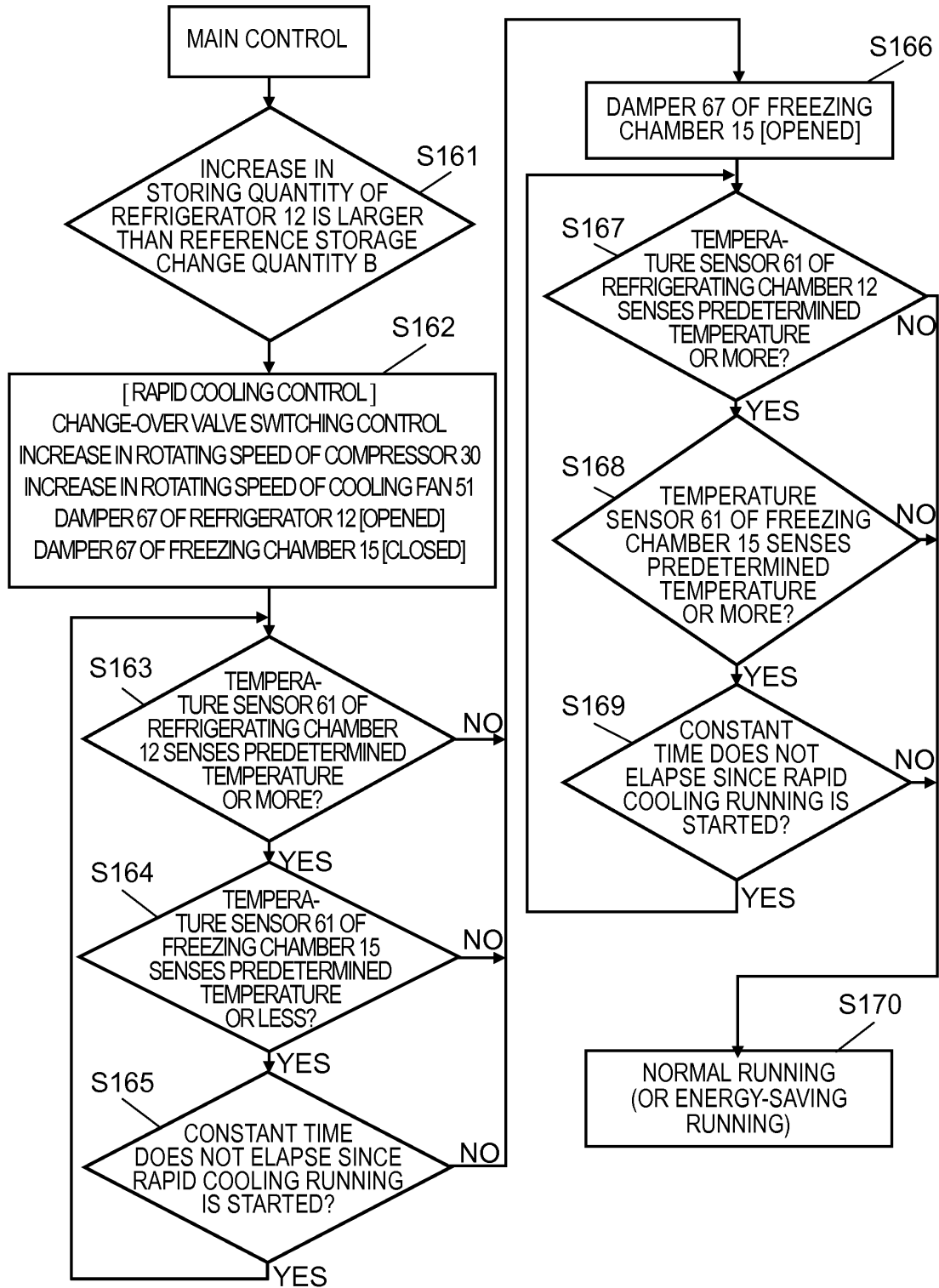


FIG. 16

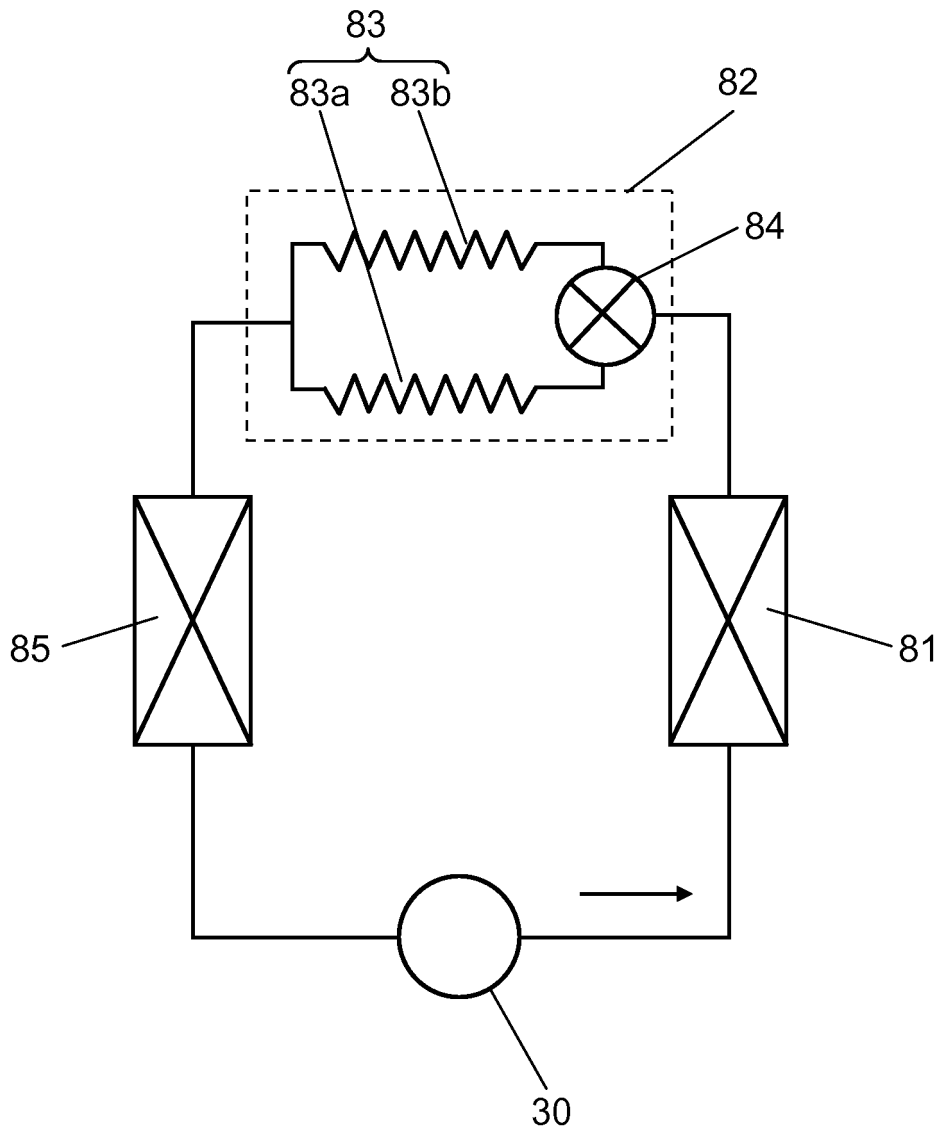


FIG. 17

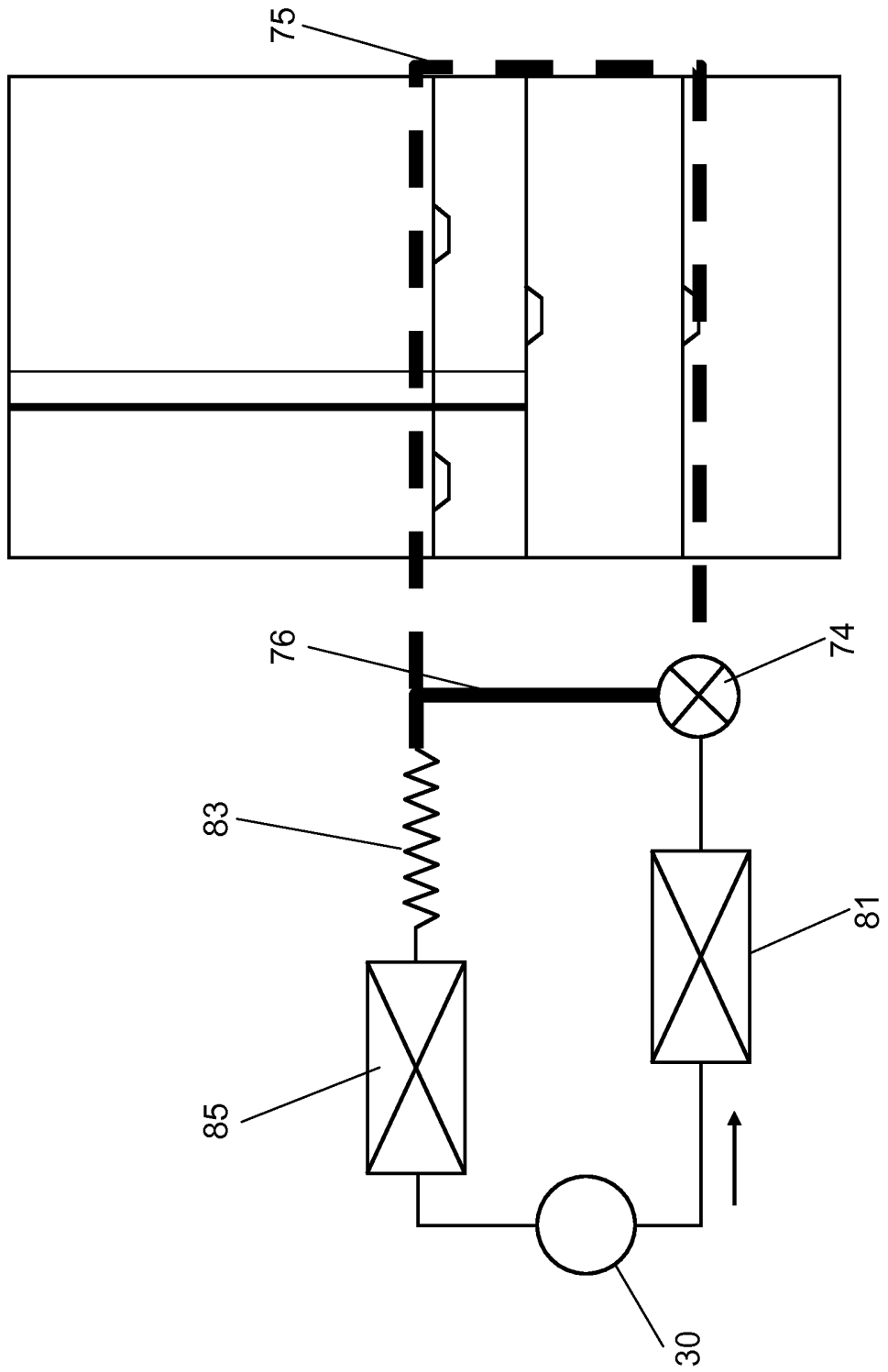


FIG. 18

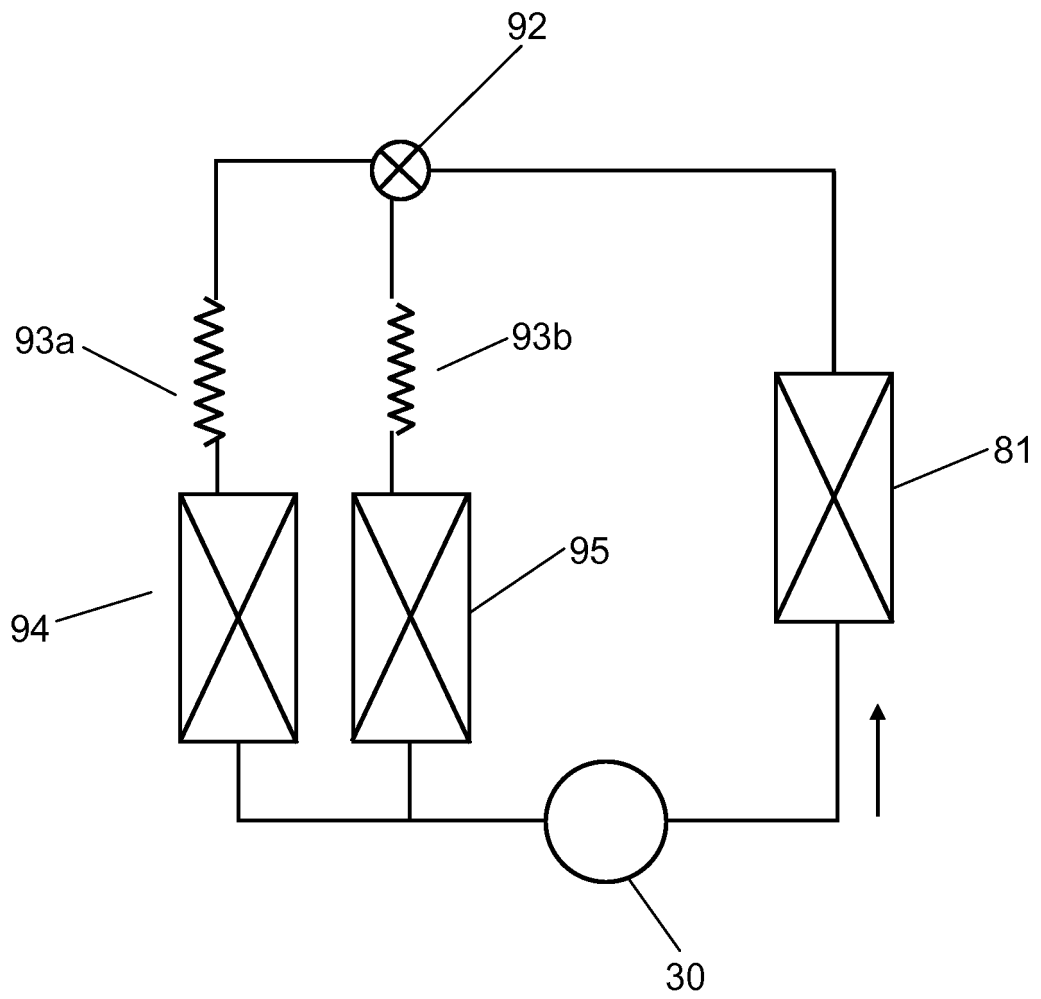


FIG. 19

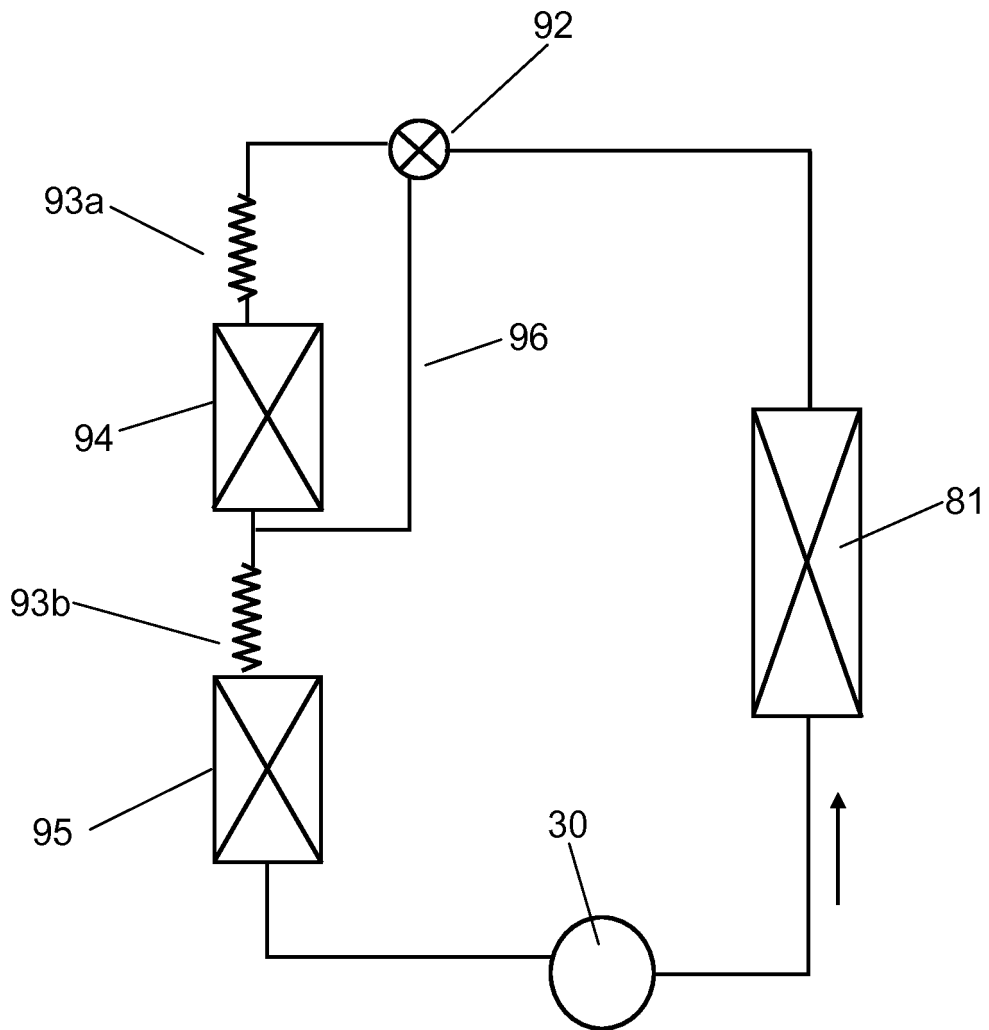


FIG. 20

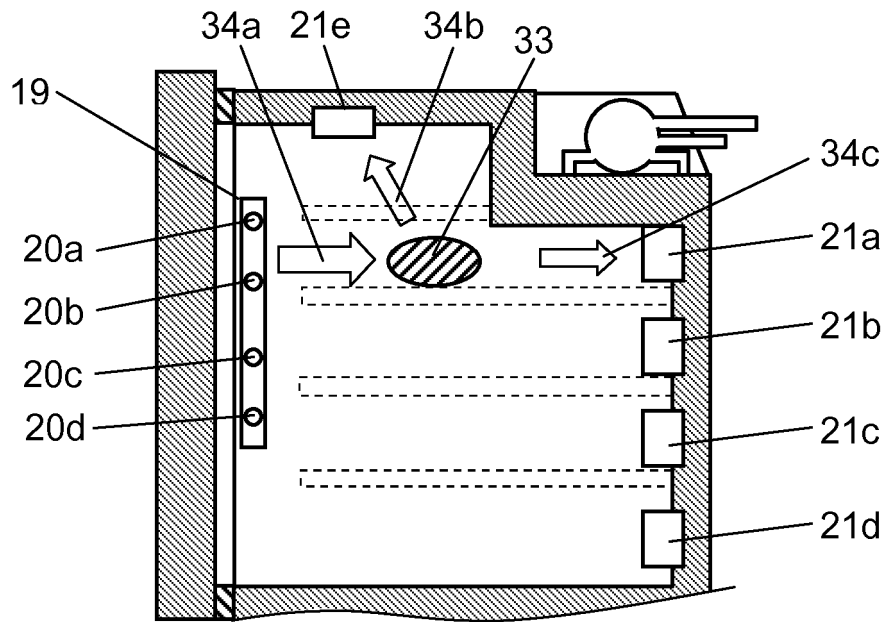


FIG. 21

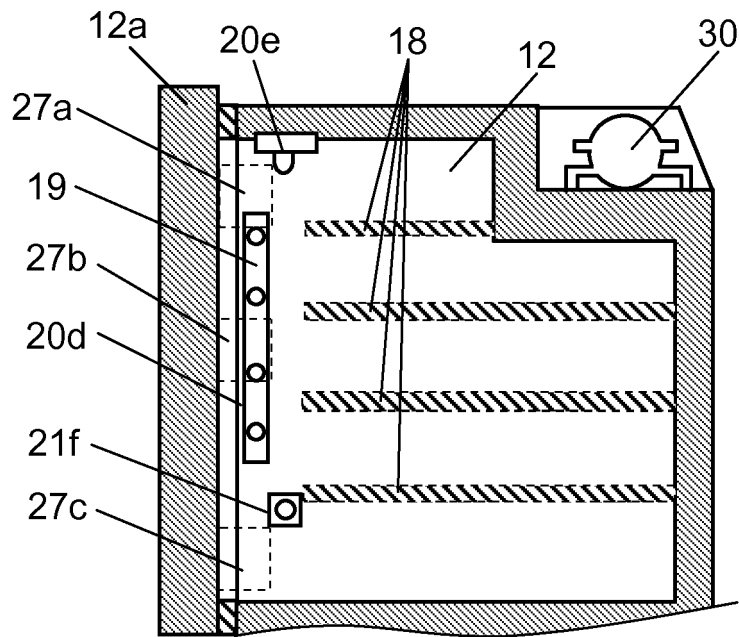


FIG. 22

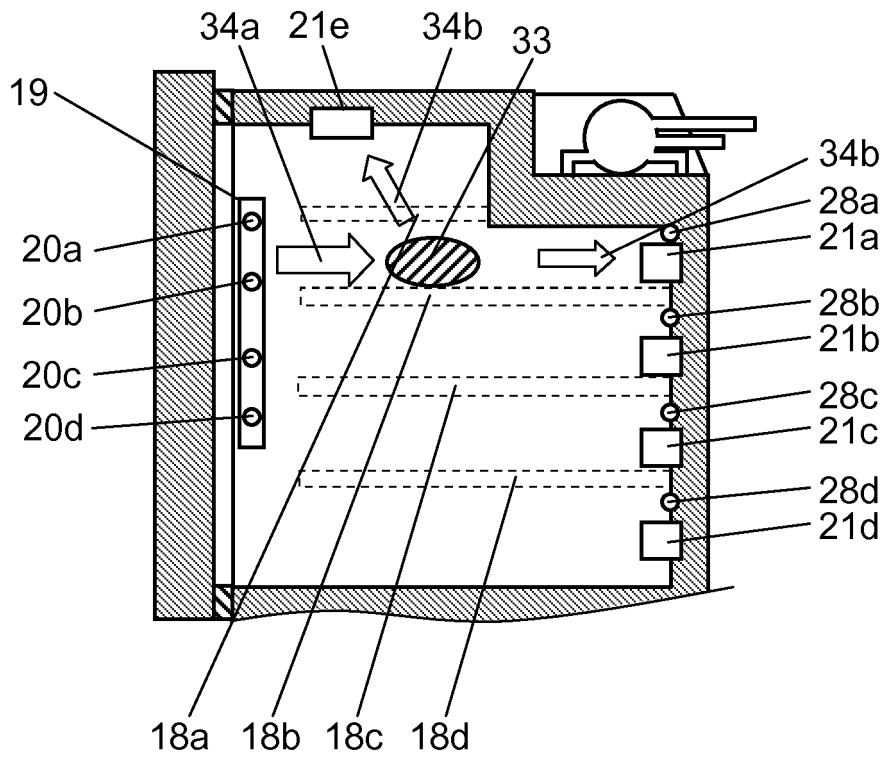


FIG. 23

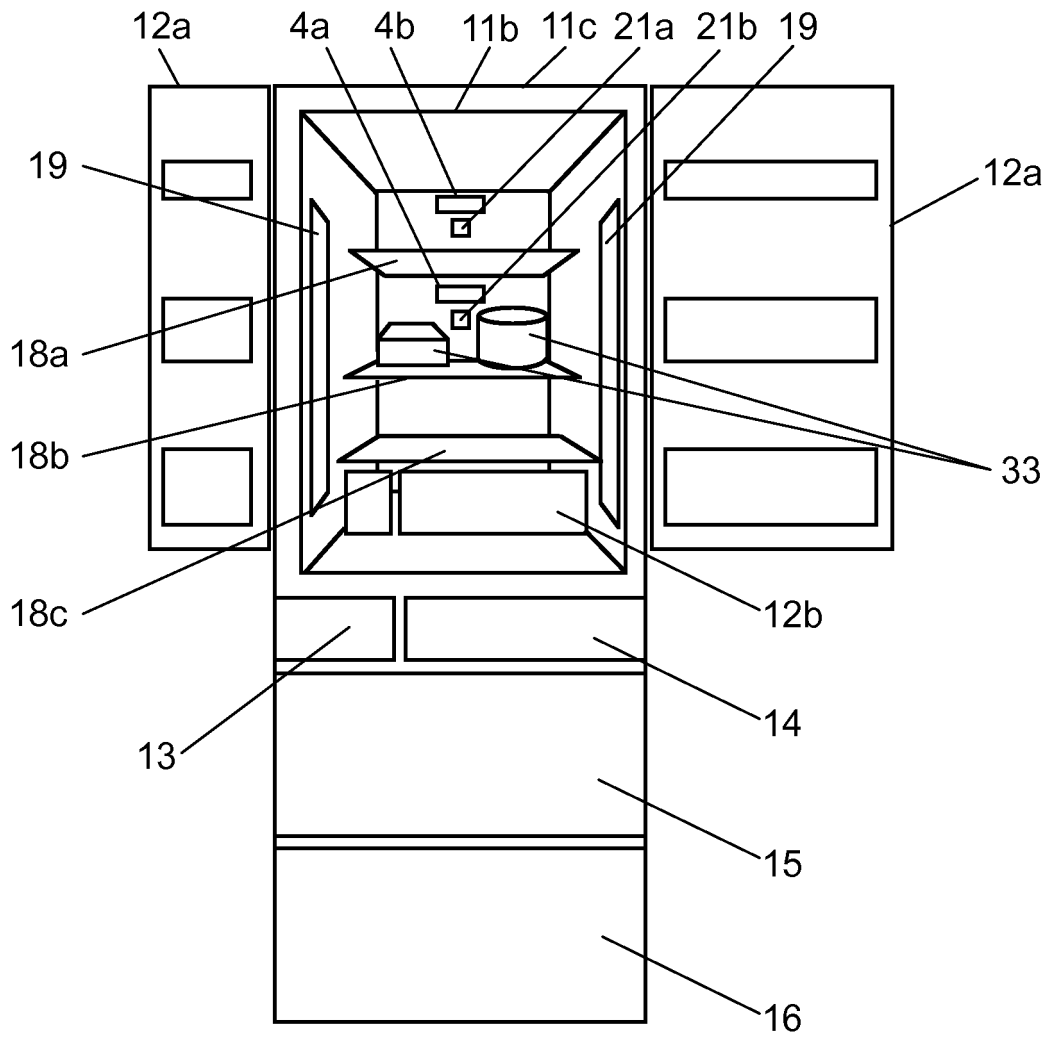


FIG. 24

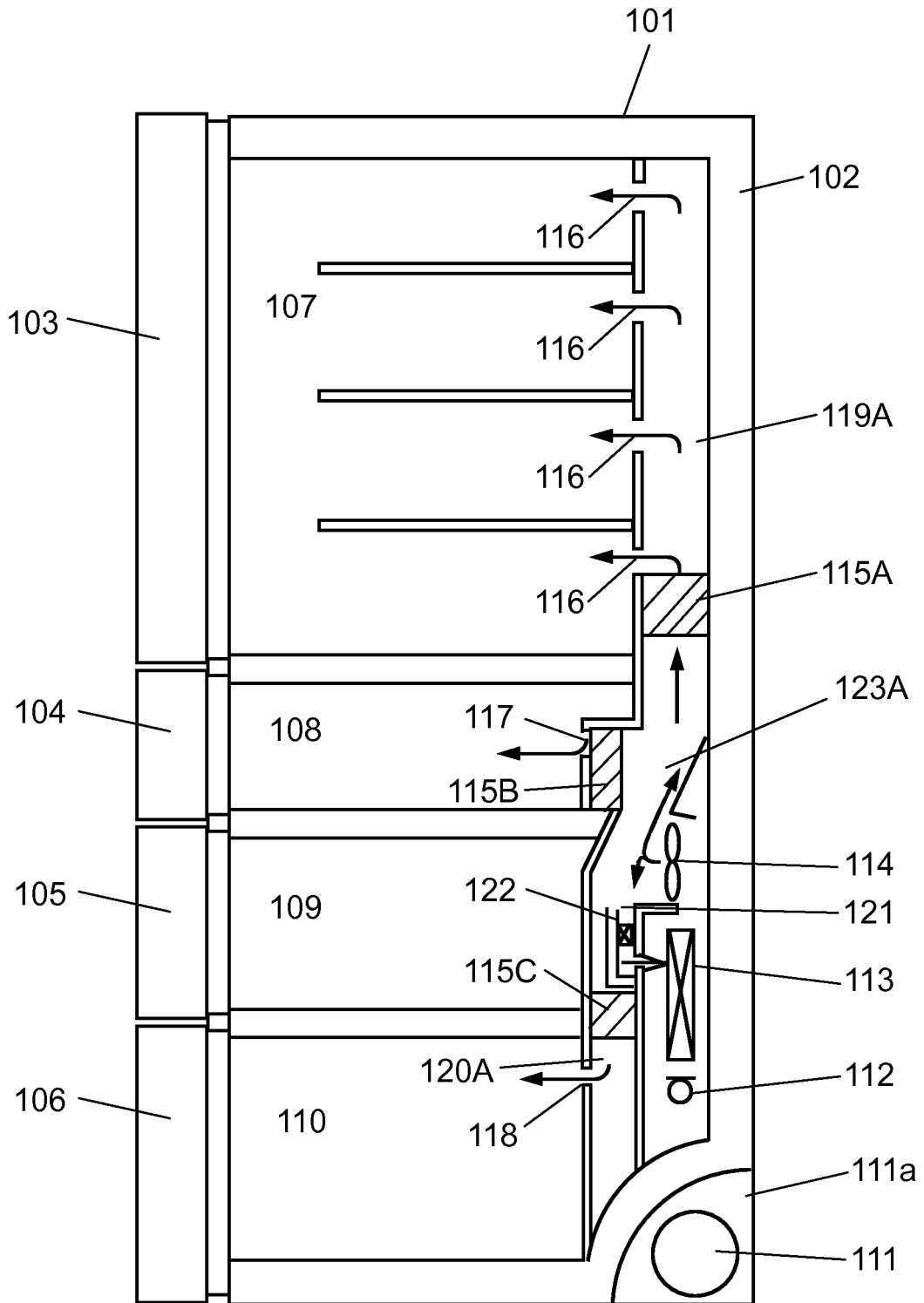
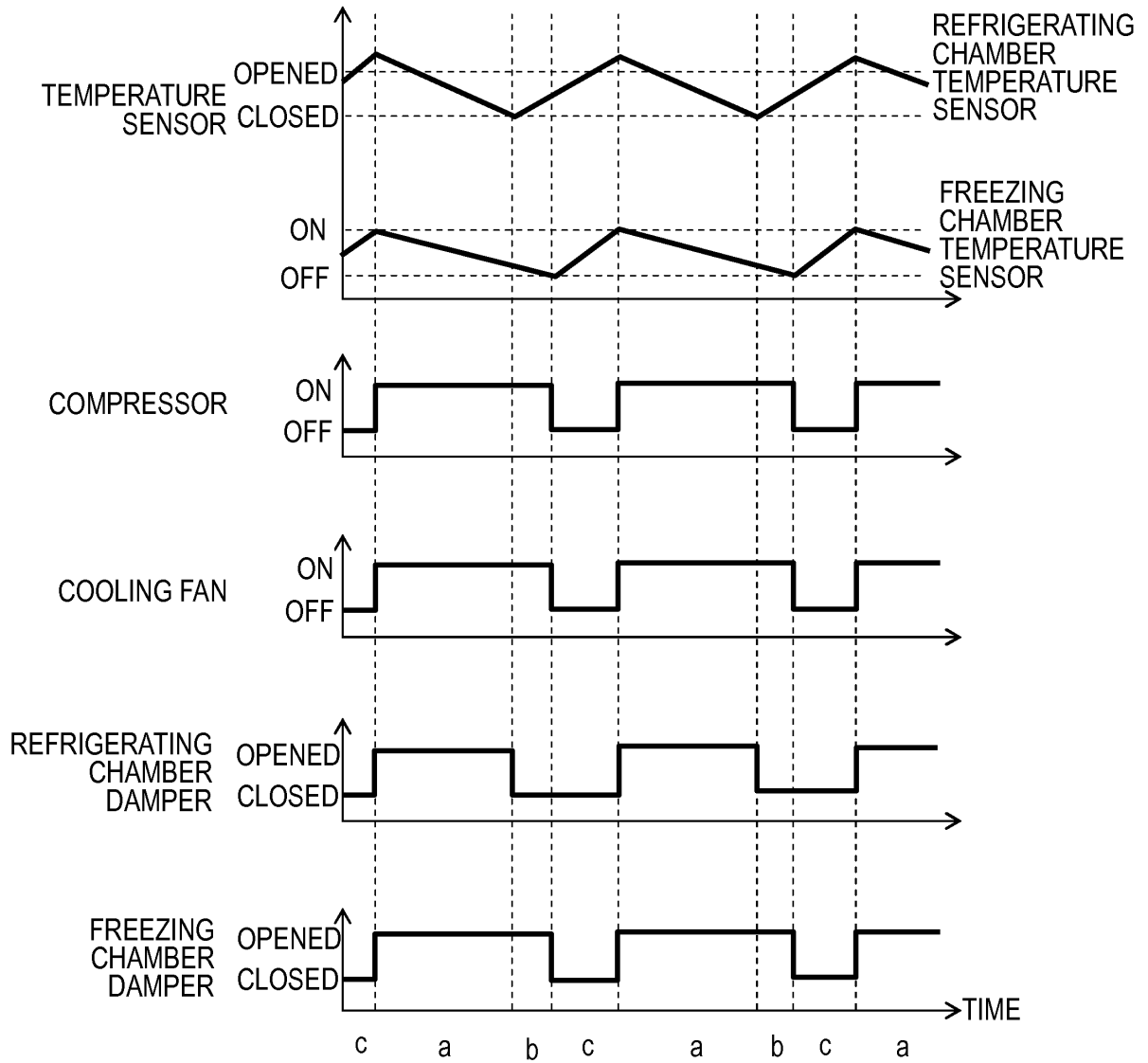


FIG. 25



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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2013/004336

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A. CLASSIFICATION OF SUBJECT MATTER
F25D11/02(2006.01)i, F25D17/08(2006.01)i, F25D23/00(2006.01)i, F25D27/00(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

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B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F25D11/02, F25D17/08, F25D23/00, F25D27/00

20

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2013
Kokai Jitsuyo Shinan Koho 1971-2013 Toroku Jitsuyo Shinan Koho 1994-2013

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

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Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 6-213548 A (Hitachi, Ltd.), 02 August 1994 (02.08.1994), entire text; all drawings (particularly, claim 3; paragraphs [0004], [0023] to [0033]; fig. 4 to 6) (Family: none)	1-4
Y	JP 2011-208906 A (Panasonic Corp.), 20 October 2011 (20.10.2011), entire text; all drawings (particularly, paragraphs [0004] to [0017], [0057]; fig. 4) (Family: none)	1-4

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Further documents are listed in the continuation of Box C. See patent family annex.

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 "P" document published prior to the international filing date but later than the priority date claimed
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Date of the actual completion of the international search
02 October, 2013 (02.10.13)

Date of mailing of the international search report
15 October, 2013 (15.10.13)

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Name and mailing address of the ISA/
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INTERNATIONAL SEARCH REPORT

International application No. PCT/JP2013/004336
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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2003-42646 A (Mitsubishi Electric Corp.), 13 February 2003 (13.02.2003), entire text; all drawings (particularly, paragraph [0022]; fig. 2) & US 2003/0024254 A1 & TW 561237 B & CN 1400444 A & SG 94871 A	3
Y	WO 2011/111382 A1 (Panasonic Corp.), 15 September 2011 (15.09.2011), entire text; all drawings (particularly, paragraph [0103]; fig. 8) & EP 2525171 A1 & WO 2011/111382 A & WO 2011/111382 A1 & CN 102770728 A	4

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2003042646 A [0019]