US012385682B2

(12) **United States Patent**
Park et al.

(10) **Patent No.: US 12,385,682 B2**
(45) **Date of Patent: Aug. 12, 2025**

(54) **REFRIGERATOR**

(71) Applicant: **LG ELECTRONICS INC**, Seoul (KR)

(72) Inventors: **Kyong Bae Park**, Seoul (KR); **Sangbok Choi**, Seoul (KR); **Sungwook Kim**, Seoul (KR)

(73) Assignee: **LG ELECTRONICS INC.**, Seoul (KR)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 175 days.

(21) Appl. No.: **18/019,337**

(22) PCT Filed: **Jul. 19, 2021**

(86) PCT No.: **PCT/KR2021/009252**

§ 371 (c)(1),
(2) Date: **Feb. 2, 2023**

(87) PCT Pub. No.: **WO2022/030806**

PCT Pub. Date: **Feb. 10, 2022**

(65) **Prior Publication Data**

US 2023/0304723 A1 Sep. 28, 2023

(30) **Foreign Application Priority Data**

Aug. 6, 2020 (KR) 10-2020-0098359

(51) **Int. Cl.**
F25D 17/08 (2006.01)
F25D 21/02 (2006.01)

(52) **U.S. Cl.**
CPC ***F25D 17/08*** (2013.01); ***F25D 21/02*** (2013.01); *F25B 2700/11* (2013.01); *F25D 2700/121* (2013.01); *F25D 2700/14* (2013.01)

(58) **Field of Classification Search**
CPC F25D 17/08; F25D 17/067; F25D 21/02; F25D 21/002; F25D 21/004; F25D 21/006; F25D 21/008; F25D 21/025; F25D 2700/121; F25D 2700/14; F25D 2700/10
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

3,355,904 A * 12/1967 Sutton, Jr. G05D 11/13 73/196
3,465,534 A * 9/1969 Schweiger G01P 5/12 62/276
3,643,457 A * 2/1972 Winkler F24F 5/001 62/151
11,493,260 B1 * 11/2022 Carden F25D 21/008
(Continued)

FOREIGN PATENT DOCUMENTS

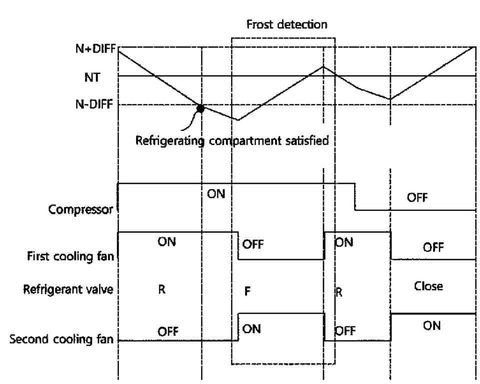
DE 102006048880 A1 * 4/2008 .... F25D 21/002
EP 2722619 A 4/2014
(Continued)

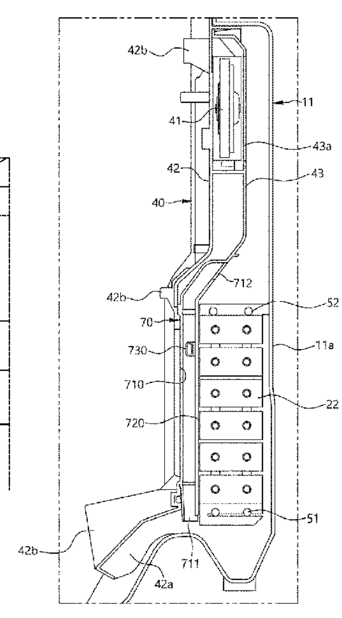
Primary Examiner — Andrew Roersma
(74) *Attorney, Agent, or Firm* — Bryan Cave Leighton Paisner LLP

(57) **ABSTRACT**

A refrigerator is configured such that a controller may control the frost detecting operation to be differently performed on the basis of at least one of a room temperature and a set reference temperature. Thus, precise frosting detection may be performed and power consumption due to the frosting detection may be minimized, and power consumption efficiency may be improved.

13 Claims, 16 Drawing Sheets





(56) **References Cited**

U.S. PATENT DOCUMENTS

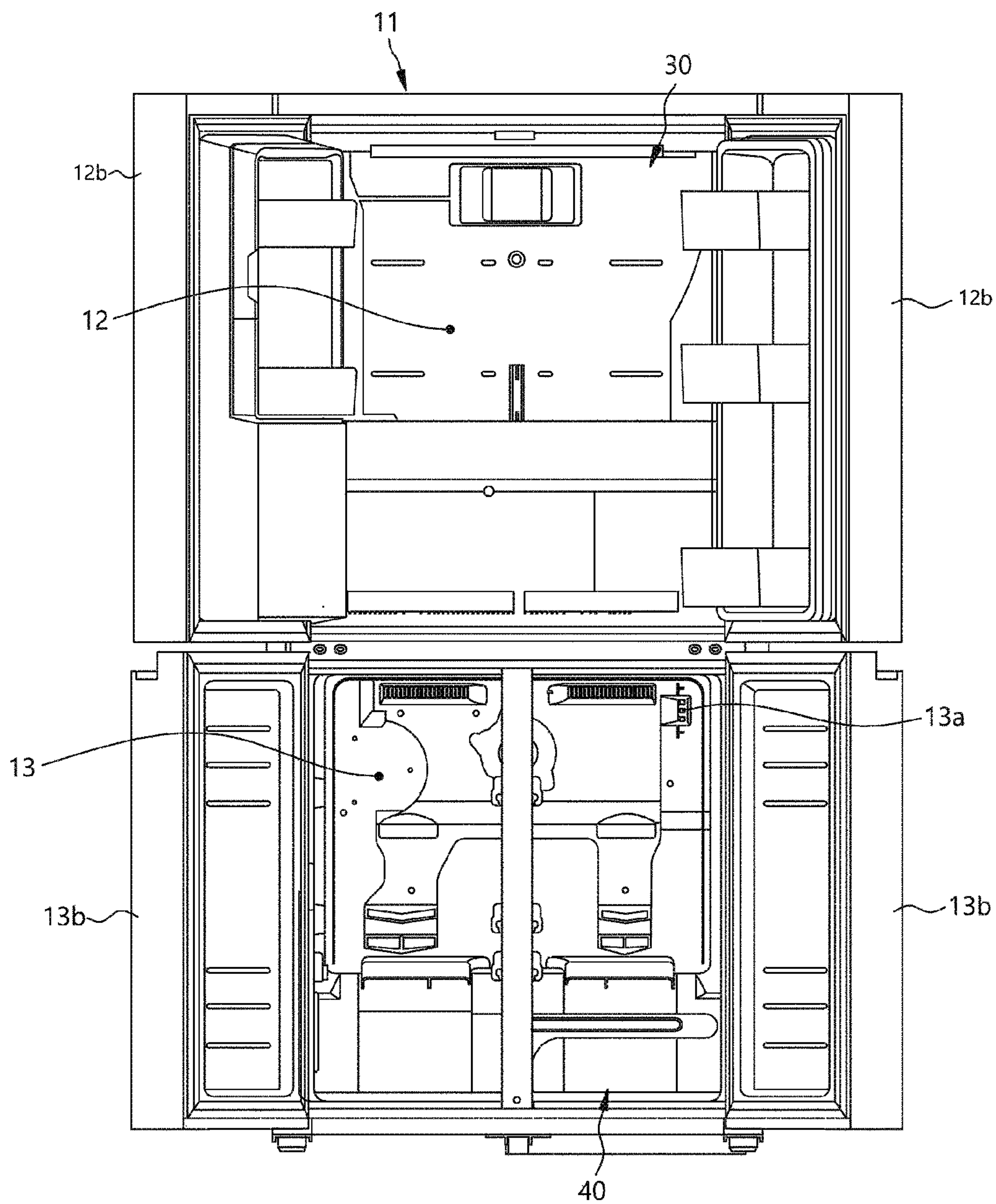
2014/0053581	A1*	2/2014	Cho	F25D 21/008 62/155
2018/0274827	A1*	9/2018	Kim	F25B 21/04
2019/0072310	A1*	3/2019	Choi	F25D 21/006
2019/0271497	A1*	9/2019	Guanye	F25B 5/00
2020/0018526	A1	1/2020	Oh et al.	
2021/0127854	A1*	5/2021	Krishnamoorthy	A47F 3/043
2023/0280081	A1*	9/2023	Park	F25D 21/02 62/80
2023/0288123	A1*	9/2023	Park	F25B 47/02
2023/0288124	A1*	9/2023	Park	F25D 21/08
2023/0288125	A1*	9/2023	Park	F28D 1/0477
2024/0011697	A1*	1/2024	Park	F25D 21/08

FOREIGN PATENT DOCUMENTS

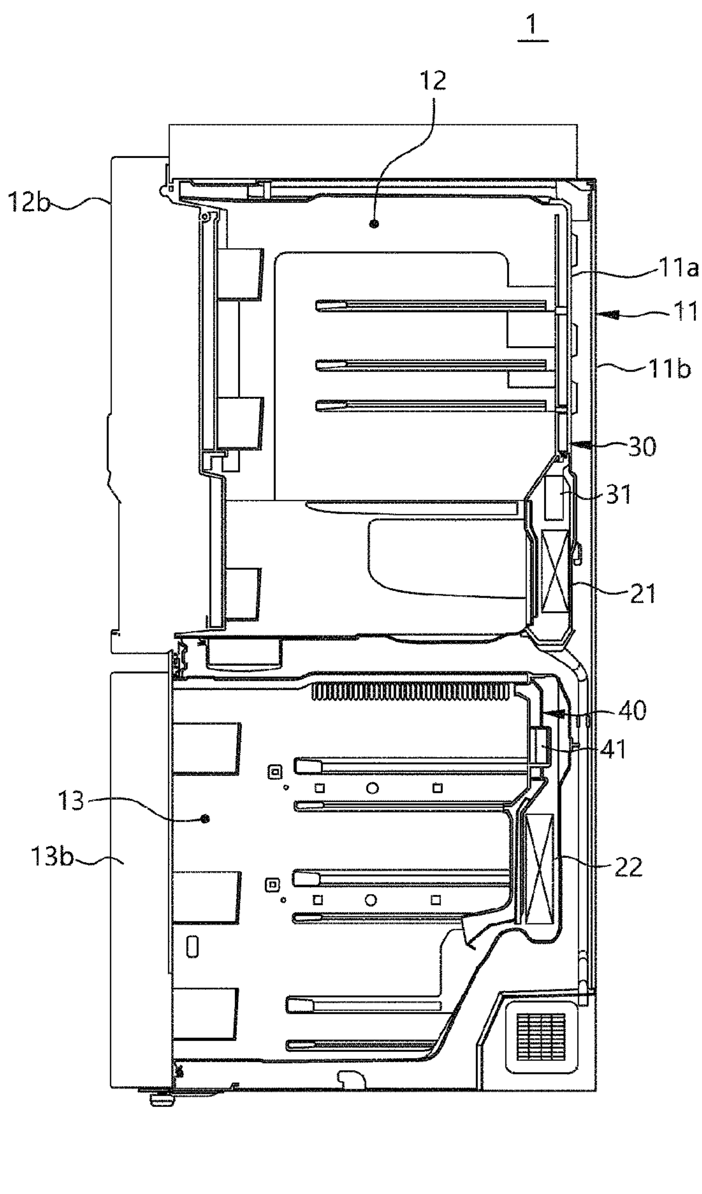
JP	6270375	A		3/2015	
JP	2019039586	A	*	3/2019	
KR	1020140050959	A	*	4/2014	
KR	10-2016-0027761	A		3/2016	
KR	10-2019-0112482	A		10/2019	
WO	WO-0235165	A1	*	5/2002	F25D 21/002
WO	2019190113	A1		3/2019	
WO	WO-2019190114	A1	*	10/2019	F25D 17/04

* cited by examiner

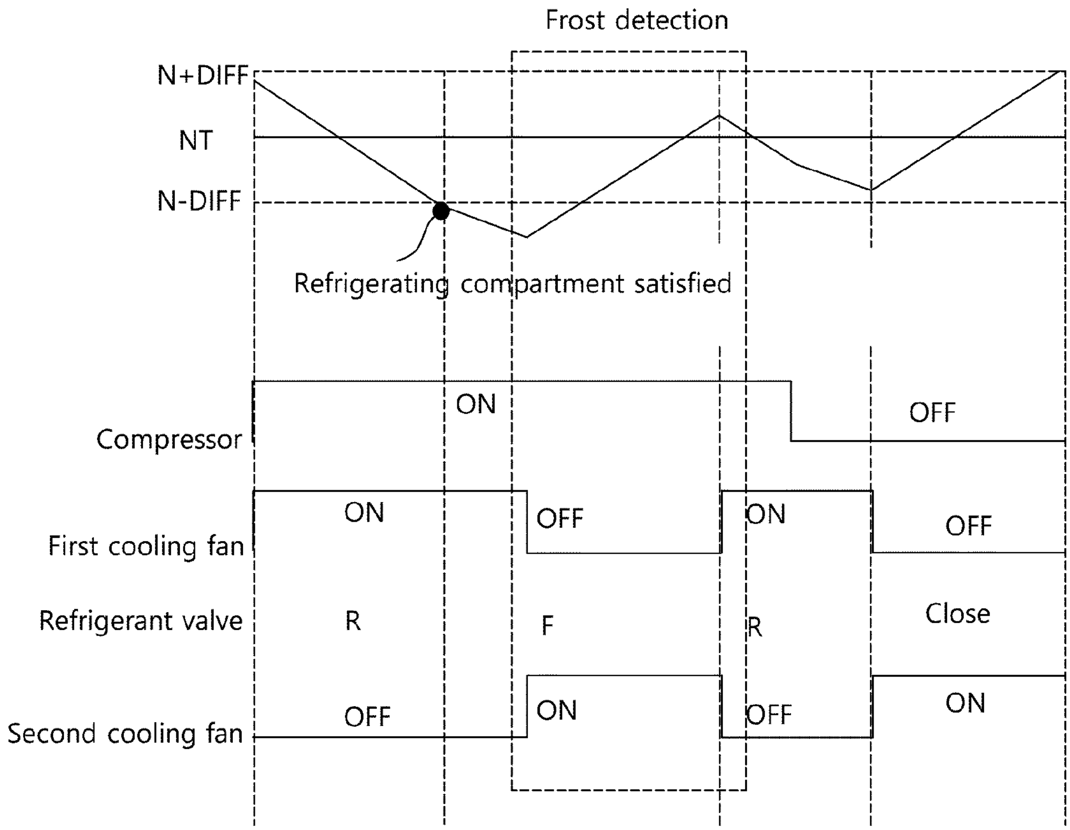
【Figure 1】



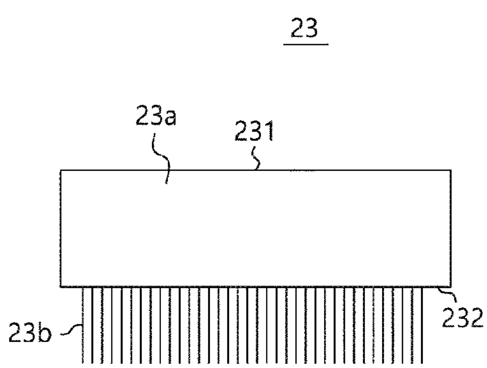
【Figure 2】



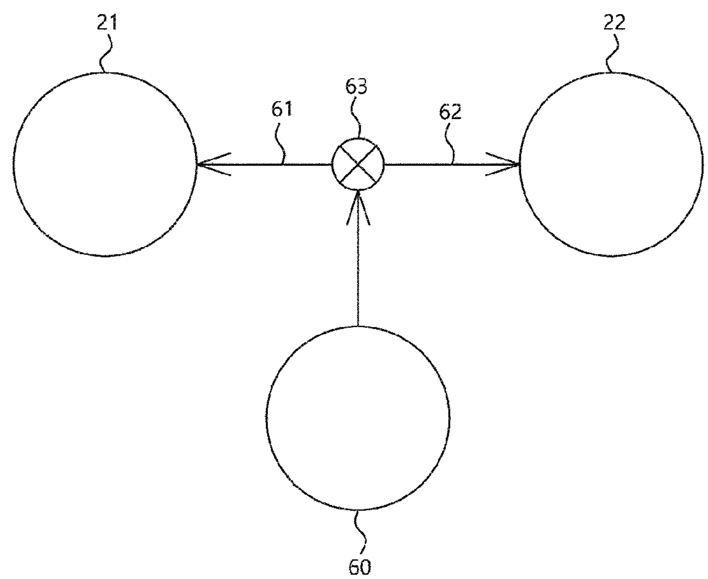
【Figure 3】



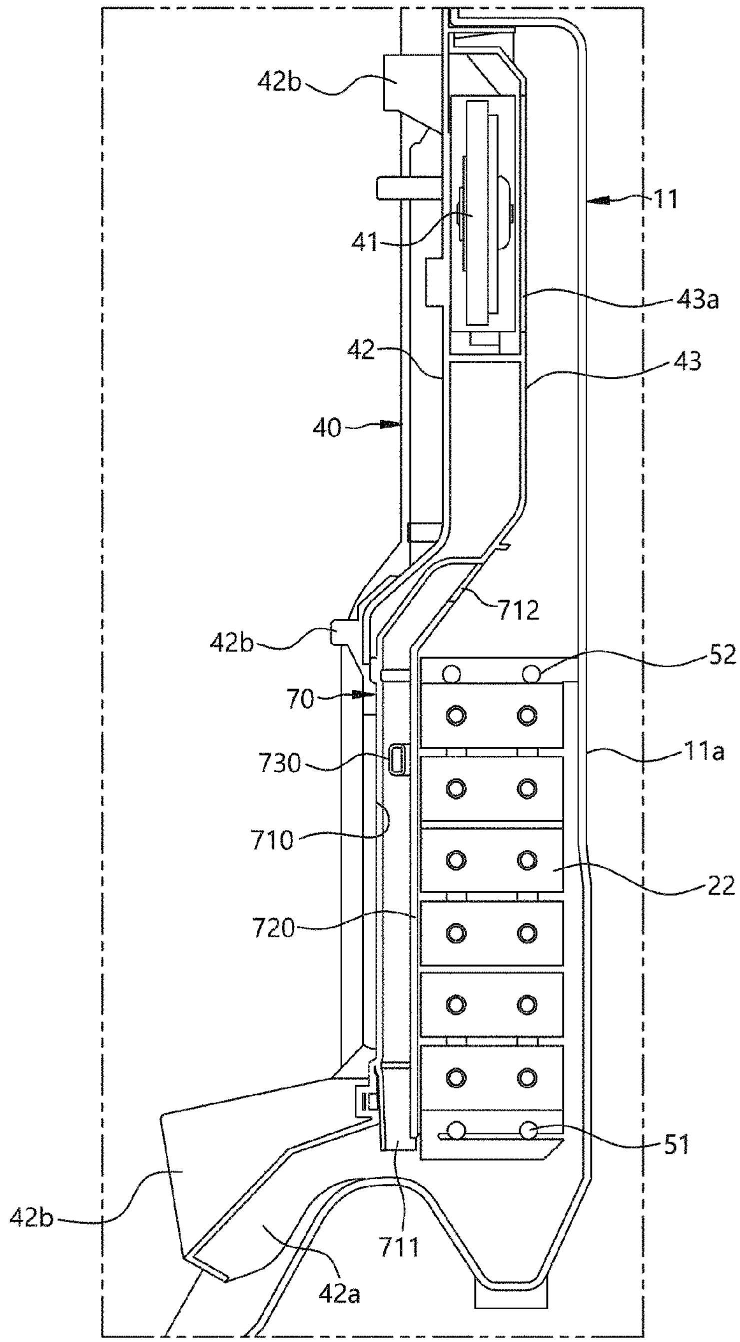
【Figure 4】



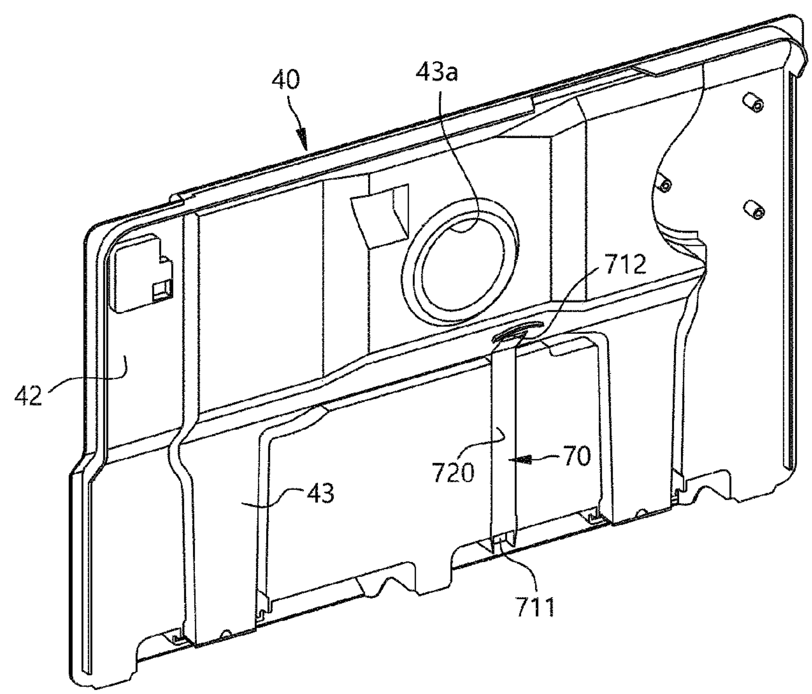
【Figure 5】



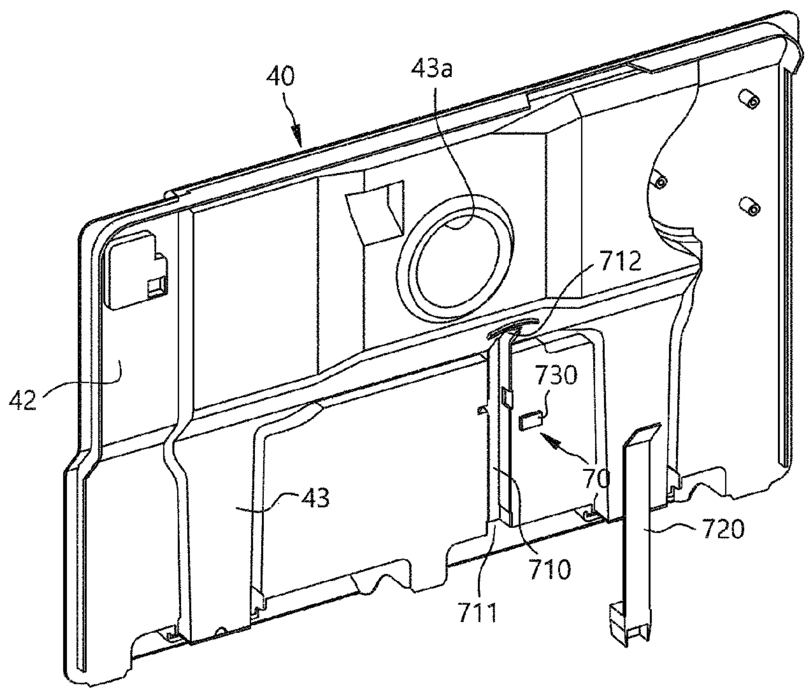
【Figure 6】


42b
11
41
43a
42
43
40
712
42b
52
70
730
11a
710
22
720
51
42b
711
42a

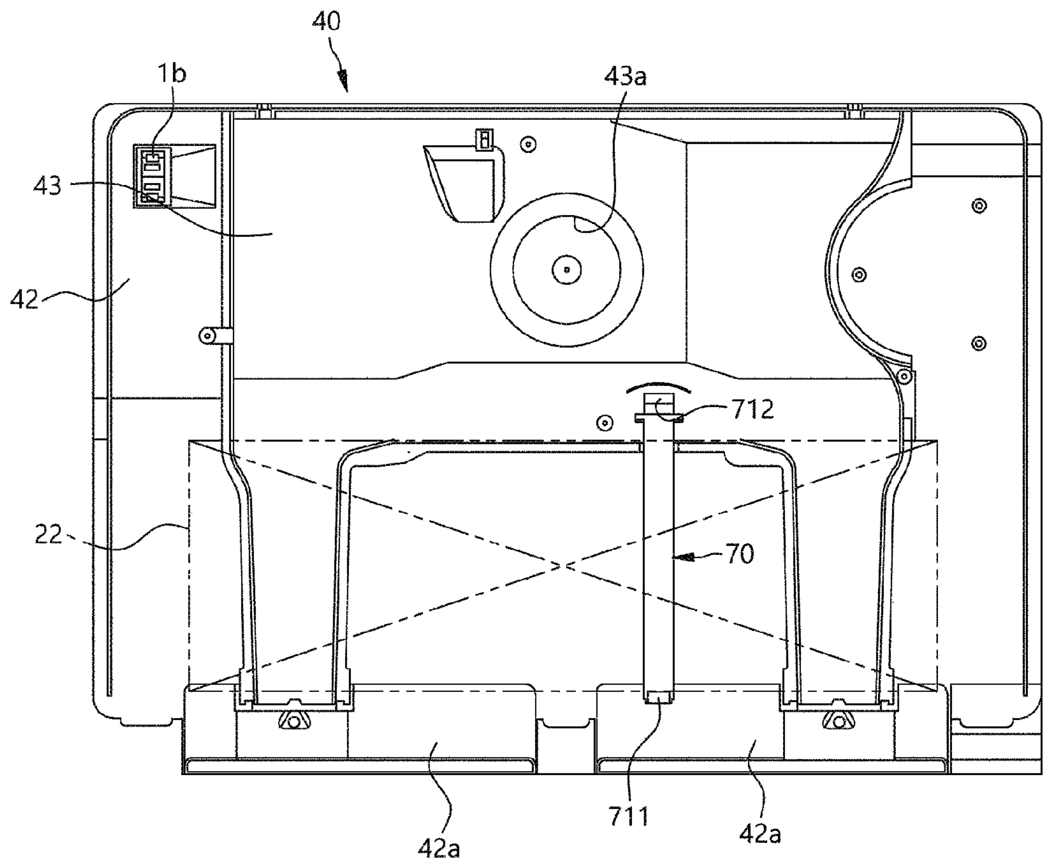
【Figure 7】



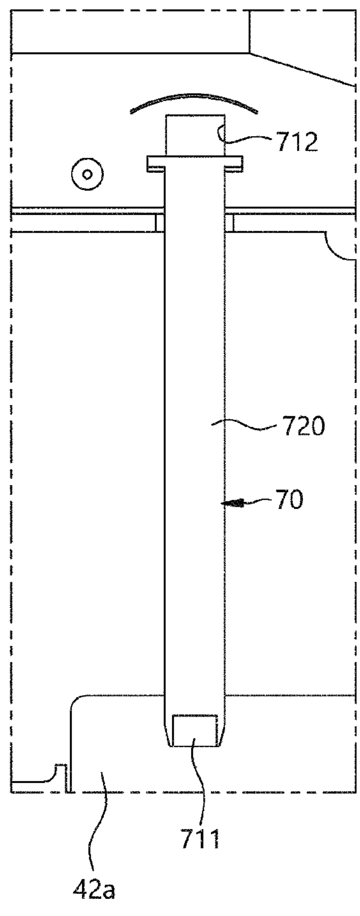
【Figure 8】



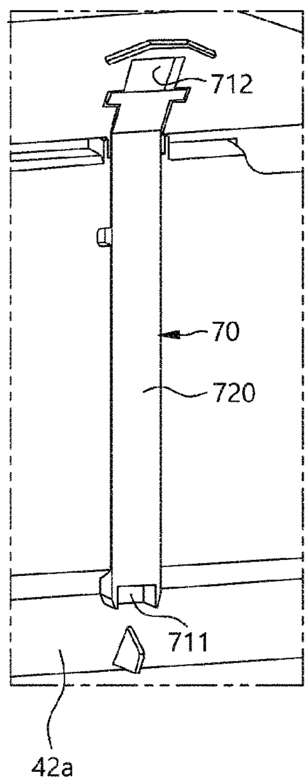
【Figure 9】



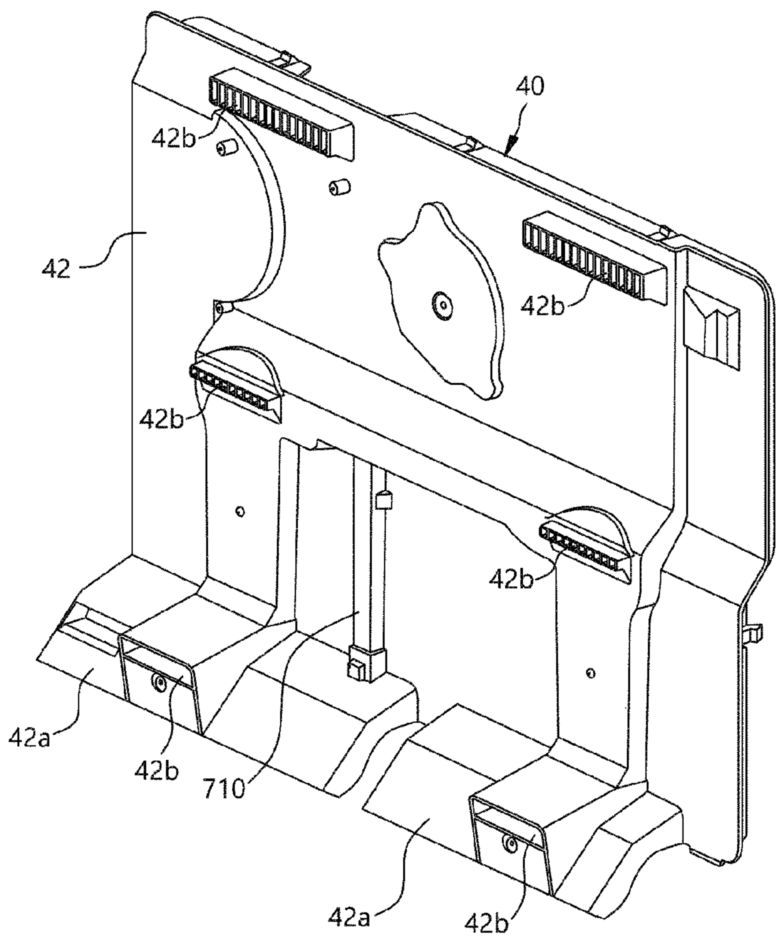
【Figure 10】



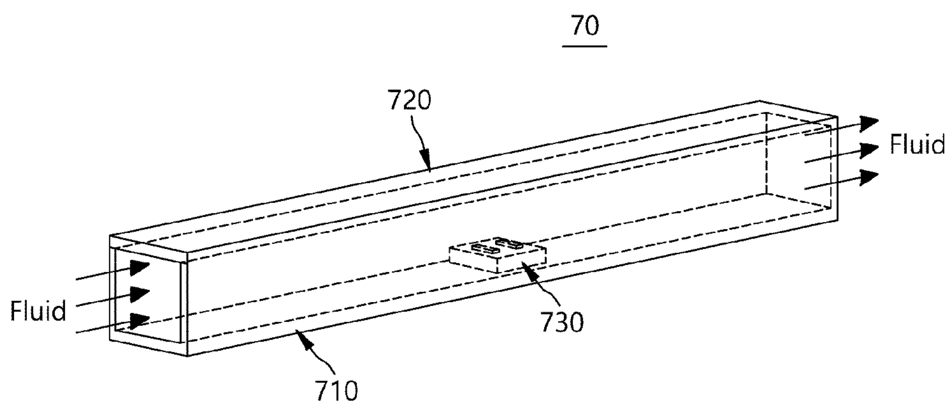
【Figure 11】



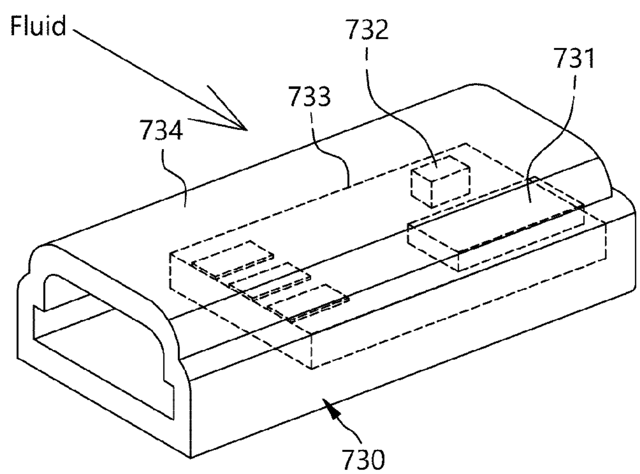
【Figure 12】



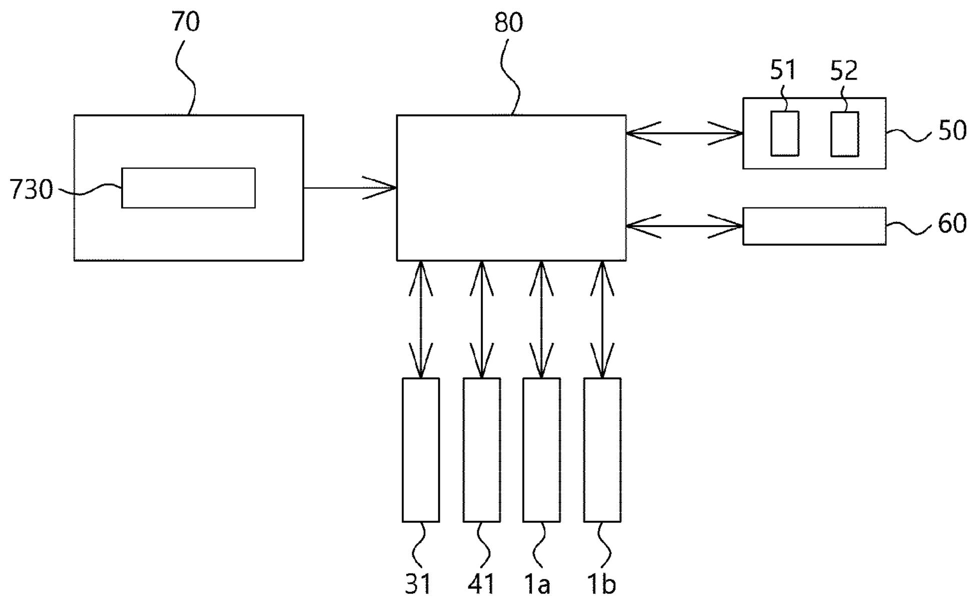
【Figure 13】



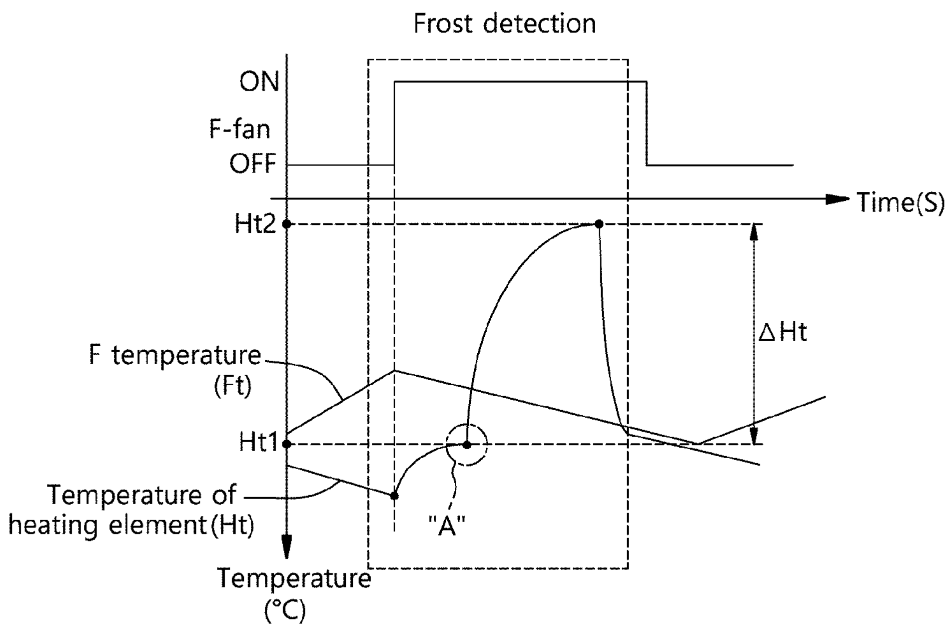
【Figure 14】



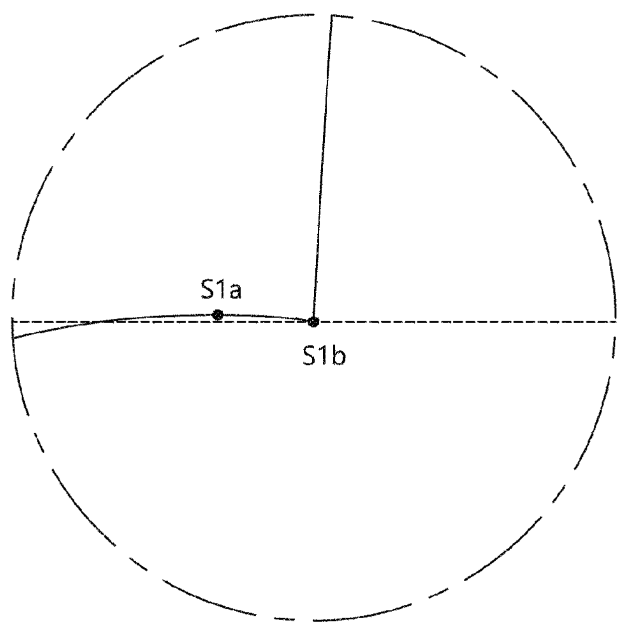
【Figure 15】



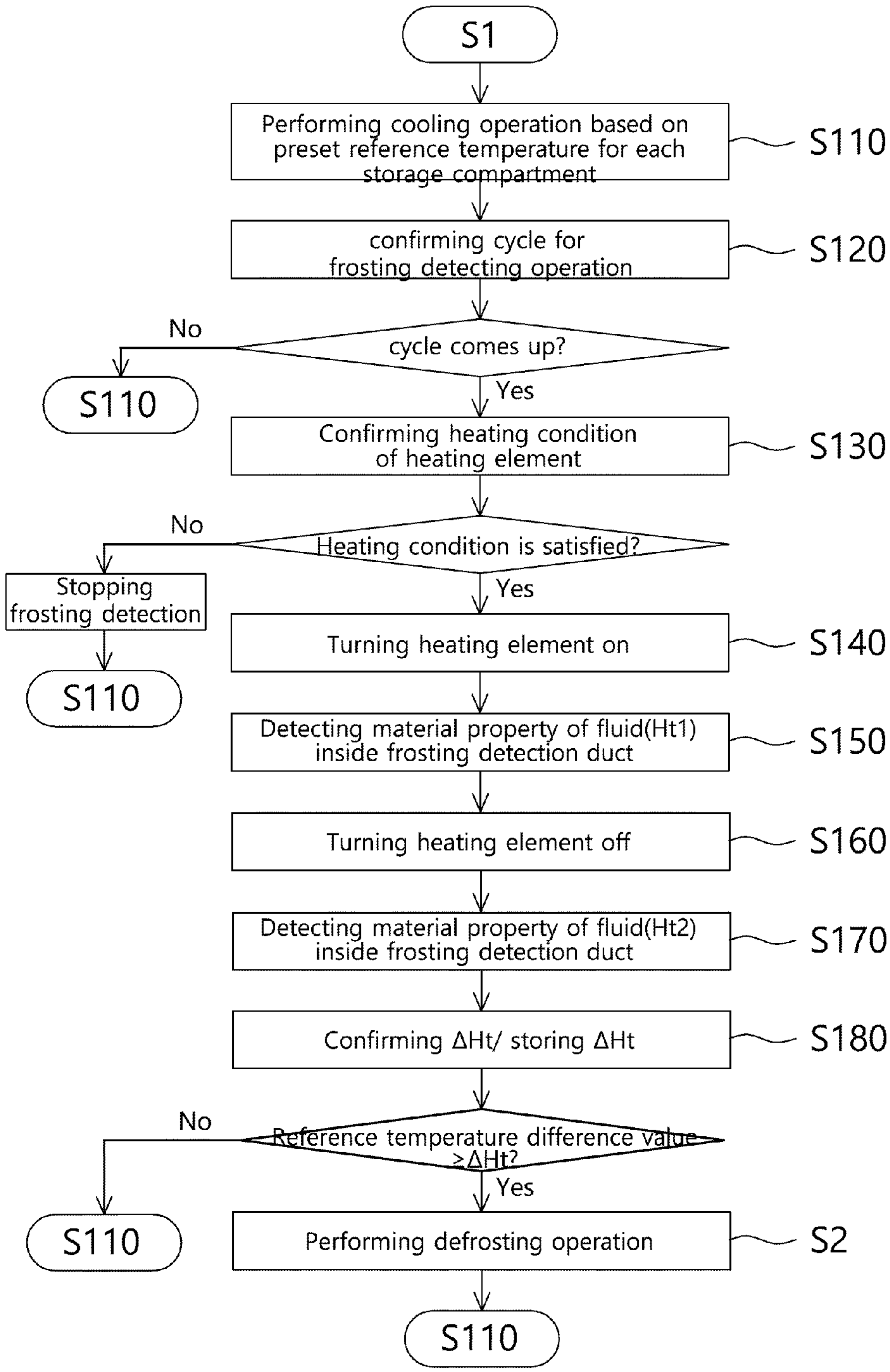
【Figure 16】



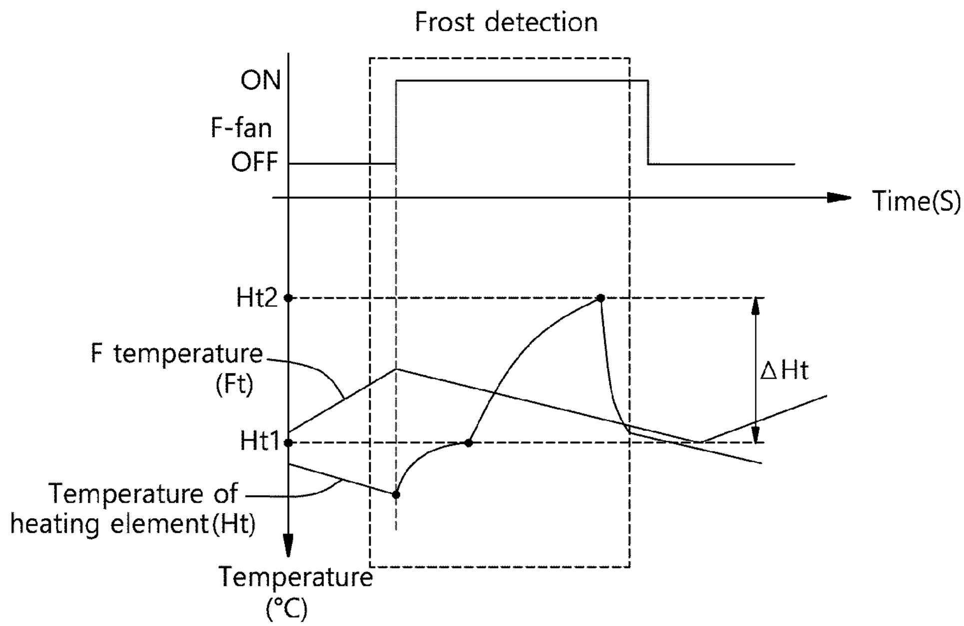
【Figure 17】



【Figure 18】


S1
Performing cooling operation based on preset reference temperature for each storage compartment
S110
confirming cycle for frosting detecting operation
S120
cycle comes up?
No
S110
Yes
Confirming heating condition of heating element
S130
Heating condition is satisfied?
No
Stopping frosting detection
S110
Yes
Turning heating element on
S140
Detecting material property of fluid(Ht1) inside frosting detection duct
S150
Turning heating element off
S160
Detecting material property of fluid(Ht2) inside frosting detection duct
S170
Confirming ΔHt/ storing ΔHt
S180
Reference temperature difference value ≥ΔHt?
No
S110
Yes
Performing defrosting operation
S2
S110

【Figure 19】


Frost detection
ON
F-fan
OFF
Time(S)
Ht2
F temperature
(Ft)
ΔHt
Ht1
Temperature of
heating element(Ht)
Temperature
(°C)

REFRIGERATOR

CROSS-REFERENCE TO RELATED APPLICATION

This application is the National Stage filing under 35 U.S.C. 371 of International Application No. PCT/KR2021/009252, filed Jul. 19, 2021, which claims priority to and the benefit of KR Patent Application No. 10-2020-0098359, filed Aug. 6, 2020, the disclosure of which is incorporated herein by reference in its entirety.

TECHNICAL FIELD

The present disclosure relates to a refrigerator that is configured to perform frosting detection with respect to a cooling source in consideration of cooling environment variable depending on what a user needs.

BACKGROUND

In general, a refrigerator is an appliance that uses cold air to store objects in a storage space for a long time while maintaining at a constant temperature.

The refrigerator includes a refrigeration system including one or more evaporators to generate and circulate the cold air.

Herein, the evaporator serves to maintain internal air of the refrigerator within a preset temperature range by exchanging heat between a low-temperature and low-pressure refrigerant with the internal air of the refrigerator (cold air circulating inside the refrigerator).

Frost is generated on a surface of the evaporator due to water or humidity contained in the internal air of the refrigerator or moisture existing around the evaporator during heat exchange with the internal air of the refrigerator.

Conventionally, when a certain time elapses after the operation of the refrigerator started, a defrosting operation is performed to remove frost generated on the surface of the evaporator.

In other words, conventionally, the defrosting operation is performed through indirect estimation based on the operation time, rather than directly detecting the amount of frost generated on the surface of the evaporator.

Accordingly, conventionally, the defrosting operation is performed even though the frosting is not generated, and thus, there are problems in that power consumption efficiency is reduced or the defrosting operation is not performed despite excessive frosting.

Specifically, the defrosting operation is performed by allowing a heater to emit heat and raise the temperature around the evaporator so that defrosting is performed. After the defrosting operation is performed as described above, a large load operation is performed so that the internal temperature of the refrigerator quickly reaches a preset temperature, resulting in large power consumption.

Accordingly, conventionally, various studies have been made to shorten the time for the defrosting operation or the cycle of the defrosting operation.

In recent years, in order to accurately detect the amount of frosting on the surface of the evaporator, a method using temperature difference or pressure difference between an inlet side and an outlet side of the evaporator has been proposed, and the method was disclosed in Korean Patent Application Publication No. 10-2019-0101669, Korean Patent Application Publication No. 10-2019-0106201, Korean Patent Application Publication No. 10-2019-0106242, Korean Patent Application Publication No. 10-2019-0112482, Korean Patent Application Publication No. 10-2019-0112464, etc.

The above documents describe technique to form a bypass flow path, which has a separate flow from an air flow passing through the evaporator, to a cold air duct, and to measure a temperature difference changed in response to a difference of the amount of air passing through the bypass flow path to precisely determine the start time of the defrosting operation.

However, the documents do not consider the cooling operation for a refrigerating compartment, so that a condition measurement of the evaporator cannot precisely performed, and power consumption efficiency may be deteriorated.

Specifically, in case of recent refrigerators, a freezing system that is configured to selectively operate two or more evaporators with one compressor is provided, and in the freezing system, when the evaporator for the cooling operation is operated, cold air does not flow to other evaporator for a freezing operation.

In other words, when a fan assembly located in the refrigerating compartment is operated, a fan assembly located in a freezing compartment is not operated.

Accordingly, the frosting detection method associated with the above does not consider an operation of the fan assembly located in the refrigerating compartment, so that there is a problem in that it is difficult to precisely recognize a temperature change of an evaporator located at the freezing compartment side, and there is a limit to improving the power consumption efficiency.

Furthermore, in recent years, during operation considering the internal temperature of the refrigerator or the temperature set by the user, an operation cycle for supplying cold air to the refrigerating compartment is controlled to be shortened to improve power consumption efficiency.

However, in proportion to the shortening of the operating cycle of the refrigerating compartment, an operating cycle or operating time of the freezing compartment-side fan assembly is inevitably shortened. However, the documents described above do not consider the internal temperature or the set temperature of the user, so a measurement error for the temperature change in the bypass flow path occurs.

Specifically, in the techniques above, despite existence of the measurement error, the operation considering the measurement error is not performed, so the measurement reliability for the frosting is inevitably low, and thus a technique supplementing the above problem is required.

SUMMARY

Accordingly, the present disclosure has been made keeping in mind the various problems, and the present disclosure is intended to achieve frosting detection of an evaporator in consideration of a cold air operation by the internal environment or the temperature set by a user.

One aspect of the present disclosure is to reduce an error during a frost detecting operation and improve the measurement reliability for frosting by allowing a heating time of the heating element to be shorter than a remaining operation time of a second cooling fan.

Another aspect of the present disclosure is to reduce power consumption when the frost detecting operation stops or an error occurs.

Yet another aspect of the present disclosure is to maximize the discrimination of a logic temperature ΔHt so that a defrosting operation is performed when the defrosting operation is actually required.

In order to achieve this, a refrigerator of the present disclosure may be provided with the following solution.

A controller constituting the refrigerator of the present disclosure may control a frost detecting device to perform frost detecting operation for a preset frost detecting time. Accordingly, the frosting detection may be performed during an operation at constant temperature.

The controller constituting the refrigerator of the present disclosure may control the frost detecting operation to be differently performed on the basis of at least one of a room temperature and a set reference temperature. Accordingly, more precise frosting detection may be performed.

The controller constituting the refrigerator of the present disclosure may perform control such that when an internal temperature of a storage compartment is within a dissatisfaction temperature region divided on the basis of the set reference temperature of a user, the amount of cold air supply may increase. Accordingly, the internal temperature may be maintained at the set reference temperature.

The controller constituting the refrigerator of the present disclosure may perform control such that when the internal temperature of the storage compartment is within a satisfaction temperature region divided on the basis of the set reference temperature of the user, the amount of cold air supply may be reduced. Accordingly, the internal temperature may be maintained at the set reference temperature and the power consumption may be reduced.

A frost detecting device constituting the refrigerator of the present disclosure may include a frosting sensor to measure a material property of a fluid passing through a frosting detection flow path. Accordingly, the frost detecting device may measure a temperature difference value (logic temperature, ΔHt) in response to the flow amount of the fluid flowing in the flow path.

At least a part of the frosting detection flow path of the refrigerator of the present disclosure may be disposed in a flow path formed between a first duct and a cooling source. Accordingly, a fluid entering the first duct and flowing to the cooling source may partially enter the frosting detection flow path.

At least a part of the frosting detection flow path of the refrigerator of the present disclosure may be disposed in a flow path formed between a second duct and the storage compartment. Accordingly, the fluid passing through the frosting detection flow path may flow into the storage compartment via the second duct.

A frosting sensor constituting the refrigerator of the present disclosure may include a detecting derivative. Accordingly, the improvement in the precision when the material property is measured may be induced.

The detecting derivative constituting the refrigerator of the present disclosure may include a heating element that generates heat. Accordingly, a temperature difference value according to the flow amount of fluid may be checked.

The refrigerator of the present disclosure may include a refrigerant valve. Accordingly, the amount of a refrigerant supplied to an evaporator may be adjusted.

The controller constituting the refrigerator of the present disclosure may control the frost detecting time to vary in response to a temperature value of the room temperature. Accordingly, an error occurring in the frosting detection may be reduced.

The controller constituting the refrigerator of the present disclosure may perform control such that the frost detecting time within a temperature range in which a temperature value of the room temperature is high is performed shorter than the frost detecting time within a temperature range in which a temperature value of the room temperature is low. Accordingly, an error occurring in the frosting detection may be reduced.

The controller constituting the refrigerator of the present disclosure may control the frost detecting time to vary on the basis of the set reference temperature. Accordingly, an error occurring in the frosting detection may be reduced.

The controller constituting the refrigerator of the present disclosure may perform control such that the frost detecting time within the temperature region in which the set reference temperature is high is performed shorter than the frost detecting time within the temperature region in which the set reference temperature is low. Accordingly, an error occurring in the frosting detection may be reduced.

The controller constituting the refrigerator of the present disclosure may stop the frost detecting operation when detecting opening of a door during the frost detecting operation. Accordingly, an error occurring in the frosting detection may be reduced and power consumption may be prevented.

The controller constituting the refrigerator of the present disclosure may stop the frost detecting operation when the cooling fan is turned off during the frost detecting operation. Accordingly, an error occurring in the frosting detection may be reduced and power consumption may be prevented.

The refrigerator of the present disclosure may measure a material property of the fluid inside the frosting detection flow path by the frosting sensor after the heating element is turned on and off. Accordingly, it may be determined whether or not frost or ice is generated on the cooling source.

The refrigerator of the present disclosure may include determining a heating condition for turning on of the heating element. Accordingly, when the heating condition is satisfied, the heating element may be turned on, and thus power consumption may be reduced, and information with low reliability is not obtained so measurement reliability may be improved.

The storage compartment constituting the refrigerator of the present disclosure may include two or more storage compartments that may be maintained at difference temperatures.

The refrigerator of the present disclosure may include a first storage compartment maintained at a first set reference temperature.

The refrigerator of the present disclosure may include a second storage compartment that may be maintained at a second set reference temperature lower than the first set reference temperature.

The refrigerator of the present disclosure may be configured such that the first operational reference value of the first storage compartment may be set to be less than the second operational reference value of the second storage compartment.

The refrigerator of the present disclosure may control the frost detecting time to be shorter than an operation time of a second cooling fan. Accordingly, an error generated when the second cooling fan stops early during frosting detection may be prevented in advance.

The refrigerator of the present disclosure may be controlled such that the amount of cold air supplied by at least one of a first evaporator and a first cooling fan may be adjusted on the basis of a temperature value measured by at least any one of the first temperature sensor and the second temperature sensor. Accordingly, the temperature of the storage compartment may be precisely controlled.

The refrigerator of the present disclosure may be controlled such that the first cooling fan may be operated when the temperature of the first storage compartment is within the dissatisfaction temperature region divided on the basis of the set reference temperature. Accordingly, when the set reference temperature is not reached, the amount of cold air supply may increase.

The refrigerator of the present disclosure may be controlled such that after the temperature of the first storage compartment reaches a lower limit temperature value (NT-DIFF) of the first operational reference value a first refrigerant path is closed.

The refrigerator of the present disclosure may be controlled such that after the temperature of the first storage compartment reaches the lower limit temperature value (NT-DIFF) of the first operational reference value a second refrigerant path is opened.

Accordingly, even when refrigerant supply to the first evaporator stops, sufficient cold air may be supplied to the first storage compartment.

The refrigerator of the present disclosure may be controlled such that after the temperature of the first storage compartment reaches the lower limit temperature value (NT-DIFF) of the first operational reference value the first cooling fan may be operated for a constant time. Accordingly, even when the refrigerant supply to the evaporator stops, sufficient cold air may be supplied to the first storage compartment.

The refrigerator of the present disclosure may be controlled such that before the temperature of the first storage compartment reaches an upper limit temperature value (NT+DIFF) of the first operational reference value the first refrigerant path is opened.

The refrigerator of the present disclosure may be controlled such before the temperature of the first storage compartment reaches an upper limit temperature value (NT+DIFF) of the first operational reference value the second refrigerant path is closed. Accordingly, before the temperature of the first storage compartment reaches the upper limit temperature value (NT+DIFF) of the first operational reference value, cold air may be supplied.

As described above, the refrigerator of the present disclosure is configured to perform the frost detecting operation to confirm frosting of the second evaporator in consideration of the internal environment of the first storage compartment or the second storage compartment or the cold air operation in response to the temperature set by the user. Accordingly, the frosting detection may be precisely performed.

The refrigerator of the present disclosure is configured to reduce an error during the frost detecting operation as a heating time of the heating element is set shorter than a remaining operation time of the second cooling fan, and the measurement reliability for frosting may be improved.

Since it is determined that the heating condition is satisfied when the heating time of the heating element is further shorter than the remaining operation time of the second cooling fan, when the heating condition is not satisfied, the heating element does not emit heat and the power consumption may be reduced.

In the refrigerator of the present disclosure, it is possible to perform the precise frosting detection as the condition maximizing the discrimination of the logic temperature ΔHt is applied as the heating condition for heat-emission of the heating element, and the defrosting operation performed based on the condition may be also performed when exactly necessary so that the consumption efficiency may be further improved.

DESCRIPTION OF DRAWINGS

FIG. **1** is a front view schematically showing an internal structure of a refrigerator according to an embodiment of the present disclosure.

FIG. **2** is a longitudinal-sectional view schematically showing a structure of the refrigerator according to the embodiment of the present disclosure.

FIG. **3** is a state view schematically showing an operational state performed on the basis of a user set reference temperature with respect to each storage compartment of the refrigerator according to the embodiment of the present disclosure.

FIG. **4** is a view schematically showing a structure of a thermoelectric module according to the embodiment of the present disclosure.

FIG. **5** is a block diagram schematically showing a refrigerating cycle of the refrigerator according to the embodiment of the present disclosure.

FIG. **6** is a main part sectional view showing a space behind a second storage compartment inside a casing in order to describe installation of a frost detecting device and an evaporator that constitute the refrigerator according to the embodiment of the present disclosure.

FIG. **7** is a rear-perspective view of a fan duct assembly used to describe installation of the frost detecting device constituting the refrigerator according to the embodiment of the present disclosure.

FIG. **8** is an exploded-perspective view showing the fan duct assembly without a flow path cover and a sensor of the refrigerator according to the embodiment of the present disclosure.

FIG. **9** is a rear view showing the fan duct assembly in order to describe installation of the frost detecting device constituting the refrigerator according to the embodiment of the present disclosure.

FIG. **10** is an enlarged view showing installation of the frost detecting device constituting the refrigerator according to the embodiment of the present disclosure.

FIG. **11** is an enlarged-perspective view showing installation of the frost detecting device constituting the refrigerator according to the embodiment of the present disclosure.

FIG. **12** is a front-perspective view showing the fan duct assembly constituting the refrigerator according to the embodiment of the present disclosure.

FIG. **13** is a main part enlarged view showing installation of the frost detecting device according to the embodiment of the present disclosure.

FIG. **14** is a view schematically showing a frosting sensor of the frost detecting device according to the embodiment of the present disclosure.

FIG. **15** is a block diagram schematically showing a control structure of the refrigerator according to the embodiment of the present disclosure.

FIG. **16** is a state graph showing temperature change in a frosting detection flow path in response to on/off of a heating element and on/off of each cooling fan right after defrosting with respect to the evaporator of the refrigerator terminates according to the embodiment of the present disclosure.

FIG. **17** is an enlarged view showing part "A" in FIG. **16**.

FIG. **18** is a flowchart showing a control process performed by a controller in an event of frost detecting operation of the refrigerator according to the embodiment of the present disclosure.

FIG. **19** is a state graph showing temperature change in the frosting detection flow path in response to on/off of the heating element and on/off of the cooling fan while frosting to the evaporator of the refrigerator is in progress according to the embodiment of the present disclosure.

DETAILED DESCRIPTION

The present disclosure is configured to allow detection of frosting of an evaporator considering cooling operation based on internal environment or set reference temperature set by a user.

In other words, the present disclosure is configured to allow a frost detecting operation to be performed in cooling operation where two evaporator are operated with one compressor, in consideration of shorted operation cycle of two cooling fans, so that it may be possible to perform precise frosting detection and to minimize power consumption caused by frosting detection, and thereby improve power consumption efficiency.

As described above, preferred embodiments of a structure and an operational control of a refrigerator of the present disclosure will be described with reference to accompanying FIGS. **1** to **19**.

FIG. **1** is a front view schematically showing an internal structure of a refrigerator according to an embodiment of the present disclosure. FIG. **2** is a longitudinal-sectional view schematically showing a structure of the refrigerator according to the embodiment of the present disclosure.

As shown in the drawings, according to the embodiment of the present disclosure, a refrigerator **1** may include a casing **11**.

The casing **11** may include an outer casing **11***b* providing an exterior shape of the refrigerator **1**.

Furthermore, the casing **11** may include an inner casing **11***a* providing an internal wall surface of the refrigerator **1**. A storage compartment may be provided at the inner casing **11***a* to store stored objects.

The storage compartment may include one storage compartment or multiple storage compartments. In the embodiment of the present disclosure, it is illustrated that the storage compartment includes two storage compartments that respectively store stored objects at different temperatures.

The storage compartments may include a first storage compartment **12** maintained at a first set reference temperature.

The first set reference temperature may be a temperature at which stored objects do not freeze and also may be a temperature range lower than external temperature of the refrigerator **1** (room temperature).

For example, the first set reference temperature may be set at a temperature range that is less than or equal to 32° C. and higher than 0° C. Of course, when necessary (for example, according to the room temperature, a type of stored objects, or the like), the first set reference temperature may be set more higher than 32° C. or equal to or less than 0° C.

Specifically, the first set reference temperature may be an internal temperature of the first storage compartment **12** set by a user. However, when the user does not set the first set reference temperature, an arbitrary designated temperature may be used as the first set reference temperature.

The first storage compartment **12** may be configured to be operated at a first operational reference value so as to maintain the first set reference temperature.

The first operational reference value may be set at a temperature range value including a first lower limit temperature NT-DIFF1. For example, when the internal temperature of the first storage compartment **12** reaches the first lower limit temperature NT-DIFF1 on the basis of the first set reference temperature, an operation for supplying cold air stops.

The first operational reference value may be set at a temperature range value including a first upper limit temperature NT+DIFF1. For example, when the internal temperature rises on the basis of the first set reference temperature, the operation for cold air supply may be resumed before reaching the first upper limit temperature NT+DIFF1.

As described above, inside the first storage compartment **12**, on the basis of the first set reference temperature, the supply of cold air is performed or interrupted in consideration of the first operational reference value with respect to the first storage compartment.

This set reference temperature NT and the operational reference value DIFF are as shown in accompanying FIG. **3**.

Furthermore, the storage compartment may include a second storage compartment **13** maintained at a second set reference temperature.

The second set reference temperature may be a temperature lower than the first set reference temperature. At this point, the second set reference temperature may be set by the user, and when the user does not set the second set reference temperature, an arbitrary set temperature may be used as the second set reference temperature.

The second set reference temperature may be a temperature at which stored objects can freeze. For example, the second set reference temperature may be set at a temperature range that is less than or equal to 0° C. and equal to or higher than −24° C. Of course, when necessary (for example, according to the room temperature, a type of stored objects, or the like), the second set reference temperature may be set higher than 0° C. or less than or equal to −24° C.

Specifically, the second set reference temperature may be an internal temperature of the second storage compartment **13** set by the user. However, when the user does not set the second set reference temperature, an arbitrary designated temperature may be used as the second set reference temperature.

The second storage compartment **13** may be configured to be operated at a second operational reference value so as to maintain the second set reference temperature.

The second operational reference value may be set at a temperature range value including a second lower limit temperature NT-DIFF2. For example, when the internal temperature of the second storage compartment **13** reaches the second lower limit temperature NT-DIFF2 on the basis of the second set reference temperature, an operation for supplying cold air stops.

The second operational reference value may be set at a temperature range value including a second upper limit temperature NT+DIFF2. For example, when the internal temperature of the second storage compartment **13** rises on the basis of the second set reference temperature, the operation for cold air supply may be resumed before reaching the second upper limit temperature NT+DIFF2.

As described above, inside the second storage compartment **13**, on the basis of the second set reference temperature, the supply of cold air is performed or interrupted considering the second operational reference value with respect to the second storage compartment.

The first operational reference value may be set with a temperature range between the upper limit temperature and the lower limit temperature smaller than the second operational reference value. for example, the second lower limit temperature NT-DIFF2 and the second upper limit temperature NT+DIFF2 of the second operational reference value may be set to ±2.0° C., and the first lower limit temperature NT-DIFF1 and the first upper limit temperature NT+DIFF1 of the first operational reference value may be set to ±1.5° C.

Meanwhile, the above-described storage compartment is configured to circulate a fluid and maintain the internal temperature of the storage compartment.

The fluid may be air. Also in the following description, it is illustrated that the fluid circulated in the storage compartment is air. Of course, the fluid may be a gas other than air.

The temperature outside the storage compartment (the room temperature) may be measured by a first temperature sensor **1***a* as shown in FIG. **15**, and the internal temperature of the storage compartment may be measured by a second temperature sensor **1***b* (referring to FIG. **9**).

The first temperature sensor **1***a* and the second temperature sensor **1***b* may be separately provided. Of course, the room temperature and the internal temperature of the storage compartment may be measured by the same one temperature sensor or be measured by two or more multiple temperature sensors that cooperate.

Furthermore, the storage compartment **12**, **13** may include a door **12***b*, **13***b*.

The door **12***b*, **13***b* serves to open and close the storage compartment **12**, **13**, and may have a rotatable opening and closing structure, or may have a drawer-type opening and closing structure.

The door **12***b*, **13***b* may include one or multiple doors.

Next, according to the embodiment of the present disclosure, the refrigerator **1** includes a cooling source.

The cooling source may include a structure that generates cold air.

The structure that generates cold air of the cooling source may be configured variously.

For example, the cooling source may include a thermoelectric module **23**.

As shown in FIG. **4**, the thermoelectric module **23** may include a thermoelement **23***a* including an endothermic surface **231** and an exothermic surface **232**. The thermoelectric module **23** may comprise of a module including a sink **23***b* connected to at least one of the endothermic surface **231** and the exothermic surface **232** of the thermoelement **23***a*.

According to the embodiment of the present disclosure, the structure that generates cold air of the cooling source comprises an evaporator **21**, **22**.

The evaporator **21**, **22** may constitute the refrigerating system together with a compressor **60** (referring to FIG. **5**), and serve to perform heat exchange with air passing through the evaporator and lower the temperature of the air.

When the storage compartment includes the first storage compartment **12** and the second storage compartment **13**, the evaporator may include a first evaporator **21** and a second evaporator **22**, and the first evaporator **21** may supply cold air to the first storage compartment **12** and the second evaporator **22** may supply cold air to the second storage compartment **13**.

At this point, inside the inside space of the inner casing **11***a*, the first evaporator **21** may be located at a rear side in the first storage compartment **12**, and the second evaporator **22** may be located at a rear side in the second storage compartment **13**.

Of course, although not shown in the drawing, one evaporator may be provided only in at least one of the first storage compartment **12** and the second storage compartment **13**.

Even when two evaporators are provided, the one compressor **60** constituting the refrigerating cycle may be provided. In this case, as shown in FIG. **5**, the compressor **60** may be connected to the first evaporator **21** so as to supply a refrigerant via a first refrigerant path **61**, and may be connected to the second evaporator **22** so as to supply the refrigerant via a second refrigerant path **62**. At this point, the refrigerant path **61**, **62** may be selectively opened and closed using a refrigerant valve **63**.

There is a structure that supplies the generated cold air to the storage compartment.

The cooling fan may be included as the structure that supplies the cold air of the cooling source. The cooling fan may serve to supply the cold air into the storage compartment **12**, **13**, the cold air being generated while passing through the cooling source.

At this point, the cooling fan may include a first cooling fan **31** that supplies the cold air generated while passing through the first evaporator **21**, into the first storage compartment **12**.

The cooling fan may include a second cooling fan **41** that supplies the cold air generated while passing through the second evaporator **22**, into the second storage compartment **13**.

Next, according to the embodiment of the present disclosure, the refrigerator **1** may include a first duct.

The first duct may be formed of at least one of a passage through which air passes (e.g., tube such as duct, pipe, or the like), a hole, and an air flow path. Air may flow from the inside space of the storage compartment to the cooling source by guidance of the first duct.

With reference to FIG. **6**, the first duct may include an inlet duct **42***a*. In other words, a fluid flowing in the second storage compartment **13** by guidance of the inlet duct **42***a* may flow into the second evaporator **22**.

The first duct may include a part of a bottom surface of the inner casing **11***a*. At this point, a part of the bottom surface of the inner casing **11***a* is a portion that is from a portion facing the bottom surface of the inlet duct **42***a* to a position to which the second evaporator **22** is mounted. Therefore, the first duct provides a flow path through which a fluid flows from the inlet duct **42***a* toward the second evaporator **22**.

Next, according to the embodiment of the present disclosure, the refrigerator **1** may include the second duct.

The second duct may be formed of at least one of a passage that guides air around the evaporator **21**, **22** constituting the cooling source so that the air flows into the storage compartment (e.g., tube such as duct, pipe, or the like), a hole, and a flow path of air.

The second duct may include a fan duct assembly **30**, **40** that is located at front of the evaporator **21**, **22**.

As shown in FIGS. **1** and **2**, the fan duct assembly **30**, **40** may include at least one of a first fan duct assembly **30** and a second fan duct assembly **40**, and the first fan duct assembly **30** guides cold air so that the cold air flows into the first storage compartment **12**, and the second fan duct assembly **40** guides cold air so that the cold air flows into the second storage compartment **13**.

At this point, a space between the fan duct assembly **30**, **40** of the inside space of the inner casing **11***a* where the evaporator **21**, **22** is located and a rear wall surface of the inner casing **11***a* may be defined as a heat-exchange flow path where air exchanges heat with the evaporator **21**, **22**.

Of course, although not shown in the drawings, even when a evaporator is provided only at one of the storage compartments, the fan duct assembly **30**, **40** may be provided at each storage compartment **12**, **13**. And even when the evaporator **21**, **22** is provided to each storage compartment **12**, **13**, only one fan duct assembly **30**, **40** may be provided. Various configurations are possible.

Meanwhile, in the embodiment descried below, it is illustrated that a structure that generates cold air of the cooling source is the second evaporator **22**, and a structure that supplies the cold air of the cooling source is the second cooling fan **41**, and the first duct is a the inlet duct **42***a* formed in the second fan duct assembly **40**, and the second duct is the second fan duct assembly **40**.

As shown in FIGS. **7** to **9**, the second fan duct assembly **40** may include a fan grille **42**.

The inlet duct **42***a* may be formed in the fan grille **42** to suction air from the second storage compartment **13**. The inlet duct **42***a* may be formed at each of opposite ends of a lower portion of the fan grille **42**, and is configured to guide a suctioned flow of air that flows along an inclined corner portion, which is inclined due to a machine chamber, between a bottom surface and the rear wall surface in the inner casing **11***a*.

At this point, the inlet duct **42***a* may be used as a partial structure of the above-described first duct. In other words, the inlet duct **42***a* allows a fluid inside the second storage compartment **13** to flow into the cooling source (second evaporator **22**).

Furthermore, as shown in FIGS. **7** to **9**, the second fan duct assembly **40** may include a shroud **43**.

The shroud **43** may be coupled to a rear surface of the fan grille **42**. Accordingly, a flow path for guiding a flow of cold air into the second storage compartment **13** may be provided between the shroud **43** and the fan grille **42**.

A fluid inlet **43***a* may be formed on the shroud **43**. In other words, cold air passing through the second evaporator **22** flows into the flow path between the fan grille **42** and the shroud **43** via the fluid inlet **43***a* and then passes through each cold air outlet **42***b* of the fan grille **42** by guidance of the flow path, so that the cold air is discharged to the second storage compartment **13**.

The cold air outlet **42***b* may include two or more multiple cold air outlets **42***b*. For example, as shown in FIG. **12**, the cold air outlets **42***b* may be respectively formed at opposite side portions of an upper portion, opposite side portions of an intermediate portion, and opposite side portions of a lower portion of the grille fan **42**.

The second evaporator **22** may be provided to be located at a lower position than the fluid inlet **43***a*.

Meanwhile, the second cooling fan **41** may be installed in the flow path between the fan grille **42** and the shroud **43**.

Preferably, the second cooling fan **41** may be installed in the fluid inlet **43***a* formed in the shroud **43**. In other words, by operation of the second cooling fan **41**, air inside the second storage compartment **13** may pass successively through the inlet duct **42***a* and the second evaporator **22** and then may flow into the flow path via the fluid inlet **43***a*.

Next, according to the embodiment of the present disclosure, the refrigerator **1** may include a frost detecting device **70**.

The frost detecting device **70** is a device that detects the amount of frost or ice generated on the cooling source.

FIG. **6** is a main part sectional view showing an installed state of the frost detecting device and the evaporator according to the embodiment of the present disclosure. FIGS. **7** to **11** are views showing installed state of the frost detecting device in the second fan duct assembly.

As in the embodiment shown in the drawings, the frost detecting device of according to the embodiment of the present disclosure is a divide that is located on a flow path of a fluid guided to the second fan duct assembly **40** and detects frosting of the second evaporator **22**.

Furthermore, the frost detecting device **70** may recognize a degree of frosting of the second evaporator **22** by using a sensor outputting different values in response to a fluid property. At this point, the fluid property may include at least one of temperature, pressure, and flux.

The frost detecting device **70** may be configured to precisely determine the execution time of defrosting operation on the basis of the degree of frosting recognized as described above.

As shown in FIG. **8**, the frost detecting device **70** may include a frosting detection flow path **710**.

The frosting detection flow path **710** may provide a flow passage (flow path) of air detected by a frosting sensor **730** in order to detect frosting of the second evaporator **22**. The frosting detection flow path **710** may be provided as a portion where a frosting sensor **730** to detect frosting of the second evaporator **22** is located.

Specifically, the frosting detection flow path **710** may be configured to provide a flow path divided from a flow of air passing through the second evaporator **22** and a flow of air flowing in the second fan duct assembly **40**.

Furthermore, at least a part of the frosting detection flow path **710** may be located at least at any one portion in a flow path of cold air circulated in the second storage compartment **13**, the inlet duct **42***a*, the second evaporator **22**, and the second fan duct assembly **40**.

Preferably, at least a part of the frosting detection flow path **710** may be arranged at an inlet flow path through which a fluid flows toward the cooling source while passing through the first duct.

For example, as shown in FIG. **9**, the fluid inlet **711** of the frosting detection flow path **710** may be located to be open on a flow path through which a fluid flowing toward an air inlet side of the second evaporator (cooling source) **22** while passing through the inlet duct (first duct) **42***a*.

In other words, some of the air suctioned into the air inlet side of the second evaporator **22** through the inlet duct **42***a* may flow into the frosting detection flow path **710**.

The fluid outlet **712** of the frosting detection flow path **710** may be located between an air outlet side of the second evaporator **22** and a flow path through which cold air is supplied to the second storage compartment **13**.

Specifically, as shown in FIG. **9**, the fluid outlet **712** of the frosting detection flow path **710** may be located to be open on a flow path through which a fluid flows toward the fluid inlet **43***a* of the shroud **43** while passing through the second evaporator **22**.

In other words, air that passed through the frosting detection flow path **710** may flow between the air outlet side of the second evaporator **22** and the fluid inlet **43***a* of the shroud **43**.

At this point, FIGS. **10** and **11** are views showing an installation state of the frost detecting device **70**.

Meanwhile, as the amount of frosting on the second evaporator **22** increases and an air flow passing through the second evaporator **22** is gradually blocked, a pressure difference between the air inlet side and the air outlet side of the second evaporator **22** gradually becomes larger. The amount of air suctioned into the frosting detection flow path **710** gradually increases by the pressure difference.

As the volume of air suctioned into the frosting detection flow path **710** becomes larger, the temperature of a heating element **731** constituting the frosting sensor **730** described below falls, and a temperature difference value ΔHt in on/off of the heating element **731** (hereinbelow, which is referred to as "logic temperature") falls.

Considering this, as the logic temperature ΔHt inside the frosting detection flow path **710** becomes lower, the logic temperature being checked by the frosting sensor **730**, the amount of frosting on the second evaporator **22** increases.

When there is no frost at the second evaporator **22** or a frosting amount is significantly less, most of the air passes through the second evaporator **22** in the heat-exchange space. On the other hand, some of the air may flow into the frosting detection flow path **710**.

For example, based on a state in which frosting does not occur on the second evaporator **22**, the frosting detection flow path **710** may be configured such that about 98% of the air suctioned via the inlet duct **42***a* passes through the second evaporator **22** and remaining of the air passes through the frosting detection flow path **710**.

At this point, the volume of air passing through the second evaporator **22** and the frosting detection flow path **710** may gradually vary in response to the amount of frosting on the second evaporator **22**.

For example, when frost is generated on the second evaporator **22**, the volume of air passing through the second evaporator **22** is reduced. On the other hand, the volume of air passing through the frosting detection flow path **710** increases.

In other words, compared to the volume of air passing through the frosting detection flow path **710** before frosting of the second evaporator **22**, the volume of air passing through the frosting detection flow path **710** in frosting of the second evaporator **22** significantly increases.

Specifically, it is desirable to configure the frosting detection flow path **710** such that change in the volume of air according to the amount of frosting on the second evaporator **22** may be at least doubled. In other words, in order to determine the amount of frosting using the volume of air, the volume of air before and after frosting should be changed by at least two times or more to obtain a detection value sufficient to have discrimination.

When the amount of frosting on the second evaporator **22** is large enough to require the defrosting operation, frost of the second evaporator **22** acts as a resistance of a flow path, so that the volume of the air flowing in the heat-exchange space of the evaporator **22** is reduced and the volume of the air flowing in the frosting detection flow path **710** increases.

As described above, the flux of the air flowing in the frosting detection flow path **710** varies according to the amount of frosting on the second evaporator **22**.

The frosting detection flow path **710** is formed by recessing a facing surface to a surface of the fan grille **42** constituting the second fan duct assembly **40**, the surface facing the second evaporator **22**, thereby allowing air to flow into the frosting detection flow path **710**.

At this point, the portion facing the second evaporator **22**, i.e., a rear surface of the frosting detection flow path **710**, is formed open, and the open rear surface is closed by a flow path cover **720**.

Of course, although not shown in the drawings, the frosting detection flow path **710** may be made separate from the fan grille **42**, and the frosting detection flow path **710** may be fixed (attached or coupled) to the fan grille **42** or provided at the shroud **43**.

Furthermore, the frost detecting device **70** may include the frosting sensor **730**.

The frosting sensor **730** is a sensor that detects a material property of a fluid passing through inside of the frosting detection flow path **710**. At this point, the fluid property may include at least one of temperature, pressure, and flux.

Specifically, the frosting sensor **730** may be configured to calculate the amount of frosting on the second evaporator **22** on the basis of a difference in an output value that is changed according to the material property of the air (fluid) passing through inside the frosting detection flow path **710**.

In other words, the amount of frosting on the second evaporator **22** is calculated by a difference in the output value confirmed by the frosting sensor **730** to be used to determine whether the defrosting operation is required.

In the embodiment of the present disclosure, it is illustrated that the frosting sensor **730** is provided to detect the amount of frosting on the second evaporator **22** by using a difference in temperature according to the volume of the air passing through inside the frosting detection flow path **710**.

In other words, as shown in FIG. **13**, the frosting sensor **730** is provided at a portion where the fluid flows, inside the frosting detection flow path **710**, so that the amount of frosting on the second evaporator **22** may be detected on the basis of the output value that changes according to a fluid flow inside the frosting detection flow path **710**.

Of course, the output value may be variously determined as not only the above-described temperature difference, but also a pressure difference, other property difference, or the like.

As shown in FIG. **14**, the frosting sensor **730** may include a detecting derivative.

The detecting derivative may provide for induced improvement of measurement precision so that the sensor may further precisely measure a material property (or output value).

In the embodiment of the present disclosure, it is illustrated that the detecting derivative comprises the heating element **731**.

The heating element **731** is supplied with power and emits heat.

As shown in FIG. **14**, the frosting sensor **730** may include a temperature sensor **732**.

The temperature sensor **732** measures the temperature around the heating element **731**.

In other words, considering that the temperature around the heating element **731** varies according to the volume of the air passing through the heating element **731** while passing through inside the frosting detection flow path **710**, the temperature sensor **732** measures a change in temperature and then the degree of frosting on the second evaporator **22** is calculated on the basis of the change in temperature.

As shown in FIG. **14**, according to the embodiment of the present disclosure, the frosting sensor **730** may include a sensor printed circuit board (PCB) **733**.

The sensor PCB **733** is configured to determine a difference between the temperature detected by the temperature sensor **732** in an OFF state of the heating element and the temperature detected by the temperature sensor **732** in an ON state of the heating element **731**.

Of course, the sensor PCB **733** may be configured to determine whether the logic temperature ΔHt is less than or equal to a reference difference value.

For example, when the amount of frosting on the second evaporator **22** is less, a flux of the air passing through inside the frosting detection flow path **710** is less, and in this case, heat generated due to the heat state of the heating element **731** is cooled relatively low by the above-described flowing air.

Accordingly, the temperature detected by the temperature sensor **732** is high, and the logic temperature ΔHt is also high.

On the other hand, when the amount of frosting on the second evaporator **22** is large, a flux of the air passing through inside the frosting detection flow path **710** is large, and in this case, heat generated due to the ON state of the heating element **731** is cooled relatively more by the above-described flowing air.

Accordingly, the temperature detected by the temperature sensor **732** is low, and the logic temperature ΔHt is also low.

Therefore, the amount of frosting on the second evaporator **22** may be precisely determined according to high or low of the logic temperature ΔHt, and on the basis of the amount of frosting on the second evaporator **22** determined as described above, and the defrosting operation may be performed at the precise time.

In other words, when the logic temperature ΔHt is high, it is determined that the amount of frosting on the second evaporator **22** is less, and when the logic temperature ΔHt is low, it is determined that the amount of frosting on the second evaporator **22** is large.

Accordingly, the reference temperature difference value may be designated, and when the logic temperature ΔHt is lower than the designated reference temperature difference value, it may be determined that the defrosting operation of the second evaporator is required.

Meanwhile, the frosting sensor **730** is installed in a direction that crosses a direction of air passing through inside the frosting detection flow path **710**, and a surface of the frosting sensor **730** and an inner surface of the frosting detection flow path **710** are located to be spaced apart from each other.

In other words, water may flow down through a gap between the frosting sensor **730** and the frosting detection flow path **710** that are spaced apart from each other.

At this point, a distance of the gap is preferably formed sufficient to prevent water from staying between the surface of the frosting sensor **730** and the inner surface of the frosting detection flow path **710**.

It is preferable that the heating element **731** and the temperature sensor **732** may be located together on any one surface of the frosting sensor **730**.

In other words, the heating element **731** and the temperature sensor **732** are located on the same surface, so that the temperature sensor **732** may precisely sense the change in temperature due to heat-emission of the heating element **731**.

Furthermore, the frosting sensor **730** may be disposed between a fluid inlet **711** and a fluid outlet **712** of the frosting detection flow path **710**, inside the frosting detection flow path **710**.

Preferably, the frosting sensor **730** may be disposed at a position spaced apart from the fluid inlet **711** and the fluid outlet **712**.

For example, the frosting sensor **730** may be disposed at an intermediate position inside the frosting detection flow path **710**. The frosting sensor **730** may be disposed at a position inside the frosting detection flow path **710** relatively close to the fluid inlet **711** than the fluid outlet **712**. Or, the frosting sensor **730** may be disposed at a position inside the frosting detection flow path **710** relatively closer to the fluid outlet **712** than the fluid inlet **711**.

Furthermore, the frosting sensor **730** may include a sensor housing **734**. The sensor housing **734** serves to prevent the water flowing down along the inside of the frosting detection flow path **710** from being brought into contact with the heating element, the temperature sensor **732**, or the sensor PCB **733**.

The sensor housing **734** may be formed such that any one of opposite ends thereof is open. Accordingly, a power wire (or signal wire) may be taken out of the sensor PCB **733**.

Next, according to the embodiment of the present disclosure, the refrigerator **1** may include a defrosting device **50**.

The defrosting device **50** is configured to provide a heat source to remove frost generated on the second evaporator **22**. Of course, the defrosting device **50** may perform defrosting of the frost detecting device **70** or prevent ice formation.

As shown in FIG. **6**, the defrosting device **50** may include a first heater **51**. In other words, frost generated on the second evaporator **22** may be removed by heat-emission of the first heater **51**.

The first heater **51** may be located at a lower portion of the second evaporator **22**. In other words, the first heater **51** is configured such that heat may be supplied in the air flowing direction from a lower end of the second evaporator **22** to an upper end thereof.

Of course, although not shown in the drawing, the first heater **51** may be located at a lateral portion of the second evaporator **22**, may be located at a front portion or a rear portion of the second evaporator **22**, may be located at an upper portion of the second evaporator **22**, or may be located to be brought into contact with the second evaporator **22**.

The first heater **51** may comprise of a sheath heater. In other words, the first heater **51** may be configured such that frost generated on the second evaporator **22** is removed by using radiant heat and convective heat of the sheath heater.

Furthermore, as shown in FIG. **6**, the defrosting device **50** may include a second heater **52**.

The second heater **52** may emit heat at a lower output than the first heater **51** and supply the heat to the second evaporator **22**.

The second heater **52** may be located to be in contact with the second evaporator **22**. In other words, the second heater **52** is configured to remove frost generated on the second evaporator **22** by heat conduction while being directly in contact with the second evaporator **22**.

As an example, the second heater **52** may comprise of an L-cord heater. In other words, the second heater may be configured to remove frost generated on the second evaporator **22** by conductive heat of the L-cord heater. The second heater **52** may be installed to be successively in contact with a heat-exchange fin located at the second evaporator **22**.

The heater included in the defrosting device **50** may include both of the first heater **51** and the second heater **52**, or may include only the first heater **51**, or include only the second heater **52**.

Meanwhile, the defrosting device **50** may include an evaporator temperature sensor.

The evaporator temperature sensor may detect the temperature around the defrosting device **50**, and the detected temperature value may be used as a factor that determines ON/OFF of the heater **51**, **52**.

As an example, after the heater **51**, **52** is turned ON, when the temperature value detected by the evaporator temperature sensor reaches a specific temperature (defrosting termination temperature), the heater **51**, **52** may be turned OFF.

The defrosting termination temperature may be set as an initial temperature, and when remaining ice is detected on the second evaporator **22**, the defrosting termination temperature may be raised by a predetermined temperature.

Next, according to the embodiment of the present disclosure, the refrigerator **1** may include a controller **80**.

As shown in FIG. **15**, the controller **80** may be a device that controls operation of the refrigerator **1**. The controller may be microprocessor, an electrical logic circuit, etc.

For example, when the internal temperature of the storage compartment **12**, **13** is within the dissatisfaction temperature region that is divided on the basis of the set reference temperature NT set for the storage compartment by the user, the controller **80** controls the amount of cold air supply to increase so that the internal temperature of the storage compartment may fall, and when the internal temperature of the storage compartment is within the satisfaction temperature region that is divided on the basis of the set reference temperature NT, the controller **80** may control the amount of cold air supply to be reduced.

Furthermore, the controller **80** may control the frost detecting device **70** to perform frost detecting operation.

To this end, the controller **80** may perform the frost detecting operation for a set frost detecting time.

At this point, the frost detecting time may be controlled to vary depending on a temperature value of the room temperature measured by the first temperature sensor.

In other words, it is considered that the room temperature may vary depending on the season, large or small change in the internal temperature due to opening and closing of the door may occur depending on the room temperature, and thus cooling operation is performed relative to the change.

For example, as the room temperature becomes higher, the frost detecting time may be controlled to be performed at short intervals due to more frequent cooling operation, and as the room temperature becomes lower, the frost detecting time may be controlled to be performed at sufficiently long intervals due to fewer cooling operations.

Preferably, a temperature value of the room temperature is divided into a high temperature region and a low temperature region and the controller may control the frost detecting time to be performed differently in response to the high and low temperature regions.

In other words, the controller may be configured to control the frost detecting time in the high temperature region in which a temperature value of the room temperature is high to be performed shorter than the frost detecting time in the low temperature region in which a temperature value of the room temperature is low.

At this point, the high temperature region may include a temperature region in which the room temperature is more higher than 32° C., and the low temperature region may include a temperature region in which the room temperature is more lower than 15° C.

As described above, the frost detecting time may vary in response to the room temperature.

Furthermore, the controller **80** may control the frost detecting operation to be performed differently on the basis of at least one of the room temperature and the set reference temperature by the user (when user does not set room temperature, which is set as basic temperature).

For example, the frost detecting time may be variously controlled in response to the above-described room temperature and the frost detecting time may be variously controlled by the set reference temperature that is set by the user to control the internal temperature of the storage compartment.

In other words, the controller **80** may control the frost detecting time in the high temperature region with the high set reference temperature to be performed shorter than the frost detecting time in the low temperature region with the low set reference temperature.

At this point, the high temperature region may include a temperature region in which the internal temperature is more higher than −16° C. and the low temperature region may include a temperature region in which the internal temperature is more lower than −24° C.

Furthermore, when door opening of the storage compartment is detected during the frost detecting operation, the controller **80** may stop the frost detecting operation.

In other words, considering that the second cooling fan **41** is set to stop operating when the door of the storage compartment **12**, **13** is opened in the basic control of the refrigerator, when the door of the storage compartment **12**, **13** is opened and the second cooling fan **41** stops operating, it may be preferable that the controller controls the frost detecting operation to stop.

Of course, even when the door are not opened, when the second cooling fan **41** is turned off, the frost detecting operation may stop.

Furthermore, the controller **80** may control the frosting sensor **730** to be operated for a predetermined cycle.

In other words, the heating element **731** of the frosting sensor **730** emits heat for a predetermined time by control of the controller **80**, and the temperature sensor **732** of the frosting sensor **730** detects the temperature directly after the heating element **731** is turned ON and detects the temperature directly after the heating element **731** is turned OFF.

Therefore, after the heating element **731** is turned ON, the lowest temperature and the highest temperature may be checked and a temperature difference value between the lowest temperature and the highest temperature may be maximized, so that discrimination for frosting detection may be more enhanced.

Furthermore, the controller **80** may check a temperature difference value (logic temperature ΔHt) when the heating element **731** is turned ON and OFF, and may determine whether the maximum value of the logic temperature ΔHt is less than or equal to a first reference difference value.

At this point, the first reference difference value may be set as a value sufficient not to operate the defrosting operation.

Of course, the sensor PCB **733** constituting the frosting sensor **730** may be configured to perform checking the logic temperature ΔHt and comparing the logic temperature to the first reference difference value.

In this case, the controller **80** may be configured to receive the checking of the logic temperature ΔHt and the comparison result value with the first reference difference value that are performed by the sensor PCB **733** to control ON/OFF of the heating element **731**.

Furthermore, when the defrosting operation terminates, the controller **80** may determine whether or not remaining ice on the second evaporator **22** exists.

In other words, the controller **80** performs defrosting on the basis of the logic temperature ΔHt, and when defrosting terminates, the controller **80** determines whether remaining ice on the second evaporator **22** exists.

However, even when defrosting terminates, when it is determined that remaining ice exists on the second evaporator **22**, the controller **80** may execute the defrosting operation again or may execute post-defrosting operation earlier than the reference time.

Furthermore, the controller **80** may be configured to check a heating condition in controlling operation of the heating element **731**.

In other words, when the heating condition of the heating element **731** is satisfied, the controller **80** may control the heating element **731** to emit heat.

As shown in FIGS. **16** and **17**, the heating condition may include a condition in which rising of temperature in the frosting detection flow path **710** stops when power is supplied to the second cooling fan **41**.

In other words, when the supply of power to the second cooling fan **41** is interrupted, normally, the temperature of the frosting sensor **730** gradually falls under the influence of the adjacent second evaporator **22**.

In this state, when power is supplied to the second cooling fan **41** and the second cooling fan **41** is operated, the inside of the frosting detection flow path **710** is supplied with air suctioned from the internal space of the second storage compartment **13** that has relatively higher temperature than the temperature of the second evaporator **22**, so that the temperature of the frosting detection flow path **710** is turned upward.

When normal supply of cold air is performed into the second storage compartment **13**, the rising temperature is influenced by cold air inside the second storage compartment **13** from a predetermined time so that the temperature rising slows down, and continuous supply of cold air inside the second storage compartment **13** causes at time Sla in which rising of temperature stops.

As described above, the heating condition may include a temperature change (stop during temperature rising) in the frosting detection flow path **710** in a normal state as satisfying the heating condition. At this point, FIG. **17** is an enlarged view of part "A" in FIG. **16**, and showing a time Sla in which rising of the temperature stops.

Furthermore, as shown in FIGS. **16** and **17**, the heating condition may include a condition in which after temperature inside the frosting detection flow path **710** gradually rises due to the supply of power to the second cooling fan **41**, the temperature is turned downward.

In other words, compared to the determination of the time when temperature inside the frosting detection flow path **710** stops rising, it is more efficient to determine when the temperature is turned downward. At this point, FIG. **17** is an enlarged view of part "A" in FIG. **16** and showing a time Sib in which the temperature is turned downward.

Furthermore, the heating condition may include a condition in which the temperature inside the second storage compartment **13** checked by a separate temperature sensor **1***b* that senses the temperature inside the second storage compartment **13** falls over a set range even by the supply of power to the second cooling fan **41**.

For example, when the temperature inside the second storage compartment **13** is not sufficiently low or a hot stored object is inserted, or the temperature inside the second storage compartment **13** does not sufficiently fall even by the supply of power to the second cooling fan **41**, in the defrosting detection operation, a changed value (temperature difference value) between ON-temperature and OFF-temperature of the heating element **731**.

At this point, the set range may be an hourly falling temperature (e.g., −0.5° C. per 1 minute), or an hourly falling temperature range (e.g., temperatures less than or equal to −0.5° C. and less than 0° C. per 1 minute).

Considering this, the heating condition may be satisfied when the temperature inside the second storage compartment **13** falls by the set range in operation of the second cooling fan **41**.

Furthermore, the heating condition may include a condition in which the temperature inside the second storage compartment **13** stops rising or falls.

For example, when external air flows into the second storage compartment **13** due to opening of the door or stored objects with relatively high temperature is inserted into the second storage compartment **13**, the internal temperature of the second storage compartment **13** may temporarily increase. In this state, the internal temperature of the frosting detection flow path **710** measured by the temperature sensor **732** may be degraded in discriminating, thereby causing a measurement error.

Considering this, it may be preferable to determine that the heating condition is satisfied in the condition in which the internal temperature of the second storage compartment **13** stops rising or falls.

Of course, the heating condition may include a condition in which after power is supplied to the second cooling fan **41**, the temperature of the second storage compartment **13** gradually falls by a predetermined range for a set time.

The predetermined range may be, for example, 0.5° C. per minute, may be 1.0° C. per 2 minutes, or may be 1.5° C. per 3 minutes. The heating condition may be set as a changed temperature per second (or, temperature range).

Furthermore, the heating condition may include a condition in which a heating time of the heating element **731** is shorter than a remaining operation time of the second cooling fan **41**.

In other words, when the heating element **731** emits heat for a predetermined time or more (e.g., 3 minutes), the temperature rises sufficiently to generate the discrimination in temperature change. Accordingly, when the desired heating time of the heating element **731** is shorter than the remaining operation time of the second cooling fan **41**, a temperature change value having the discrimination may not be obtained.

Considering this, it may be preferable to determine that the heating condition is satisfied when the heating time of the heating element **731** is shorter than the remaining operation time of the second cooling fan **41**.

Specifically, a control logic of the remaining operation time of the second cooling fan **41** may be changed in response to an internal environment of the first storage compartment **12** or the second storage compartment **13**, or a storage temperature of the first storage compartment **12** or the second storage compartment **13** that is set by a user.

For example, when the internal temperature of the first storage compartment **12** is set excessively low, the operation time of the first cooling fan **31** is relatively longer than the operation time of the first cooling fan **31** when the first cooling fan is operated within a normal temperature range, or the operational cycle is more shorter, and the operation time of the second cooling fan **41** is relatively shorter or the operational cycle is more shorter.

Accordingly, when the heating condition is determined, it may be preferable that the remaining operation time of the second cooling fan **41** is performed according to control considering the operation time of the second cooling fan **41** to which the internal environment or the temperature set by the user is applied.

At this point, the heating time of the heating element **731** may be shorter than the operation time of the second cooling fan **41** when the storage temperature is set at the lowest temperature that may be set by the user for the first storage compartment **12**.

Conventionally, as the heating time of the heating element **731** does not consider the remaining operation time of the second cooling fan **41**, during heat-emission of the heating element **731**, the operation time of the second cooling fan **41** terminates and the second cooling fan **41** stops operating. Accordingly, a measurement error may occur and power consumption due to unnecessary heat-emission of the heating element **731** may result, but the above-described measurement error and power consumption may be prevented by the above-described heating condition.

Furthermore, the heating condition may include a condition in which the second cooling fan **41** is maintained at a middle speed or more.

In other words, when the second cooling fan **41** is operated at a sufficient speed that allows air to flow into the frosting detection flow path **710**, it may be determined that the heating condition is satisfied.

Furthermore, the heating condition may include a condition in which the rotation speed of the second cooling fan **41** is maintained without change.

In other words, when the second cooling fan **41** continues to be operated for a predetermined time at equal speed, it may be determined that the heating condition is satisfied.

Meanwhile, the heating condition may include a basic condition.

For example, the basic heating condition may include a condition in which when a set time elapses after operation of the second cooling fan **41**, the heating element **731** is controlled to automatically emit heat.

Of course, the set time may be the time for the heating element **731** may emit heat for a predetermined time within the remaining operation time of the second cooling fan **41**.

Furthermore, the basic heating condition may include a condition in which before operation of the second cooling fan **41**, the internal temperature of the frosting detection flow path (temperature checked by temperature sensor) gradually falls.

In other words, as described above, when the internal environment of the second storage compartment **13** or the peripheral environment of the second evaporator **22** is normal, in the stop state of the second cooling fan **41**, the internal temperature of the frosting detection flow path **710** should gradually fall under the influence of the second evaporator **22** located adjacent to the frosting detection flow path **710**.

However, when abnormal stored objects (for example, hot stored objects) are stored in the second storage compartment **13**, even when the second cooling fan **41** is not operated, the temperature may continue to rise, and in this case, a difference between temperatures in the ON and OFF states of the heating element **731** is small, thereby lacking in the discrimination.

Accordingly, when the internal temperature of the frosting detection flow path **710** rises before operation of the second cooling fan **41**, it may be determined that the heating condition is not satisfied. In this case, it may be preferable not to perform the control logic for frosting detection.

Furthermore, the basic heating condition may include a condition in which the second cooling fan **41** is in operation.

For example, when the first cooling fan **31** is operated, the operation of the second cooling fan **41** stops, and when the operation of the second cooling fan **41** stops, it may be determined that the heating condition is not satisfied.

Furthermore, the basic heating condition may include a condition in which the door of the second storage compartment **13** is not opened. When the door of the second storage compartment **13** is opened, the operation of the second cooling fan **41** stops temporarily, and although the operation of the second cooling fan **41** stops, the measured temperature change value lacks in the discrimination, thereby causing a measurement error.

Next, according to the embodiment of the present disclosure, the frost detecting operation provided to detect the amount of frosting with respect to the second evaporator **22** of the refrigerator **1** will be described.

FIG. **18** is a flowchart showing a control process in which the defrosting operation is performed by determining a defrosting requirement time of the refrigerator according to the embodiment of the present disclosure. FIGS. **16** and **19** are state graphs showing change in the temperature that is measured by the frosting sensor before and after frosting of the second evaporator according to the embodiment of the present disclosure.

FIG. **16** is a state view showing change in temperature the second storage compartment **13** and change in temperature of the heating element before frosting of the second evaporator **22**. FIG. **19** is a state view showing change in temperature of the second storage compartment and change in temperature of the heating element when frosting of the second evaporator is in progress.

As shown in the drawings, after the preceding frosting operation terminates, at **S1**, cooling operation of each storage compartment **12**, **13** based on the first set reference temperature and the second set reference temperature is performed under the control of the controller **80**, at **S110**.

At this point, the above-described cooling operation is performed under the operation control of at least any one of the first evaporator **21** and the first cooling fan **31** according to the first operational reference value designated on the basis of the first set reference temperature, and the cooling operation is performed under the operation control of at least any one of the second evaporator **22** and the second cooling fan **41** according to the second operational reference value designated on the basis of the second set reference temperature.

For example, when the internal temperature of the first storage compartment **12** is within the dissatisfaction temperature region divided on the basis of the first set reference temperature set by the user, the controller **80** controls the first cooling fan **31** to be operated, and when the internal temperature is within the satisfaction temperature region, the controller **80** controls the first cooling fan **31** to stop operating.

Specifically, when the internal temperature of the first storage compartment **12** reaches the first lower limit temperature NT-DIFF1 on the basis the first set reference temperature, the controller **80** stops operation for cold air supply.

However, when the internal temperature rises on the basis of the first set reference temperature, the operation for cold air supply is resumed before the reaching the first upper limit temperature NT+DIFF1.

After the internal temperature of the first storage compartment **12** reaches the first lower limit temperature NT-DIFF1, the controller **80** may control the refrigerant valve **63** such that the first refrigerant path **61** is closed and the second refrigerant path **62** is opened.

At this point, after the internal temperature of the first storage compartment **12** reaches the first lower limit temperature NT-DIFF1, the controller **80** may control the first cooling fan **31** to be operated for a predetermined time.

Furthermore, when the internal temperature of the first storage compartment **12** reaches the first upper limit temperature NT+DIFF1, the controller **80** may control the refrigerant valve **63** such that the first refrigerant path **61** is opened and the second refrigerant path **62** is closed.

At this point, the controller **80** may control the first cooling fan **31** to supply cold air, and control to reduce the amount of cold air supplied by the second cooling fan **41**.

In addition, during the general cooling operation described above, coming up of the cycle for the frost detecting operation is continuously checked, at S**120**.

At this point, the performance cycle of the frost detecting operation may be a cycle of time, and may be a cycle in which the same operation such as a specific component or operation cycle is repeatedly performed.

In the embodiment of the present disclosure, the cycle may be a cycle in which the second cooling fan **41** is operated.

In other words, considering that the frost detecting device **70** is configured to check the amount of frosting on the second evaporator **22** on the basis of a temperature difference value (logic temperature ΔHt) in response to a change in the flux of air passing through the frosting detection flow path **710**, as the logic temperature ΔHt becomes higher, the reliability of a detection result of the frost detecting device **70** may be secured, and when the second cooling fan **41** is operated, the highest logic temperature ΔHt may be secured.

At this point, the cycle may be each operation time of the second cooling fan **41** or alternating operation time of the second cooling fan **41**. Of course, immediately after the defrosting operation terminates, since frequent performance of the frost detecting operation are not required, for example, the cycle may be set such that the frost detecting operation is performed for every 3 operations of the second cooling fan **41**.

Furthermore, the second cooling fan **41** of the second fan duct assembly **40** may be operated while the operation of the first cooling fan **31** of the first fan duct assembly **30** stops. Of course, when necessary, the second cooling fan **41** may be controlled to be operated also when the operation of the first cooling fan **31** does not completely stop.

In addition, in order to increase a difference between temperature values in response to change in the flux of air passing through the frosting detection flow path **710**, the flux of air should be large. In other words, a change in the flux of air of which reliability cannot be secured is virtually meaningless or may cause an error in determination.

Considering this, it may be preferable that the frosting sensor **730** is operated when the second cooling fan **41** having a virtually valid change in the flux of air is operated. In other words, during operation of the second cooling fan **41**, it may be preferable to control the heating element **731** of the frosting sensor **730** to emit heat.

The heating element **731** may be controlled to emit heat simultaneously while power is supplied to the second cooling fan **41**, or the heating element **731** may be controlled to emit heat immediately after power is supplied to the second cooling fan **41** or when a certain condition is satisfied while power has been supplied to the second cooling fan **41**.

In the embodiment of the present disclosure, it is illustrated that the heating element **731** is controlled to emit heat when the certain condition is satisfied while power is supplied to the second cooling fan **41**.

In other words, when the cycle for the frost detecting operation comes, when the heating condition of the heating element **731** is confirmed, at S**130**, and then the heating condition is satisfied, the heating element **731** is controlled to emit heat.

This heating condition is the same as the above-mentioned description.

In other words, the heating condition may include at least one of the condition, in which when power is supplied to the second cooling fan **41**, rising of the temperature in the frosting detection flow path stops; the condition in which the temperature inside the frosting detection flow path **710** gradually rises by power supply to the second cooling fan **41** and then turns downward; the condition in which the temperature of the second storage compartment **13** checked by the separate temperature sensor **1***b* that senses the temperature inside the second storage compartment **13** falls over the set range despite the power supply to the second cooling fan **41**; the condition in which the temperature inside the second storage compartment **13** stops rising or falls; the condition in which the heating time of the heating element **731** is shorter than the remaining operation time of the second cooling fan **41**; the condition in which the second cooling fan **41** is maintained at a middle speed or more; and the condition in which the rotation speed of the second cooling fan **41** is maintained without change.

Of course, the heating condition may include the basic condition.

The basic heating condition may include at least any one basic condition of the condition in which after the second cooling fan **41** is operated and the set time elapses, the heating element is controlled to automatically emit heat; the condition in which before the second cooling fan **41** is operated the internal temperature (temperature checked by temperature sensor) of the frosting detection flow path **710** gradually falls; the condition in which the second cooling fan **41** is in operation; and the condition in which the door of the second storage compartment **13** is not opened.

In addition, when it is confirmed that the above-described heating condition is satisfied, while power is supplied to the heating element **731** under the control of the controller **80** (or control of sensor PCB), the heating element **731** emits heat, at S**140**.

Furthermore, when the above-described heating of the heating element **731** is performed, the temperature sensor **732** detects a material property of the fluid in the frosting detection flow path **710**, e.g., the temperature Ht1, at S**150**.

The temperature sensor **732** may detect the temperature Ht1 simultaneously while the heating element **731** emits heat, and after heat-emission of the heating element **731** is performed, the temperature sensor **732** may detect the temperature Ht1.

Specifically, the temperature Ht1 detected by the temperature sensor **732** may be the minimum temperature inside the frosting detection flow path **710** to be checked after the heating element **731** is turned ON.

The detected temperature Ht1 may be stored in the controller (or sensor PCB).

In addition, the heating element **731** emits heat for a set heating time. At this point, the set heating time may be time that may have the discrimination for a change in temperatures inside the frosting detection flow path **710**.

For example, it is preferable that the logic temperature ΔHt when the heating element **731** emits heat for the set heating time has the discrimination except for the logic temperature ΔHt by predicted or unpredicted other factors.

The set heating time may be a specific time, or may be time that is variable in response to the peripheral environment.

For example, the set heating time may be time shorter than a difference between the time, which is required for the changed cycle when the operational cycle of the first cooling fan **31** for the cooling operation of the first storage compartment **12** is changed to be shorter than the preceding operational cycle, and the time required for the above-described heating condition.

Furthermore, the set heating time may be time shorter than a difference between the time changed when the operational time of the second cooling fan **41** for the cooling operation of the second storage compartment **13** is changed to be shorter than the preceding operational time, and the time required for the above-described heating condition.

Furthermore, the set heating time may be time shorter than the operational time of the second cooling fan **41** when the second storage compartment **13** is operated at the maximum load.

Furthermore, the set heating time may be time shorter than a difference between the time for the second cooling fan **41** to be operated in response to a change in the internal temperature of the second storage compartment **13** and the time required for the above-described heating condition.

Furthermore, the preset heating time may be time shorter than a difference between the operation time of the second cooling fan **41** changed in response to the designated internal temperature of the second storage compartment **13** designated by the user and the time required for the above-described heating condition.

In addition, when the set heating time elapses, while the supply of power to the heating element **731** is interrupted, heat-emission of the heating element **731** may stop, at S**160**.

Of course, even when the heating time does not elapse, supply of power to the heating element **731** may be controlled to be interrupted.

For example, when the temperature detected by the temperature sensor **732** exceeds a set temperature value (e.g., 70° C.), the supply of power to the heating element **731** may be controlled to be interrupted, and when the door of the second storage compartment **13** is opened, the supply of power to the heating element **731** may be controlled to be interrupted.

When unexpected operation of the first storage compartment **12** (operation of first cooling fan) occurs, the supply of power to the heating element **731** may be controlled to be interrupted.

When the second cooling fan **41** is turned OFF, the supply of power to the heating element **731** may be controlled to be interrupted.

As described above, when heat-emission of the heating element **731** stops, a value of a material property of the frosting detection flow path **710** detected by the temperature sensor **732**, i.e., the temperature Ht2 may be detected, at S**170**.

At this point, the temperature detection of the temperature sensor **732** may be performed simultaneously with the stopping of heat-emission of the heating element **731**, and may be performed after heat-emission of the heating element **731** stops.

Specifically, the temperature Ht2 detected by the temperature sensor **732** may be the highest internal temperature of the frosting detection flow path **710** checked at the time before and after the heating element **731** is turned off.

The detected temperature Ht2 may be stored in the controller **80** (or, sensor PCB).

In addition, the controller **80** (or sensor PCB) may calculate each logic temperature ΔHt on the basis of each detected temperature Ht1, Ht2, and may determine whether or not the defrosting operation with respect to the cooling source **22** (second evaporator) is performed, on the basis of the logic temperature ΔHt calculated as described above.

In other words, after calculating at S**180** and storing a difference value ΔHt between the temperature Ht1 when the heating element **731** emits heat and the temperature Ht2 when heat-emission of the heating element **731** terminates, the controller **80** may determine whether or not the defrosting operation is performed, on the basis of the logic temperature ΔHt.

For example, when the logic temperature ΔHt is higher than the set first reference difference value, the flux of air in the frosting detection flow path **710** is less, and thus the controller may determine that the amount of frosting on the second evaporator **22** is less than the amount of frosting required for the defrosting operation.

In other words, when the amount of frosting on the second evaporator **22** is less, a difference between a pressure at an air inlet and a pressure at an air outlet of the second evaporator **22** is small, and thus the flux of air flowing in the frosting detection flow path **710** is small, so that the logic temperature ΔHt is relatively high.

On the other hand, when the logic temperature ΔHt is lower than the set second reference difference value, the flux of air in the frosting detection flow path **710** is large, so that the controller may determine that the amount of frosting on the second evaporator **22** is sufficient to perform the defrosting operation.

In other words, when the amount of frosting on the second evaporator **22** is large, a difference between a pressure at the air inlet and a pressure at the air outlet of the second evaporator **22** is great, and the flux of air flowing in the frosting detection flow path **710** is large due to the difference in pressure, so that the logic temperature ΔHt is relatively low.

At this point, the second reference difference value may be a value that is set sufficiently to perform the defrosting operation. Of course, the first reference difference value and the second reference difference value may be the same value, or the second reference difference value may be set as a lower value than the first reference difference value.

The first reference difference value and the second reference difference value may be one specific value or be a value in a range.

For example, the second reference difference value may be 24° C., and the first reference difference value may be the temperature in the range from 24° C. to 30° C.

In addition, in response to a result of the above-described determination, when the logic temperature ΔHt confirmed by the controller **80** is higher than the set first reference difference value, it may be determined that the amount of frosting on the second evaporator **22** failed to reach the set amount of frosting.

In this case, after operation of the second cooling fan **41** stops, frosting detection may stop until a following cycle is operated.

Next, when the operation of the following cycle of the second cooling fan **41** is performed, the process of determining whether or not the heating condition for the frosting detection is satisfied may be repeatedly performed.

However, when the logic temperature ΔHt confirmed by the controller **80** is lower than the set second reference difference value, the controller may determine that the second evaporator **22** exceeds the set amount of frosting, and the defrosting operation may be controlled to be performed, at S**2**.

At this point, when the defrosting operation is performed, the logic temperature ΔHt for each frosting detection cycle that is stored may be reset.

In addition, the logic temperature ΔHt checked by the frosting detecting device **70** may be sequentially stored for each frosting detection until the defrosting operation is performed, and may be compared.

In other words, when using the logic temperature ΔHt that is sequentially stored as described, not only whether or not frosting of the second evaporator **22** occurs, but also at least any one problem of an error of the temperature sensor **732**, clogging of the frosting detection flow path **710**, freezing of the heating element **731**, freezing of the second cooling fan **41**, and remaining ice of the second evaporator **22** may be confirmed.

For example, although the logic temperature ΔHt sequentially stored should gradually fall as the order goes on, when the logic temperature ΔHt of the present order is confirmed to be higher than the logic temperature ΔHt of the preceding order, it may be determined as clogging of the frosting detection flow path **710** or freezing of the second cooling fan **41**.

Furthermore, although the logic temperature ΔHt that is sequentially stored should fall as the order goes on, when the logic temperature ΔHt of the present order is confirmed to be sharply lower than the logic temperature ΔHt of the preceding order, it may be determined as an error or freezing of the heating element **731**.

Furthermore, although the defrosting operation is performed, when the logic temperature ΔHt fails to reach the initial temperature difference value, it may be determined that remaining frost exists.

Of course, checking the above-described situations may be possible when the logic temperature ΔHt has sufficient discrimination. In other words, as the logic temperature ΔHt becomes higher, the discrimination is improved and thus various situations may be determined.

Meanwhile, during performance of the above-described frost detecting operation, a situation in which the heating condition of the heating element **731** is not satisfied or an unexpected situation may occur.

In other words, it is set that heat-emission of the heating element **731** for the frost detecting operation is performed when the heating condition is satisfied, and although the heating time of the heating element **731** is set to be shorter than the minimum operating time of the second cooling fan **41** that is changed according to the internal environment or a temperature setting of the user, an error in the frosting detection may occur.

Accordingly, during the frost detecting operation that is performed cyclically every time power is supplied to the second cooling fan **41**, when the heating condition is not satisfied, it is controlled that the heating element **731** does not emit heat and the frost detecting operation at the present cycle terminates.

In other words, it may be preferable that improvement of the power consumption efficiency is achieved as the heating element **731** does not emit heat.

In this unexpected situation, a situation of opening of the door of the first storage compartment **12** or the second storage compartment **13** during the frost detecting operation may be included.

In this unexpected situation, a situation in which during the frost detecting operation the time required for the heating condition of the heating element **731** to be satisfied is higher than the minimum time may be included.

The frost detecting operation as described above may be performed periodically, and the cycle may be a cycle according to the time or a cycle according to the operation of the second cooling fan **41**.

Furthermore, when the cyclically frost detecting operation is performed and the heating condition is not satisfied, the frost detecting operation of the present cycle terminates and the information obtained in the present cycle is deleted so that the information is not stored.

A cycle of the periodically frost detecting operation may not be constant.

For example, the frost detecting operation that is performed after completion of the defrosting operation is provided to check various defects and may not be performed every time power is supplied to the second cooling fan **41**.

In other words, in response to the temperature range of the logic temperature ΔHt obtained by performing the frost detecting operation, the cycle of the frost detecting operation may be set variously, for example, as one performance for each 5th power supply to the second cooling fan **41**, one performance for each 3th power supply to the second cooling fan **41**, or one performance for every power supply to the second cooling fan **41**.

Of course, when the logic temperature ΔHt is within the temperature range that requires attention, it may be preferable to perform the frost detecting operation for each power supply to the second cooling fan **41**.

Meanwhile, the operation time of the above-described frost detecting operation may be differently set in response to the room temperature measured by the first temperature sensor.

In other words, the controller **80** may perform a control such that the frost detecting time performed within a temperature region with the high room temperature is performed shorter than the frost detecting time performed within a temperature region with the low room temperature.

For example, in the temperature region with the room temperature higher than 32° C., the frost detecting time is controlled to be performed shorter than in the temperature region with the room temperature lower than 15° C.

Furthermore, the frost detecting time may be controlled to vary in response to a value of the internal temperature of the storage compartment.

In other words, the controller **80** performs control such that the frost detecting time within a temperature region with a high temperature value of the internal temperature measured by the second temperature sensor is performed shorter than the frost detecting time within a temperature region with a low internal temperature.

For example, in the temperature region with the internal temperature higher than 16° C., the frost detecting time is controlled to be performed shorter than in the temperature region with the internal temperature lower than 24° C.

Next, according to the embodiment of the present disclosure the refrigerator, a process S**2** of performing the defrosting operation with respect to the second evaporator **22** will be described below.

First, after the heating element **731** is turned off, the defrosting operation may be performed by determination of the controller **80**.

When the defrosting operation is performed, the first heater **51** constituting the defrosting device **50** may emit heat.

In other words, it is configured that heat generated by heat-emission of the first heater **51** is used to remove frost generated on the second evaporator **22**.

At this point, when the first heater **51** comprising of the sheath heater is turned on, heat generated by the first heater **51** removes frost generated on the second evaporator in radiation and convection.

Furthermore, when the defrosting operation is performed, the second heater **52** constituting the defrosting device **50** may emit heat.

In other words, it is configured that heat generated by heat-emission of the second heater **52** is used to remove frost generated on the second evaporator **22**.

At this point, when the second heater **52** comprising of the L-cord heater is turned on, heat generated by the second heater **52** is conductive into a heat-exchange fin, thereby removing frost generated on the second evaporator **22**.

The first heater **51** and the second heater **52** may be controlled to emit heat simultaneously, or it may be controlled that the first heater **51** emits heat preferentially and then the second heater **52** emits heat, or it may be controlled that the second heater **52** emits heat preferentially and then the first heater **51** emits heat.

In addition, after heat-emission of the first heater **51** or the second heater **52** is performed for a set time, heat-emitting of the first heater **51** or the second heater **52** stops.

At this time, even when the first heater **51** and the second heater **52** are provided together, the stopping of heat-emission may be performed in the two heaters **51** and **52**, but may be controlled such that heat-emission of one of the heater is stopped preferentially and then heat-emission of the other heater is stopped next.

The time for heat-emission of each heater **51**, **52** may be set by the specific time (e.g., 1 time, etc.) or may be set by the time that is variable in response to the amount of frosting.

Furthermore, the first heater **51** or the second heater **52** may be operated at the maximum load, or operated at the load that is variable in response to the amount of defrosting.

In addition, when the defrosting operation depending on operation of the defrosting device **50** is performed, the heating element **731** constituting the frosting sensor **730** may be controlled to emit heat with the defrosting operation.

In other words, in the defrosting operation, considering that water caused by frost melting may also flow into the frosting detection flow path **710**, it may be preferable that the heating element **731** also emits heat to prevent the flowing water from being frozen in the frosting detection flow path **710**.

Furthermore, the defrosting operation may be performed on the basis of time, or temperature.

In other words, when the defrosting operation is performed for randomized time, the defrosting operation may be controlled to terminate, and when the temperature of the second evaporator **22** reaches the set temperature, the defrosting operation may be controlled to terminate.

In addition, when operation of the above-described defrosting device **50** is completed, the first cooling fan **31** is operated at the maximum load to allow the first storage compartment **12** to reach the set temperature range and then the second cooling fan **41** is operated at the maximum load, so that the second storage compartment **13** may reach the set temperature range.

At this point, when the first cooling fan **31** is operated, the refrigerant compressed from the compressor **60** may be controlled to be supplied to the first evaporator **21**, and when the second cooling fan **41** is operated, the refrigerant compressed from the compressor **60** may be controlled to be supplied to the second evaporator **22**.

In addition, when the temperature conditions of the first storage compartment **12** and the second storage compartment **13** are satisfied, the above-described control for the frosting detection of the second evaporator **22** performed by the frost detecting device **70** is successively performed.

Of course, immediately after operation of the defrosting device **50** is completed, it may be preferable to detect remaining ice to determine whether or not additional defrosting operation is required.

In other words, when remaining ice is checked, as additional defrosting operation is performed even though the defrosting operation time does not come up, the remaining ice may be completely removed.

Meanwhile, the defrosting operation may not be performed only based on the information obtained by the frost detecting device **70**.

For example, due to the user's negligence, the door of any one storage compartment may be opened for a long time (including tiny-opening, etc.).

This state may be recognized by a sensor that performs opening detection of the door, and in this case, the defrosting operation may be set to be forcibly performed when a certain time elapses without operating the frost detecting device **70**.

Furthermore, when the frosting detection operation is not cyclically performed due to excessive frequent opening and closing of the door, without using the information obtained by the frost detecting device **70**, the defrosting operation may be set to be forcibly performed at set time considering frequent opening and closing of the door.

As described above, the refrigerator **1** of the present disclosure is configured to perform the frost detecting operation that checks frosting of the second evaporator **22** in consideration of the cooling operation in response to the internal environment of the first storage compartment **12** or the second storage compartment **13** or the temperature set by the user, so that the frosting detection may be precise performed.

In other words, when the operation time of the second cooling fan **41** is set shorter than the operation time in normal operation due to the internal environment or the user-set temperature, the frost detecting operation is performed within the operation time of the second cooling fan **41**, so that the reliability of the frosting detection may be improved.

Furthermore, in the refrigerator **1** of the present disclosure, the heating condition of the heating element **731** may include a condition in which the heating time of the heating element **731** is shorter than the remaining driving time of the second cooling fan **41**, thereby reducing an error in the frost detecting operation and improving the measurement reliability with respect to frosting.

In other words, the refrigerator **1** of the present disclosure is configured to sufficiently secure the heating time of the heating element **731** constituting the frost detecting device **70**, and the discrimination in a temperature change may be improved.

Specifically, since it is determined that the heating condition is satisfied when the heating time of the heating element **731** is shorter than the remaining driving time of the second cooling fan **41**, when the heating condition is not satisfied, the heating element **731** does not emit heat and power consumption may be reduced.

Furthermore, the refrigerator **1** of the present disclosure is configured to allow more precise frosting detection as the heating condition for heat-emission of the heating element **731** that may maximally improve the discrimination of the logic temperature ΔHt is applied, and the defrosting operation that is performed on the basis of the frosting detection may be also performed when exactly necessary, so that the consumption efficiency may be further improved.

Meanwhile, the refrigerator of the present disclosure is not limited to being applied only to the structure in which two storage compartments are provided or two evaporators are provided.

In other words, the present disclosure may be applied to a refrigerator having a structure in which only one storage compartment is provided or only one evaporator is provided. Various configurations are possible.

As described above, the refrigerator of the present disclosure may be applied to various models.

The invention claimed is:

1. A refrigerator comprising:

a casing providing a storage compartment;

a door to open and close the storage compartment;

a first temperature sensor to measure a room temperature outside the storage compartment;

a second temperature sensor to measure an internal temperature of the storage compartment;

a cooling source to cool a fluid supplied to the storage compartment;

a first duct to guide the fluid inside the storage compartment to move to the cooling source;

a second duct to guide the fluid around the cooling source to move to the storage compartment;

a controller configured to adjust an amount of fluid supply, based on the room temperature measured by the first temperature sensor and the internal temperature of the storage compartment measured by the second temperature sensor; and

a frost detecting device to detect an amount of frost or ice generated on the cooling source,

a cooling fan to circulate the fluid around the cooling source into the storage compartment,

wherein, based on the internal temperature of the storage compartment being within a dissatisfaction temperature region that is divided by an upper limit temperature on the basis of a set reference temperature set by a user for the storage compartment, the controller is configured to adjust the amount of fluid supply to increase so that the internal temperature of the storage compartment falls, and based on the internal temperature of the storage compartment being within a satisfaction temperature region divided by a lower limit temperature on the basis of the set reference temperature, the controller is configured to adjust the amount of fluid supply to be reduced,

the frost detecting device comprises a frosting detection flow path to provide a flow path to allow a portion of the fluid to flow, and a frosting sensor disposed at the frosting detection flow path to measure a material property of the portion of the fluid passing through the frosting detection flow path,

the controller is configured to control the frost detecting device to perform a frost detecting operation for a frost detecting time that is set,

the controller is configured to control the frost detecting time of the frost detecting operation to be differently performed, on the basis of at least one of the room temperature and the set reference temperature, and

wherein the controller is configured to stop the frost detecting operation based on the cooling fan being turned off while the frost detecting operation is performed.

2. The refrigerator of claim 1, wherein at least a part of the frosting detection flow path is disposed in a flow path between the first duct and the cooling source.

3. The refrigerator of claim 1, wherein at least a part of the frosting detection flow path is disposed in a flow path between the second duct and the storage compartment.

4. The refrigerator of claim 1, wherein the material property comprises at least one of temperature, pressure, and flux.

5. The refrigerator of claim 1, wherein the frosting sensor comprises a sensor and a detecting derivative.

6. The refrigerator of claim 1, wherein the cooling source comprises at least one of a thermoelectric module or an evaporator.

7. The refrigerator of claim 1, wherein the controller is configured to control the frost detecting time to vary in response to a value of the room temperature measured by the first temperature sensor.

8. The refrigerator of claim 1, wherein the controller is configured to perform control such that the frost detecting time within a temperature region where a value of the room temperature measured by the first temperature sensor is high is performed shorter than the frost detecting time within a temperature region where a value of the room temperature is low.

9. The refrigerator of claim 1, wherein the controller is configured to perform control such that the frost detecting time varies on the basis of the set reference temperature.

10. The refrigerator of claim 1, wherein the controller is configured to perform control such that the frost detecting time within a temperature region where the set reference temperature is high is performed shorter than the frost detecting time within a temperature region where the set reference temperature is low.

11. The refrigerator of claim 1, wherein the controller is configured to stop the frost detecting operation based on the controller detecting opening of the door while the frost detecting operation is performed.

12. A refrigerator comprising:

a casing providing a storage compartment;

a door to open and close the storage compartment;

a first temperature sensor to measure a room temperature outside the storage compartment;

a second temperature sensor to measure an internal temperature of the storage compartment;

a cooling source to cool a fluid supplied to the storage compartment;

a first duct to guide the fluid inside the storage compartment to move to the cooling source;

a second duct to guide the fluid around the cooling source to move to the storage compartment;

a controller configured to adjust an amount of fluid supply, based on the room temperature measured by the first temperature sensor and the internal temperature of the storage compartment measured by the second temperature sensor; and

a frost detecting device to detect an amount of frost or ice generated on the cooling source,

a cooling fan to circulate the fluid around the cooling source into the storage compartment,

wherein, based on the internal temperature of the storage compartment being within a dissatisfaction temperature region that is divided by an upper limit temperature on the basis of a set reference temperature set by a user for the storage compartment, the controller is configured to adjust the amount of fluid supply to increase so that the internal temperature of the storage compartment falls, and based on the internal temperature of the storage compartment being within a satisfaction temperature region divided by a lower limit temperature on the basis of the set reference temperature, the controller is configured to adjust the amount of fluid supply to be reduced,

the frost detecting device comprises a frosting detection flow path to provide a flow path to allow a portion of the fluid to flow, and a frosting sensor disposed at the frosting detection flow path to measure a material property of the portion of the fluid passing through the frosting detection flow path, the controller is configured to control the frost detecting device to perform a frost detecting operation for a frost detecting time that is set,

the controller is configured to control the frost detecting time of the frost detecting operation to be differently performed, on the basis of at least one of the room temperature and the set reference temperature,

wherein the frost detecting operation comprises the controller configured to determine a heating condition before the controller turns a heating element on, and

wherein the heating condition comprises at least one among (i) a condition in which based on power being supplied into the cooling fan, rising of temperature in the frosting detection flow path stops, (ii) a condition in which due to supply of power to the cooling fan, after a temperature in the frosting detection flow path gradually rises, the temperature turns downward, (iii) a condition in which an internal temperature of the storage compartment falls over a set range despite operation of the cooling fan, (iv) a condition in which a heating time of the heating element is shorter than a remaining operation time of the cooling fan, (v) a condition in which the cooling fan is maintained at a middle speed or more, or (vi) a condition in which a rotation speed of the cooling fan is maintained without change.

13. A refrigerator comprising:

a casing providing a storage compartment;

a door to open and close the storage compartment;

a first temperature sensor to measure a room temperature outside the storage compartment;

a second temperature sensor to measure an internal temperature of the storage compartment;

a cooling source to cool a fluid supplied to the storage compartment;

a first duct to guide the fluid inside the storage compartment to move to the cooling source;

a second duct to guide the fluid around the cooling source to move to the storage compartment;

a controller configured to adjust an amount of fluid supply, based on the room temperature measured by the first temperature sensor and the internal temperature of the storage compartment measured by the second temperature sensor; and

a frost detecting device to detect an amount of frost or ice generated on the cooling source,

wherein, based on the internal temperature of the storage compartment being within a dissatisfaction temperature region that is divided by an upper limit temperature on the basis of a set reference temperature set by a user for the storage compartment, the controller is configured to adjust the amount of fluid supply to increase so that the internal temperature of the storage compartment falls, and based on the internal temperature of the storage compartment being within a satisfaction temperature region divided by a lower limit temperature on the basis of the set reference temperature, the controller is configured to adjust the amount of fluid supply to be reduced,

the frost detecting device comprises a frosting detection flow path to provide a flow path to allow a portion of the fluid to flow, and a frosting sensor disposed at the frosting detection flow path to measure a material property of the portion of the fluid passing through the frosting detection flow path,

the controller is configured to control the frost detecting device to perform a frost detecting operation for a frost detecting time that is set,

the controller is configured to control the frost detecting time of the frost detecting operation to be differently performed, on the basis of at least one of the room temperature and the set reference temperature,

wherein the frost detecting operation comprises the controller configured to determine a heating condition before the controller turns a heating element on, and

wherein the heating condition comprises a condition in which the internal temperature of the storage compartment stops rising or falls.

* * * * *