(12) STANDARD PATENT (11) Application No. **AU 2014303819 B2**
(19) AUSTRALIAN PATENT OFFICE

(54) Title
Refrigerator

(51) International Patent Classification(s)
F25B 1/00 (2006.01) ***F25D 11/00*** (2006.01)
F25B 6/04 (2006.01) ***F25D 21/04*** (2006.01)

(21) Application No: **2014303819** (22) Date of Filing: **2014.06.26**

(87) WIPO No: **WO15/019740**

(30) Priority Data

(31) Number	(32) Date	(33) Country
2013-166060	**2013.08.09**	**JP**

(43) Publication Date: **2015.02.12**
(44) Accepted Journal Date: **2016.10.13**

(71) Applicant(s)
Mitsubishi Electric Corporation

(72) Inventor(s)
Eto, Hiroshi;Nakatsu, Satoshi;Tashiro, Yusuke

(74) Agent / Attorney
FPA Patent Attorneys Pty Ltd, ANZ Tower 161 Castlereagh Street, Sydney, NSW, 2000

(56) Related Art
JP 2003-106684 A
JP 54-021660 A
JP 2013-072595 A

(12) 特許協力条約に基づいて公開された国際出願

(19) 世界知的所有権機関
国際事務局

(43) 国際公開日
2015 年 2 月 12 日(12.02.2015)

WIPO | PCT

(10) 国際公開番号
WO 2015/019740 A1

(51) 国際特許分類:
F25B 1/00 (2006.01) *F25D 11/00* (2006.01)
F25B 6/04 (2006.01) *F25D 21/04* (2006.01)

(21) 国際出願番号: PCT/JP2014/067061

(22) 国際出願日: 2014 年 6 月 26 日(26.06.2014)

(25) 国際出願の言語: 日本語

(26) 国際公開の言語: 日本語

(30) 優先権データ:
特願 2013-166060 2013 年 8 月 9 日(09.08.2013) JP

(71) 出願人: 三菱電機株式会社(**MITSUBISHI ELECTRIC CORPORATION**) [JP/JP]; 〒1008310 東京都千代田区丸の内二丁目７番３号 Tokyo (JP).

(72) 発明者: 衛藤 浩(**ETO, Hiroshi**); 〒1008310 東京都千代田区丸の内二丁目７番３号 三菱電機株式会社内 Tokyo (JP). 中津 哲史(**NAKATSU, Satoshi**); 〒1008310 東京都千代田区丸の内二丁目７番３号 三菱電機株式会社内 Tokyo (JP). 田代雄亮(**TASHIRO, Yusuke**); 〒1008310 東京都千代田区丸の内二丁目７番３号 三菱電機株式会社内 Tokyo (JP).

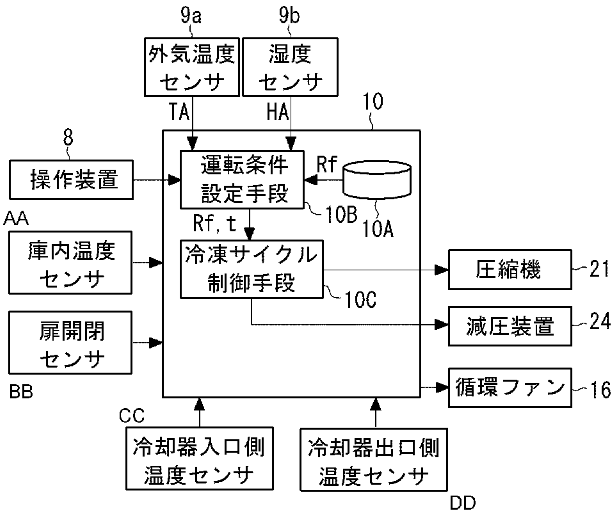
(74) 代理人: 安島 清, 外(**AJIMA, Kiyoshi** et al.); 〒1050001 東京都港区虎ノ門二丁目１０番１号 虎ノ門ツインビルディング東棟８階 特許業務法人きさ特許商標事務所 Tokyo (JP).

(81) 指定国 (表示のない限り、全ての種類の国内保護が可能): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

[続葉有]

(54) Title: REFRIGERATOR

(54) 発明の名称 : 冷蔵庫



8 Operation device
9a Outside air temperature sensor
9b Humidity sensor
10B Driving condition setting means
10C Refrigeration cycle control means
16 Circulation fan
21 Compressor
24 Decompression device
AA Internal temperature sensor
BB Door opening/closing sensor
CC Cooler entrance-side temperature sensor
DD Cooler exit-side temperature sensor

(57) Abstract: The control device of this refrigerator has: a setting table that associates and stores the flow resistance of a decompression device differing for each outside air temperature; a driving condition setting means that selects a flow resistance from the setting table on the basis of the outside air temperature detected by an outside air temperature sensor; and a refrigeration cycle control means that sets the driving time at the flow resistance selected by the driving condition setting means and controls a refrigeration cycle in a manner so as to perform a power-saving driving by means of the flow resistance (Rf) and driving time

(57) 要約: 冷蔵庫の制御装置は、外気温度毎に異なる減圧装置の流動抵抗が関連付けして記憶されている設定テーブルと、外気温度センサにより検出された外気温度に基づいて設定テーブルから流動抵抗を選択する運転条件設定手段と、運転条件設定手段において選択された流動抵抗での運転時間を設定し、流動抵抗Ｒｆ及び運転時間による節電運転が行われるように冷凍サイクルを制御する冷凍サイクル制御手段とを有する。

WO 2015/019740 A1

(84) 指定国 (表示のない限り、全ての種類の広域保護が可能): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), ユーラシア (AM, AZ, BY, KG, KZ, RU, TJ, TM), ヨーロッパ (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

添付公開書類:

— 国際調査報告（条約第 21 条(3)）

DESCRIPTION

Title of Invention

REFRIGERATOR

Technical Field

[0001]

The present invention relates to a refrigerator having an anti-condensation pipe for preventing dew condensation.

Background Art

[0002]

A refrigerator typically includes a cabinet that is an open-front heat-insulating box, a divider for dividing an inner space of the cabinet into a plurality of storage rooms, and heat-insulating doors that cover the front openings of the respective storage rooms in such a manner that they can be freely opened and closed. In the refrigerator of this type, cold air flows between the cabinet and the divider and the heat-insulating doors, reducing the surface temperature of the edge of the front opening of the cabinet. When the surface temperature drops below the outside air temperature and then to the dew point temperature or lower, dew condensation occurs. To address this problem, an anti-condensation pipe, through which high-pressure refrigerant flows, is provided at the front edges of the cabinet and the divider, which are the openings of the storage rooms of the refrigerator, to reduce the occurrence of the dew condensation by heating the front sides of the cabinet and the divider with condensation heat of the refrigerant flowing through the anti-condensation pipe.

[0003]

Meanwhile, if the anti-condensation pipe is heated excessively, a part of the condensation heat enters the storage rooms from the anti-condensation pipe, increasing the cooling load of the refrigerator. Hence, a refrigerator in which the flow rate of the refrigerant flowing through the anti-condensation pipe or the temperature of the refrigerant is adjusted to prevent excessive heating of the anti-condensation pipe while preventing the dew condensation has been proposed (for example, see Patent Literatures 1 and 2).

[0004]

Patent Literature 1 discloses a refrigerator in which a refrigerant-flow-rate distributing device is disposed between a heat-rejecting condenser and an anti-condensation condenser. The refrigerant-flow-rate distributing device distributes the refrigerant to the anti-condensation condenser and the bypass tube depending on the difference in temperature between the ambient temperature and the anti-condensation condenser. Patent Literature 2 discloses a refrigerator in which a condenser pipe is provided on each of the upstream and downstream sides of a condenser, and an adjustable expansion valve is provided between the condenser and an anti-condensation pipe on the downstream side. By adjusting the expansion valve, the temperature of the refrigerant flowing to the anti-condensation pipe on the downstream side is adjusted to the optimum temperature.

Citation List

Patent Literature

[0005]

Patent Literature 1: Japanese Unexamined Patent Application Publication No. 8-285426 (Fig. 1)

Patent Literature 2: Japanese Unexamined Patent Application Publication No. 54-21660 (Fig. 5)

[0005a]

Reference to any prior art in the specification is not, and should not be taken as, an acknowledgment or any form of suggestion that this prior art forms part of the common general knowledge in any jurisdiction or that this prior art could reasonably be expected to be understood, regarded as relevant and/or combined with other pieces of prior art by a person skilled in the art.

Summary of Invention

[0005b]

As used herein, except where the context requires otherwise, the term "comprise" and variations of the term, such as "comprising", "comprises" and "comprised", are not intended to exclude further additives, components, integers or steps.

Technical Problem

[0006]

However, in the refrigerator in Patent Literature 1, because the flow rate of the refrigerant flowing to the anti-condensation pipe changes, to adjust the temperature of the refrigerant flowing into the anti-condensation pipe to a target temperature, a flow-rate adjusting device and a pressure detecting device for precisely detecting the flow rate and the pressure of the refrigerant flowing into the anti-condensation pipe are provided. Thus, the cost increases, and extra compressor input is needed, leading to an increase in power consumption. Furthermore, because the refrigerator in Patent

Literature 2 requires the anti-condensation pipe to be disposed at positions depending on the temperatures of the opening edges of the storage rooms having different temperature settings, the arrangement and disposition structure of the anti-condensation pipe become complex.

[0007]

The present invention has been made in view of the above-described problems, and an object thereof is to provide a refrigerator having a reasonable and simple structure capable of reducing an increase in cooling load of the refrigerator due to the heat of the anti-condensation pipe. It is an alternative or additional object of the present invention to provide the public with a useful choice.

Solution to Problem

[0008]

A refrigerator according to an aspect of the present invention includes a cabinet having an inner space, a divider for dividing the inner space of the cabinet into a plurality of storage rooms, a refrigeration cycle accommodated in the cabinet, the refrigeration cycle connecting in series in an order of a compressor, a condenser pipe, a pressure reducing device, an anti-condensation pipe, and a capillary tube, an outside-air-temperature sensor provided outside the cabinet and configured to detect an outside air temperature, and a controller configured to control operation of the refrigeration cycle. The controller includes a setting table storing a flow resistance of the pressure reducing device associated with each one of outside air temperatures, the flow resistances being different from each other, an operating-condition setting unit configured to select one from the flow resistances in the setting table based on the outside air temperature detected by the outside-air-temperature sensor and configured to set an operating time for the selected flow resistance, and a refrigeration-cycle control unit configured to control the refrigeration cycle to allow operation to be performed with the flow resistance and the operating time set by the operating-condition setting unit.

Advantageous Effects of Invention

[0009]

According to the refrigerator of the present invention, by automatically setting the flow resistance of the pressure reducing device and the operating time therefor depending on the outside air temperature, it is possible to prevent the dew condensation while reducing an increase in power consumption due to the heat of the anti-condensation pipe with a reasonable and simple structure, without providing a pressure detecting device or a bypass pipe as needed in the conventional configuration. Additional and alternative effects of the invention will be apparent from the present disclosure.

Brief Description of Drawings

[0010]

[Fig. 1A] Fig. 1A is a front view showing preferred Embodiment of a refrigerator of the present invention.

[Fig. 1B] Fig. 1B is a side sectional view showing preferred Embodiment of the refrigerator of the present invention.

[Fig. 1C] Fig. 1C is a front view of the refrigerator of the present invention according to preferred Embodiment, in a state without doors.

[Fig. 2] Fig. 2 is a refrigerant circuit diagram showing an example of a refrigeration cycle of the refrigerator in Fig. 1.

[Fig. 3] Fig. 3 is a plan view showing an example of an anti-condensation pipe accommodated in a cabinet in Fig. 1.

[Fig. 4] Fig. 4 is a function block diagram showing an example of a controller of the refrigerator in Fig. 1.

[Fig. 5] Fig. 5 is a table showing an example of a setting table in the controller in Fig. 4.

[Fig. 6] Fig. 6 is a graph showing control of the opening degree of a pressure reducing device when the refrigeration cycle in Fig. 2 is operated.

[Fig. 7] Fig. 7 is a flowchart showing an operation example of the refrigerator in Fig. 1.

Description of Embodiments

[0011]

Embodiment of a refrigerator according to the present invention will be described below with reference to the drawings. Note that the present invention is not limited by Embodiment described below. Furthermore, in the drawings below including Fig. 1, the dimensional relationships among components may be different from those in reality. Fig. 1A is a front view showing preferred Embodiment of the refrigerator of the present invention. Fig. 1B is a side sectional view showing preferred Embodiment of the refrigerator of the present invention. Fig. 1C is a front view of the refrigerator of the present invention according to preferred Embodiment, in a state without doors. A refrigerator 100 in Figs. 1A to 1C includes a cabinet 1, which constitutes the main body of the refrigerator, and dividers (partition walls) 2.

[0012]

The cabinet 1 is an open-front box-like member and includes an outer box 11 that forms an outer shell and an inner box 12 that forms an inner wall. A heat-insulating material, such as urethane, is provided between the outer box 11 and the inner box 12. The dividers 2 divide the inner space of the cabinet 1 into a plurality of storage rooms, such as a refrigerator compartment 3, an ice box 4, a switchable compartment 5, a freezer compartment 6, and a vegetable compartment 7.

[0013]

The refrigerator compartment 3 is provided at the top of the refrigerator 100, and the front side thereof is covered with double-swing doors 31 having heat-insulating structures in such a manner that it can be freely opened and closed. The ice box 4 and the switchable compartment 5 are provided side-by-side on the left and right, below the refrigerator compartment 3, and the front sides thereof are covered with drawer-type doors 41 and 51 having heat-insulating structures, in such a manner that they can be freely opened and closed. The freezer compartment 6 is provided below the ice box 4 and the switchable compartment 5, and the front thereof is covered with a drawer-type door 61 having a heat-insulating structure in such a manner that it can be freely opened and closed. The vegetable compartment 7 is provided below the freezer compartment 6, at the bottom of the refrigerator 100, and the front side thereof is covered with a drawer-type door 71 having a heat-insulating structure in such a manner that it can be freely opened and closed. Note that the doors of the respective storage rooms 3 to 7 are provided with a door opening/closing sensor (not shown) that detects the opening/closing state.

[0014]

The storage rooms 3 to 7 are distinguished by the temperature range that can be set (preset temperature range). For example, the refrigerator compartment 3 can be set to approximately from 0 degrees C to 4 degrees C, the vegetable compartment 7 can be set to approximately from 3 degrees C to 10 degrees C, the ice box 4 can be set to approximately -18 degrees C, and the freezer compartment 6 can be set to approximately from -16 degrees C to -22 degrees C. Furthermore, the temperature range for the switchable compartment 5 can be switched among the temperature ranges for a chilled mode (approximately 0 degrees C), a soft freezing mode (approximately -7 degrees C), or the like. In this way, the preset temperature ranges for the refrigerator compartment 3 and the vegetable compartment 7 are set higher than those of the ice box 4, the switchable compartment 5, and the freezer compartment 6. Note that the preset temperatures of the storage rooms 3 to 7 are not limited to the aforementioned values, but may be appropriately changed depending on the installation location and the content. Furthermore, the storage rooms 3 to 7 are each provided with an inside temperature sensor (not shown) for detecting the temperature of the corresponding storage room. Furthermore, air outlets 32, 42, 52, 62, and 72 are each provided with a damper (not shown) on an air passage 14 side.

[0015]

The cabinet 1 has a back wall 13 on the back side of the respective storage rooms 3 to 7. The air passage 14 and a cooling unit chamber 15 are formed between the inner box 12 and the rear surface of the back wall 13. The air passage 14 is a cold-air supply passage for supplying cold air to the respective storage rooms and is provided in, for example, an area facing the back surfaces of the respective storage rooms 3 to 7. The cooling unit chamber 15 is provided in, for example, an area facing the back surface of the freezer compartment 6 and accommodates a cooling unit 28 of a refrigeration cycle 20. Then, cold air resulting from heat exchange by the cooling unit 28 is supplied from the cooling unit chamber 15 to the air passage 14.

[0016]

The back surfaces of the respective storage rooms 3 to 7 in the cabinet 1 are provided with the air outlets, through which cold air flowing through the air passage 14 is blown into the respective storage rooms 3 to 7. More specifically, the refrigerator compartment 3 is provided with the air outlet 32, the ice box 4 is provided with the air outlet 42, the switchable compartment 5 is provided with the air outlet 52, the freezer compartment 6 is provided with the air outlet 62, and the vegetable compartment 7 is provided with the air outlet 72. Note that the air outlets 32, 42, 52, 62, and 72 are provided with the dampers (not shown), and the temperatures in the respective storage rooms 3 to 7 are controlled by opening or closing the dampers.

[0017]

The refrigeration cycle 20 is disposed on the back side of the cabinet 1, and produces cold air for cooling the inside of the refrigerator 100 by using the refrigeration cycle 20 of a vapor-compression type. Fig. 2 is a refrigerant circuit diagram showing an example of the refrigeration cycle of the refrigerator in Figs. 1A to 1C. In the refrigeration cycle 20 of the refrigerator 100 in Fig. 2, a compressor 21, a condenser pipe 22, a strainer 23, a pressure reducing device 24, an anti-condensation pipe 25, a drier 26, a capillary tube 27, and a cooling unit 28 are connected in series by a pipe.

[0018]

The compressor 21 is disposed in, for example, a machine room provided at the lower part, on the back side, of the refrigerator 100. The compressor 21 compresses refrigerant to produce high-temperature, high-pressure refrigerant and is driven by an inverter circuit. The operating capacity of the compressor 21 is controlled depending on the situation. The condenser pipe 22 exchanges heat between the refrigerant discharged from the compressor 21 and the outside air, and is formed of, for example, a hot pipe for drain evaporation, an air-cooled condenser disposed in the installation space for the compressor 21, and a pipe embedded in the side surface and back surface of the refrigerator 100 with a heat-insulating material therebetween. The strainer 23 is formed of a filter for removing dust, metal powder, or the like from the refrigerant flowing out of the condenser pipe 22.

[0019]

The pressure reducing device 24 expands the refrigerant by reducing the pressure of the refrigerant flowing therein from the condenser pipe 22 via the strainer 23 and is configured so that, for example, the opening degree of an electronic expansion valve can be variably controlled. Furthermore, the anti-condensation pipe 25 is connected in series to the pressure reducing device 24, and the refrigerant flowing into the pressure reducing device 24 via the condenser pipe 22 and the strainer 23 flows into the anti-condensation pipe 25 without being separated.

[0020]

The anti-condensation pipe 25 is connected in series to the condenser pipe 22 via the pressure reducing device 24. The anti-condensation pipe 25 functions as the condenser, together with the condenser pipe 22, and also has a function of preventing the dew condensation on the cabinet 1 and the dividers 2. Fig. 3 is a plan view showing an example of the anti-condensation pipe 25 accommodated in the cabinet 1 in Fig. 1. The anti-condensation pipe 25 is bent and accommodated in the peripheral portion of the front opening in the cabinet 1 and in the front edges of the dividers 2. The anti-condensation pipe 25 is mounted in the cabinet 1 and the dividers 2 with an elastic member having a large thermal capacity, such as butyl rubber, therebetween. The dew condensation at the front portion of the main body of the refrigerator 100 is prevented because the refrigerant flows through the anti-condensation pipe 25.

[0021]

Note that, although Fig. 3 shows an example case where the anti-condensation pipe 25 is located at a part of the front edges of the cabinet 1 and the dividers 2, the position of the anti-condensation pipe 25 is not limited thereto, and the anti-condensation pipe 25 may be located at any position at which it can reduce dew formation caused by low-temperature cold air leaking out side. For example, the anti-condensation pipe 25 may be disposed in the overall front edges of the cabinet 1 and the dividers 2. Alternatively, the anti-condensation pipe 25 may be disposed only in the front edges of the cabinet 1 and the dividers 2 adjoining the ice box 4, the switchable compartment 5, and the freezer compartment 6 (i.e., in the area where the cold air in the refrigeration temperature range can leak out). In this case, it is possible to prevent the arrangement and disposition of the anti-condensation pipe 25 from becoming complex.

[0022]

The drier 26 in Fig. 2 is formed of a filter for preventing dust, metal powder, or the like, contained in the refrigerant flowing from the anti-condensation pipe 25 from entering the compressor 21, an adsorbing member for adsorbing moisture in the refrigeration cycle, and the like. The capillary tube 27 is made of, for example, a copper capillary tube, and serves as a pressure reducing device that reduces the pressure of the refrigerant flowing through the drier 26 and allows the refrigerant to flow to the cooling unit 28 side.

[0023]

The cooling unit 28 is connected between the capillary tube 27 and a suction pipe side of a refrigerant-to-refrigerant heat exchanger 29. The cooling unit 28 is provided in the cooling unit chamber 15 and cools the inside of the cooling unit chamber 15 to produce cold air. A circulating fan 16 is provided above the cooling unit 28. The circulating fan 16 supplies air to the cooling unit 28 and sends the cold air cooled in the vicinity of the cooling unit 28 to the respective storage rooms 3 to 7.

[0024]

The refrigeration cycle 20 further includes the refrigerant-to-refrigerant heat exchanger 29 that exchanges heat between the refrigerant flowing through the capillary tube 27 and the refrigerant flowing through a pipe (suction pipe) between the cooling unit 28 and the compressor 21. The refrigerant-to-refrigerant heat exchanger 29 exchanges heat between the refrigerant flowing through the capillary tube 27 and the refrigerant to be taken into the compressor 21.

[0025]

As has been described above, in the refrigeration cycle 20, the anti-condensation pipe 25 is connected in series to the condenser pipe 22 via the pressure reducing device 24 and has a function as a condenser and a function of preventing the dew condensation. For example, when the required cooling capability is large, the amount of heat rejected by the condenser pipe 22 and the anti-condensation pipe 25 also need to be increased. When the inside load is small, and the required cooling capability is small, the amount of heat rejected by the condenser pipe 22 and the anti-condensation pipe 25 may be small. If the cabinet 1 and the dividers 2 are heated excessively by the refrigerant flowing through the anti-condensation pipe 25, the heat from the anti-condensation pipe 25 propagates to the respective storage rooms 3 to 7, increasing the power consumption for cooling the respective storage rooms 3 to 7. Hence, it is preferable that, when the inside load is small, the opening degree of the pressure reducing device 24 be controlled so that the temperature of the refrigerant flowing through the anti-condensation pipe 25 is low.

[0026]

Meanwhile, from the standpoint of anti-condensation, dew condensation may occur when the surface temperatures of the cabinet 1 and the dividers 2 drop below the dew point temperature. Hence, by increasing the refrigerant temperature through a reduction in refrigerant pressure in the anti-condensation pipe 25, the surface temperatures of the cabinet 1 and the dividers 2 need to be maintained to the dew point temperature of the outside air or higher by utilizing the condensation heat of the refrigerant obtained.

[0027]

Thus, the refrigerator 100 has a function of performing an expansion mode (energy saving mode) for reducing the power consumption according to the input by a user or the like and a function of switching between a plurality of expansion modes to be performed depending on the outside air temperature in the installation environment of the refrigerator 100.

[0028]

Fig. 4 is a function block diagram showing an example of the controller 10 in Figs. 1A to 1C. The refrigerator 100 in Figs. 1A to 1C and Fig. 4 includes an operating device 8, an outside-air-temperature sensor 9a, a humidity sensor 9b, and the controller 10. The operating device 8 receives various types of input from the user, and is provided on the surface of the door 31 of the refrigerator compartment 3, for example. The operating device 8 includes an operating switch that allows adjustment of the temperature settings or other settings of the respective storage rooms 3 to 7, a liquid crystal panel that displays the temperatures of the respective storage rooms 3 to 7, and the like. The operating device 8 also includes an operating switch that allows, for example, selection of the expansion mode. The user can select any one from the plurality of expansion modes by operating the operating device 8.

[0029]

The outside-air-temperature sensor 9a detects an outside air temperature TA in the installation environment where the refrigerator 100 is installed. Furthermore, the humidity sensor 9b detects humidity HA of the outside air in the installation environment where the refrigerator 100 is installed. The outside-air-temperature sensor 9a and the humidity sensor 9b are disposed at, for example, the position of the operating device 8. Note that the outside-air-temperature sensor 9a and the humidity sensor 9b may be disposed at a position other than the position of the operating device 8 (for example, a position in the vicinity of a connecting part between the door 31 of the refrigerator compartment 3 and the cabinet 1).

[0030]

The controller 10 in Figs. 1A to 1C controls the overall operation of the refrigeration cycle 20 and the refrigerator 100, and is formed of a microcomputer or the like and is mounted to the upper part of the back surface of the refrigerator 100. The controller 10 controls the operation of the refrigeration cycle 20, as well as opening and closing movement of the damper, so that values of the inside temperatures detected by the inside temperature sensors disposed in, for example, the respective storage rooms 3 to 7 equals the preset temperatures. Furthermore, the controller 10 detects the opening and closing states of the doors based on the output from respective door opening-and-closing sensors, and when, for example, a door is kept open for a long time, it controls so that the operating device 8 or a voice output device informs the user of that state.

[0031]

In particular, the controller 10 has a function of adjusting the refrigerant pressure inside the anti-condensation pipe 25 by controlling the opening degree (flow resistance) of the pressure reducing device 24 according to the input via the operating device 8. More specifically, the controller 10 includes a setting table 10A, an operating-condition setting unit 10B, and a refrigeration-cycle control unit 10C.

[0032]

Fig. 5 is a table showing an example of the setting table 10A in Fig. 4. As shown in Figs. 4 and 5, the setting table 10A stores different flow resistances Rf0 to Rf3 associated with the respective outside air temperatures TA (expansion modes 1 to 3). Furthermore, the operating-condition setting unit 10B selects any of the expansion modes 1 to 3 from the setting table 10A based on the outside air temperature TA detected by the outside-air-temperature sensor 9a. Note that Fig. 5 shows an example case where three expansion modes, 1 to 3, are stored, and the flow resistances Rf0 to Rf3 are stored in association with the respective outside air temperatures TA, corresponding to the expansion modes 1 to 3. More specifically, the classification is made into a case where the outside air temperature TA is higher than or equal to a first temperature threshold TAref1 (expansion mode 1), a case where the outside air temperature TA is smaller than the first temperature threshold TAref1 and is larger than a second temperature threshold TAref2 (expansion mode 2), and a case where the outside air temperature TA is lower than or equal to the second temperature threshold TAref2 (expansion mode 3).

[0033]

Then, the operating-condition setting unit 10B selects the flow resistance Rf of the pressure reducing device 24 from the setting table 10A, based on the outside air temperature TA and the temperature thresholds TAref1 and TAref2. In Fig. 5, the first flow resistance Rf1 is greater than the minimum flow resistance (fully open state) Rf0 (Rf1 > Rf0), the second flow resistance Rf2 is greater than the first flow resistance Rf1 (Rf1 > Rf2), and the third flow resistance Rf3 is greater than the second flow resistance Rf2 (Rf3 > Rf2). Note that, as the opening degree of the pressure reducing device 24 increases, the flow resistance Rf decreases, and, as the flow resistance Rf decreases, the temperature of the refrigerant flowing through the anti-condensation pipe 25 increases.

[0034]

In particular, in the setting table 10A, a plurality of different flow resistances Rf0 to Rf3 are associated with the respective outside air temperatures TA (expansion modes 1 to 3). For example, a combination of the minimum flow resistance Rf0 and the first flow resistance Rf1 is associated with the expansion mode 1, a combination of the minimum flow resistance Rf0 and the second flow resistance Rf2 is associated with the expansion mode 2, and a combination of the minimum flow resistance Rf0 and the third flow resistance Rf3 is associated with the expansion mode 3.

[0035]

Furthermore, the operating-condition setting unit 10B sets an operating time t for each of the different flow resistances Rf, after selecting the flow resistance Rf. More specifically, the setting table 10A previously stores temperatures of the refrigerant Tmp0 to Tmp3 flowing through the anti-condensation pipe 25 corresponding to the respective flow resistances Rf0 to Rf3. Then, the operating-condition setting unit 10B calculates the operating time t0 and t1 so that the temperature of the refrigerant flowing through the anti-condensation pipe 25 is higher than or equal to dew point temperature Td and is lower than or equal to the outside air temperature TA, as shown by Expression (1) below. Note that Expression (1) below shows an example case where the expansion mode 1, i.e., the combination of the minimum flow resistance Rf0 and the first flow resistance Rf1, is selected.

[0036]

[Math. 1]

$$\text{OUTSIDE AIR TEMPERATURE } TA \geq \frac{Tmp0 \times t0 + Tmp1 \times t1}{t0 + t1} \geq \text{DEW POINT TEMPERATURE } Td \cdots (1)$$

[0037]

The dew point temperature Td in Expression (1) is calculated by the operating-condition setting unit 10B, based on the outside air temperature TA detected by the outside-air-temperature sensor 9a and the humidity HA detected by the humidity sensor 9b, and various known calculation methods may be used.

[0038]

That is, Expression (1) means that, by changing the ratio between the operating time t0 with the minimum flow resistance Rf0 and the operating time t1 with the first flow resistance Rf1, the flow resistance Rf of the pressure reducing device 24 is adjusted so that the average value per unit time of the temperature of the refrigerant flowing through the anti-condensation pipe 25 is higher than or equal to the dew point temperature Td and is lower than or equal to the outside air temperature TA. The ratio of the operating times t0 or t1 changes depending on the installation environment, which varies in temperature and humidity, and, for example, as the dew point temperature Td increases, the operating time t0 with the minimum flow resistance Rf0 becomes shorter than the operating time t1 with the first flow resistance Rf1.

[0039]

Although an example case where the operating-condition setting unit 10B calculates the dew point temperature Td and calculates the operating time t using the above-described Expression (1) has been shown, the operating-condition setting unit 10B is not limited to this example as long as it performs control so that the temperature of the refrigerant is higher than the dew point temperature Td. For example, the operating-condition setting unit 10B may calculate the operating times t0 and t1 so that the average temperature of the refrigerant flowing through the anti-condensation pipe 25 equals the outside air temperature TA or a value lower than the outside air temperature TA by a predetermined temperature (e.g., 5 degrees C). By doing so, the humidity sensor 9b for calculating the dew point temperature Td becomes unnecessary, and the power consumption in the refrigerator 100 due to the heat of the anti-condensation pipe 25 can be reduced with a reasonable configuration, while the dew condensation is reliably prevented.

[0040]

Furthermore, although an example case where the operating times t0 and t1 are calculated using Expression (1) has been shown, it is also possible that the operating times t0 to t3 corresponding to the respective flow resistances Rf0 to Rf3 are also stored in the setting table 10A in advance, and then the flow resistance Rf and the operating time t stored in the setting table 10A are set depending on the outside air temperature TA.

[0041]

Furthermore, the operating-condition setting unit 10B has a function of selecting, from the setting table 10A, the flow resistance Rf that matches the expansion mode 1, 2, or 3 selected by a user when the user selects one from the three expansion modes 1 to 3 via the operating device 8. In this way, anti-condensation operation may be performed not only when transition to the expansion mode is automatically performed, but also manually upon a request from the user. In this case, the operating time t may be one that is calculated according to Expression (1) or one that is stored in the setting table 10A in advance.

[0042]

The refrigeration-cycle control unit 10C controls the refrigeration cycle 20 so that the expansion mode (energy-saving operation) according to the expansion mode 1, 2, or 3 (flow resistance Rf and operating time t) set by the operating-condition setting unit 10B is performed. More specifically, the refrigeration-cycle control unit 10C starts to drive the compressor 21 and controls the refrigeration cycle 20 so that the flow resistances Rf0 and Rf1 of the pressure reducing device 24 and the operating times t0 and t1 therefor are achieved.

[0043]

Fig. 6 is a graph showing control of the opening degree of the pressure reducing device 24 when the refrigeration cycle 20 in Fig. 2 is operated. As shown in Fig. 6, the refrigeration-cycle control unit 10C controls the pressure reducing device 24 so that the operating time t0 with the minimum flow resistance Rf0 and the operating time t1 with the first flow resistance Rf1 are alternately switched. As a result, during the period of the operating time t0 with the minimum flow resistance Rf0, the temperature of the refrigerant flowing through the anti-condensation pipe 25 is Tmp0, and during the period of the operating time t1 with the first flow resistance Rf1, the temperature of the refrigerant is Tmp1 (< Tmp0). Thus, the average value per unit time of the temperature of the refrigerant flowing through the anti-condensation pipe 25 during the period (t0 + t1) is obtained as Expression (1) above.

[0044]

Furthermore, the refrigeration-cycle control unit 10C may be configured to forcibly quit the expansion modes 1 to 3, depending on the inside load. For example, when the inside load has reached or exceeded a predetermined threshold, the refrigeration-cycle control unit 10C may perform control so that the performance of the expansion mode is quitted or so that setting to the expansion mode is prohibited to prevent insufficient cooling.

[0045]

Fig. 7 is a flowchart showing an operation example of the refrigerator in Figs. 1A to 1C. Referring to Figs. 1A to 1C to Fig. 7, an operation example of the refrigerator 100 will be described. Note that, in an initial state, the refrigerator 100 is not set to any of the expansion modes, and the pressure reducing device 24 is set to a fully open state in which it does not adjust the refrigerant pressure, that is, a state in which the refrigerant pressure loss in the pressure reducing device 24 is minimized.

[0046]

First, information on whether or not the transition to the expansion modes 1 to 3 is allowed is input to the operating device 8 by a user's operation (step ST1). When information that the transition to the expansion modes 1 to 3 is prohibited is input to the operating device 8, the refrigeration-cycle control unit 10C sets the pressure reducing device 24 to a fully open state (minimum flow resistance Rf0) (step

ST2). As a result, operation is performed with the cooling capability of the refrigerator 100 being maximized (step ST8).

[0047]

Meanwhile, when information that the transition to the expansion modes 1 to 3 is allowed is input via the operating device 8, the operating-condition setting unit 10B additionally determines whether or not information that selection of the expansion modes 1 to 3 is automatically performed is input via the operating device 8 (step ST3). When the information that the expansion modes 1 to 3 are automatically performed is input via the operating device 8, the operating-condition setting unit 10B obtains the outside air temperature TA detected by the outside-air-temperature sensor 9a (step ST4). Thereafter, the operating-condition setting unit 10B selects the expansion mode 1, 2, or 3 (flow resistance Rf) from the setting table 10A, based on the outside air temperature TA (step ST5). Furthermore, the operating time t corresponding to the flow resistance Rf is set based on Expression (1) or the like (step ST6). Thereafter, operation of the compressor 21 is started (step ST8), and driving of the pressure reducing device 24 with the set flow resistance Rf and operating time is controlled. In this way, the refrigerant temperature (refrigerant pressure) of the anti-condensation pipe 25 is controlled so that it is higher than or equal to the dew point temperature Td and lower than or equal to the outside air temperature (see Fig. 6).

[0048]

On the other hand, when selection of any of the expansion modes is not automatically performed, but is directly input to the operating device 8 by the user, the operating-condition setting unit 10B sets the flow resistance Rf associated with the expansion mode 1, 2, or 3 input to the operating device 8 (step ST7) and sets the operating time t. At this time, as described above, the setting of the operating time t may be calculated using Expression (1), or the operating time t previously stored in association with the flow resistance Rf may be used. Thereafter, operation of the compressor 21 is started (step ST8).

[0049]

As has been described above, according to this embodiment, when energy-saving operation of the refrigerator 100 is performed, by setting the flow resistance Rf using the setting table 10A and by setting the operating time t with the set flow resistance Rf, the temperature of the refrigerant flowing through the anti-condensation pipe 25 can be maintained at the dew point temperature Td or higher. Hence, at any outside air temperature TA, such as when the humidity of the outside air is high (e.g., an RH of 90% or more), when the humidity of the outside air is low (e.g., an RH of 50% or more), when the temperature of the outside air is high (e.g., 30 degrees C), and when the temperature of the outside air is low (e.g., 15 degrees C), it is possible to reliably prevent the dew condensation under any outside air environment, while power consumption is minimized.

[0050]

In particular, because the temperature of the refrigerant flowing through the anti-condensation pipe 25 is controlled by using the setting table 10A, there is no need to perform the control as needed in the conventional configuration, such as monitoring the state of the refrigerant flowing through the refrigeration cycle 20 and subsequently changing the opening degree of the pressure reducing device 24. In this way, it is possible to control the refrigerant temperature so that it equals a predetermined refrigerant temperature by utilizing that the temperature of the refrigerant flowing through the anti-condensation pipe 25 changes depending on the flow resistances Rf0 to Rf3. Thus, it is possible to prevent the dew condensation at low cost and in a manner suitable for the installation environment, without providing a refrigerant temperature sensor, a refrigerant pressure sensor, or the like and monitoring the state of the refrigerant.

[0051]

Furthermore, when the controller 10 is to perform the expansion mode 1, 2, or 3 upon receipt of the input information that performance of the expansion mode is allowed via the operating device 8, but is unable to start the expansion mode due to, for example, high inside load, it can fully open the pressure reducing device 24 to use the anti-condensation pipe 25 as the condenser, making the anti-condensation pipe

25, in addition to the condenser pipe 22, condense the refrigerant. Thus, it is possible to keep cooling while necessary amount of condensation heat is ensured.

[0052]

Furthermore, when the operating times t0 to t3 are set for the respective flow resistances Rf0 to Rf3 corresponding to the selected expansion modes 1 to 3, precise refrigerant temperature control becomes possible, and the dew condensation can be reliably prevented in any installation environment.

[0053]

The embodiment of the present invention is not limited to the above-described embodiment. For example, although Fig. 5 shows an example case where the outside air temperature TA is classified into three ranges, it is only needed to be defined by two or more temperature thresholds, TAref1 and Tref2, and classified into a plurality of categories. Furthermore, although the setting table 10A in Fig. 5 shows an example case where the combinations of the minimum flow resistance Rf0 and the flow resistances Rf1, Rf1, or Rf3 are stored, the combinations are not limited to these combinations, and any combination of the flow resistances Rf0 to Rf3 may be stored. Furthermore, not the combinations of two flow resistances, but a single flow resistance may be stored, or the combinations of three or more different flow resistances may be stored.

Reference Signs List

[0054]

1 cabinet 2 divider 3 refrigerator compartment 4 ice box 5 switchable compartment 6 freezer compartment 7 vegetable compartment 8 operating device 9a outside-air-temperature sensor 9b humidity sensor 10 controller 10A setting table 10B operating-condition setting unit 10C refrigeration-cycle control unit 11 outer box 12 inner box 13 back wall

14 air passage 15 cooling unit chamber 16 circulating fan 20 refrigeration cycle 21 compressor 22 condenser pipe 23 strainer 24 pressure reducing device 25 anti-condensation pipe 26 drier 27 capillary tube 28 cooling unit 29 refrigerant-to-refrigerant heat exchanger 31, 41,

51, 61, 71 door 32, 42, 52, 62, 72 air outlet 100 refrigerator HA humidity Rf flow resistance Rf0 minimum flow resistance Rf1 first flow resistance Rf2 second flow resistance Rf3 third flow resistance t, t0, t1, t2, t3 operating time TA outside air temperature TAref1 first temperature threshold TAref2 second temperature threshold Td dew point temperature Tmp0, Tmp1, Tmp2, Tmp3 temperature of the refrigerant

CLAIMS

[Claim 1]

A refrigerator comprising:

a cabinet having an inner space;

a divider for dividing the inner space of the cabinet into a plurality of storage rooms;

a refrigeration cycle accommodated in the cabinet, the refrigeration cycle connecting in series in an order of a compressor, a condenser pipe, a pressure reducing device, an anti-condensation pipe, and a capillary tube;

an outside-air-temperature sensor provided outside the cabinet and configured to detect an outside air temperature; and

a controller configured to control operation of the refrigeration cycle,

the controller including

a setting table storing a flow resistance of the pressure reducing device associated with each one of outside air temperatures, the flow resistances being different from each other,

an operating-condition setting unit configured to select one from the flow resistances in the setting table based on the outside air temperature detected by the outside-air-temperature sensor and configured to set an operating time for the selected flow resistance, and

a refrigeration-cycle control unit configured to control the refrigeration cycle to allow operation to be performed with the flow resistance and the operating time set by the operating-condition setting unit.

[Claim 2]

The refrigerator of Claim 1, further comprising an operating device configured to receive information on whether or not adjustment of the flow resistance is allowed,

wherein, when the operating device receives input information that selection of the flow resistance is allowed, the controller selects the flow resistance of the refrigeration cycle and sets the operating time of the refrigeration cycle.

[Claim 3]

The refrigerator of Claim 2,

wherein the operating device includes an operating switch used to directly input the flow resistance selected from the setting table, and

wherein the operating-condition setting unit has a function of selecting the flow resistance input from the operating device.

[Claim 4]

The refrigerator of any one of Claims 1 to 3,

wherein the flow resistance associated with each one of outside air temperatures stored in the setting table includes a plurality of the flow resistances, the plurality of the flow resistances being different from each other, and

wherein the operating-condition setting unit sets the operating time for each one of the plurality of flow resistances.

[Claim 5]

The refrigerator of Claim 4,

wherein the setting table previously stores temperatures of refrigerant flowing through the anti-condensation pipe corresponding to the respective flow resistances, and

wherein the operating-condition setting unit sets the operating time for each one of the plurality of flow resistances so that an average temperature of the refrigerant flowing through the anti-condensation pipe is higher than a dew point temperature.

[Claim 6]

The refrigerator of Claim 5,

wherein the operating-condition setting unit sets the operating time for each one of the plurality of flow resistances so that the average temperature of the refrigerant flowing through the anti-condensation pipe equals the outside air temperature.

[Claim 7]

The refrigerator of Claim 5,

2014303819 03 Dec 2015

wherein the operating-condition setting unit sets the operating time for each one of the plurality of flow resistances so that the average temperature of the refrigerant flowing through the anti-condensation pipe is lower than the outside air temperature by a predetermined temperature.

[Claim 8]

The refrigerator of Claim 5, further comprising a humidity sensor configured to detect humidity of the outside air,

wherein the operating-condition setting unit calculates the dew point temperature based on the humidity detected by the humidity sensor and based on the outside air temperature and sets the operating time for each one of the plurality of flow resistances so that a temperature of the refrigerant flowing through the anti-condensation pipe is higher than the dew point temperature.

[Claim 9]

The refrigerator of any one of Claims 1 to 8,

wherein the outside air temperatures are classified into three categories in the setting table.

[Claim 10]

The refrigerator of any one of Claims 1 to 9,

wherein the anti-condensation pipe is accommodated in at least a part of front edges of the cabinet and the divider.

FIG. 1A

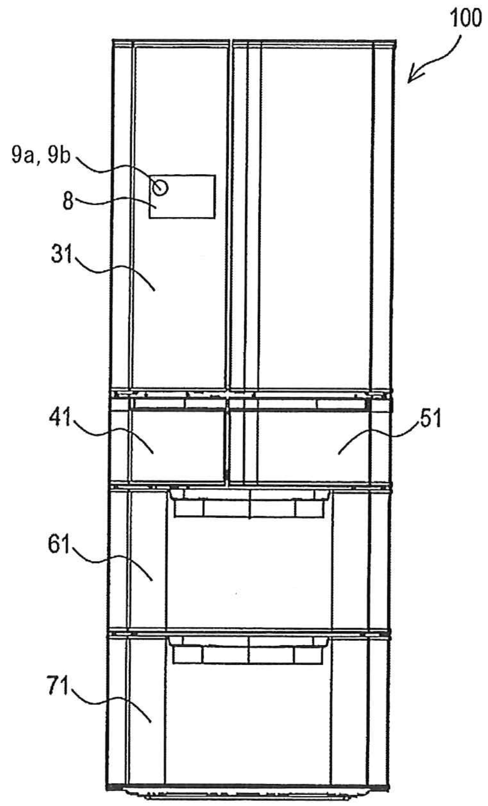

100
9a, 9b
8
31
41
51
61
71

FIG. 1B

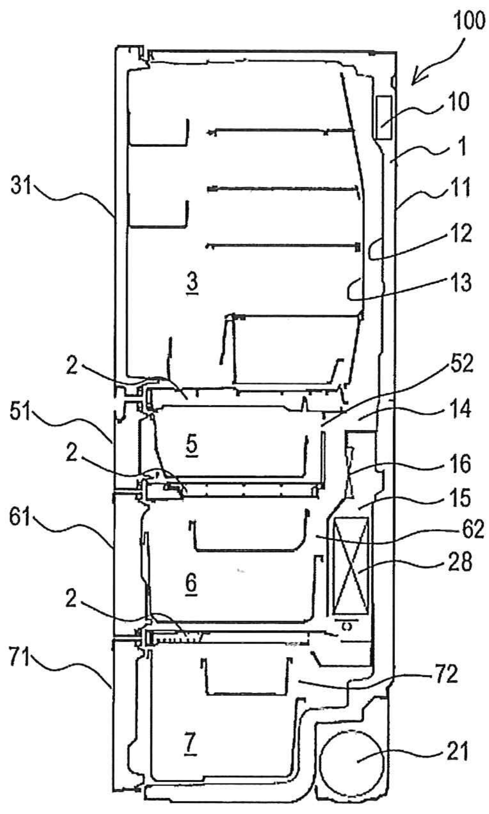

100
10
1
11
12
13
31
3
2
52
14
51
5
2
16
15
61
62
28
6
2
71
72
7
21

FIG. 1C

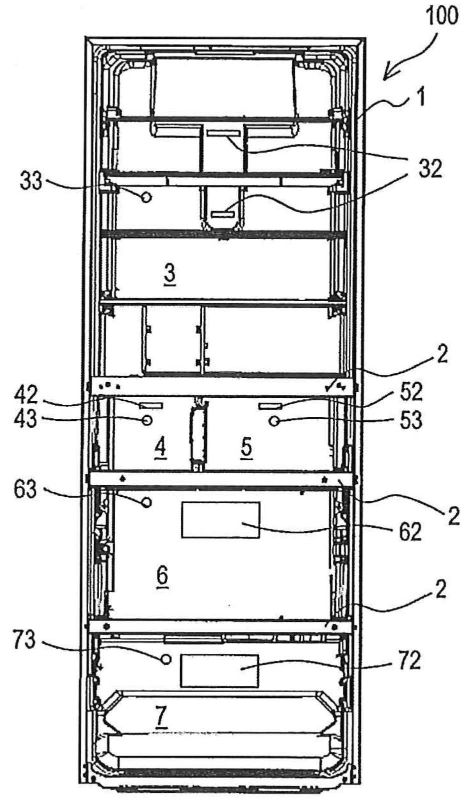

100
1
32
33
32
3
2
42
43
52
53
4
5
63
2
62
6
2
73
72
7

FIG. 2

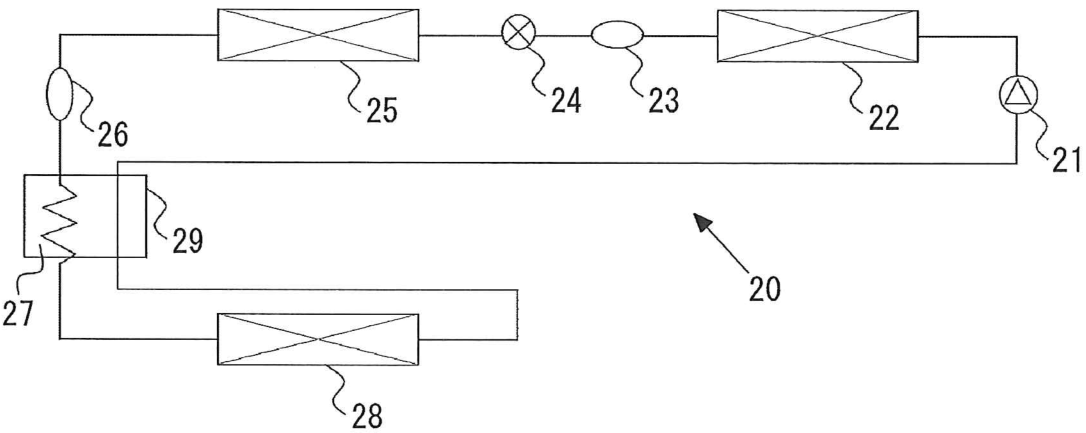

25
24
23
22
21
26
29
27
20
28

FIG. 3

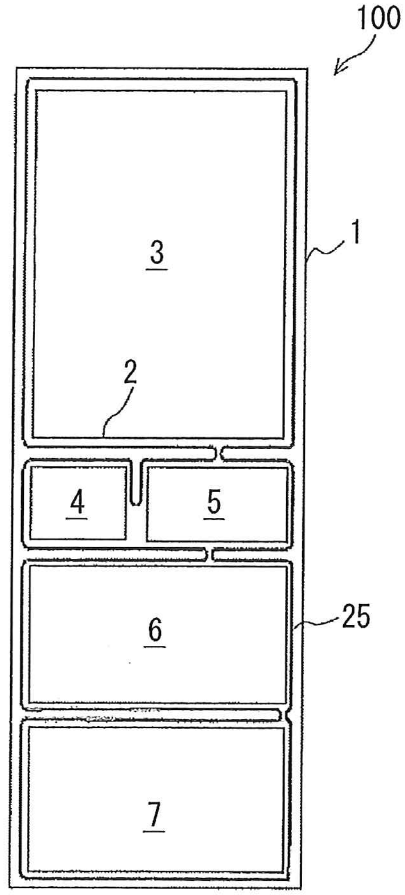

100
1
3
2
4
5
6
25
7

FIG. 4

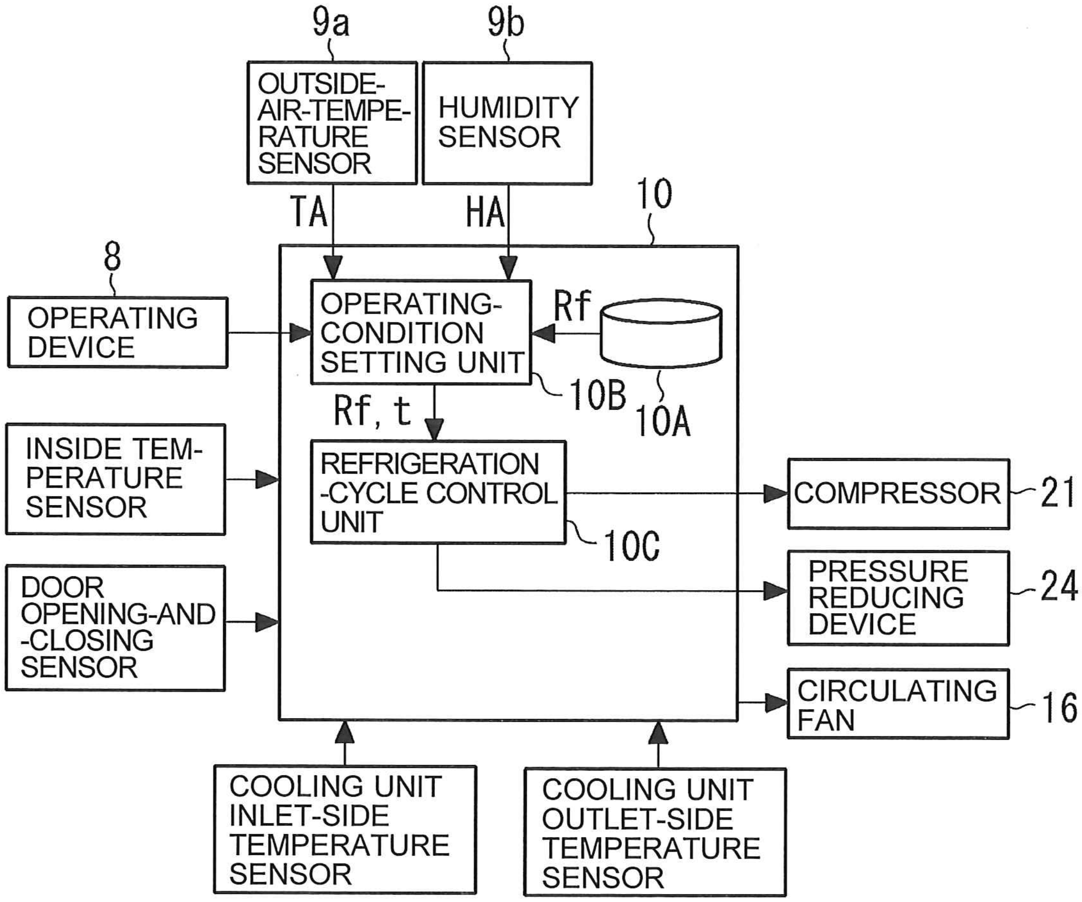

9a
9b
OUTSIDE-AIR-TEMPERATURE SENSOR
HUMIDITY SENSOR
TA
HA
10
8
OPERATING DEVICE
OPERATING-CONDITION SETTING UNIT
Rf
10B
10A
Rf, t
INSIDE TEMPERATURE SENSOR
REFRIGERATION-CYCLE CONTROL UNIT
COMPRESSOR
21
10C
DOOR OPENING-AND-CLOSING SENSOR
PRESSURE REDUCING DEVICE
24
CIRCULATING FAN
16
COOLING UNIT INLET-SIDE TEMPERATURE SENSOR
COOLING UNIT OUTLET-SIDE TEMPERATURE SENSOR

FIG. 5

10A

EXPANSION MODE	OUTSIDE AIR TEMPERATURE TA	FLOW RESISTANCE Rf OF PRESSURE REDUCING DEVICE 24
EXPANSION MODE 1	TA≧TAref1	MINIMUM FLOW RESISTANCE Rf0 (TEMPERATURE Tmp0)
		FIRST FLOW RESISTANCE Rf1 (TEMPERATURE Tmp1)
EXPANSION MODE 2	TAref2＜TA＜TAref1	MINIMUM FLOW RESISTANCE Rf0 (TEMPERATURE Tmp0)
		SECOND FLOW RESISTANCE Rf2 (TEMPERATURE Tmp2)
EXPANSION MODE 3	TA≦TAref2	MINIMUM FLOW RESISTANCE Rf0 (TEMPERATURE Tmp0)
		THIRD FLOW RESISTANCE Rf3 (TEMPERATURE Tmp3)
EXPANSION MODE PROHIBITED	—	MINIMUM FLOW RESISTANCE Rf0 (TEMPERATURE Tmp0)

FIG. 6

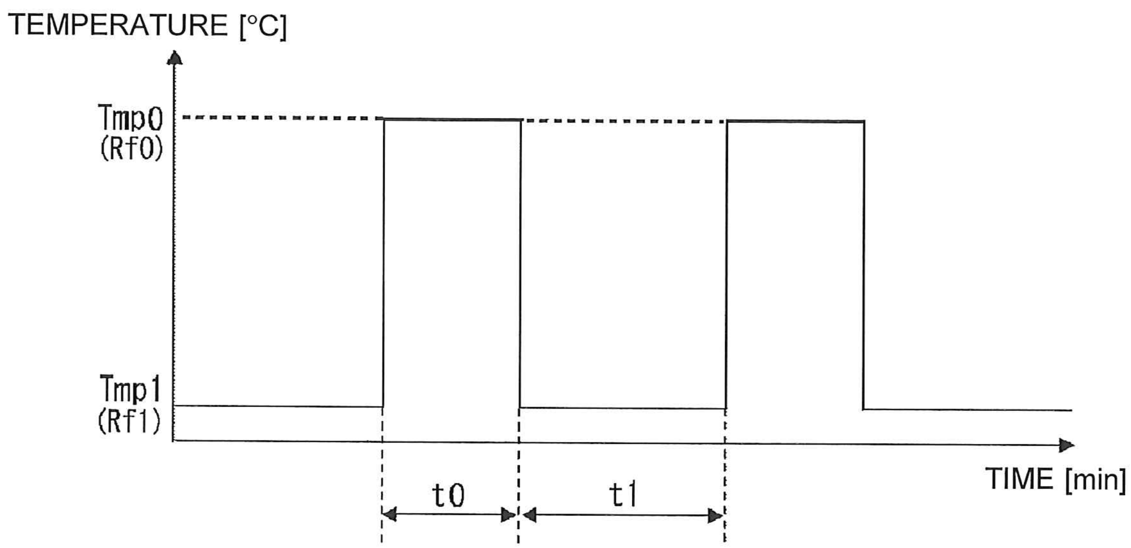
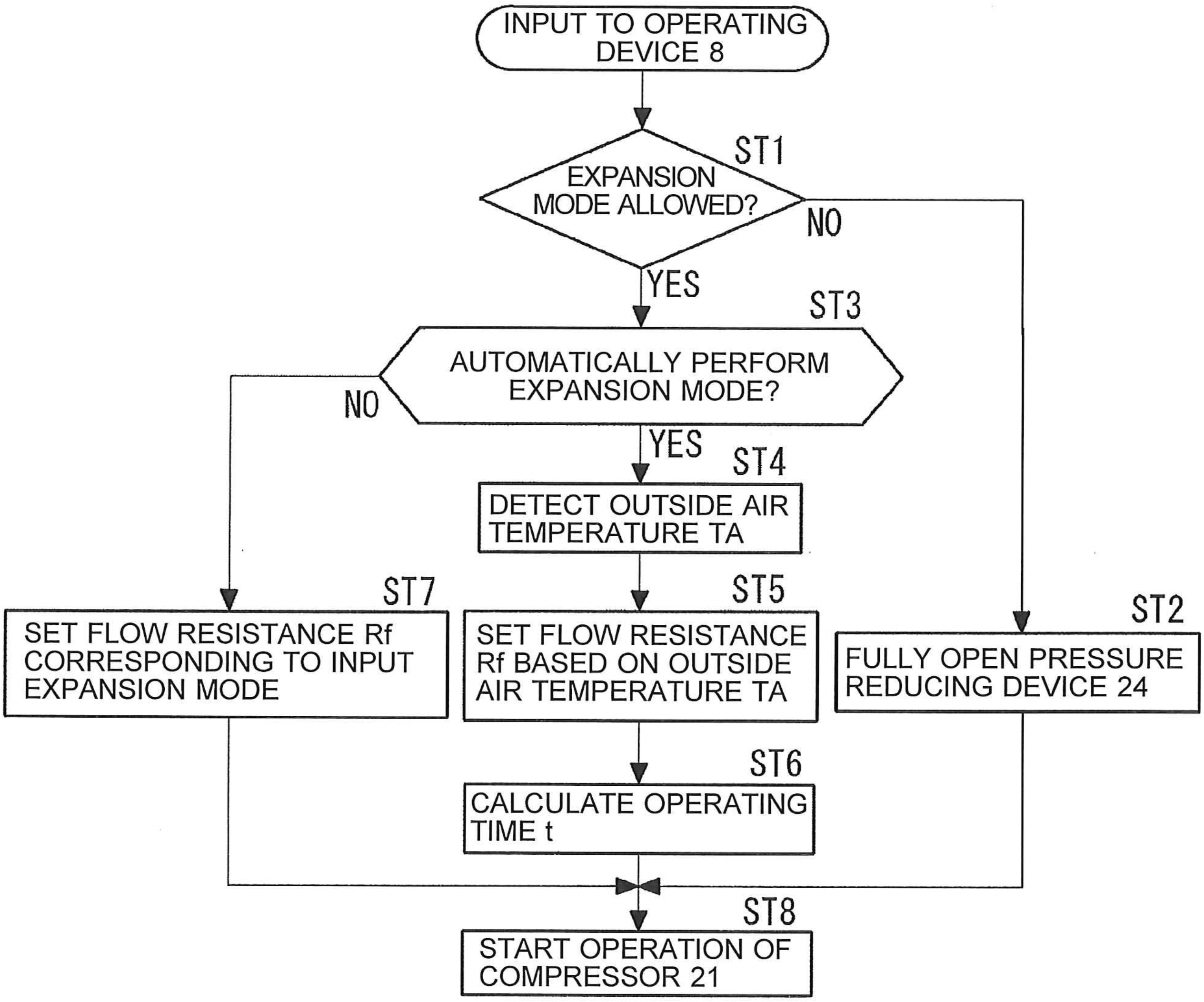


FIG. 7


INPUT TO OPERATING DEVICE 8
ST1
EXPANSION MODE ALLOWED?
NO
YES
ST3
AUTOMATICALLY PERFORM EXPANSION MODE?
NO
YES
ST4
DETECT OUTSIDE AIR TEMPERATURE TA
ST7
SET FLOW RESISTANCE Rf CORRESPONDING TO INPUT EXPANSION MODE
ST5
SET FLOW RESISTANCE Rf BASED ON OUTSIDE AIR TEMPERATURE TA
ST2
FULLY OPEN PRESSURE REDUCING DEVICE 24
ST6
CALCULATE OPERATING TIME t
ST8
START OPERATION OF COMPRESSOR 21