(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 3 608 602 A1

(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 153(4) EPC

(43) Date of publication:
12.02.2020 Bulletin 2020/07

(21) Application number: **17904729.5**

(22) Date of filing: **04.04.2017**

(51) Int Cl.:
F24H 4/02 *(2006.01)*

(86) International application number:
PCT/JP2017/014048

(87) International publication number:
WO 2018/185826 (11.10.2018 Gazette 2018/41)

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
MA MD

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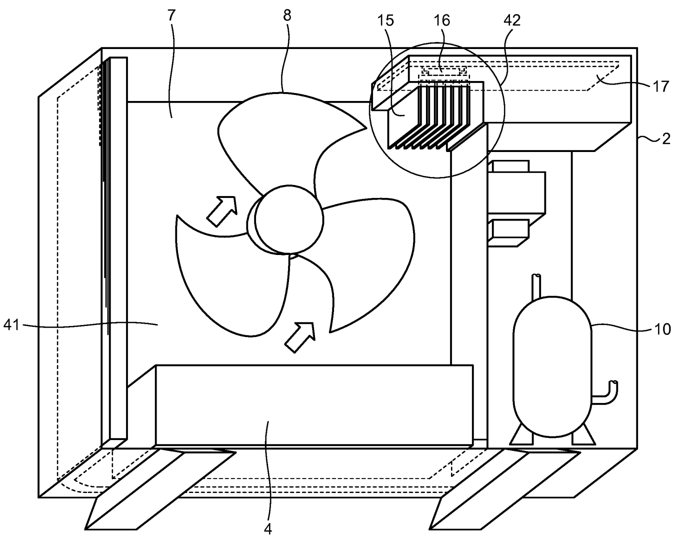
(54) OUTDOOR UNIT OF HEAT-PUMP-TYPE WATER HEATER

(57) A heat-pump hot water dispenser's outdoor unit (2) includes an air heat exchanger (7); a compressor (10); a water heat exchanger (4); an expansion valve; a fan (8) that moves air outside the outdoor unit (2) into the air heat exchanger (7); a motor that rotates the fan (8); a power device (16) used for driving the compressor (10); a heat sink (15) located in a space (42) that is an extension portion beyond the air heat exchanger (7), of a channel (41) of air moved by rotation of the fan (8) during heating of the water from outside the outdoor unit (2) into the air heat exchanger (7), where the heat sink (15) dissipates heat generated by the power device (16) during driving of the compressor (10); and a control unit that provides control, upon completion of a water heating operation, to drive the compressor (10), to open the expansion valve, and to rotate the fan (8) in the same direction as the rotation direction of the fan (8) during heating of the water.

FIG.4



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Description

Field

[0001] The present invention relates to an outdoor unit of a heat-pump hot water dispenser for heating water.

Background

[0002] A heat-pump hot water dispenser for heating water is conventionally used. For example, a heat-pump hot water dispenser is used for boiling water. A heat-pump hot water dispenser includes an outdoor unit that heats water and a hot water dispenser tank unit that stores water. The outdoor unit includes an air heat exchanger, a fan that moves air outside the outdoor unit into the air heat exchanger, a motor that rotates the fan, a compressor that compresses a refrigerant, a water heat exchanger, a power device used for control of the compressor and of the motor, and a heat sink that dissipates heat generated in the power device during driving of the compressor.

[0003] Conventionally, when a boiling operation finishes, the air heat exchanger is cooled, and the air heat exchanger cooled has an effect of cooling the heat sink. Cooling of the heat sink may cause dew condensation to form on a surface of the power device. Formation of dew condensation on the surface may cause current leakage from the power device, thereby preventing a normal operation of the power device. A technology has been proposed in which when dew condensation may occur, the number of revolutions per unit time of the compressor is increased, or the switching loss of the switching element included in the power device is increased, to increase the temperature of the power device, thereby to reduce or prevent formation of dew condensation on the surface of the power device (see, e.g., Patent Literature 1).

Citation List

Patent Literature

[0004] Patent Literature 1: Japanese Patent Application Laid-open No. 2010-25373

Summary

Technical Problem

[0005] However, in the foregoing conventional technology, the heat sink is cooled after termination of the operation of the power device after completion of a water heating operation. This may cause dew condensation to form on a surface of the power device.

[0006] The present invention has been made in view of the foregoing, and it is an object of the present invention to provide an outdoor unit of a heat-pump hot water dispenser (hereinafter referred to as "heat-pump hot water dispenser's outdoor unit") that reduces the formation of dew condensation on the power device after completion of a water heating operation.

Solution to Problem

[0007] To solve the problem and achieve the object described above, a heat-pump hot water dispenser's outdoor unit according to the present invention includes: an air heat exchanger that exchanges heat between air outside the outdoor unit and a refrigerant; a compressor that compresses the refrigerant flowed out of the air heat exchanger; a water heat exchanger that exchanges heat between the refrigerant flowed out of the compressor and water; an expansion valve that reduces a pressure of the refrigerant flowed out of the water heat exchanger; a fan that moves air outside the outdoor unit into the air heat exchanger; a motor that rotates the fan; a power device used for driving the compressor, the expansion valve, and the motor; a heat sink that is located in a space that is an extension portion beyond the air heat exchanger, of a channel of air moved by rotation of the fan during heating of the water from outside the outdoor unit into the air heat exchanger, the heat sink dissipating heat generated by the power device during driving of the compressor; and a control unit that provides control, upon completion of operation of heating of the water, to drive the compressor, to open the expansion valve, and to rotate the fan in a same direction as a rotation direction of the fan during heating of the water.

Advantageous Effects of Invention

[0008] A heat-pump hot water dispenser's outdoor unit according to the present invention provides an advantage in being capable of reducing the formation of dew condensation on the power device after completion of a water heating operation.

Brief Description of Drawings

[0009]

FIG. 1 is a first diagram illustrating a configuration of a heat-pump hot water dispenser according to a first embodiment.

FIG. 2 is a diagram schematically illustrating a cross section of the heat-pump hot water dispenser's outdoor unit according to the first embodiment when the outdoor unit is viewed from one lateral side of the heat-pump hot water dispenser's outdoor unit according to the first embodiment.

FIG. 3 is a diagram schematically illustrating a cross section of the heat-pump hot water dispenser's outdoor unit according to the first embodiment when the outdoor unit is viewed from the front side of the heat-pump hot water dispenser's outdoor unit according to the first embodiment.

FIG. 4 is a perspective view schematically illustrating the inside of the heat-pump hot water dispenser's outdoor unit according to the first embodiment.

FIG. 5 is a perspective view for describing a method of attaching the heat sink to the power device that is attached to the control board provided inside the heat-pump hot water dispenser's outdoor unit according to the first embodiment.

FIG. 6 is a second diagram illustrating the configuration of the heat-pump hot water dispenser according to the first embodiment.

FIG. 7 is a flowchart illustrating an operation procedure of the heat-pump hot water dispenser's outdoor unit according to the first embodiment.

FIG. 8 is a flowchart illustrating an operation procedure of a heat-pump hot water dispenser's outdoor unit according to a second embodiment.

FIG. 9 is a diagram schematically illustrating a cross section of the heat-pump hot water dispenser's outdoor unit according to the second embodiment when the outdoor unit is viewed from one lateral side of the heat-pump hot water dispenser's outdoor unit according to the second embodiment.

FIG. 10 is a diagram illustrating a processing circuit in a case in which at least a portion of components including a communication unit, a control unit, a temperature acquisition unit, a motor drive circuit, a compressor drive circuit, an expansion valve drive circuit, and a timer included in the heat-pump hot water dispenser's outdoor unit according to the first and second embodiments is or are implemented by the processing circuit.

FIG. 11 is a diagram illustrating a processor in a case in which at least a portion of the functions of the communication unit, the control unit, the temperature acquisition unit, the motor drive circuit, the compressor drive circuit, the expansion valve drive circuit, and the timer included in the heat-pump hot water dispenser's outdoor unit according to the first and second embodiments is implemented by the processor.

Description of Embodiments

[0010] A heat-pump hot water dispenser's outdoor unit according to embodiments of the present invention will be described in detail below with reference to the drawings. Note that these embodiments are not intended to limit the scope of this invention.

First Embodiment.

[0011] A configuration of a heat-pump hot water dispenser 1 according to a first embodiment will first be described. FIG. 1 is a first diagram illustrating a configuration of the heat-pump hot water dispenser 1 according to the first embodiment. The heat-pump hot water dispenser 1 includes a heat-pump hot water dispenser's outdoor unit 2, which heats water; and a hot water dispenser tank unit 3, which stores water. The term "heat-pump hot water dispenser's outdoor unit 2" may hereinafter also be referred to simply as "outdoor unit 2".

[0012] The outdoor unit 2 includes a water heat exchanger 4, which exchanges heat between a refrigerant and water. The water heat exchanger 4 is connected with an inlet pipe 5. The inlet pipe 5 is also connected to the hot water dispenser tank unit 3. Water stored in the hot water dispenser tank unit 3 flows through the inlet pipe 5 into the water heat exchanger 4. The water heat exchanger 4 heats, by the heated refrigerant, the water flowing from the hot water dispenser tank unit 3 through the inlet pipe 5 into the water heat exchanger 4, thus to generate hot water. The water heat exchanger 4 is also connected with an outlet pipe 6. The outlet pipe 6 is also connected to the hot water dispenser tank unit 3. The hot water generated in the water heat exchanger 4 passes through the outlet pipe 6 into the hot water dispenser tank unit 3, and is then stored in the hot water dispenser tank unit 3.

[0013] The outdoor unit 2 further includes an air heat exchanger 7, which exchanges heat between air outside the outdoor unit 2 and the refrigerant; a fan 8, which moves the air outside the outdoor unit 2 into the air heat exchanger 7; and a motor 9, which rotates the fan 8. One example of the fan 8 is a propeller fan. The outdoor unit 2 further includes a compressor 10, capable of compressing the refrigerant flowed out of the air heat exchanger 7; an expansion valve 11, capable of expanding the compressed refrigerant; and a refrigerant circuit 12, which is a refrigerant channel. The water heat exchanger 4 exchanges heat between the refrigerant flowed out of the compressor 10, and water. The expansion valve 11 is capable of reducing the pressure of the refrigerant flowed out of the water heat exchanger 4. One example of the expansion valve 11 is an electronically controlled expansion valve.

[0014] The outdoor unit 2 further includes an exchanger temperature detection sensor 13, which detects a temperature of the air heat exchanger 7. The exchanger temperature detection sensor 13 is attached to a pipe for the refrigerant flowing out of the air heat exchanger 7, near the outlet of the pipe. This pipe is a part of the refrigerant circuit 12. For example, the exchanger temperature detection sensor 13 includes a thermistor, and detects a temperature of the air heat exchanger 7 based on the resistance of the thermistor.

[0015] In the air heat exchanger 7, heat is exchanged between the refrigerant and air outside the outdoor unit 2. The refrigerant flowed out of the air heat exchanger 7 is compressed by the compressor 10, which increases the temperature of the refrigerant in the compressor 10. The refrigerant compressed, and thus heated, by the compressor 10 then flows into the water heat exchanger 4. In the water heat exchanger 4, heat is exchanged between the refrigerant compressed by the compressor 10 and the water flowed out of the hot water dispenser tank unit 3 into the water heat exchanger 4. This heats the water, and hot water is thus generated. The refrigerant flows out of the water heat exchanger 4 into the expansion valve 11, and is expanded in the expansion valve 11. The refrigerant then flows into the air heat exchanger 7.

[0016] In the outdoor unit 2, the refrigerant repeatedly passes from the air heat exchanger 7 through the compressor 10, the water heat exchanger 4, and the expansion valve 11, in sequence, and then back to the air heat exchanger 7. The outdoor unit 2 further includes an outdoor air temperature detection sensor 14, which detects an outdoor air temperature outside the outdoor unit 2. For example, the outdoor air temperature detection sensor 14 includes a thermistor, and detects an outdoor air temperature outside the outdoor unit 2 based on the resistance of the thermistor.

[0017] FIG. 2 is a diagram schematically illustrating a cross section of the heat-pump hot water dispenser's outdoor unit 2 according to the first embodiment when the outdoor unit 2 is viewed from one lateral side of the heat-pump hot water dispenser's outdoor unit 2 according to the first embodiment. As illustrated in FIG. 2, the outdoor unit 2 further includes a heat sink 15, which cools a power device used for driving the motor 9, the compressor 10, and the expansion valve 11. The power device is a semiconductor device. The power device is not illustrated in FIG. 2.

[0018] The heat sink 15 is, for example, attached to the power device, and is located in a space that is an extension portion beyond the air heat exchanger 7, of the channel of the air moved by rotation of the fan 8 during heating of the water from outside the outdoor unit 2 into the air heat exchanger 7. That is, the heat sink 15 is provided at a location where the heat sink 15 is exposed to wind, generated by rotation of the fan 8, passed through the air heat exchanger 7. The heat sink 15 dissipates heat generated by the power device during driving of the compressor 10. The arrows of FIG. 2 indicate that the wind generated by rotation of the fan 8 moves in the direction from the fan 8 to the air heat exchanger 7.

[0019] FIG. 3 is a diagram schematically illustrating a cross section of the heat-pump hot water dispenser's outdoor unit 2 according to the first embodiment when the outdoor unit 2 is viewed from the front side of the heat-pump hot water dispenser's outdoor unit 2 according to the first embodiment. As illustrated in FIG. 3, the outdoor unit 2 further includes the power device 16 used for driving the motor 9, the compressor 10, and the expansion valve 11; and a control board 17, which provides control to reduce the formation of dew condensation on the power device 16 after completion of a water heating operation. The control board 17 is provided inside the outdoor unit 2, and the power device 16 is attached to the control board 17.

[0020] FIG. 4 is a perspective view schematically illustrating the inside of the heat-pump hot water dispenser's outdoor unit 2 according to the first embodiment. As illustrated in FIG. 4, the heat sink 15 is, for example, attached to the power device 16, and is located in a space 42 that is an extension portion beyond the air heat exchanger 7, of a channel 41 of the air moved by rotation of the fan 8 during heating of the water from outside the outdoor unit 2 into the air heat exchanger 7. The arrows of FIG. 4 indicate that the wind generated by rotation of the fan 8 moves in the direction from the fan 8 to the air heat exchanger 7.

[0021] FIG. 5 is a perspective view for describing a method of attaching the heat sink 15 to the power device 16 that is attached to the control board 17 provided inside the heat-pump hot water dispenser's outdoor unit 2 according to the first embodiment. In the first embodiment, the power device 16 includes a first power device unit 16a and a second power device unit 16b as illustrated in FIG. 5. The first power device unit 16a has a first notch 16x formed on one of a pair of lateral faces facing each other, and has a second notch 16y formed on the other one of the pair of lateral faces facing each other.

[0022] The second power device unit 16b has a hole 16z formed therethrough in the thickness direction. The control board 17 has three through-holes formed therein. One of the three through-holes is a hole 17a. The first power device unit 16a is attached to the control board 17 such that the first notch 16x of the first power device unit 16a is aligned with the hole 17a, and the second notch 16y of the first power device unit 16a is aligned with one through-hole, other than the hole 17a, formed in the control board 17. The second power device unit 16b is attached to the control board 17 such that the hole 16z of the second power device unit 16b is aligned with another through-hole, other than the hole 17a, formed in the control board 17.

[0023] There are a first bolt 18a inserted through the hole 17a and through the first notch 16x into a first hole of the heat sink 15; a second bolt 18b inserted through the second notch 16y into a second hole of the heat sink 15; and a third bolt 18c inserted through the hole 16z into a third hole of the heat sink 15. The first hole, the second hole, and the third hole are not illustrated. The first bolt 18a, the second bolt 18b, and the third bolt 18c respectively inserted into the corresponding holes of the heat sink 15 each have a nut attached thereto, where no nut is illustrated. The heat sink 15 is attached to the power device 16 using the first bolt 18a, the second bolt 18b, the third bolt 18c, and the three nuts.

[0024] FIG. 6 is a second diagram illustrating the configuration of the heat-pump hot water dispenser 1 according to the first embodiment. As illustrated in FIG. 6, the hot water dispenser tank unit 3 includes a communication unit 31, which communicates with the outdoor unit 2. The control board 17 included in the outdoor unit 2 includes a communication unit 21, which communicates with the communication unit 31 of the hot water dispenser tank unit 3. Upon completion of a water heating operation, the communication unit 21 receives an operation completion signal, which is a signal indicating completion of the water heating operation, from the communication unit 31 of the hot water dispenser tank unit 3

[0025] The control board 17 further includes a memory 22, which stores first information indicating a first reference temperature, which is a lower limit temperature for determining whether to perform a condensation prevention operation. The condensation prevention operation is an operation to reduce the formation of dew condensation on the power device 16 after completion of a water heating operation. The control board 17 further includes a control unit 23, which controls the condensation prevention operation; and a temperature acquisition unit 24, which acquires, from the outdoor air temperature detection sensor 14, information indicating the outdoor air temperature outside the outdoor unit 2, and also acquires, from the exchanger temperature detection sensor 13, information indicating the temperature of the air heat exchanger 7.

[0026] When the communication unit 21 receives an operation completion signal, which is a signal indicating completion of a water heating operation, from the communication unit 31 of the hot water dispenser tank unit 3, the control unit 23 controls the condensation prevention operation in a case in which the outdoor air temperature outside the outdoor unit 2 indicated by the information acquired by the temperature acquisition unit 24 is higher than the first reference temperature indicated by the first information stored in the memory 22. Specifically, in a case in which the outdoor air temperature outside the outdoor unit 2 is higher than the first reference temperature upon completion of a water heating operation, the control unit 23 provides control to drive the compressor 10, to open the expansion valve 11, and to rotate the fan 8 in the same direction as the rotation direction of the fan 8 during heating of the water. For example, when the expansion valve 11 is to be opened, the control unit 23 fully opens the expansion valve 11. For example, in the condensation prevention operation, the control unit 23 rotates the fan 8 at a rotation speed lower than the rotation speed when a water heating operation is being performed.

[0027] The control board 17 further includes a motor drive circuit 25, which drives the motor 9; a compressor drive circuit 26, which drives the compressor 10; and an expansion valve drive circuit 27, which drives the expansion valve 11. The motor drive circuit 25, the compressor drive circuit 26 and the expansion valve drive circuit 27 are controlled by the control unit 23 for operation.

[0028] In the condensation prevention operation, the operation of the compressor 10 heats the refrigerant by the compressor 10, after which no heat exchange takes place in the water heat exchanger 4 and the expansion valve 11 is open. This causes the refrigerant flowed out of the compressor 10 to reach the air heat exchanger 7 in a heated state. That is, the temperature of the air heat exchanger 7 becomes higher than a temperature when the compressor 10 is not in operation. In addition, rotation of the fan 8 causes the wind that is the air flowing from outside the outdoor unit 2 into the inside of the outdoor unit 2 to be heated in the air heat exchanger 7 while the wind passes through the air heat exchanger 7. The wind heated in the air heat exchanger 7 then reaches the heat sink 15, and heats the heat sink 15. This prevents the heat sink 15 from being cooled even after completion of the water heating operation, thereby reducing the formation of dew condensation on the power device 16.

[0029] The control board 17 further includes a timer 28, which measures time. The memory 22 also stores second information indicating a second reference temperature, which is a lower limit temperature for determining whether to terminate the condensation prevention operation after performing of the condensation prevention operation. After starting of control regarding the condensation prevention operation, the control unit 23 determines whether the temperature of the air heat exchanger 7 indicated by the information acquired by the temperature acquisition unit 24 is higher than or equal to the second reference temperature indicated by the second information stored in the memory 22. If it is determined that the temperature of the air heat exchanger 7 is higher than or equal to the second reference temperature, the control unit 23 starts the timer 28 measuring time. When the time period measured by the timer 28 reaches a predetermined time duration to terminate the condensation prevention operation, the control unit 23 provide control to stop operation of the motor 9 and of the compressor 10. Information on the predetermined time duration is stored in the memory 22.

[0030] An operation of the heat-pump hot water dispenser's outdoor unit 2 according to the first embodiment will next be described. FIG. 7 is a flowchart illustrating an operation procedure of the heat-pump hot water dispenser's outdoor unit 2 according to the first embodiment. The description below describes an operation in the condensation prevention operation.

[0031] The outdoor air temperature detection sensor 14 detects the outdoor air temperature (S1). When the communication unit 21 receives the operation completion signal, which is a signal indicating completion of a water heating operation, from the communication unit 31 of the hot water dispenser tank unit 3, the control unit 23 determines whether the outdoor air temperature outside the outdoor unit 2 is higher than the first reference temperature, which is used as the criterion of starting of the condensation prevention operation (S2). If the control unit 23 determines that the outdoor air temperature outside the outdoor unit 2 is lower than or equal to the first reference temperature, which is used as the criterion of starting of the condensation prevention operation (No at S2), the condensation prevention operation is not performed.

[0032] If it is determined that the outdoor air temperature outside the outdoor unit 2 is higher than the first reference temperature, which is used as the criterion of starting of the condensation prevention operation (Yes at S2), the control unit 23 provides control to operate the compressor 10 and to open the expansion valve 11 (S3). The operation at step S3 increases the temperature of the air heat exchanger 7 to a temperature higher than the temperature of the air heat exchanger 7 when the compressor 10 is not in operation. The control unit 23 drives the motor 9 to rotate the fan 8 (S4).

[0033] The exchanger temperature detection sensor 13 detects the temperature of the air heat exchanger 7 (S5). The control unit 23 determines whether the temperature of the air heat exchanger 7 is higher than or equal to the second reference temperature indicated by the second information stored in the memory 22 (S6). If the control unit 23 determines that the temperature of the air heat exchanger 7 is lower than the second reference temperature (No at S6), the operation of the outdoor unit 2 proceeds to step S5. If it is determined that the temperature of the air heat exchanger 7 is higher than or equal to the second reference temperature (Yes at S6), the control unit 23 stops the operation of the fan 8 and of the compressor 10 after a certain time period has elapsed since it is determined that the temperature of the air heat exchanger 7 is higher than or equal to the second reference temperature (S7). That is, at step S6, the control unit 23 stops the operation of the fan 8 and of the compressor 10 after a predetermined time duration has elapsed since it is determined that the temperature of the air heat exchanger 7 is higher than or equal to the second reference temperature.

[0034] As described above, upon completion of the water heating operation, the control unit 23 of the outdoor unit 2 provides control to drive the compressor 10, to open the expansion valve 11, and to rotate the fan 8 in the same direction as the rotation direction of the fan 8 during heating of the water. The control of the control unit 23 heats the refrigerant by the compressor 10, causes no heat exchange to occur in the water heat exchanger 4, and opens the expansion valve 11 thereby causing the refrigerant flowed out of the compressor 10 to reach the air heat exchanger 7 in a heated state. That is, the temperature of the air heat exchanger 7 becomes higher than the temperature when the compressor 10 is not in operation. In more detail, the temperature of the air heat exchanger 7 becomes higher than a temperature around the air heat exchanger 7.

[0035] In addition, rotation of the fan 8 causes the wind that is the air flowing from outside the outdoor unit 2 into the inside of the outdoor unit 2 to be heated in the air heat exchanger 7 while the wind passes through the air heat exchanger 7. The wind heated in the air heat exchanger 7 then reaches the heat sink 15. Due to the wind heated reaching the heat sink 15, the heat sink 15 is not cooled. No cooling of the heat sink 15 reduces the formation of dew condensation on the power device 16 even after completion of the water heating operation. That is, the heat-pump hot water dispenser's outdoor unit 2 can reduce the formation of dew condensation on the power device 16 after completion of the water heating operation.

[0036] As described above, when the temperature of the air heat exchanger 7 becomes higher than or equal to the second reference temperature after starting of the condensation prevention operation, the control unit 23 stops the condensation prevention operation when a certain time period has elapsed that is sufficient to determine that the heat sink 15 has been sufficiently heated. That is, the heat-pump hot water dispenser's outdoor unit 2 performs the condensation prevention operation only under a condition likely to induce dew condensation. This enables the heat-pump hot water dispenser's outdoor unit 2 to prevent an increase in power consumption.

[0037] Conventionally, completion of the water heating operation when the outside air temperature is relatively high in summer causes the heat sink 15 to be cooled, and this readily induce dew condensation on the power device 16. In contrast, in winter when the outdoor air temperature falls near 0°C, even completion of the water heating operation, which cools the heat sink 15, is unlikely to cause dew condensation to form on the power device 16. That is, the condensation prevention operation is demanded in summer, rather than in winter. The heat-pump hot water dispenser's outdoor unit 2 performs the condensation prevention operation only under a condition likely to induce dew condensation.

Second Embodiment.

[0038] A heat-pump hot water dispenser's outdoor unit 2 according to a second embodiment will next be described. The heat-pump hot water dispenser's outdoor unit 2 according to the second embodiment has the same configuration as the configuration of the heat-pump hot water dispenser's outdoor unit 2 according to the first embodiment. In the first embodiment, the control unit 23 provides control, upon completion of the water heating operation, to drive the compressor 10, to open the expansion valve 11, and to rotate the fan 8 in the same direction as the rotation direction of the fan 8 during heating of the water.

[0039] In the second embodiment, the control unit 23 provides control, upon completion of the water heating operation, to rotate the fan 8 in the direction opposite to the rotation direction of the fan 8 during heating of the water. That is, upon completion of the water heating operation, the control unit 23 causes the motor 9 to drive the fan 8 to rotate in the direction opposite to the rotation direction of the fan 8 during heating of the water.

[0040] An operation of the heat-pump hot water dispenser's outdoor unit 2 according to the second embodiment will next be described. FIG. 8 is a flowchart illustrating an operation procedure of the heat-pump hot water dispenser's outdoor unit 2 according to the second embodiment. The description below describes an operation in the condensation prevention operation.

[0041] The outdoor air temperature detection sensor 14 detects the outdoor air temperature (S11). When the communication unit 21 receives the operation completion signal, which is a signal indicating completion of the water heating operation, from the communication unit 31 of the hot water dispenser tank unit 3, the control unit 23 determines whether the outdoor air temperature outside the outdoor unit 2 is higher than the first reference temperature, which is used as the criterion of starting of the condensation prevention operation (S12). If the control unit 23 determines that the outdoor air temperature outside the outdoor unit 2 is lower than or equal to the first reference temperature, which is used as the criterion of starting of the condensation prevention operation (No at S12), the condensation prevention operation is not performed.

[0042] If the control unit 23 determines that the outdoor air temperature outside the outdoor unit 2 is higher than the first reference temperature, which is used as the criterion of starting of the condensation prevention operation (Yes at S12), the control unit 23 provides control to rotate the fan 8 in the direction opposite to the rotation direction of the fan 8 during heating of the water (S13). The operation at step S13 causes the air outside the outdoor unit 2 to reach the heat sink 15 without passing through the air heat exchanger 7.

[0043] FIG. 9 is a diagram schematically illustrating a cross section of the heat-pump hot water dispenser's outdoor unit 2 according to the second embodiment when the outdoor unit 2 is viewed from one lateral side of the heat-pump hot water dispenser's outdoor unit 2 according to the second embodiment. The configuration illustrated in FIG. 9 is the same as the configuration illustrated in FIG. 2. The arrows of FIG. 9 indicate that the wind generated by rotation of the fan 8 moves in the direction from the air heat exchanger 7 to the fan 8. As is apparent from a comparison between FIG. 2 according to the first embodiment and FIG. 9 according to the second embodiment, rotation of the fan 8 in the second embodiment generates an wind in the direction generally opposite to the direction of the wind generated by rotation of the fan 8 in the first embodiment. That is, the foregoing operation at step S13 causes the air outside the outdoor unit 2 to reach the heat sink 15 without passing through the air heat exchanger 7.

[0044] The exchanger temperature detection sensor 13 detects the temperature of the air heat exchanger 7 (S14). The control unit 23 determines whether the difference between the temperature of the air heat exchanger 7 and the outdoor air temperature upon completion of the water heating operation is less than or equal to a predetermined value (S15). Information indicating the predetermined value is stored in the memory 22. If the control unit 23 determines that the difference is greater than the predetermined value (No at S15), the operation of the outdoor unit 2 proceeds to step S14. If it is determined that the difference is less than or equal to the predetermined value (Yes at S15), the control unit 23 stops the operation of the fan 8 after a certain time period has elapsed since it is determined that the difference is less than or equal to the predetermined value (S16). That is, at step S16, the control unit 23 stops the operation of the fan 8 after a predetermined time duration has elapsed since it is determined that the difference is less than or equal to the predetermined value.

[0045] As described above, upon completion of the water heating operation, the control unit 23 of the outdoor unit 2 provides control to rotate the fan 8 in the direction opposite to the rotation direction of the fan 8 during heating of the water. Rotation of the fan 8 in the direction opposite to the rotation direction during heating of the water enables the air outside the outdoor unit 2 to reach the heat sink 15 without passing through the air heat exchanger 7. As described above, the condensation prevention operation is demanded in summer, rather than in winter. Thus, rotation of the fan 8 in the direction opposite to the rotation direction during heating of the water enables air at a relatively high temperature to reach the heat sink 15 from outside the outdoor unit 2 to reduce or prevent formation of dew condensation on the power device 16.

[0046] As described above, similarly to the first embodiment, the control unit 23 stops the condensation prevention operation when a certain time period has elapsed that is sufficient to determine that the heat sink 15 has been sufficiently heated after starting of the condensation prevention operation. That is, the heat-pump hot water dispenser's outdoor unit 2 performs the condensation prevention operation only under a condition likely to induce dew condensation, and thus can prevent an increase in power consumption.

[0047] Upon completion of the water heating operation, the heat-pump hot water dispenser's outdoor unit 2 may operate to perform the condensation prevention operation of the first embodiment in a case in which the outdoor air temperature outside the outdoor unit 2 is higher than or equal to a predetermined temperature, and to perform the condensation prevention operation of the second embodiment in a case in which the outdoor air temperature outside the outdoor unit 2 is lower than the predetermined temperature.

[0048] FIG. 10 is a diagram illustrating a processing circuit 91 in a case in which at least a portion of components including the communication unit 21, the control unit 23, the temperature acquisition unit 24, the motor drive circuit 25, the compressor drive circuit 26, the expansion valve drive circuit 27, and the timer 28 included in the heat-pump hot water dispenser's outdoor unit 2 according to the first and second embodiments is or are implemented by the processing circuit 91. That is, at least a portion of the functions of the communication unit 21, the control unit 23, the temperature acquisition unit 24, the motor drive circuit 25, the compressor drive circuit 26, the expansion valve drive circuit 27, and the timer 28 may be implemented by the processing circuit 91.

[0049] The processing circuit 91 is dedicated hardware. That is, the processing circuit 91 is, for example, a single circuit, a composite circuit, a programmed processor, a parallel programmed processor, an application specific integrated circuit (ASIC), a field-programmable gate array (FPGA), or a combination thereof. One or more of the communication unit 21, the control unit 23, the temperature acquisition unit 24, the motor drive circuit 25, the compressor drive circuit 26, the expansion valve drive circuit 27, and the timer 28 may be implemented by dedicated hardware separate from the remainder.

[0050] FIG. 11 is a diagram illustrating a processor 93 in a case in which at least a portion of the functions of the communication unit 21, the control unit 23, the temperature acquisition unit 24, the motor drive circuit 25, the compressor drive circuit 26, the expansion valve drive circuit 27, and the timer 28 of the heat-pump hot water dispenser's outdoor unit 2 according to the first and second embodiments is implemented by the processor 93. That is, at least a portion of the functions of the communication unit 21, the control unit 23, the temperature acquisition unit 24, the motor drive circuit 25, the compressor drive circuit 26, the expansion valve drive circuit 27, and the timer 28 may be implemented by the processor 93, which executes a program stored in a memory 92. The processor 93 is a central processing unit (CPU), a processing unit, a computing unit, a microprocessor, a microcomputer, or a digital signal processor (DSP). FIG. 11 also illustrates the memory 92.

[0051] In a case in which at least a portion of the functions of the communication unit 21, the control unit 23, the temperature acquisition unit 24, the motor drive circuit 25, the compressor drive circuit 26, the expansion valve drive circuit 27, and the timer 28 is implemented by the processor 93, the portion of the functions is implemented by the processor 93, and software, firmware, or a combination of software and firmware. The software or firmware is described as a program, and is stored in the memory 92. The processor 93 reads and executes the program stored in the memory 92 to implement the at least a portion of the functions of the communication unit 21, the control unit 23, the temperature acquisition unit 24, the motor drive circuit 25, the compressor drive circuit 26, the expansion valve drive circuit 27, and the timer 28.

[0052] That is, in a case in which at least a portion of the functions of the communication unit 21, the control unit 23, the temperature acquisition unit 24, the motor drive circuit 25, the compressor drive circuit 26, the expansion valve drive circuit 27, and the timer 28 is implemented by the processor 93, the heat-pump hot water dispenser's outdoor unit 2 includes the memory 92 for storing a program that causes the steps to be performed by at least one or more of the communication unit 21, the control unit 23, the temperature acquisition unit 24, the motor drive circuit 25, the compressor drive circuit 26, the expansion valve drive circuit 27, and the timer 28. It can also be said that the program stored in the memory 92 causes a computer to perform a procedure or method that is performed by at least one or more of the communication unit 21, the control unit 23, the temperature acquisition unit 24, the motor drive circuit 25, the compressor drive circuit 26, the expansion valve drive circuit 27, and the timer 28.

[0053] The memory 92 is, for example, a non-volatile or volatile semiconductor memory such as a random access memory (RAM), a read-only memory (ROM), a flash memory, an erasable programmable read-only memory (EPROM), or an electrically erasable programmable read-only memory (EEPROM); a magnetic disk, a flexible disk, an optical disk, a compact disc, a MiniDisc, a digital versatile disk (DVD), or the like.

[0054] Multiple functions of the communication unit 21, the control unit 23, the temperature acquisition unit 24, the motor drive circuit 25, the compressor drive circuit 26, the expansion valve drive circuit 27, and the timer 28 may be provided such that a portion of the multiple functions is or are implemented by dedicated hardware, and the remainder of the multiple functions is or are implemented by software or firmware. Thus, the multiple functions of the communication unit 21, the control unit 23, the temperature acquisition unit 24, the motor drive circuit 25, the compressor drive circuit 26, the expansion valve drive circuit 27, and the timer 28 can be implemented by hardware, software, firmware, or a combination thereof.

[0055] The configurations described in the foregoing embodiments are merely examples of various aspects of the present invention. These configurations may be combined with a known other technology, and moreover, a part of such configurations may be omitted or modified without departing from the spirit of the present invention.

Reference Signs List

[0056] 1 heat-pump hot water dispenser; 2 heat-pump hot water dispenser's outdoor unit; 3 hot water dispenser tank unit; 4 water heat exchanger; 5 inlet pipe; 6 outlet pipe; 7 air heat exchanger; 8 fan; 9 motor; 10 compressor; 11 expansion valve; 12 refrigerant circuit; 13 exchanger temperature detection sensor; 14 outdoor air temperature detection sensor; 15 heat sink; 16 power device; 16a first power device unit; 16b second power device unit; 16x first notch; 16y second notch; 16z, 17a hole; 17 control board; 18a first bolt; 18b second bolt; 18c third bolt; 21, 31 communication unit; 22, 92 memory; 23 control unit; 24 temperature acquisition unit; 25 motor drive circuit; 26 compressor drive circuit; 27 expansion valve drive circuit; 28 timer; 41 air channel; 42 space; 91 processing circuit; 93 processor.

Claims

1. An outdoor unit of a heat-pump hot water dispenser, the outdoor unit comprising:

an air heat exchanger to exchange heat between air outside the outdoor unit and a refrigerant;
a compressor to compress the refrigerant flowed out of the air heat exchanger;
a water heat exchanger to exchange heat be-

tween the refrigerant flowed out of the compressor and water;
an expansion valve to reduce a pressure of the refrigerant flowed out of the water heat exchanger;
a fan to move air outside the outdoor unit into the air heat exchanger;
a motor to rotate the fan;
a power device used for driving the compressor, the expansion valve, and the motor;
a heat sink located in a space that is an extension portion beyond the air heat exchanger, of a channel of air moved by rotation of the fan during heating of the water from outside the outdoor unit into the air heat exchanger, the heat sink dissipating heat generated by the power device during driving of the compressor; and
a control unit to provide control, upon completion of operation of heating of the water, to drive the compressor, to open the expansion valve, and to rotate the fan in a same direction as a rotation direction of the fan during heating of the water.

2. An outdoor unit of a heat-pump hot water dispenser, the outdoor unit comprising:

an air heat exchanger to exchange heat between air outside the outdoor unit and a refrigerant;
a compressor to compress the refrigerant flowed out of the air heat exchanger;
a water heat exchanger to exchange heat between the refrigerant flowed out of the compressor and water;
an expansion valve to reduce a pressure of the refrigerant flowed out of the water heat exchanger;
a fan to move air outside the outdoor unit into the air heat exchanger;
a motor to rotate the fan;
a power device used for driving the compressor, the expansion valve, and the motor;
a heat sink located in a space that is an extension portion beyond the air heat exchanger, of a channel of air moved by rotation of the fan during heating of the water from outside the outdoor unit into the air heat exchanger, the heat sink dissipating heat generated by the power device during driving of the compressor; and
a control unit to provide control, upon completion of operation of heating of the water, to rotate the fan in a direction opposite to a rotation direction of the fan during heating of the water.

FIG.1

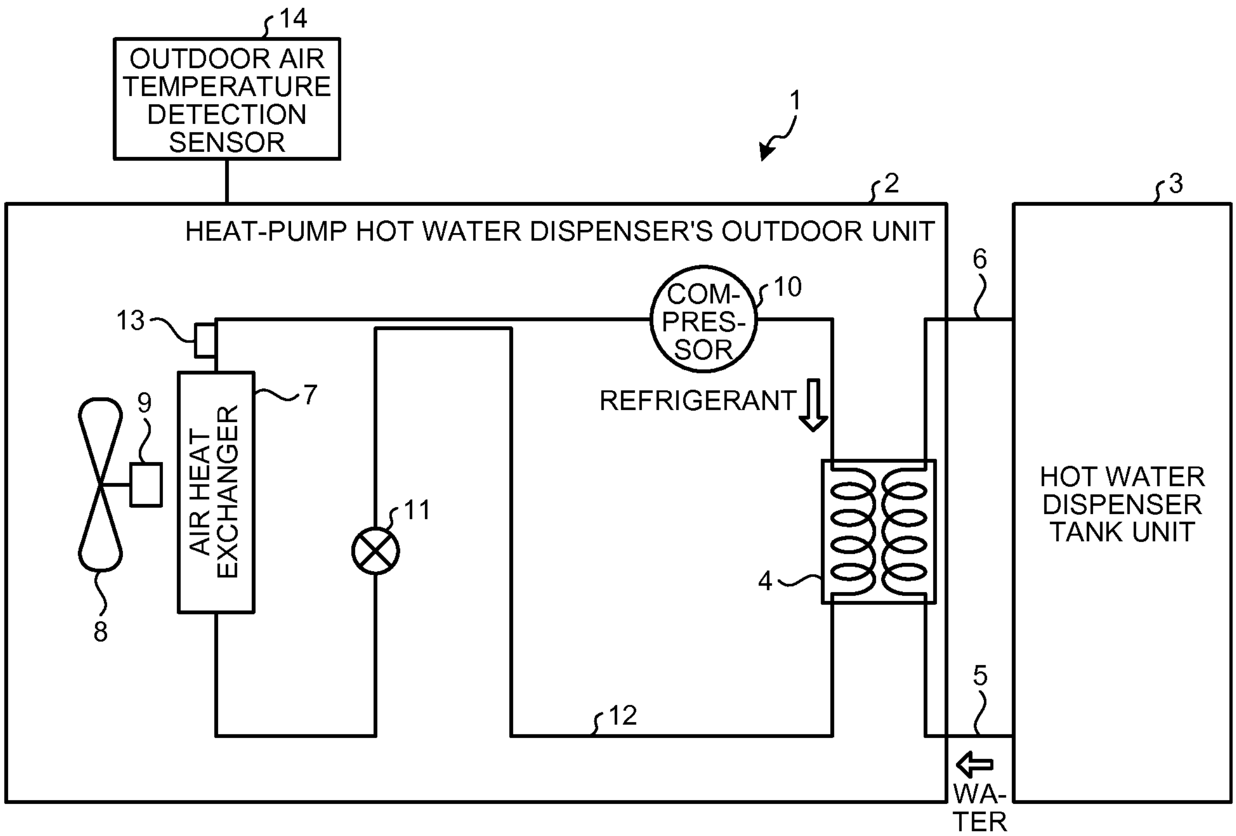
14
OUTDOOR AIR TEMPERATURE DETECTION SENSOR
1
2
3
HEAT-PUMP HOT WATER DISPENSER'S OUTDOOR UNIT
6
COM-PRES-SOR
10
13
REFRIGERANT
7
9
AIR HEAT EXCHANGER
11
HOT WATER DISPENSER TANK UNIT
8
4
5
12
WA-TER

FIG.2

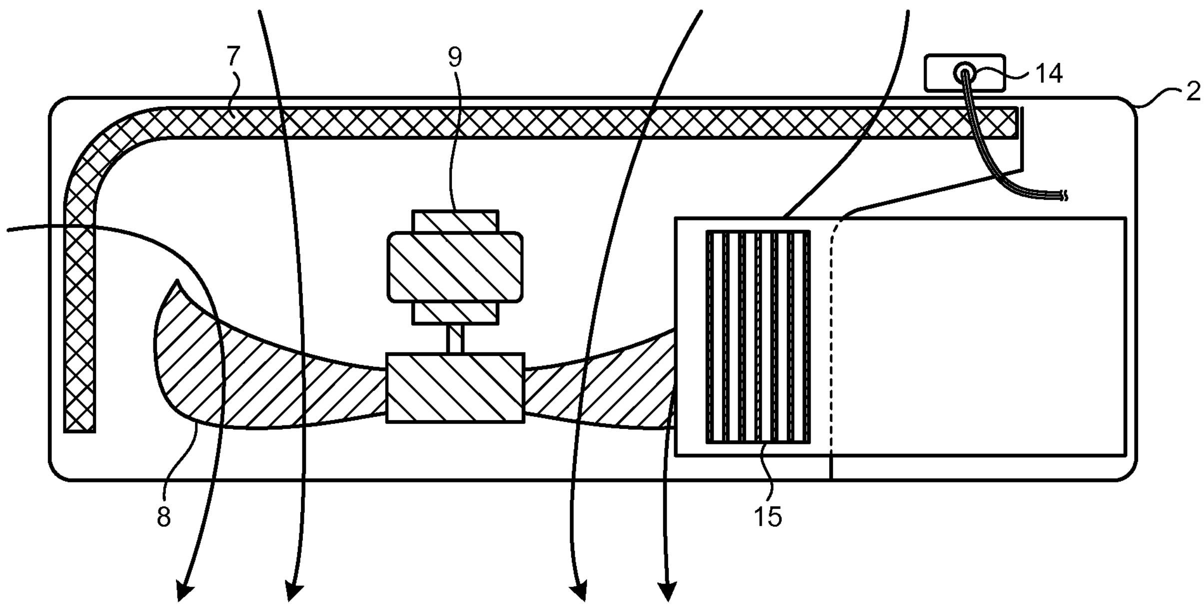
7
9
14
2
8
15

FIG.3

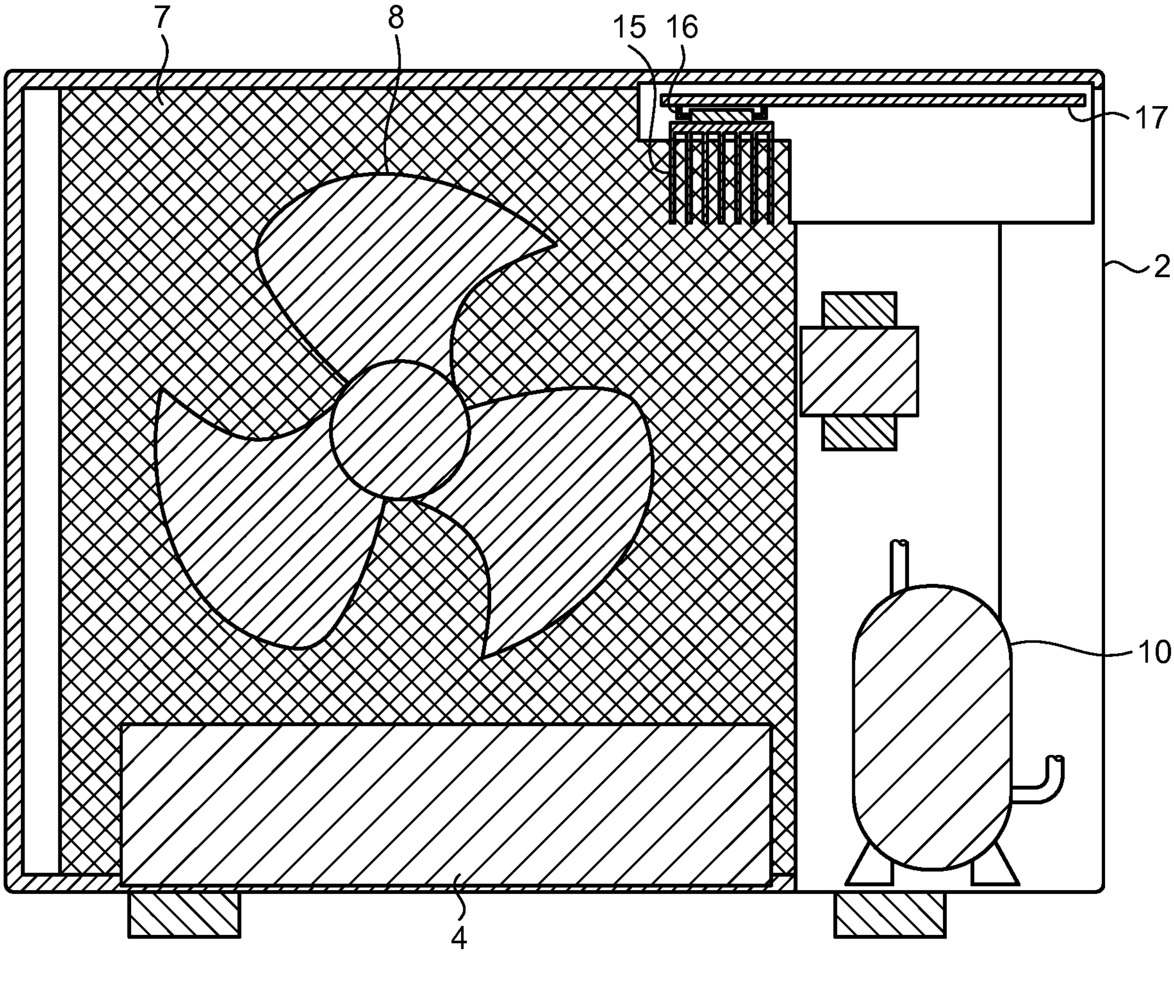

FIG.4

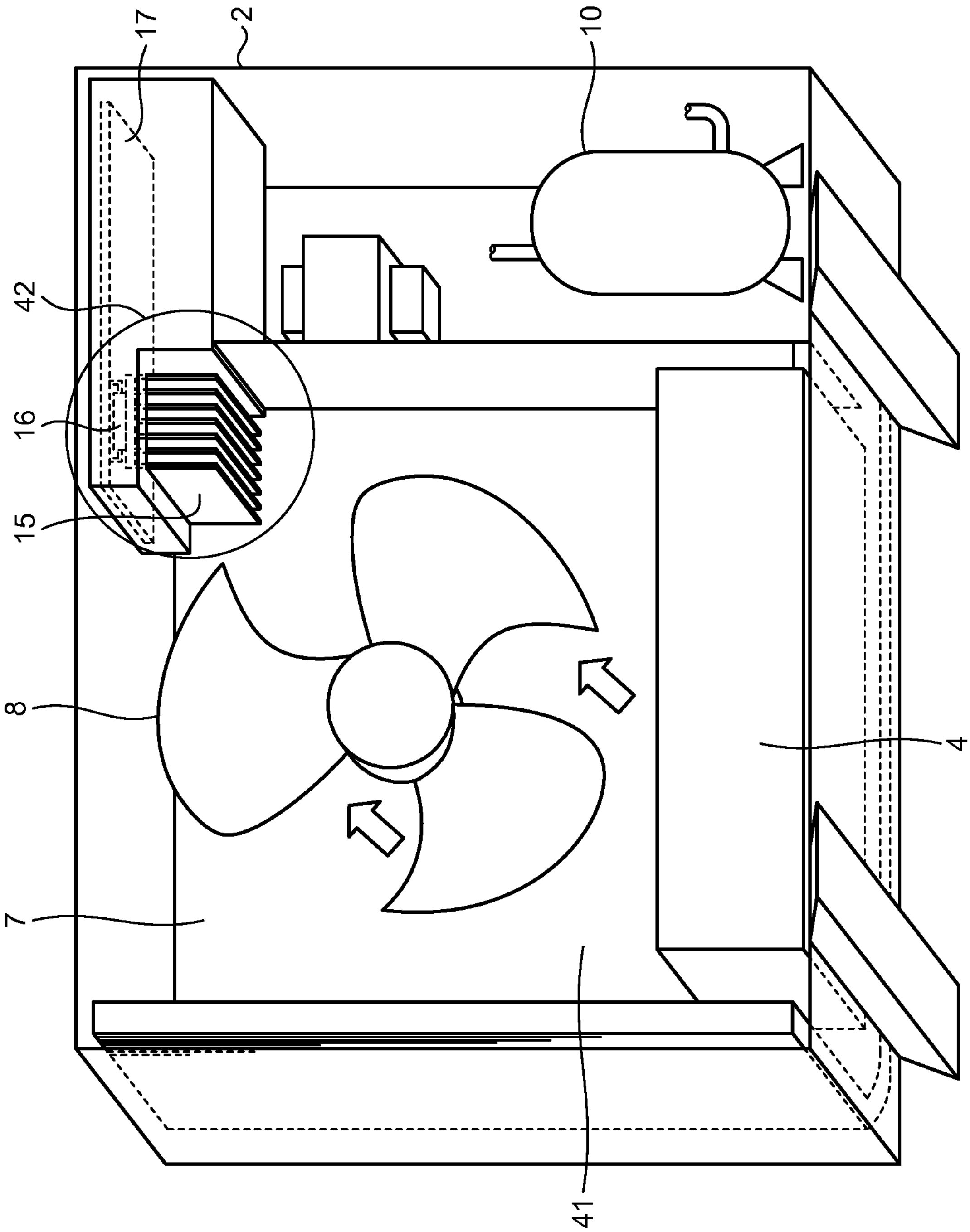

FIG.5

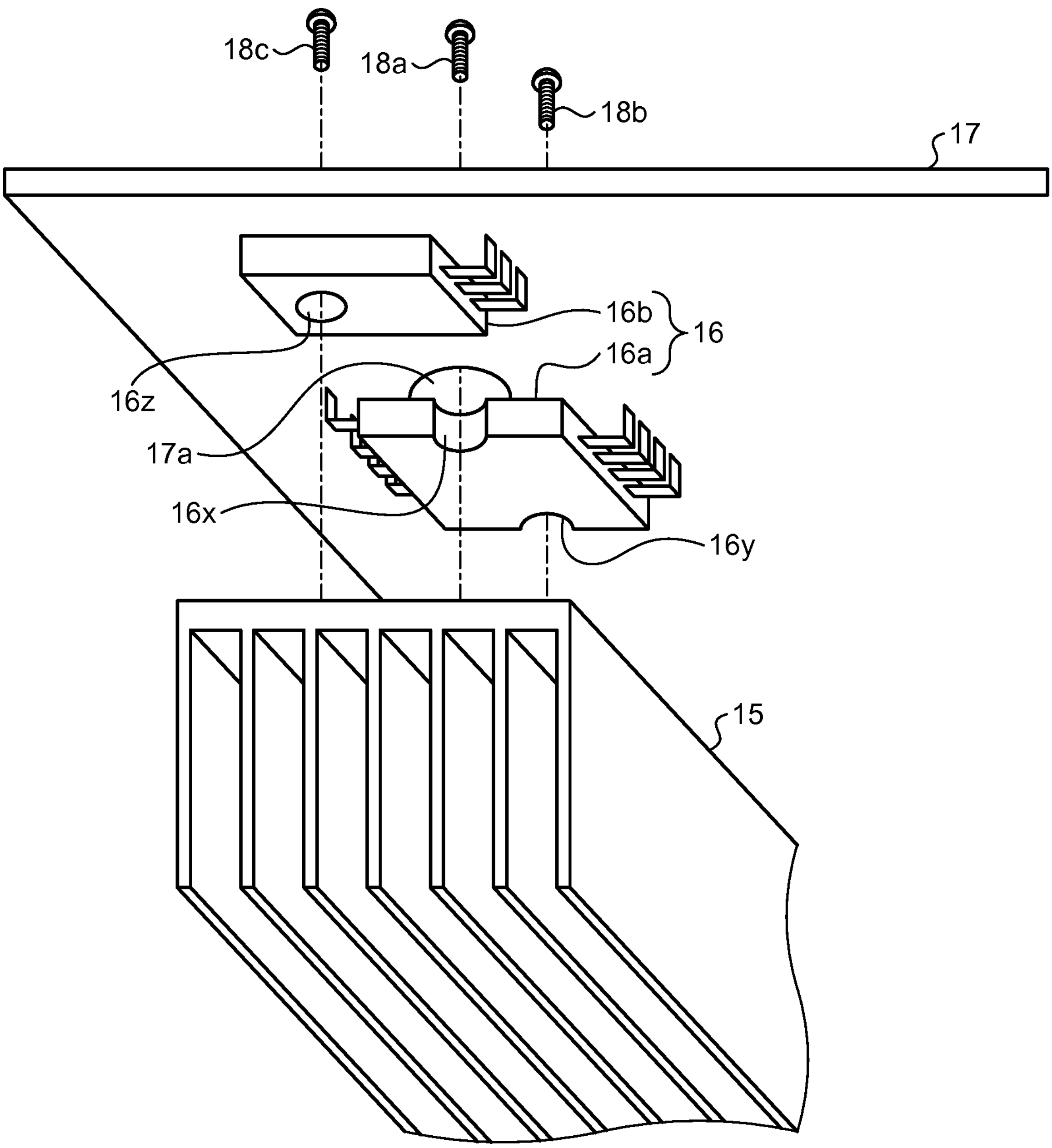

FIG.6

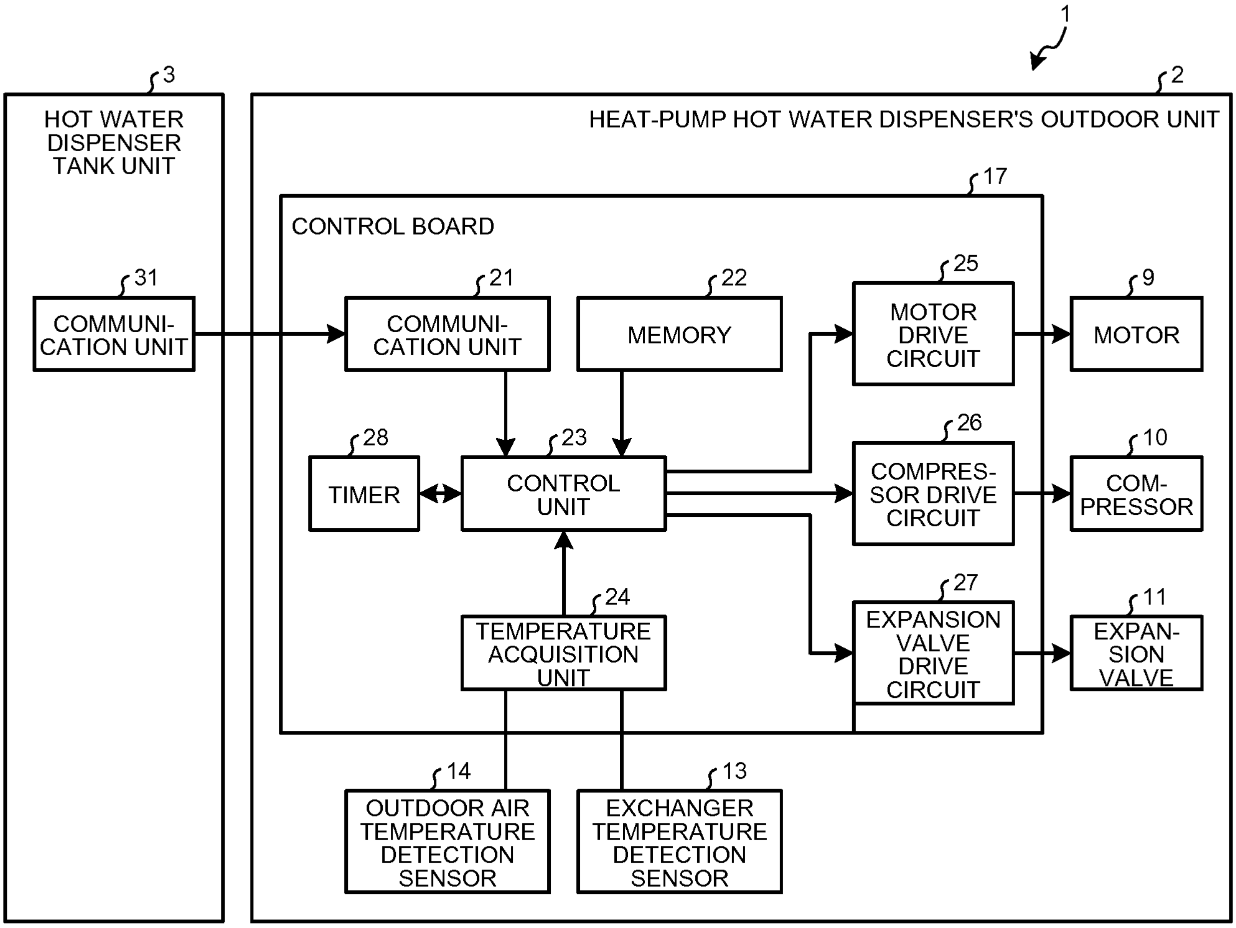
1
3
HOT WATER DISPENSER TANK UNIT
2
HEAT-PUMP HOT WATER DISPENSER'S OUTDOOR UNIT
17
CONTROL BOARD
31
COMMUNI-CATION UNIT
21
COMMUNI-CATION UNIT
22
MEMORY
25
MOTOR DRIVE CIRCUIT
9
MOTOR
28
TIMER
23
CONTROL UNIT
26
COMPRES-SOR DRIVE CIRCUIT
10
COM-PRESSOR
24
TEMPERATURE ACQUISITION UNIT
27
EXPANSION VALVE DRIVE CIRCUIT
11
EXPAN-SION VALVE
14
OUTDOOR AIR TEMPERATURE DETECTION SENSOR
13
EXCHANGER TEMPERATURE DETECTION SENSOR

FIG.7

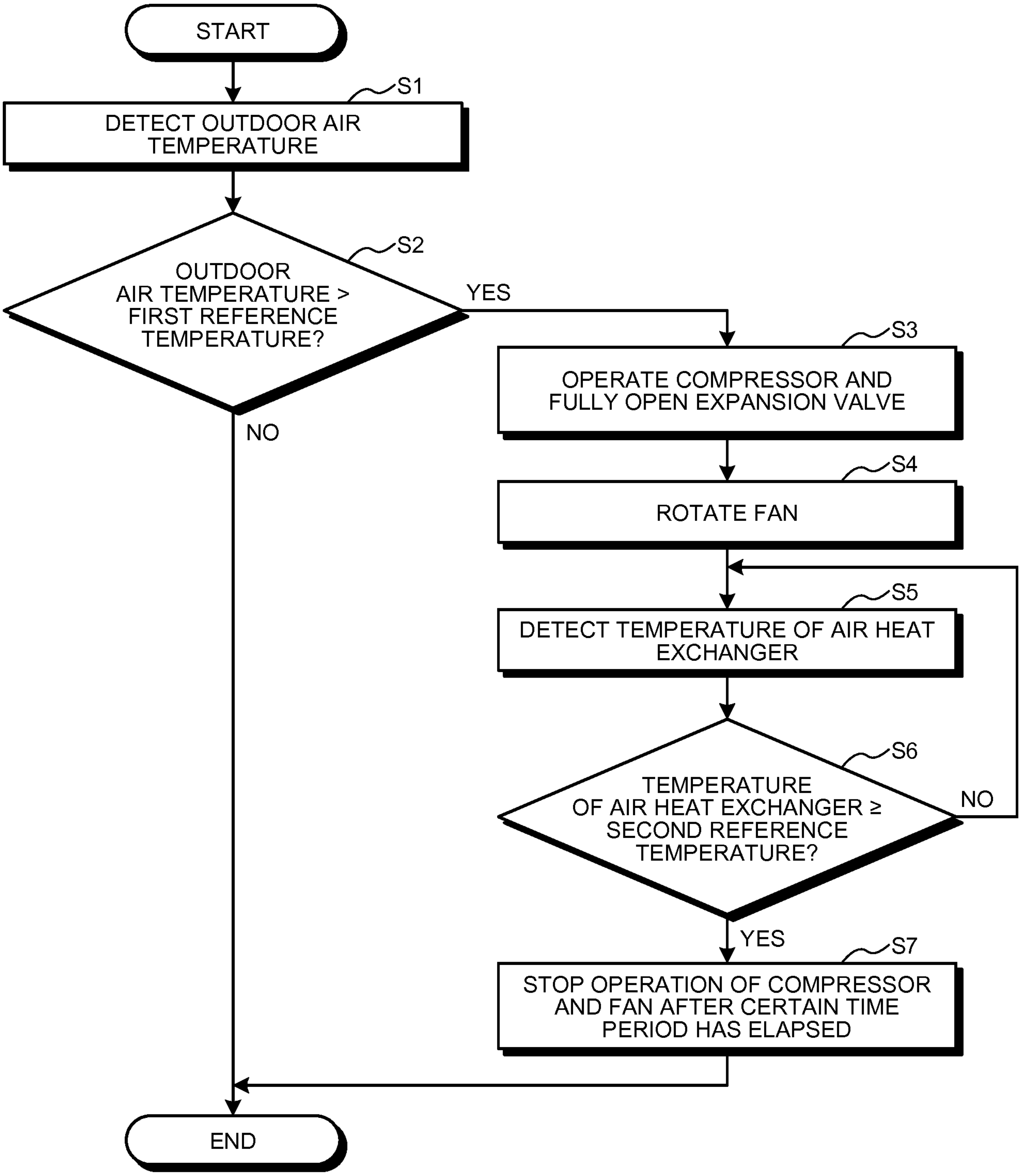
START
S1
DETECT OUTDOOR AIR TEMPERATURE
S2
OUTDOOR AIR TEMPERATURE > FIRST REFERENCE TEMPERATURE?
YES
NO
S3
OPERATE COMPRESSOR AND FULLY OPEN EXPANSION VALVE
S4
ROTATE FAN
S5
DETECT TEMPERATURE OF AIR HEAT EXCHANGER
S6
TEMPERATURE OF AIR HEAT EXCHANGER ≥ SECOND REFERENCE TEMPERATURE?
NO
YES
S7
STOP OPERATION OF COMPRESSOR AND FAN AFTER CERTAIN TIME PERIOD HAS ELAPSED
END

FIG.8

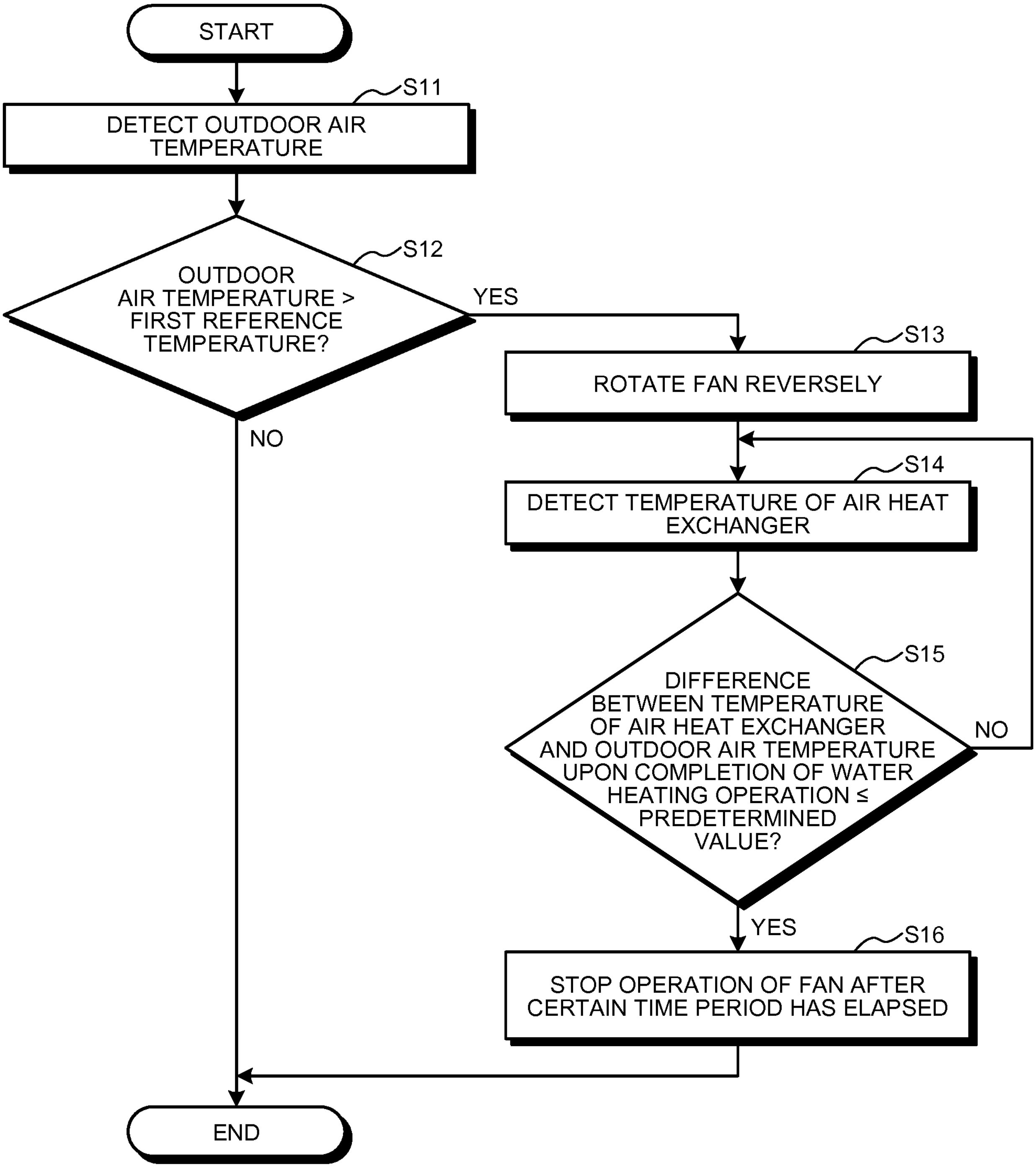
START
S11
DETECT OUTDOOR AIR TEMPERATURE
S12
OUTDOOR AIR TEMPERATURE > FIRST REFERENCE TEMPERATURE?
YES
NO
S13
ROTATE FAN REVERSELY
S14
DETECT TEMPERATURE OF AIR HEAT EXCHANGER
S15
DIFFERENCE BETWEEN TEMPERATURE OF AIR HEAT EXCHANGER AND OUTDOOR AIR TEMPERATURE UPON COMPLETION OF WATER HEATING OPERATION ≤ PREDETERMINED VALUE?
NO
YES
S16
STOP OPERATION OF FAN AFTER CERTAIN TIME PERIOD HAS ELAPSED
END

FIG.9

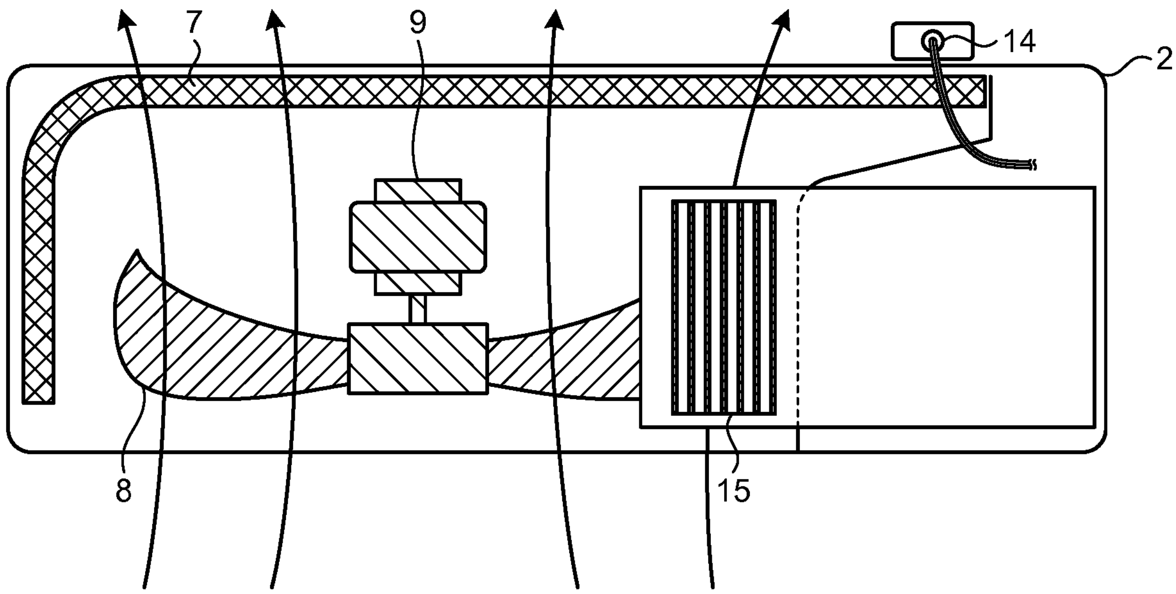

FIG.10

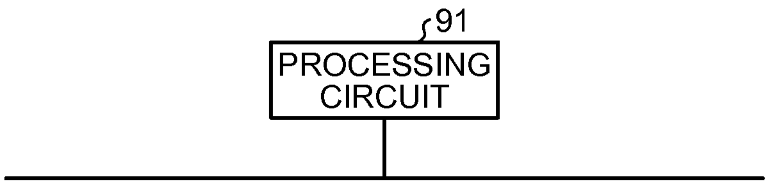

FIG.11

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2017/014048

A. CLASSIFICATION OF SUBJECT MATTER
F24H4/02(2006.01)i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F24H4/02

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2017
Kokai Jitsuyo Shinan Koho	1971-2017	Toroku Jitsuyo Shinan Koho	1994-2017

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	JP 2010-127560 A (Panasonic Corp.), 10 June 2010 (10.06.2010), paragraphs [0028] to [0029], [0033], [0040]; fig. 1 (Family: none)	1 2
Y A	JP 2008-304115 A (Sharp Corp.), 18 December 2008 (18.12.2008), paragraph [0012]; fig. 1, 3 (Family: none)	1 2
Y A	JP 2017-26240 A (Hitachi Appliances, Inc.), 02 February 2017 (02.02.2017), paragraphs [0010] to [0012], [0029]; fig. 1 to 2 (Family: none)	1 2

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

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
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"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
16 May 2017 (16.05.17)	30 May 2017 (30.05.17)

Name and mailing address of the ISA/	Authorized officer
Japan Patent Office 3-4-3,Kasumigaseki,Chiyoda-ku, Tokyo 100-8915,Japan	Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT

International application No. PCT/JP2017/014048

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2004-53119 A (Matsushita Electric Industrial Co., Ltd.), 19 February 2004 (19.02.2004), paragraphs [0003], [0032] to [0034]; fig. 3 (Family: none)	2
A	JP 2010-25373 A (Daikin Industries, Ltd.), 04 February 2010 (04.02.2010), claim 1; fig. 1 to 4 (Family: none)	1-2

Form PCT/ISA/210 (continuation of second sheet) (January 2015)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2010025373 A **[0004]**