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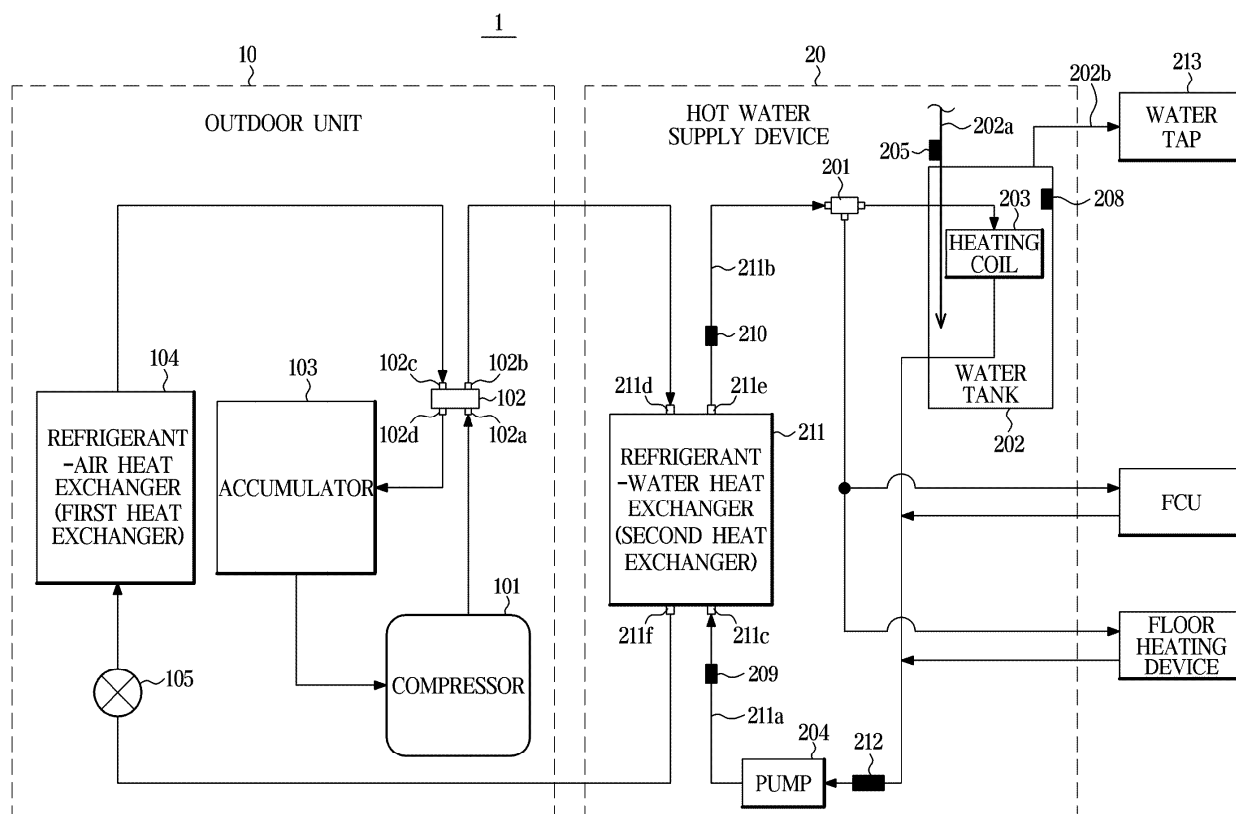
(54) **HEAT PUMP SYSTEM AND CONTROL METHOD THEREOF**

(57) A heat pump system according to one aspect of the disclosed invention comprises: a compressor for compressing a refrigerant; a water tank for storing water; a heat exchanger for exchanging heat between the refrigerant introduced from the compressor and the water introduced from the water tank and supplying the heat-exchanged water to the water tank; a heating coil for heating the water stored in the water tank; and a pipe temperature sensor for detecting a first temperature of an inlet pipe for supplying cold water to the water tank or a

second temperature of an outlet pipe for discharging hot water from the water tank; and a first control unit for determining whether to use the hot water on the basis of the first temperature of the inlet pipe or the second temperature of the outlet pipe directed by the pipe temperature sensor, determining a hot water use pattern of a user according to the use of the hot water, and determining on or off of the compressor on the basis of the hot water use pattern.

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FIG. 1



Description

[Technical Field]

- 5 **[0001]** The present disclosure relates to a heat pump system and a control method thereof, and more particularly, to a heat pump type system capable of supplying hot water through heat exchange and a control method thereof.

[Background Art]

- 10 **[0002]** In general, a heat pump is an apparatus that transfers heat from a low-temperature side to a high-temperature side by using heat generated and recovered during the cycle of compression, condensation, and evaporation of a refrigerant. Heat pumps are primarily used for various temperature-related tasks such as heating, cooling, freezing, and hot water production.

- 15 **[0003]** Hot water supply devices (hereinafter, referred to as "heat pump systems") using heat pumps are mainly used when hot water is needed in residential buildings or commercial facilities. The hot water supply devices using the heat pumps are widely used because of the advantage of being more energy efficient and environmentally friendly than traditional hot water supply systems such as electric or gas boilers that heat water.

[0004] The inside of the water tank that stores hot water to be supplied to users for hot water use needs to always be maintained within an appropriate temperature range.

- 20 **[0005]** Conventional heat pump systems maintain an appropriate temperature range by repeatedly turning the systems on and off. Typically, this process may result in reduced energy efficiency due to heat loss, and accordingly, energy-saving operation based on the user's hot water use pattern is implemented.

[0006] However, there are problems that a complex process is required and price competitiveness is low because a number of sensors need to be installed to determine the user's hot water use pattern.

[Disclosure]

[Technical Problem]

- 30 **[0007]** An aspect of the present disclosure provides a heat pump system and a control method thereof capable of supplying hot water with optimal efficiency by identifying whether a user uses hot water based on a temperature of a temperature sensor on a water tank pipe to determine the user's hot water use pattern for a preset section and determining turning-on/off of a compressor of the heat pump system based on the hot water use pattern.

[Technical Solution]

- 35 **[0008]** A heat pump system according to an aspect of the present disclosure may include: a compressor configured to compress a refrigerant; a water tank storing water; a heat exchanger configured to exchange heat between the refrigerant received from the compressor and the water received from the water tank and supply the heat-exchanged water to the water tank; a heating coil configured to heat cold water stored in the water tank; a pipe temperature sensor configured to detect a first temperature of an inlet pipe through which cold water is supplied to the water tank or a second temperature of an outlet tank through which hot water is discharged from the water tank; and a controller configured to identify whether the hot water is used, based on the first temperature of the inlet pipe or the second temperature of the outlet pipe, detected by the pipe temperature sensor, determine a hot water use pattern of a user according to use of the hot water, and determine turning-on/off of the compressor based on the hot water use pattern.

- 40 **[0009]** The heat pump system according to an aspect of the present disclosure may further include: a first water temperature sensor configured to detect a third temperature of the hot water stored in the water tank; a second water temperature sensor configured to detect a fourth temperature of water flowing into a first heat exchanger; a third water temperature sensor configured to detect a fifth temperature of water supplied from the first heat exchange to the water tank; and a flow sensor configured to detect a flow of water flowing into the first heat exchanger.

- 45 **[0010]** A method of controlling a heat pump system according to an aspect of the present disclosure, the heat pump system including: a compressor configured to compress a refrigerant; a water tank storing water; a heat exchanger configured to exchange heat between the refrigerant and the water; and a pipe temperature sensor configured to detect a first temperature of an inlet pipe through which cold water is supplied to the water tank or a second temperature of an outlet pipe through which hot water is discharged from the water tank, may include identifying whether the hot water is used, based on a first temperature of the inlet pipe or a second temperature of the outlet pipe, detected by the pipe temperature sensor, determining a hot water use pattern of a user according to use of the hot water, and determining turning-on/off of the compressor based on the hot water use pattern.

[Advantageous Effects]

[0011] According to an aspect of the present disclosure, by controlling turning-on/off of a compressor by adding only a temperature sensor for detecting a temperature of a water tank pipe without having to add a plurality of sensors to determine a user's hot water use pattern, a process may be simplified, price competitiveness may be ensured, and hot water may be supplied with optimal energy efficiency.

[Description of Drawings]

[0012]

FIG. 1 is a configuration diagram of a heat pump system according to an embodiment.

FIG. 2 is a control block diagram of a heat pump system according to an embodiment.

FIG. 3 is a diagram showing temperature changes of a water tank inlet pipe over time according to an embodiment.

FIG. 4 is a diagram showing temperature changes of a water tank outlet pipe over time according to an embodiment.

FIG. 5 is a diagram for describing a method of identifying hot water use sections, according to an embodiment.

FIG. 6 is a diagram showing both temperature changes of a water tank inlet pipe and temperature changes of hot water in a water tank 202 over time, according to an embodiment.

FIG. 7 is a diagram for describing a change in heat quantity inside a water tank, according to an embodiment.

FIG. 8 is an overall control flowchart of a heat pump system 1 according to an embodiment.

FIG. 9 is a flowchart showing a control method of a heat pump system for identifying whether hot water is used based on a temperature of a water inlet pipe, according to an embodiment.

FIG. 10 is a flowchart showing a control method of a heat pump system for identifying whether hot water is used based on a temperature of a water tank outlet pipe, according to an embodiment.

FIG. 11 is a flowchart showing a control method of a heat pump system for determining a user's hot water use pattern, according to an embodiment.

FIG. 12 is a flowchart showing a control method of a heat pump system for determining turning-on/off of a compressor based on a determined hot water use pattern, according to an embodiment.

[Modes of the Invention]

[0013] Various embodiments of the present document and terms used therein are not intended to limit the technical features described in this document to specific embodiments, and should be understood to include various modifications, equivalents, or substitutes of the corresponding embodiments.

[0014] In connection with the description of the drawings, similar reference numerals may be used for similar or related components.

[0015] The singular form of a noun corresponding to an item may include one or a plurality of the items unless clearly indicated otherwise in a related context.

[0016] In this document, phrases, such as "A or B", "at least one of A and B", "at least one of A or B", "A, B or C", "at least one of A, B and C," and "at least one of A, B, or C", may include any one or all possible combinations of items listed together in the corresponding phrase among the phrases.

[0017] For example, "at least one of A, B, and C" may represent A, B, C, a combination of A and B, a combination of A and C, a combination of B and C, or a combination of A, B, and C.

[0018] As used herein, such terms as "1st" and "2nd", or "first" and "second" may be used to simply distinguish a corresponding component from another, and does not limit the components in other aspect (for example., importance or order).

[0019] It is to be understood that if a certain component (for example, a first component) is referred to, with or without the

term "operatively" or "communicatively", as "coupled with," "coupled to," "connected with," or "connected to" another component (for example, a second component), it means that the component may be coupled with the other component directly (for example, wiredly), wirelessly, or via a third element.

[0020] It is to be understood that the terms such as "including", "comprising" or "having," etc., are intended to indicate the existence of the features, numbers, steps, operations, components, parts, or combinations thereof disclosed in the specification, and are not intended to preclude the possibility that one or more other features, numbers, steps, operations, components, parts, or combinations thereof may exist or may be added.

[0021] It is to be understood that if a certain component is referred to as being "coupled with," "coupled to," "supported on" or "in contact with" another component, it means that the component may be coupled with the other component directly or indirectly via a third component.

[0022] It will also be understood that when a certain component is referred to as being "on" or "over" another component, it can be directly on the other component or intervening components may also be present.

[0023] As used herein, the term "and/or" includes any and all combinations of one or more of associated listed components.

[0024] Hereinafter, an operation principle and embodiments of the present disclosure will be described with reference to the accompanying drawings.

[0025] FIG. 1 is a configuration diagram of a heat pump system 1 according to an embodiment.

[0026] Referring to FIG. 1, the heat pump system 1 may include an outdoor unit 10 that supplies heat obtained by an operation of a compressor 101 and heat exchange of a refrigerant-air heat exchanger (hereinafter, referred to as a "first heat exchanger") to a hot water supply device 20, and the hot water supply device 20 that provides hot water to a user by supplying heat supplied from the outdoor unit 10 to cold water stored in a water tank 202 to heat the water.

[0027] More specifically, the outdoor unit 10 according to an embodiment may include the compressor 101, a four-way valve 102, an expansion valve 105, an accumulator 103, and a first heat exchanger 104. In addition, the outdoor unit 10 may further include components, such as a plurality of sensors and valves.

[0028] The compressor 101 may compress a low-temperature, low-pressure refrigerant received through an inlet side connected to the accumulator 103 to form a high-temperature, high-pressure refrigerant, and then discharge the high-temperature, high-pressure refrigerant through an outlet side connected to a refrigerant-water heat exchanger (hereinafter, referred to as a "second heat exchanger") 211 of the hot water supply device 20.

[0029] The compressor 101 may be configured as an inverter compressor of which a compression capacity varies depending on an input frequency, or may be configured as a combination of a plurality of constant-speed compressors with a constant compression capacity.

[0030] The four-way valve 102 may switch a flow of a refrigerant discharged from the compressor 101 according to a mode (a cooling mode or a heating mode), thereby forming a refrigerant path required for an operation of the corresponding mode.

[0031] The four-way valve 102 may include a first port 102a connected to the outlet side 102b of the compressor 100, a second port 102b connected to the first heat exchanger 104, a third port 102c connected to the first exchanger 211 211, and a fourth port 102d connected to the accumulator 103.

[0032] The accumulator 103 may be installed between the inlet side of the compressor 101 and the four-way valve 102.

[0033] The accumulator 103 may temporarily store a mixture of oil and refrigerant supplied from the first heat exchanger 104 through the four-way valve 102 and separate a non-vaporized liquid refrigerant to prevent the liquid refrigerant from being sucked into the compressor 101, thereby preventing damage to the compressor 101. A gas refrigerant separated by the accumulator 104 may be supplied to the compressor 101.

[0034] The first heat exchanger 104 may perform heat exchange between outside air and a refrigerant. That is, the first heat exchanger 104 may operate as a condenser in a cooling mode and as an evaporator in a heating mode. The first heat exchanger 104 may include an outdoor fan (not shown) for increasing heat exchange efficiency between the refrigerant and outside air.

[0035] The expansion valve 105 may include an electronic expansion valve and the expansion valve 105 may expand the refrigerant and supply the refrigerant to the first heat exchanger 104.

[0036] In addition, the expansion valve 105 may adjust a flow rate of the refrigerant and block a flow of the refrigerant as necessary. The expansion valve 105 may be replaced by an expansion device with another structure that performs the function.

[0037] The hot water supply device 20 according to an embodiment may include the second heat exchanger 211, a flow path switching valve 201, the water tank 202, a heating coil 203 provided inside the water tank 202, and a pump 204.

[0038] The second heat exchanger 211 may perform heat exchange between a high-temperature refrigerant received from the outdoor unit 10 and water received from the water tank 202.

[0039] The second heat exchanger 211 may be formed as a double-pipe heat exchanger in which a refrigerant flow path and a water flow path are formed internally and externally with a heat transfer member in between, or may be formed as a plate heat exchanger in which a refrigerant flow path and a water flow path are formed alternately with a heat transfer

member in between. Through heat exchange between a heat exchange plate (or a refrigerant flow path) which a refrigerant passes and a heat exchange plate (or a water flow path) which water passes, hot water may be generated.

[0040] The second heat exchanger 211 may include a heat exchanger inlet pipe 211a through which water is supplied to the second heat exchanger 211, and a heat exchanger outlet pipe 211b through which water discharged from the second heat exchanger 211 is supplied to the heating coil 203 inside the water tank 202, a fan coil unit (FCU), or a floor heating device.

[0041] The FCU may be used in air conditioning systems inside buildings for cooling and heating, and the floor heating device may also perform the similar function. The FCU may be mainly used in various buildings, such as hotels, offices, hospitals, and houses.

[0042] That is, hot water generated in the second heat exchanger 211 may be provided to the heating coil 203 inside the water tank 202, the FCU, or the floor heating device and used for hot water supply and heating.

[0043] Because the present disclosure is mainly aimed to supply hot air through heat exchange between a refrigerant and water, a refrigerant cycle in a heating mode will be mainly described below.

[0044] According to an embodiment, a refrigerant circulation circuit passing the first heat exchanger 104, the expansion valve 105, the second heat exchanger 211, the four-way valve 102, the accumulator 103, and the compressor 101 may be formed.

[0045] In other words, the heat pump system 1 may configure a refrigerant circulation circuit through which a refrigerant circulates in the order of compressor 101 → four-way valve 102 → second heat exchanger 211 → expansion valve 105 → first heat exchanger 104 → four-way valve 102 → accumulator 103 → compressor 102, thereby performing a heating operation.

[0046] The flow path switching valve 201 may be connected to the heat exchanger outlet pipe 211b of the second heat exchanger 211.

[0047] During a heating operation, the flow path switching valve 201 may control a flow path of water heat-exchanged and heated in the second heat exchanger 211 to supply the heated water to at least one of the heating coil 203 inside the water tank 202, the FCU, or the floor heating device.

[0048] The water tank 202 may include a water tank inlet pipe 202a through which cold water is supplied to the water tank 202 from outside, the heating coil 203 that heats the supplied cold water to generate hot water, and a water tank outlet pipe 202b through which the generated hot water is supplied from the water tank 202 to a water tap 213.

[0049] The heating coil 203 provided inside the water tank may be supplied heated water from the second heat exchanger 211 by flow path switching of the flow path switching valve 201, and the heated water supplied from the second heat exchanger 211 may flow through the heating coil 203 to supply heat to cold water supplied to the water tank 202, thereby generating hot water.

[0050] The heating coil 203 may be provided in a coil shape to increase heat exchange efficiency.

[0051] One end of the water tank inlet pipe 202a may be connected to a cold water supply source, and another end may penetrate a wall of the water tank 202 and extend to an inner bottom of the water tank 202 to supply cold water to the bottom of the water tank 202. The cold water supply source may be, but is not limited to, a separate water tank (not shown) where cold water is stored, and may be any means capable of supplying cold water.

[0052] One end of the water tank outlet pipe 202b may be connected to an upper end of the wall of the water tank, and another end may be connected to the water tap 213 such that hot water is discharged through the water tap 213.

[0053] The pump 204 may be provided between the water tank 202 and the second heat exchanger 211 and cause water passed through the heating coil 203, supplied heat to cold water and then cooled to again flow into the second heat exchanger 211.

[0054] According to an embodiment, a water circulation circuit passing the second heat exchanger 211, the flow path switching valve 201, the heating coil 203, and the pump 204 may be formed.

[0055] That is, the heat pump system 1 may configure a water circulation circuit through which water circulates in the order of second heat exchanger 211 → flow path switching valve 201 → heating coil 203 → pump 204 → second heat exchanger 211 to heat cold water supplied to the inside of the water tank 202 and generate hot water.

[0056] In addition, referring to FIG. 1, the hot water supply device 20 according to an embodiment may include a plurality of sensors.

[0057] According to an embodiment, the hot air supply device 20 may further include a pipe temperature sensor 205.

[0058] Referring to FIG. 1, the pipe temperature sensor 205 is shown to be positioned on the water tank inlet pipe 202a, however, the pipe temperature sensor 205 may be positioned on the water tank outlet pipe 202b.

[0059] The pipe temperature sensor 205 may detect a temperature (hereinafter, referred to as a 'first temperature') of the water tank inlet pipe 202a through which cold water is supplied to the water tank 202, or a temperature (hereinafter, referred to as a 'second temperature') of the water tank outlet pipe 202b through which hot water is discharged from the water tank 202.

[0060] The pipe temperature sensor 205 may be positioned on an outer side of the water tank inlet pipe 202a.

[0061] The water tank 202 may include an inlet into which the water tank inlet pipe 202a is inserted. The pipe temperature

sensor 205 may be positioned adjacent to the inlet of the water tank 202.

[0062] The pipe temperature sensor 205 may be positioned on an outer side of the water tank outlet pipe 202b.

[0063] The water tank 202 may include an outlet to which the water tank outlet pipe 202a is connected. The pipe temperature sensor 205 may be positioned adjacent to an outlet of the water tank 202.

[0064] A separate pump (not shown) for discharging hot water to the water tank outlet pipe 202b may be provided inside the water tank 202.

[0065] According to an embodiment, the hot water supply device 20 may further include a first water temperature sensor 208.

[0066] The first water temperature sensor 208 may detect a temperature of hot water heated by the heating coil 203.

[0067] Because cold water is located lower than hot water due to changes in density of water depending on temperatures, cold water supplied through the water tank inlet pipe 202a may be positioned to the bottom of the water tank and hot water heated by the heating coil 203 may be positioned to a top of the water tank.

[0068] Accordingly, the first water temperature sensor 208 may be positioned to an upper end of an inner wall of the water tank 202.

[0069] According to an embodiment, the hot air supply device 20 may further include a second water temperature sensor 209 that detects a temperature of water to be supplied to the second heat exchanger 211, and a third water temperature sensor 210 that detects a temperature of water discharged from the second heat exchanger 211.

[0070] The second water temperature sensor 209 may be provided inside the heat exchanger inlet pipe 211a connected to a water inlet 211c of the second heat exchanger 211 into which water flows, and may detect a temperature of water to be supplied to the second heat exchanger 211 for heat exchange.

[0071] The third water temperature sensor 210 may be provided inside the heat exchanger inlet pipe 211b connected to a water outlet 211e of the second heat exchanger 211 through which water is discharged, and may detect a temperature of water heat-exchanged with a high-temperature refrigerant supplied from the outdoor unit 10 in the second heat exchanger 211 and then discharged.

[0072] The hot air supply device 20 according to an embodiment may further include a flow sensor 212 that detects a flow rate of water flowing into the second heat exchanger 211.

[0073] The flow sensor 212 may be one of an electronic flow sensor, an ultrasonic flow sensor, or a displacement flow sensor that measures a flow rate by dividing a fluid into a certain volume.

[0074] Components of the hot water supply device 20 are not limited to the present disclosure, and according to various embodiments, in addition to the components described above, a component for efficiently supplying hot water may be further provided or at least one of the above-described components may be omitted.

[0075] So far, components configuring the heat pump system 1 have been described with reference to FIG. 1. Hereinafter, a control block diagram of the heat pump system will be described with reference to FIG. 2.

[0076] FIG. 2 is a control block diagram of a heat pump system according to an embodiment.

[0077] The heat pump system 1 may include the compressor 101, the four-way valve 102, the accumulator 103, and/or the expansion valve 105, which are controllable, and a first controller 106 for controlling the compressor 10, the four-way valve 102, the accumulator 103, and/or the expansion valve 105.

[0078] The first controller 106 may include at least one memory 126 that stores various data required to perform the above-described operations or operations which will be described below, and at least one processor 116 that performs operations. Hereinafter, the memory 126 included in the first controller 106 is referred to as 'first memory' and the processor 116 is referred to as a 'first processor'.

[0079] The first controller 106 may be provided inside the indoor unit 10.

[0080] In addition, the outdoor unit 10 may include a first communication device 107 connected to a second communication device 207 to receive various information related to operations of the heat pump system 1 and control of the compressor 101 from the hot air supply device 20 and transfer the information to the first controller 106.

[0081] Also, the heat pump system 1 may include the flow path switching valve 201, the heating coil 203, and/or the pump 204, which are controllable, a second controller 206 for controlling the flow path switching valve 201, the heating coil 203, and/or the pump 204, the pipe temperature sensor 205, the first to third water temperature sensors 208 to 210, and the flow sensor 212.

[0082] The second controller 206 may include at least one memory 226 that stores various data required to perform the above-described operations and operations that will be described below, and at least one processor 216 that performs operations. Hereinafter, the memory 226 included in the second controller 206 is referred to as 'second memory', and the processor 216 is referred to as a 'second processor'.

[0083] The second controller 206 may be positioned inside the hot water supply device 20.

[0084] Also, the hot water supply device 20 may include the second communication device 207 that transfers a control signal generated by the second controller 206 to the outdoor unit 10 and receives various information from the outdoor unit 10.

[0085] According to an embodiment, the first processor 116 and the first memory 226 of the first controller 106 may be

integrated into one body or provided separately, and the second processor 216 and the second memory 226 of the second controller 206 may also be integrated into one body or provided separately.

[0086] The first memory 226 or the second memory 216 may include volatile memory, such as Static Random Access Memory (S-RAM) and Dynamic Random Access Memory (D-RAM), for temporarily memorizing data. The first memory 226 or the second memory 216 may include non-volatile memory, such as Read Only Memory (ROM), Erasable Programmable Read Only Memory (EPROM), and Electrically Erasable Programmable Read Only Memory (EEPROM), for storing data for a long time.

[0087] The first processor 116 or the second processor 216 may include various logic circuits and arithmetic circuits, and process data according to a program provided from each of the first memory 126 or the second memory 226 and generate a control signal according to the processed result.

[0088] Hereinafter, the first controller 106 and the second controller 116 will be described in detail.

[0089] According to an embodiment, the first controller 106 may control driving (on/off) of the compressor 101. The first controller 106 may control the four-way valve 102 to connect the first port 102a with the third port 102c and connect the second port 102b with the fourth port 102d to form a refrigerant flow path. By connecting the first port 102a with the third port 102c and connecting the second port 102b with the fourth port 102d, the refrigerant flow path may be formed.

[0090] More specifically, the first controller 106 may turn on/off the compressor based on a compressor control signal generated by the second controller 206 and received by the first communication device 107.

[0091] In the present disclosure, turning on/off the compressor 101 by the first controller 106 may include controlling a motor of the compressor 101 and controlling a driving circuit for driving the compressor 101.

[0092] The first controller 106 may obtain operation information of the compressor 101 from the driving circuit for driving the compressor 101.

[0093] The first controller 106 may control an oil separator provided inside the accumulator 103 to separate or discharge an oil from oil mixed with the refrigerant, and may control the accumulator 103 to cause the refrigerant from which oil has been separated to flow into the compressor 101.

[0094] In the present disclosure, the oil separator has been described as a component of the accumulator 103, however, the oil separator may be provided as a separate component.

[0095] The first controller 106 may control an opening degree of the expansion valve 105 to adjust a flow rate of a refrigerant flowing into the first heat exchanger 104 or block the refrigerant from flowing into the first heat exchanger 104.

[0096] According to an embodiment, the second controller 206 may control the flow path switching valve 201 to supply water heated by the second heat exchanger 211 to the heating coil 203.

[0097] Also, the heating coil 203 may include a flow rate control valve (not shown) for adjusting a quantity of water supplied from the second heat exchanger 211, and the second controller 206 may control the flow rate control valve to adjust a quantity of water flowing into the heating coil 203.

[0098] The second controller 206 may receive information on a first temperature of the water tank inlet pipe 202a or a second temperature of the water tank outlet pipe 202b from the pipe temperature sensor 205.

[0099] Also, the second controller 206 may receive information on a temperature (hereinafter, referred to as a 'third temperature') of hot water inside the water tank 202 from the first water temperature sensor 208, receive information on a temperature (hereinafter, referred to as a 'fourth temperature') of water flowing into the second heat exchanger 211 from the second temperature sensor 209, and receive information on a temperature (hereinafter, referred to as a 'fifth temperature') of water discharged from the second heat exchanger 211 from the third temperature sensor 210.

[0100] The second controller 206 may receive information on a flow rate of water flowing into the second heat exchanger 211 from the flow sensor 212.

[0101] According to an embodiment, the second controller 206 may determine a user's hot water use pattern based on information on a first temperature of the water tank inlet pipe 202a, a second temperature of the water tank outlet pipe 202b, a third temperature of hot water inside the water tank 202, a fourth temperature of water flowing into the second heat exchanger 211, and a fifth temperature of water discharged from the second heat exchanger 211, and information on a flow rate.

[0102] In other words, the second controller 206 may identify whether hot water is used, based on a first temperature of the inlet pipe 202a or a second temperature of the outlet pipe 202b, detected by the pipe temperature sensor 205.

[0103] Also, the second controller 206 may determine a user's hot water use pattern according to use of hot water.

[0104] The second controller 206 may determine turning-on/off of the compressor based on the hot water use pattern.

[0105] Also, in an embodiment, the second controller 206 may determine turning-on/off of the compressor 101 based on the determined hot water use pattern, generate a control signal related to turning-on/off of the compressor 101, and transfer the control signal to the first communication device 107 through the second communication device 207.

[0106] The first communication device 107 or the second communication device 207 may communicate with an external device, such as a server, a mobile device, and another home appliance, through a surrounding Access Point (AP). The AP may connect a Local Area Network (LAN) to which a refrigerator or a user device is connected to a Wide Area Network (WAN) to which a server is connected. The refrigerator or the user device may be connected to the server through the WAN.

[0107] In this case, the first communication device 107 and the second communication device 207 may communicate with each other through a wired network and/or a wireless network. For example, the first communication device 107 and the second communication device 207 may be connected to each other through a cable to transmit/receive various control signals and various data to/from each other. The first communication device 107 and the second communication device 207 may transmit/receive various data and various control signals to/from each other through Wireless-Fidelity (Wi-Fi), wireless LAN (WLAN), etc.

[0108] In the present disclosure, a case in which the second controller 206 determines turning-on/off of the compressor 101 and transmits a control signal generated by the second controller 206 to the first communication device 107 through the second communication device 207, and the first controller 106 turns on/off the compressor 101 based on a received control command has been described. However, the first controller 106 may receive sensing values of the plurality of sensors provided in the hot water supply device 20 through the first communication device 107, perform a series of processes of determining turning-on/off of the compressor 101, and then turn on/off the compressor 101.

[0109] Also, the first controller 106 may be omitted and the second controller 206 may directly control turning-on/off of the compressor 101.

[0110] So far, the control block diagram of the heat pump system 1 according to an embodiment has been described with reference to FIG. 2.

[0111] Based on this, a method of identifying whether hot water is used based on a temperature detected by the pipe temperature sensor 205 and identifying a hot water use section will be described in detail with reference to FIGS. 3 to 5.

[0112] The pipe temperature sensor 205 according to an embodiment may be positioned on the water tank inlet pipe 202a or the water tank outlet pipe 202b among pipes connected to the water tank 202 to detect a change in temperature of the water tank inlet pipe 202a or the water tank outlet pipe 202b over time.

[0113] FIG. 3 is a diagram showing temperature changes of the water tank inlet pipe 202a over time according to an embodiment.

[0114] A first graph 300 shows temperature changes of the water tank inlet pipe 202a over time, wherein an X axis represents time (s) and an y axis represents temperature ($^{\circ}\text{C}$).

[0115] According to the first graph 300, a temperature of the water tank inlet pipe 202a may change based on a user starting and ending use of hot water.

[0116] Generally, because the water tank inlet pipe 202a is installed adjacent to the water tank 202, heat from the water tank 202 may be supplied to the water tank inlet pipe 202a due to heat conduction caused by a temperature difference between the water tank inlet pipe 202a and the water tank 202. Accordingly, the water tank inlet pipe 202a may be maintained at a temperature similar to that of the water tank 202 (for example, a section from t_n to t_n).

[0117] However, when use of hot water starts, cold water may be supplied to the water tank 202 through the water tank inlet pipe 202a by a quantity of hot water discharged from the water tank 202 to the water tap 213.

[0118] At this time, heat supplied to the water tank inlet pipe 202a may be lost by the cold water, and a temperature of the water tank inlet pipe 202a may be lowered (for example, a section from t_n to t_{n+1}).

[0119] While hot water is used, water heated through heat exchange in the second heat exchanger 211 may be discharged and supplied to the heating coil 203 provided in the water tank 202, and according to heat being supplied to the inside of the water tank 202, the heat may be supplied to the water tank inlet pipe 202a by heat conduction. Meanwhile, cold water may continue to be added by a quantity of hot water discharged from the water tank 202 and accordingly, the heat supplied to the water tank inlet pipe 202 may be lost by the cold water (for example, a section from t_{n+1} to t_{n+2}).

[0120] That is, while hot water is used, two heat transfer phenomena of heat supply from the water tank 202 to the water tank inlet pipe 202a and heat loss of the water tank inlet pipe 202a due to cold water flowing into the water tank inlet pipe 202a may occur simultaneously to change a temperature of the water tank inlet pipe 202a.

[0121] Referring to FIG. 3, in the present disclosure, a temperature of the water tank inlet pipe 202a is shown as decreasing or increasing while hot water is used. However, the present disclosure is not limited thereto. For example, there may be a section in which a temperature of the water tank inlet pipe 202a is maintained within a preset range due to various factors, such as a flow rate and temperature of cold water supplied to the water tank 202, an output of the compressor 101, or a size of the second heat exchanger 211.

[0122] When use of hot water ends, cold water may no longer flow into the water tank inlet pipe 202a, and accordingly, heat loss caused by cold water flowing through the water tank inlet pipe 202a may not occur.

[0123] Also, when use of hot water ends, a flow path of a refrigerant may be blocked by the four-way valve 102 provided in the outdoor unit 10, and thus, a high-temperature refrigerant may not flow to the second heat exchanger 211 or the compressor 101 may be turned off. However, because the water tank 202 still stores heated hot water although a quantity of heat supplied from the heating coil 203 to the water tank 202 is reduced, heat may continue to be supplied from the water tank 202 to the water tank inlet pipe 202a. Accordingly, a temperature of the water tank inlet pipe 202a may increase (for example, a section of t_{n+2} to t_{n+3}).

[0124] According to an embodiment, based on this phenomenon, the second controller 206 may identify a start time of hot water use based on a temperature decrease of the water tank inlet pipe 202a during a preset reference time (for

example, 10 seconds) being greater than or equal to a preset first reference value $\Delta\text{Temp} 1$ (for example, 1°C).

[0125] That is, according to a temperature of the water tank inlet pipe 202a at a time t_{n+1} after 10 seconds from a time t_n being 1°C lower than a temperature of the water tank inlet pipe 202a at the time t_n , the second controller 206 may identify the time t_n as a start time of hot water use.

[0126] Also, according to an embodiment, based on a temperature increase of the water tank inlet pipe 202a during a preset reference time (for example, 10 seconds) after use of hot water starts being greater than or equal to a preset second reference value $\Delta\text{Temp}2$ (for example, 0.5°C), the second controller 206 may identify an end time of hot water use.

[0127] In this case, the first reference value and the second reference value may be equal to or different from each other.

[0128] For example, according to a temperature of the water tank inlet pipe 202a at a time t_{n+3} after 10 seconds from a time t_{n+2} being 0.5°C higher than a temperature of the water tank inlet pipe 202a at the time t_{n+2} , the second controller 206 may identify the time t_{n+2} as an end time of hot water use.

[0129] So far, the principle and method of identifying start and end times of hot water use to identify whether hot water is used, in the case in which the pipe temperature sensor 205 is provided on the water tank inlet pipe 202a have been described.

[0130] Hereinafter, a principle and method of identifying start and end times of hot water use to identify whether hot water is used, in the case in which the pipe temperature sensor 205 is provided on the water tank outlet pipe 202b will be described in detail with reference to FIG. 4.

[0131] FIG. 4 is a diagram showing temperature changes of the water tank outlet pipe 202b over time according to an embodiment.

[0132] A second graph 400 shows temperature changes of the water tank outlet pipe 202b over time, wherein an x axis represents time (s) and an y axis represents temperature ($^\circ\text{C}$).

[0133] According to the second graph 400, a temperature of the water tank outlet pipe 202b may change based on a user starting and ending use of hot water. Unlike the water tank inlet pipe 202a, the water tank outlet pipe 202b may receive heat from hot water flowing through the water tank outlet pipe 202b, but no cold water may flow through the water tank outlet pipe 202b. Therefore, heat loss may not occur.

[0134] Referring to the second graph 400, because the water tank outlet pipe 202b is connected to the upper wall of the water tank 202, the water tank outlet pipe 202b may be maintained at a temperature that is similar to that of the water tank 202 due to heat conduction (for example, a section from t'_0 to t'_n).

[0135] When use of hot water starts, hot water stored in the water tank 202 may flow through the water tank outlet pipe 202b and the water tank outlet pipe 202b may directly receive more heat from the hot water. Therefore, a temperature of the inlet pipe 202a may increase (for example, a section from t'_n to t'_{n+1}).

[0136] While use of hot water continues, water heated through heat exchange in the second heat exchanger 211 may be discharged and supplied to the heating coil 203 provided inside the water tank 202, and accordingly, heat may be supplied to hot water inside the water tank 202. Also, heat from hot water inside the water tank 202 may be supplied to the water tank outlet pipe 202b by heat conduction, as in the water tank inlet pipe 202a.

[0137] Also, because the water tank outlet pipe 202b receives heat from hot water flowing therethrough, a temperature of the water tank outlet pipe 202b may increase until reaching a temperature that is similar to that of hot water flowing through the water tank outlet pipe 202b and then be maintained within a constant temperature range (for example, a section from t'_{n+1} to t'_{n+2}).

[0138] When use of hot water ends, hot water may no longer flow into the water tank outlet pipe 202b, and direct heat supply by hot water flowing through the water tank outlet pipe 202b may not occur.

[0139] Accordingly, when use of hot water ends, a temperature of the water tank outlet pipe 202b may decrease (for example, a section from t'_{n+2} to t'_{n+3}).

[0140] According to an embodiment, based on this phenomenon, the second controller 206 may identify a start time of hot water use based on a temperature increase of the water tank outlet pipe 202b during a preset reference time (for example, 10 seconds) being greater than or equal to a preset third reference value $\Delta\text{Temp}3$ (for example, 0.3°C).

[0141] For example, according to a temperature of the water tank outlet pipe 202b at the time t'_{n+1} after 10 seconds from the time t'_n being 0.3°C higher than a temperature of the water tank outlet pipe 202b at the time t'_n , the second controller 206 may identify the time t'_n as a start time of hot water use.

[0142] Also, according to an embodiment, based on a temperature decrease of the water tank outlet pipe 202b during a preset reference time (for example, 10 seconds) after use of hot water starts being greater than or equal to a preset fourth reference value $\Delta\text{Temp}4$ (for example, 0.3°C), the second controller 206 may identify an end time of hot water use.

[0143] For example, in the case in which a temperature of the water tank inlet pipe 202a at the time t_{n+3} after 10 seconds from the time t_{n+2} is 0.5°C lower than a temperature of the water tank inlet pipe 202a at the time t_{n+2} , the second controller 206 may identify the time t_{n+2} as an end time of hot water use.

[0144] In this case, the third reference value and the fourth reference value may be equal to or different from each other.

[0145] Also, as described above, according to an embodiment, because a temperature change of the water tank inlet pipe 202a and a temperature change of the water tank inlet pipe 202a are caused by different factors, it will be easily

understood by one of ordinary skill in the art that the first and second reference values are distinguished from the third and fourth reference values.

[0146] FIG. 5 is a diagram for describing a method of identifying hot water use sections, according to an embodiment.

[0147] FIG. 5 relates to a case in which the pipe temperature sensor 205 is positioned on the water tank inlet pipe 202a.

However, the same principle may also be applied to a case in which the pipe temperature sensor 205 is positioned on the water tank outlet pipe 202b.

[0148] Referring to FIG. 5, a third graph 500 shows temperature changes of the water tank inlet pipe 202a over time, wherein an x axis represents time (s) and an y axis represents temperature (°C).

[0149] As described above with reference to FIG. 3, the second controller 206 may identify a section (hereinafter, referred to as a 'hot water use section') for which a user uses hot water, based on a temperature change of the water tank inlet pipe 202a over time.

[0150] That is, whenever the second controller 206 identifies that use of hot water has started, the second controller 206 may identify at least one hot water use section based on a start time of hot water use and an end time of hot water use.

[0151] According to an embodiment, one or plurality of hot water use sections may be identified, and the first controller 106 may calculate a time length of each hot water use section based on a start time of hot water use and an end time of hot water use of the hot water use section.

[0152] For example, referring to the third graph 500, two hot water use sections of S1 and S2 may be identified, wherein a time length of the hot water use section S1 may be identified as $t_2 - t_1$ (s), and a time length of the hot water use section S2 may be identified as $t_4 - t_3$ (s).

[0153] That is, the heat pump system 1 may have an advantage of identifying a hot water use section through simple calculation by using only one sensor.

[0154] Based on this, a method of calculating a total heat loss quantity of the water tank 202 according to hot water use during a reference section and calculating a section heat loss quantity for each hot water use section based on the total heat loss quantity will be described with reference to FIGS. 6 and 7.

[0155] FIG. 6 is a diagram showing both temperature changes of the water tank inlet pipe 202a and temperature changes of hot water in the water tank 202 over time, according to an embodiment.

[0156] Referring to FIG. 6, the third graph 500 and the fourth graph 600 as described above are shown in FIG. 5, and the fourth graph 600 shows temperature changes of hot water in the water tank 202 over time, wherein the x axis represents time (s) and the y axis represents temperature (°C).

[0157] According to an embodiment, the second controller 206 may identify a section (hereinafter, referred to as a 'reference section') from a start time at which a third temperature detected by the first water temperature sensor 208 reaches a first setting temperature to an end time at which the third temperature reaches a second setting temperature, and identify a time length elapsed from the start time to the end time.

[0158] The second controller 206 may identify whether the reference section includes at least one hot water use section, based on a change of a first temperature or a second temperature detected by the pipe temperature sensor 205 as described above.

[0159] For example, referring to the third graph 500 and the fourth graph 600 of FIG. 6, the second controller 206 may identify a reference section SECTION 1 of t_5 to t_6 by using a start time t_5 at which a temperature of hot water inside the water tank 202 reaches the first setting temperature and an end time t_6 at which a temperature of hot water inside the water tank 202 reaches the second setting temperature.

[0160] At this time, the second controller 206 may identify whether at least one hot water use section exists in the reference section SECTION 1.

[0161] That is, the second controller 206 may identify that the hot water use sections S1 (that is, t_1 to t_2) and S2 (that is, t_3 to t_4) exist between t_5 and t_6 .

[0162] Meanwhile, because a total heat loss quantity of the water tank 202 according to use of hot water within the reference section is caused by hot water discharged from the water tank 202 during at least one hot water use section existing in the reference section, the total heat loss quantity of the water tank 202 according to the use of hot water within the reference section may correspond to a sum of heat loss quantities of the water tank 202 according to the use of hot water in the at least one hot water use section included in the reference section.

[0163] Accordingly, the second controller 206 may calculate a total heat loss quantity of the water tank 202 according to use of hot water within the reference section, based on information on a third temperature of hot water inside the water tank 202, a fourth temperature of water flowing into the second heat exchanger 211, and a fifth temperature of water discharged from the second heat exchanger 211 and a flow rate detected by the flow sensor 212.

[0164] After the second controller 206 calculates the total heat loss quantity, the second controller 206 may calculate a section heat loss quantity of the water tank 202 based on a time length of each hot water use section existing in the reference section. Details about a method for the calculation will be described with reference to FIG. 7, below.

[0165] FIG. 7 is a diagram for describing a change in heat quantity inside a water tank, according to an embodiment.

[0166] A heat quantity stored in the water tank 202 according to an embodiment may change over time.

[0167] Referring to FIG. 7, a stored heat quantity of the water tank 202 according to an embodiment may change by a heat loss quantity (that is, a total heat loss quantity Q1 of the water tank 202 according to use of hot water') occurring while hot water is discharged, a heat loss quantity (hereinafter, referred to as a 'basic heat loss quantity Q2') caused by a temperature difference between the water tank 202 and outside air, and a heat quantity (hereinafter, referred to as a 'supplied heat quantity Q3') generated by an operation of the compressor 101 and supplied to the water tank 202 through heat exchange in the second heat exchanger 211.

[0168] That is, a difference between a first stored heat quantity Q4 of the water tank 202 at the time t_5 at which the third temperature reaches the first setting temperature and a second stored heat quantity Q5 at the time t_6 at which the third temperature reaches the second setting temperature may correspond to a sum of the total heat loss quantity Q1, the basic heat loss quantity Q2, and the supplied heat quantity Q3 of the water tank 202 according to use of hot water.

[0169] Accordingly, the total heat loss quantity Q1 of the water tank 202 according to use of hot water may be defined by Equation 1.

Total Heat Loss Quantity Q1 of Water Tank 202 According to Use of Hot Water = First Stored Heat Quantity Q4 - Second Stored Heat Quantity Q5 + Supplied Heat Quantity Q3 - Basic Heat Loss Quantity Q2. [Equation 1]

[0170] The first stored heat quantity Q4 or the second stored heat quantity Q5 may be defined as a heat quantity stored inside the water tank 202 at the time at which the third temperature reaches the first setting temperature or the second setting temperature.

[0171] Data about stored heat quantities according to temperatures of water may have been calculated in advance through an experiment and stored in the second memory 226.

[0172] The second controller 206 may calculate the first stored heat quantity Q4 or the second stored heat quantity Q5 by comparing a third temperature detected by the first water temperature sensor 208 to the data about the stored heat quantities according to the temperatures of water, stored in the second memory 226.

[0173] Also, the supplied heat quantity Q3 may be calculated by Equation 2 below.

[Equation 2]

$$\text{Supplied Heat Quantity Q3} = F(\text{L/s}) * (T_{\text{Water out}} - T_{\text{Water in}}) * C$$

[0174] (C is a heat capacity constant of water, typically 4.18 J/(g°C))

[0175] Here, F(L/s) may be defined as a flow rate of water flowing into the second heat exchanger 211 through the second heat exchanger inlet pipe 212a, detected by the flow sensor 212.

[0176] $T_{\text{Water in}}$ may be defined as a fourth temperature detected by the second water temperature sensor 209, and $T_{\text{Water out}}$ may be defined as a fifth temperature detected by the third water temperature sensor 210.

[0177] That is, in an embodiment, the second controller 206 may calculate a heat quantity received through heat exchange in the second heat exchanger 211, based on a temperature difference and flow rates of water between before the water passes through the second heat exchanger 211 and after the water passes through the second heat exchanger 211.

[0178] Also, the basic heat loss quantity Q2 may be set to a constant depending on a surface area and material of the water tank and/or a temperature and wind speed of outside air.

[0179] In an embodiment, the second controller 206 may calculate a section heat loss quantity for each hot water use section by distributing the total heat loss quantity Q1 of the water tank 202 according to use of hot water, calculated by Equation 1 described above, in proportion to a time length of the hot water use section existing within the reference section.

[0180] For example, in the case in which two hot water use sections exist within the reference section, time lengths for the respective hot water use sections are 30 minutes and 20 minutes, respectively, and a total heat loss quantity Q1 of the water tank 202 according to use of hot water, calculated by Equation 1 described above is 100 J, section heat loss quantities may be 60 J and 40 J, respectively.

[0181] Therefore, the second controller 206 may obtain a data set of a plurality of hot water use sections and section heat loss quantities by repeatedly calculating a total heat loss quantity Q1 and section heat loss quantities of the water tank 202 according to use of hot water as described above.

[0182] The second controller 206 may determine the hot water use pattern based on a data set of at least one hot water use section and a section heat loss quantity.

[0183] By calculating only a total heat loss quantity Q1 for a reference section without having to calculate a heat loss quantity for each hot water use section, a heat loss quantity for each of a plurality of hot water use sections may be obtained only through simple calculation.

[0184] FIG. 8 is an overall control flowchart of the heat pump system 1 according to an embodiment.

[0185] According to an embodiment, the second controller 206 may identify whether a user uses hot water, based on a temperature (a first temperature) of the water tank inlet pipe 202a or a temperature (a second temperature) of the water tank outlet pipe 202b, detected by the pipe temperature sensor 205 (801).

[0186] That is, the second controller 206 may identify a start time of hot water use and an end time of hot water use through a temperature change of the first temperature or the second temperature over time. Also, the second controller 206 may identify a hot water use section and calculate a time length of each hot water use section based on the start time of hot water use and the end time of hot water use.

[0187] Also, the second controller 206 may calculate a total heat loss quantity for each reference section and calculate a section heat loss quantity for each hot water use section within the reference section, thereby determining a hot water use pattern (802).

[0188] The second controller 206 may determine turning-on/off of the compressor based on the hot water use pattern (803).

[0189] The second controller 206 may increase efficiency of energy-saving operation of the heat pump system 1 by determining turning-on/off of the compressor, which will be described in detail with reference to FIGS. 9 to 12 below.

[0190] FIG. 9 is a flowchart showing a control method of the heat pump system 1 for identifying whether hot water is used based on a temperature of the water inlet pipe 202a, according to an embodiment.

[0191] The second controller 206 according to an embodiment may receive information on a temperature (a first temperature) of the water tank inlet pipe 202a, detected by the pipe temperature sensor 205 (901).

[0192] The second controller 206 may identify whether the detected first temperature decreases by a first reference value or more during a reference time (902).

[0193] That is, the second controller 206 may identify a start time of hot water use in response to a temperature decrease of the first temperature during the reference time being greater than or equal to the first reference value (YES in 902). Also, in response to the temperature decrease of the first temperature during the reference time being less than the first reference value (NO in 902), the second controller 206 may identify whether a first temperature detected during a next reference time decreases by the first reference value or more, thereby identifying a start time of hot water use (903).

[0194] After the start time of hot water use, the second controller 206 may identify whether an increase of the first temperature during a preset reference time is greater than or equal to a preset second reference value (904).

[0195] According to the increase of the first temperature during the reference time being greater than or equal to the preset second reference value (YES in 904), the second controller 206 may identify an end time of hot water use (905).

[0196] According to the increase of the first temperature during the reference time being less than the preset second reference value (NO in 904), the second controller 206 may identify whether an increase of a first temperature during a next reference time is greater than or equal to the second reference time, thereby identifying an end time of hot water use (906).

[0197] After the second controller 206 identifies the start time of hot water use and the end time of hot water use, the second controller 206 may identify a hot water use section based on the start time of hot water use and the end start of hot water use and calculate a time length of each hot water use section (907).

[0198] In other words, whenever use of hot water starts, the second controller 206 may identify at least one hot water use section based on a start time of hot water use and an end time of hot water use and calculate a time length of each of the at least hot water use section.

[0199] FIG. 10 is a flowchart showing a control method of the heat pump system 1 for identifying whether hot water is used based on a temperature of the water tank outlet pipe 202b, according to another embodiment.

[0200] A control method of the heat pump system for identifying whether hot water is used in the case in which the pipe temperature sensor 205 is provided on the water tank outlet pipe 202b, according to another embodiment, will be described with reference to FIG. 10, below.

[0201] According to another embodiment, the second controller 206 may receive information on a temperature (a second temperature) of the water tank outlet pipe 202b, detected by the pipe temperature sensor 205 (1001).

[0202] The second controller 206 may identify whether the detected second temperature increases by a third reference value or more during a preset reference time (1002).

[0203] That is, according to an increase of the second temperature during the preset reference time being greater than or equal to the preset third reference value (YES in 1002), the second controller 206 may identify a start time of hot water use (1003).

[0204] Meanwhile, according to the increase of the second temperature during the reference time being less than the preset third reference value (NO in 1002), the second controller 206 may identify whether an increase of a second temperature during a next reference time is greater than or equal to the third reference value, thereby identifying an end time of hot water use.

[0205] After the start time of hot water use, the second controller 206 may identify whether an increase of a second temperature during the preset reference time is greater than or equal to the third reference value (1004).

[0206] According to the increase of the second temperature during the reference time being greater than or equal to the

preset third reference value (YES in 1004), the second controller 206 may identify an end time of hot water use. Also, according to the increase of the second temperature during the reference time being less than the preset fourth reference value (NO in 1004), the second controller 206 may identify whether an increase of a second temperature during a next reference time is greater than or equal to the fourth reference value, thereby identifying an end time of hot water use (1005).

[0207] It will be obvious to one of ordinary skill in the art that, even in the case in which the pipe temperature sensor 205 is positioned on the water tank outlet pipe 202b, according to another embodiment, the second controller 206 may identify a hot water use section based on a start time of hot water use and an end time of hot water use and calculate a time length of each hot water use section (1006).

[0208] Also, whenever use of hot water starts, the second controller 206 may identify at least one hot water use section based on a start time of hot water use and an end time of hot water use, and calculate a time length of each of the at least one hot water use section.

[0209] FIG. 11 is a flowchart showing a control method of the heat pump system 1 for determining a user's hot water use pattern, according to an embodiment.

[0210] Referring to FIG. 11, according to an embodiment, the second controller 206 may identify a reference section of which a start time is a time at which a third temperature detected by the first water temperature sensor 208 reaches a preset first setting temperature and of which an end time is a time at which the third temperature reaches the preset first setting temperature (1101).

[0211] The second controller 206 may identify whether the reference section includes a hot water use section identified as described above with reference to FIGS. 8 and 9 (1102).

[0212] According to at least one hot water use section being included in the reference section (YES in 1102), the second controller 206 may calculate a total heat loss quantity Q3 of the water tank 202 according to use of hot water within the reference section, based on third to fifth temperatures and a flow rate received from the first to third temperature sensors 208 to 210 and the flow sensor 212 as described above with reference to FIG. 7 (1103).

[0213] Thereafter, the second controller 206 may distribute the total heat loss quantity Q3 in proportion to a time length of the at least one hot water use section existing within the reference section, thereby calculating a section heat loss quantity of each hot water use section (1104).

[0214] Whenever a third temperature reaches the first setting temperature, the second controller 206 may identify a start point and an end point of a reference section to identify the reference section and calculate a section heat loss quantity of a hot water use section existing in the reference section, thereby obtaining a plurality of data sets.

[0215] The second controller 206 may identify whether the data sets regarding the hot water use section and the section heat loss quantity for each hot water use section is sufficient to determine a hot water use pattern hourly on a daily basis (1105).

[0216] For example, in the case in which data on at least 10 or more hot water use sections and section heat loss quantities for the respective hot water use sections is obtained based on 24 hours, the second controller 206 may identify that sufficient data sets to determine a hot water use pattern have been obtained.

[0217] It is obvious to those skilled in the art that the number of data acquired for each time in the present disclosure is only an example, and should not be interpreted as limited thereto, but the number of data based on which whether sufficient data sets to determine a hot water use pattern have been acquired is identified may depend on various criteria.

[0218] According to the second controller 206 identifying that sufficient data sets have not been obtained (NO in 1105), the second controller 206 may identify a reference section based on a third temperature received from the pipe temperature sensor 205 and calculate a section heat loss quantity of a hot water use section existing within the identified reference section to additionally obtain a plurality of data sets.

[0219] According to the second controller 206 identifying that sufficient data sets have been obtained (YES in 1105), the second controller 206 may determine a hot water use pattern based on the obtained data sets (1106).

[0220] The hot water use pattern determined according to an embodiment may be stored in the second memory 226 of the second controller 206, and information on the hot water use pattern may be transmitted to the first communication device 107 through the second communication device 207 and transferred to the first controller 107 of the outdoor unit 10.

[0221] According to another embodiment, the second controller 206 may determine turning-on/off of the compressor 101 based on the hot water use pattern, and then transmit a control signal for turning on/off the compressor 101 to the first communication device 107 through the second communication device 207 to transmit the control signal to the first controller 106 of the outdoor unit 10, which will be described in detail with reference to FIG. 12, below.

[0222] FIG. 12 is a flowchart showing a control method of the heat pump system 1 for determining turning-on/off of a compressor based on a determined hot water use pattern, according to an embodiment.

[0223] Referring to FIG. 12, according to an embodiment, the second controller 206 may receive a third temperature detected by the first water temperature sensor 208 at a preset measurement time (hereinafter, the third temperature at the preset measurement time is referred to as ' T_0 ') (1201)

[0224] The second controller 206 may compare T_0 to a stored heat quantity for each temperature of water, calculated in advance and stored in the second memory 226, and identify an initial stored heat quantity of the water tank 202 at the

measurement time (1202).

[0225] Thereafter, the second controller 206 may predict a stored heat quantity of the water tank 202 after a preset time interval (for example, a time interval of one hour) from the measurement time, based on a determined hot water use pattern and the initial stored heat quantity identified at the measurement time (1203).

5 [0226] For example, according to the measurement time being 7:00 PM, the initial stored heat quantity of the water tank being 100 J, and an average heat loss quantity between 7:00 PM and 8:00 PM based on the determined hot water use pattern being 130 J, the second control unit 206 may predict a stored heat quantity of the water tank 202 at 8:00 PM as -30 J.

[0227] The second controller 206 may identify whether the predicted stored heat quantity after the preset time interval is less than a threshold value (1204).

10 [0228] According to an embodiment, the second controller 206 may determine turning-on of the compressor 101 based on the predicted stored heat quantity being less than the threshold value (YES in 1204).

[0229] For example, because the stored heat quantity of the water tank 202 at 8:00 PM is predicted to be -30J, which is less than 0, the second controller 206 may determine turning-on of the compressor 101 to supply hot water one hour later.

15 [0230] According to the second controller 206 determining turning-on of the compressor 101, the second controller 206 may generate a control signal for controlling the compressor 101 and transmit the control signal to the first controller 106 of the outdoor unit 10 through the second communication device 207.

[0231] The first controller 106 may receive the control signal and turn on the compressor 101 according to the control signal (1205).

20 [0232] According to an embodiment, the second controller 206 may determine turning-off of the compressor 101 based on a third temperature detected by the first water temperature sensor 208 being a preset reference temperature T' higher than that at the time at which the compressor 101 has been turned on (1206).

[0233] For example, in the case in which the reference temperature T' is 10 °C, a third temperature at a time at which the compressor 101 has been turned on is 40 °C, and the third temperature increases by 10 °C or more while the compressor 101 operates, the second controller 206 may determine turning-off of the compressor 101.

25 [0234] Based on the second controller 206 determining turning-off of the compressor 101, the second controller 206 may generate a control signal for controlling the compressor 101 and transmit the control signal to the first controller 106 of the outdoor unit 10 through the second communication device 207.

[0235] The first controller 106 may turn off the compressor by controlling the compressor 101 based on the received control signal (1207).

30 [0236] A heat pump system according to an embodiment of the present disclosure may include: a compressor configured to compress a refrigerant; a water tank storing water; a heat exchanger configured to exchange heat between the refrigerant received from the compressor and the water received from the water tank and supply the heat-exchanged water to the water tank; a heating coil configured to heat cold water stored in the water tank; a pipe temperature sensor configured to detect a first temperature of an inlet pipe through which cold water is supplied to the water tank or a second temperature of an outlet tank through which hot water is discharged from the water tank; and a controller.

35 [0237] The controller may identify whether the hot water is used, based on the first temperature of the inlet pipe or the second temperature of the outlet pipe, detected by the pipe temperature sensor.

[0238] The controller may determine a hot water use pattern of a user according to use of the hot water.

[0239] The controller may determine turning-on/off of the compressor based on the hot water use pattern.

40 [0240] The controller may identify a start time of hot water use based on a decrease of a temperature of the inlet pipe during a preset reference time being greater than or equal to a preset first reference value.

[0241] The controller may identify an end time of hot water use based on an increase of a temperature of the inlet pipe during the preset reference time after use of hot water starts being greater than or equal to a preset second reference value.

45 [0242] Whenever use of hot water starts, the controller may identify at least one hot water use section based on a start time of hot water use and an end time of hot water use.

[0243] The controller may identify a start time of hot water use based on an increase of a temperature of the outlet pipe during the preset reference time being greater than or equal to a preset third reference value.

50 [0244] The controller may identify an end time of hot water use based on a decrease of a temperature of the outlet pipe during the preset reference time after the start time of the hot water use being greater than or equal to a preset fourth reference value.

[0245] Whenever use of hot water starts, the controller may determine at least one hot water use section based on a start time of hot water use and an end time of hot water use.

55 [0246] The heat pump system may further include a first water temperature sensor configured to detect a third temperature of the hot water stored in the water tank, and the controller may identify a reference section of which a start time is a time at which the third temperature of the hot water reaches a first setting temperature and of which an end time is a time at which the third temperature of the hot water reaches a second setting temperature.

[0247] The controller may identify whether the reference section includes at least one hot water use section.

[0248] The heat pump system may further include: a second water temperature sensor configured to detect a fourth

temperature of water flowing into the first heat exchanger; a third water temperature sensor configured to detect a fifth temperature of water supplied from the first heat exchanger to the water tank; and a flow sensor configured to detect a flow rate of water flowing into the first heat exchanger, and the controller may calculate a first stored heat quantity of the water tank at a time at which the third temperature of the hot water reaches the first setting time.

[0249] The controller may calculate a second stored heat quantity of the water tank at a time at which the third temperature of the hot water reaches the second setting time.

[0250] The controller may calculate a supplied heat quantity supplied to the water tank based on a temperature difference between the fourth temperature and the fifth temperature and a flow rate detected by the flow sensor.

[0251] The controller may calculate a total heat loss quantity of the water tank according to use of hot water within the reference section based on the first stored heat quantity, the second stored heat quantity, the supplied heat quantity, and a basic heat loss quantity depending on characteristics of the water tank.

[0252] The controller may divide the total heat loss quantity into at least one section heat loss quantity based on a time length of each of the at least one hot water use section.

[0253] The controller may determine the hot water use pattern based on the at least one hot water use section and the at least one section heat loss quantity.

[0254] The controller may identify an initial stored heat loss quantity of the water tank based on a third temperature of the hot water at a preset measurement time.

[0255] The controller may predict a stored heat loss quantity of the water tank after a preset time interval from the measurement time, based on the hot water use pattern and the initial stored heat loss quantity identified at the measurement time.

[0256] The controller may determine turning-on of the compressor based on the predicted, stored heat quantity being less than a preset threshold value.

[0257] The controller may determine turning-off of the compressor according to a third temperature detected by the first water temperature sensor being a preset reference temperature higher than a temperature at a time at which the compressor is turned on.

[0258] A method of controlling a heat pump system according to an embodiment of the present disclosure, the heat pump system including: a compressor configured to compress a refrigerant; a water tank storing water; a heat exchanger configured to exchange heat between the refrigerant and the water; and a pipe temperature sensor configured to detect a first temperature of an inlet pipe through which cold water is supplied to the water tank or a second temperature of an outlet pipe through which hot water is discharged from the water tank, may include identifying whether the hot water is used, based on a first temperature of the inlet pipe or a second temperature of the outlet pipe, detected by the pipe temperature sensor.

[0259] The control method of the heat pump system may include determining a hot water use pattern of a user according to use of the hot water.

[0260] The control method of the heat pump system may include determining turning-on/off of the compressor based on the hot water use pattern.

[0261] The identifying of whether the hot water is used may include, based on a decrease of a temperature of the inlet pipe during a preset reference time being greater than or equal to a preset first reference value, identifying a start time of hot water use.

[0262] The identifying of whether the hot water is used may include, based on an increase of a temperature of the inlet pipe during the preset reference time after use of hot water starts being greater than or equal to a preset second reference value, identifying an end time of hot water use.

[0263] The identifying of whether the hot water is used may include, whenever use of hot water starts, identifying at least one hot water use section based on a start time of hot water use and an end time of hot water use.

[0264] The identifying of whether the hot water is used may include, based on an increase of a temperature of the outlet pipe during a preset reference time being greater than or equal to a preset third reference value, identifying a start time of hot water use.

[0265] The identifying of whether the hot water is used may include, based on a decrease of a temperature of the outlet pipe during the reference time after the start time of hot water use being greater than or equal to a fourth reference value, identifying an end time of hot water use.

[0266] The identifying of whether the hot water is used may include, whenever use of hot water starts, identifying at least one hot water use section based on a start time of hot water use and an end time of hot water use.

[0267] The heat pump system may further include a first water temperature sensor configured to detect a third temperature of hot water stored in the water tank, and the determining of the hot water use pattern of the user according to use of the hot water may include identifying a reference section of which a start time is a time at which the third temperature of the hot water reaches a first setting temperature and of which an end time is a time at which the third temperature of the hot water reaches a second setting temperature.

[0268] The determining of the hot water use pattern of the user according to use of the hot water may include identifying

whether at least one hot water use section exists in the reference section.

[0269] The heat pump system may further include a second water temperature sensor configured to detect a fourth temperature of water flowing into the first heat exchanger; a third water temperature sensor configured to detect a fifth temperature of water supplied from the first heat exchanger to the water tank; and a flow sensor configured to detect a flow rate of water flowing into the first heat exchanger, wherein the determining of the hot water use pattern of the user according to use of hot water may include calculating a first stored heat quantity of the water tank at a time at which a third temperature of the hot water reaches the first setting temperature.

[0270] The determining of the hot water use pattern of the user according to use of hot water may include calculating a second stored heat quantity of the water tank at a time at which a third temperature of the hot water reaches the second setting temperature.

[0271] The determining of the hot water use pattern of the user according to use of hot water may include calculating a supplied heat quantity supplied to the water tank based on a temperature difference between the fourth temperature and the fifth temperature and a flow rate detected by the flow sensor.

[0272] The determining of the hot water use pattern of the user according to use of hot water may include calculating a total heat loss quantity of the water tank according to use of hot water within the reference section based on the first stored heat quantity, the second stored heat quantity, the supplied heat quantity, and a basic heat loss quantity depending on characteristics of the water tank.

[0273] The determining of the hot water use pattern of the user according to use of hot water may include dividing the total heat loss quantity into at least one section heat loss quantity based on a time length of each of the at least one hot water use section.

[0274] The determining of the hot water use pattern of the user according to use of hot water may include determining the hot water use pattern based on the at least one hot water use section and the at least one section heat loss quantity.

[0275] The determining of turning on/off of the compressor based on the hot water use pattern may include calculating an initial stored heat quantity of the water tank based on a third temperature of the hot water at a preset measurement time.

[0276] The determining of turning on/off of the compressor based on the hot water use pattern may include predicting a stored heat quantity of the water tank after a preset time interval from the measurement time based on the hot water use pattern and the initial stored heat quantity calculated at the measurement time.

[0277] The determining of turning on/off of the compressor based on the hot water use pattern may include determining turning-on of the compressor based on the predicted stored heat quantity being less than a preset threshold value.

[0278] The determining of turning on/off of the compressor based on the hot water use pattern may include determining turning off of the compressor according to a third temperature detected by the first water temperature sensor being a preset reference temperature higher than a temperature at a time which the compressor is turned on.

[0279] According to an aspect of the present disclosure, by controlling turning-on/off of a compressor by adding only a temperature sensor for detecting a temperature of the water tank pipe without having to add a plurality of sensors to determine a user's hot water use pattern, a process may be simplified, price competitiveness may be ensured, and hot water may be supplied with optimal energy efficiency.

[0280] The disclosed embodiments may be implemented in the form of a recording medium that stores instructions executable by a computer. The instructions may be stored in the form of a program code, and when executed by a processor, the instructions may create a program module to perform operations of the disclosed embodiments.

[0281] The machine-readable storage medium may be provided in the form of a non-transitory storage medium, wherein the term 'non-transitory storage medium' simply means that the storage medium is a tangible device, and does not include a signal (e.g., an electromagnetic wave), but this term does not differentiate between where data is semi-permanently stored in the storage medium and where the data is temporarily stored in the storage medium. For example, a 'non-transitory storage medium' may include a buffer in which data is temporarily stored.

[0282] According to an embodiment, the method according to various embodiments of the present disclosure may be included and provided in a computer program product. The computer program product may be traded as a product between a seller and a buyer. The computer program product may be distributed in the form of a machine-readable storage medium (e.g., compact disc read only memory (CD-ROM)), or be distributed (e.g., downloadable or uploadable) online via an application store (e.g., Play Store™) or between two user devices (e.g., smart phones) directly. When distributed online, at least part of the computer program product (e.g., a downloadable app) may be temporarily generated or at least temporarily stored in the machine-readable storage medium, such as a memory of the manufacturer's server, a server of the application store, or a relay server.

[0283] So far, the disclosed embodiments have been described with reference to the accompanying drawings. It will be understood by one of ordinary skill in the art to which the present disclosure belongs that the present disclosure can be implemented in different forms from the disclosed embodiments without changing the technical spirit or essential features of the present disclosure. Thus, it should be understood that the disclosed embodiments are merely for illustrative purposes and not for limitation purposes.

Claims**1.** A heat pump system comprising:

5 a compressor configured to compress a refrigerant;
 a water tank storing water;
 a heat exchanger configured to exchange heat between the refrigerant received from the compressor and the water received from the water tank and supply the heat-exchanged water to the water tank;
 a heating coil configured to heat cold water stored in the water tank;
 10 a pipe temperature sensor configured to detect a first temperature of an inlet pipe through which cold water is supplied to the water tank or a second temperature of an outlet tank through which hot water is discharged from the water tank; and
 a controller configured to identify whether the hot water is used, based on the first temperature of the inlet pipe or the second temperature of the outlet pipe, detected by the pipe temperature sensor,
 15 determine a hot water use pattern of a user according to use of the hot water, and
 determine turning-on/off of the compressor based on the hot water use pattern.

2. The heat pump system of claim 1, wherein

the controller is configured to identify a start time of hot water use based on a decrease of a temperature of the inlet pipe during a preset reference time being greater than or equal to a preset first reference value.

3. The heat pump system of claim 2, wherein

the controller is configured to identify an end time of hot water use based on an increase of a temperature of the inlet pipe during the preset reference time after use of hot water starts being greater than or equal to a preset second reference value.

4. The heat pump system of claim 3, wherein

the controller is configured to, whenever use of hot water starts, identify at least one hot water use section based on a start time of hot water use and an end time of hot water use.

5. The heat pump system of claim 3, wherein

the controller is configured to
 identify a start time of hot water use based on an increase of a temperature of the outlet pipe during the preset reference time being greater than or equal to a preset third reference value,
 35 identify an end time of hot water use based on a decrease of a temperature of the outlet pipe during the preset reference time after the start time of the hot water use being greater than or equal to a preset fourth reference value, and
 whenever use of hot water starts, determine at least one hot water use section based on a start time of hot water use and an end time of hot water use.

6. The heat pump system of claim 4 or 5, further comprising

a first water temperature sensor configured to detect a third temperature of the hot water stored in the water tank,
 45 wherein the controller is configured to
 identify a reference section of which a start time is a time at which the third temperature of the hot water reaches a first setting temperature and of which an end time is a time at which the third temperature of the hot water reaches a second setting temperature, and
 identify whether the reference section includes at least one hot water use section.

7. The heat pump system of claim 6, further comprising:

a second water temperature sensor configured to detect a fourth temperature of water flowing into the first heat exchanger;
 55 a third water temperature sensor configured to detect a fifth temperature of water supplied from the first heat exchanger to the water tank; and
 a flow sensor configured to detect a flow rate of water flowing into the first heat exchanger,
 wherein the controller is configured to

calculate a first stored heat quantity of the water tank at a time at which the third temperature of the hot water reaches the first setting time,
 calculate a second stored heat quantity of the water tank at a time at which the third temperature of the hot water reaches the second setting time, and
 calculate a supplied heat quantity supplied to the water tank based on a temperature difference between the fourth temperature and the fifth temperature and a flow rate detected by the flow sensor, and
 calculate a total heat loss quantity of the water tank according to use of hot water within the reference section based on the first stored heat quantity, the second stored heat quantity, the supplied heat quantity, and a basic heat loss quantity depending on characteristics of the water tank.

8. The heat pump system of claim 7, wherein

the controller is configured to
 divide the total heat loss quantity into at least one section heat loss quantity based on a time length of each of the at least one hot water use section, and
 determine the hot water use pattern based on the at least one hot water use section and the at least one section heat loss quantity.

9. The heat pump system of claim 8, wherein

the controller is configured to
 identify an initial stored heat loss quantity of the water tank based on a third temperature of the hot water at a preset measurement time,
 predict a stored heat loss quantity of the water tank after a preset time interval from the measurement time, based on the hot water use pattern and the initial stored heat loss quantity identified at the measurement time, and
 determine turning-on of the compressor based on the predicted, stored heat quantity being less than a preset threshold value.

10. The heat pump system of claim 8, wherein

the controller is configured to
 determine turning-off of the compressor according to a third temperature detected by the first water temperature sensor being a preset reference temperature higher than a temperature at a time at which the compressor is turned on.

11. A method of controlling a heat pump system, the heat pump system including: a compressor configured to compress a refrigerant; a water tank storing water; a heat exchanger configured to exchange heat between the refrigerant and the water; and a pipe temperature sensor configured to detect a first temperature of an inlet pipe through which cold water is supplied to the water tank or a second temperature of an outlet pipe through which hot water is discharged from the water tank, the method comprising

identifying whether the hot water is used, based on a first temperature of the inlet pipe or a second temperature of the outlet pipe, detected by the pipe temperature sensor,
 determining a hot water use pattern of a user according to use of the hot water, and
 determining turning-on/off of the compressor based on the hot water use pattern.

12. The method of claim 11, wherein

the identifying of whether the hot water is used comprises,
 based on a decrease of a temperature of the inlet pipe during a preset reference time being greater than or equal to a preset first reference value, identifying a start time of hot water use.

13. The method of claim 12, wherein

the identifying of whether the hot water is used comprises,
 based on an increase of a temperature of the inlet pipe during the preset reference time after use of hot water starts being greater than or equal to a preset second reference value, identifying an end time of hot water use.

14. The method of claim 13, wherein

the identifying of whether the hot water is used comprises,
whenever use of hot water starts, identifying at least one hot water use section based on a start time of hot water
use and an end time of hot water use.

15. The method of claim 13, wherein

the identifying of whether the hot water is used comprises,
based on an increase of a temperature of the outlet pipe during a preset reference time being greater than or equal
to a preset third reference value, identifying a start time of hot water use,
based on a decrease of a temperature of the outlet pipe during the reference time after the start time of hot water
use being greater than or equal to a fourth reference value, identifying an end time of hot water use, and
whenever use of hot water starts, identifying at least one hot water use section based on a start time of hot water
use and an end time of hot water use.

FIG. 1

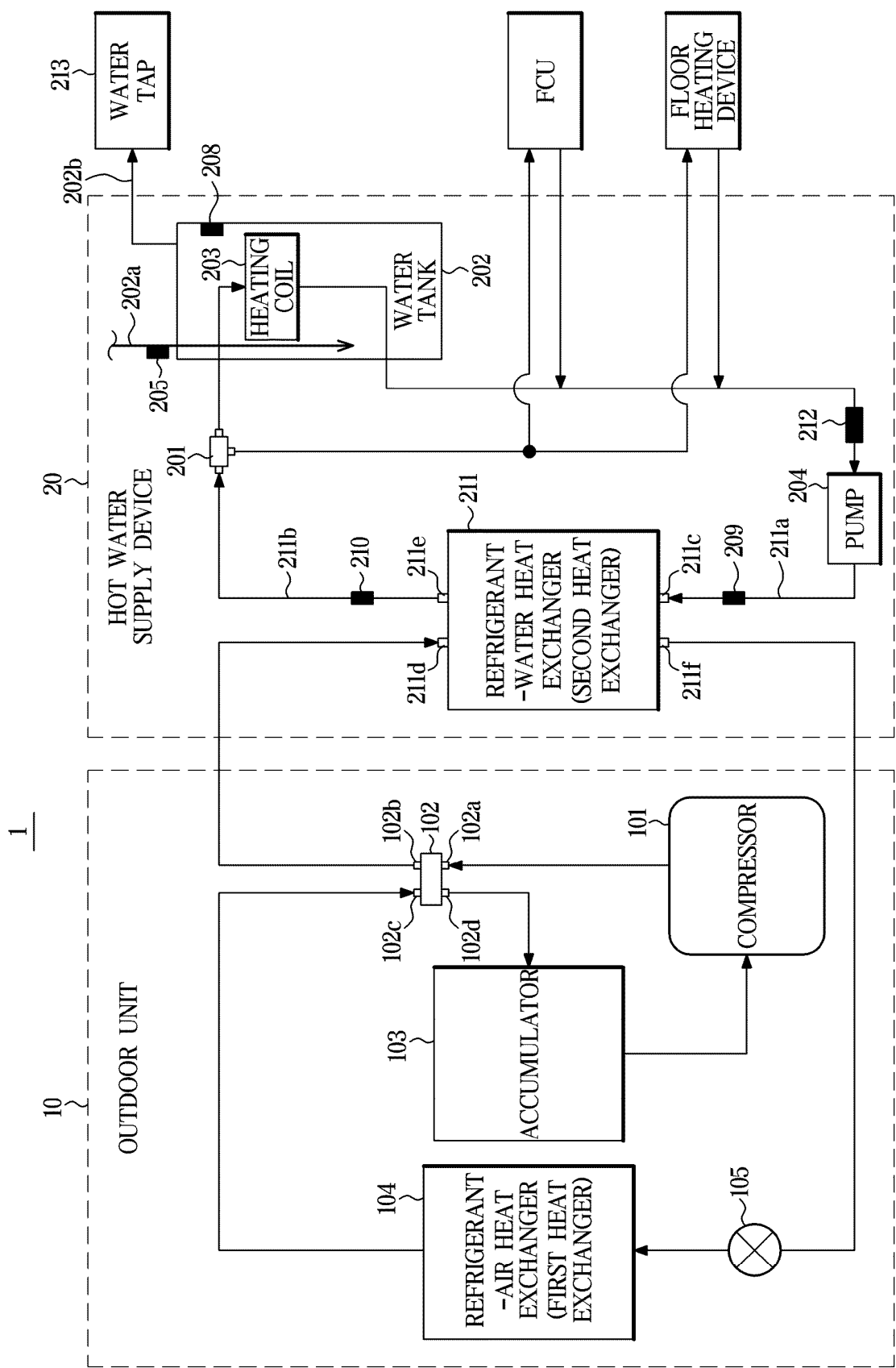


FIG. 2

1

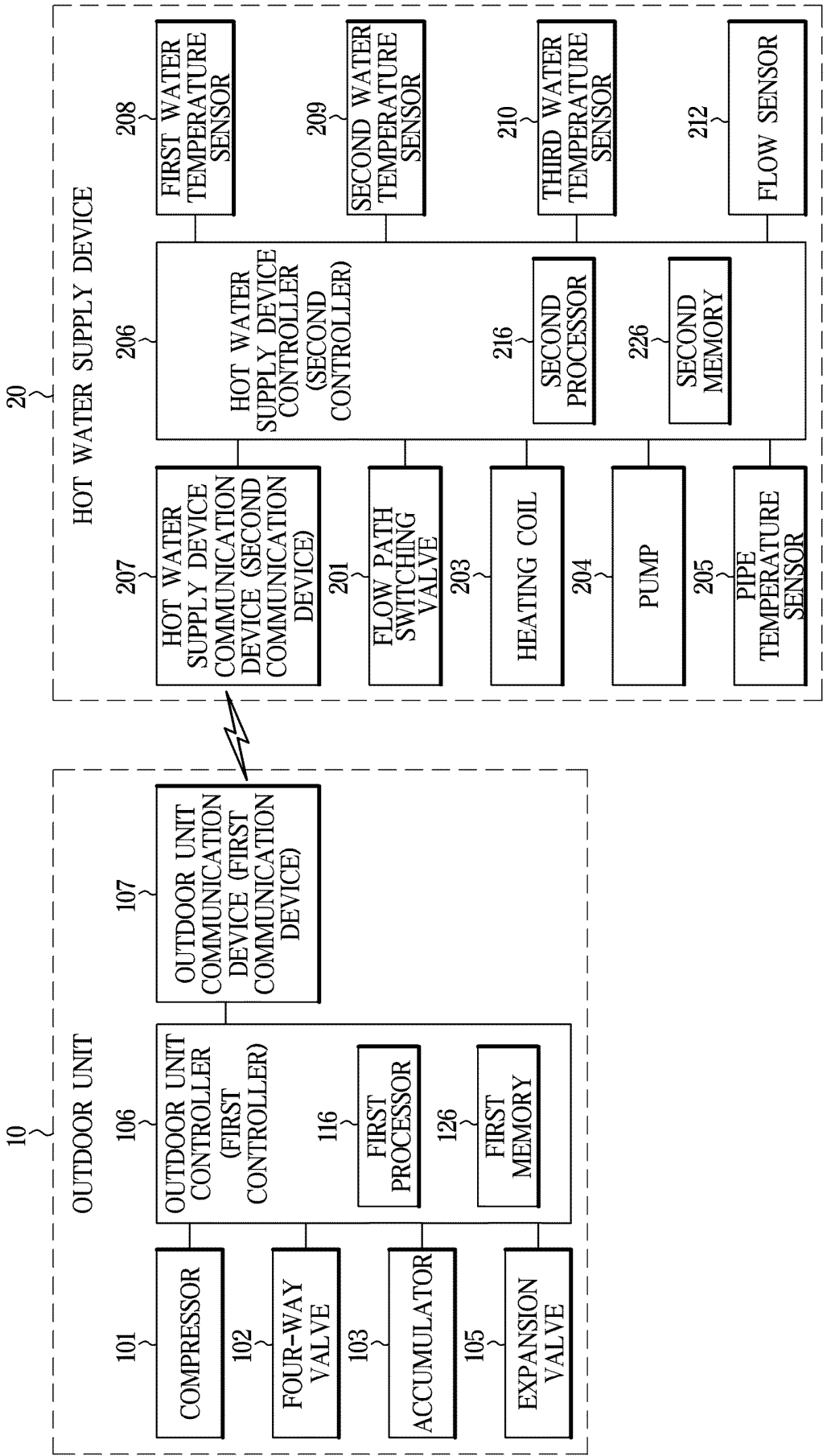


FIG. 3

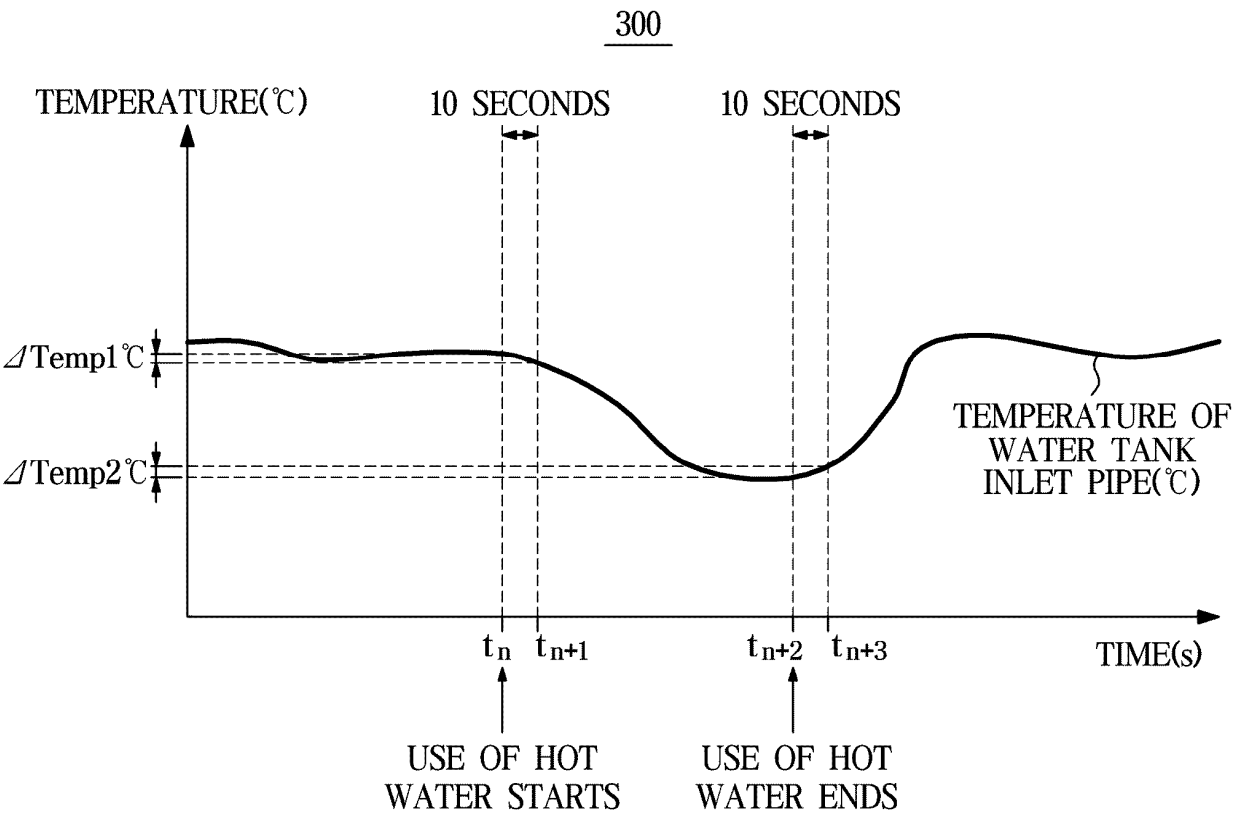


FIG. 4

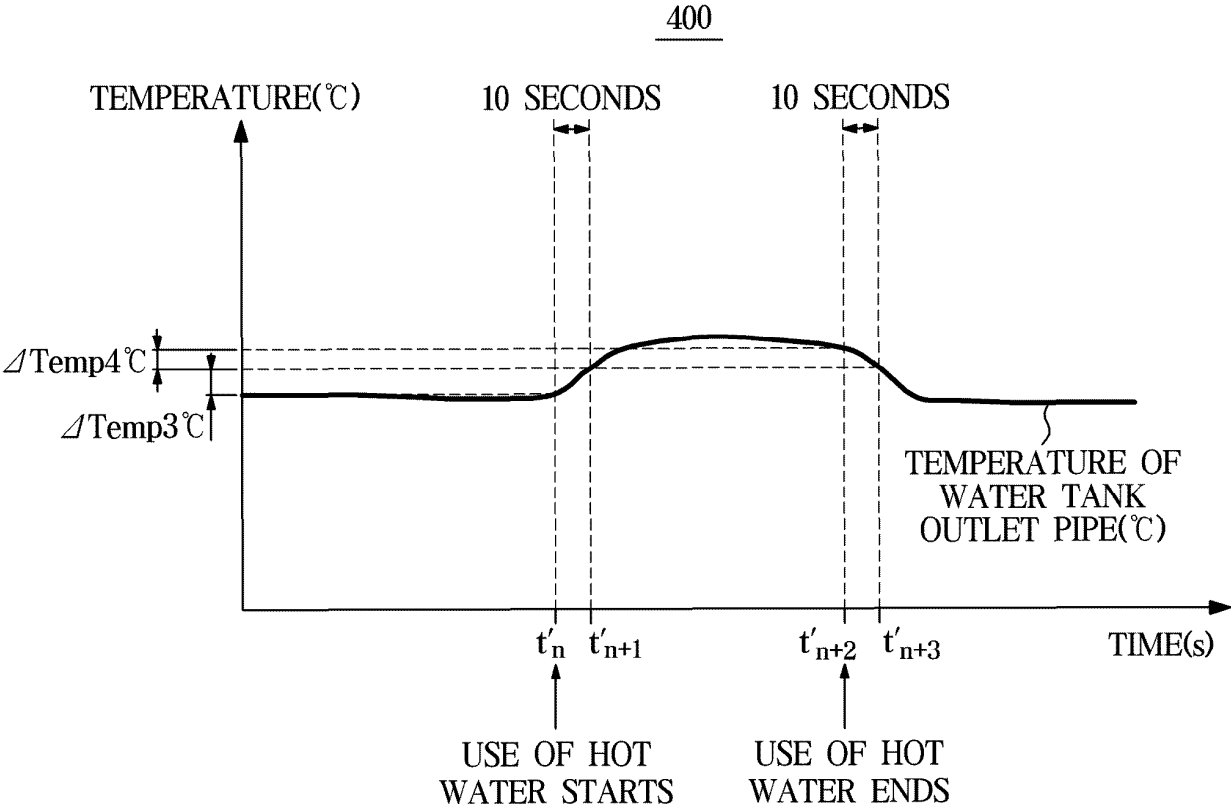


FIG. 5

500

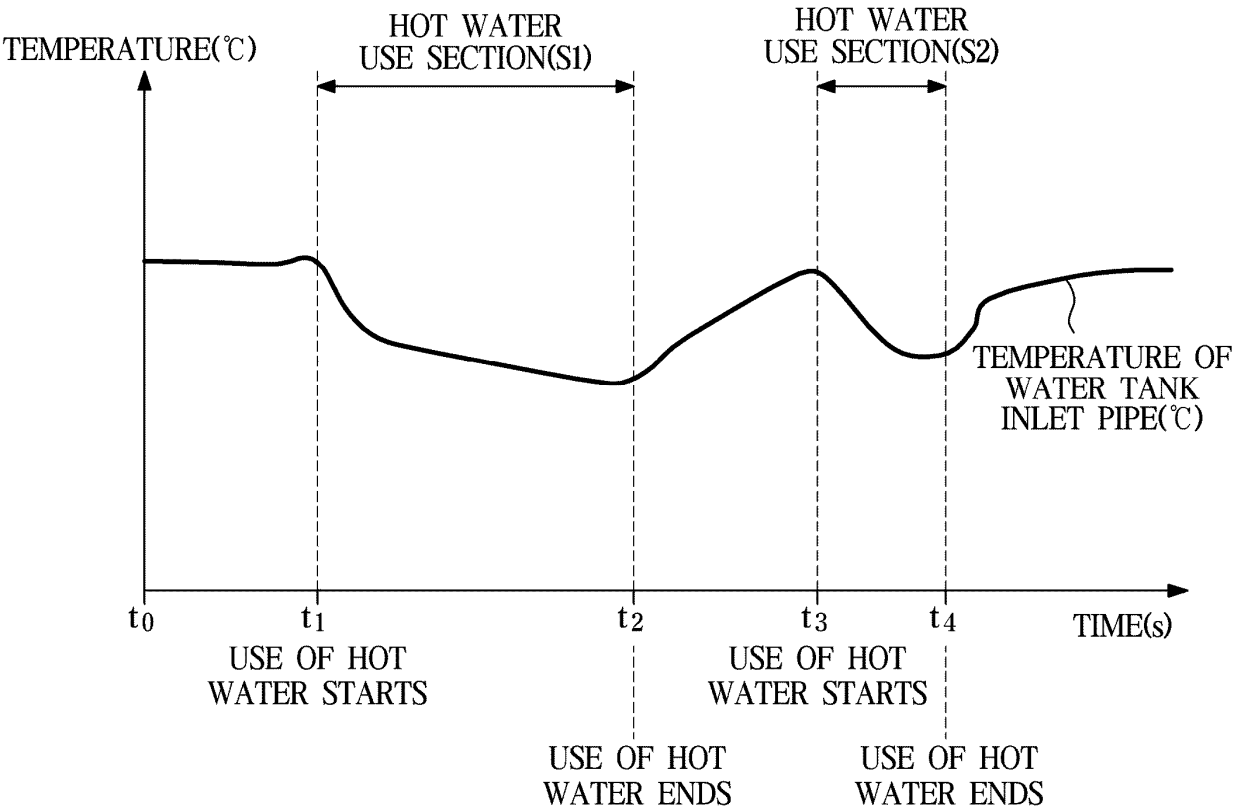


FIG. 6

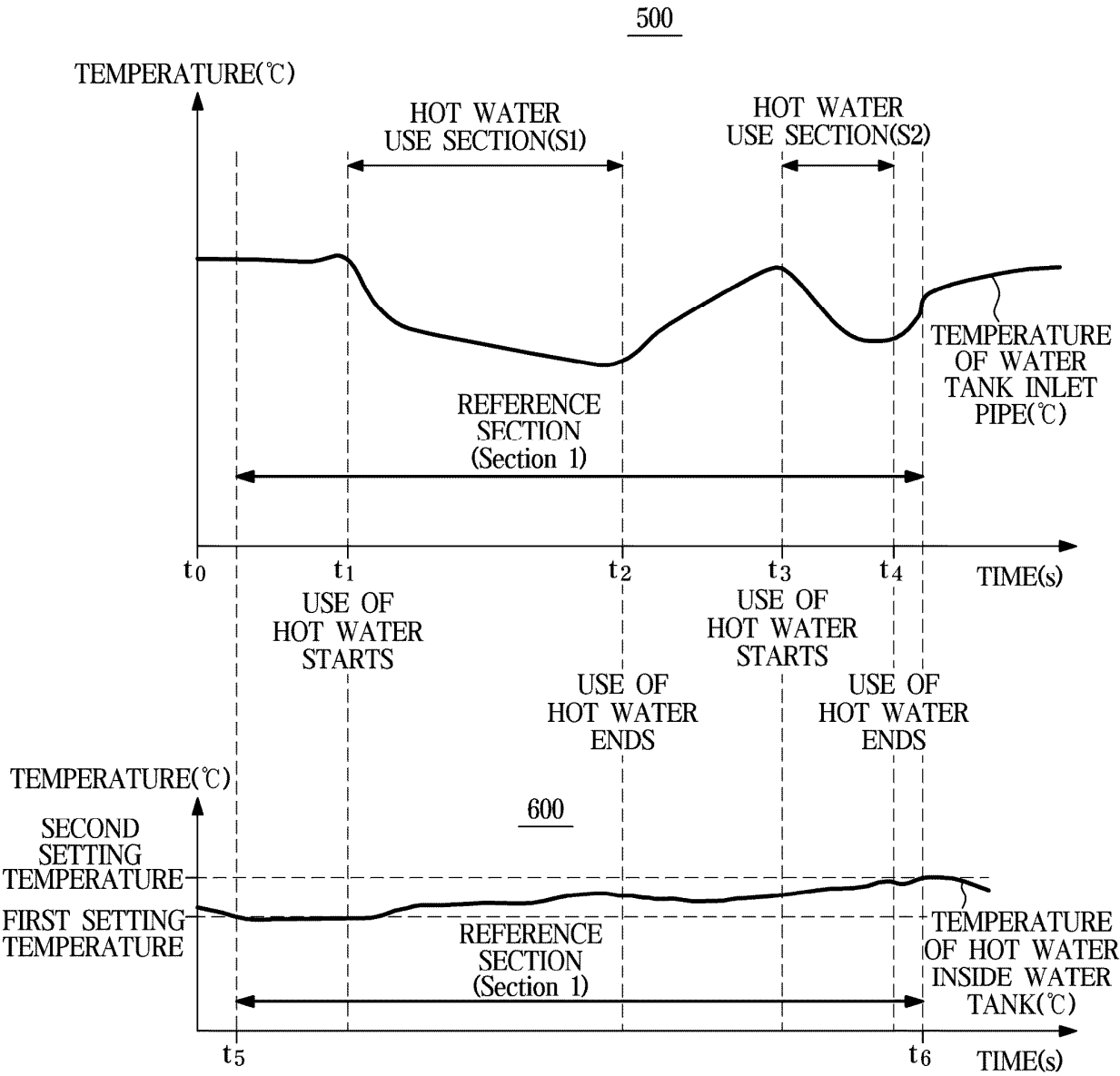


FIG. 7

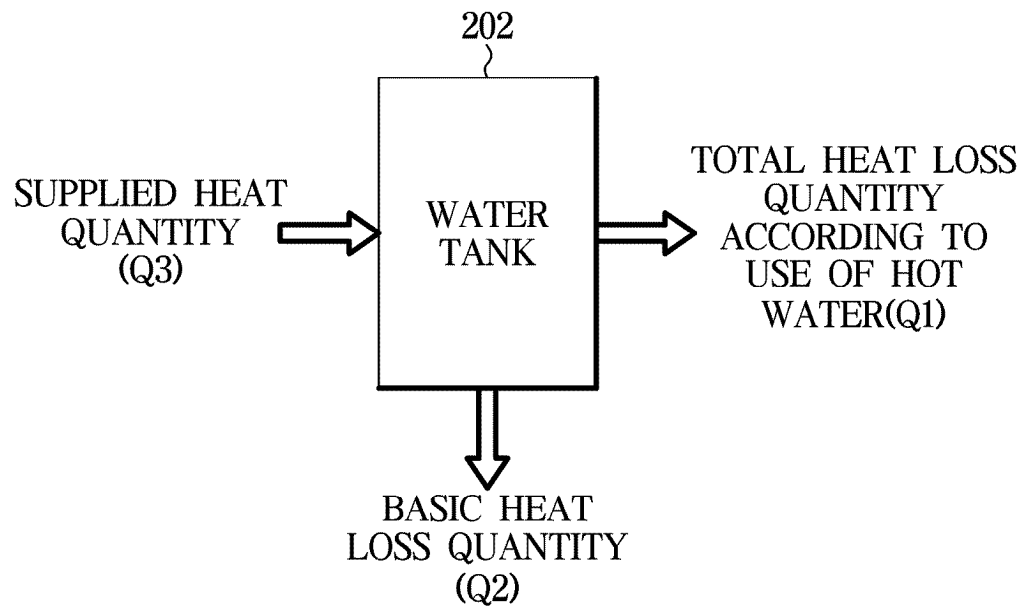


FIG. 8

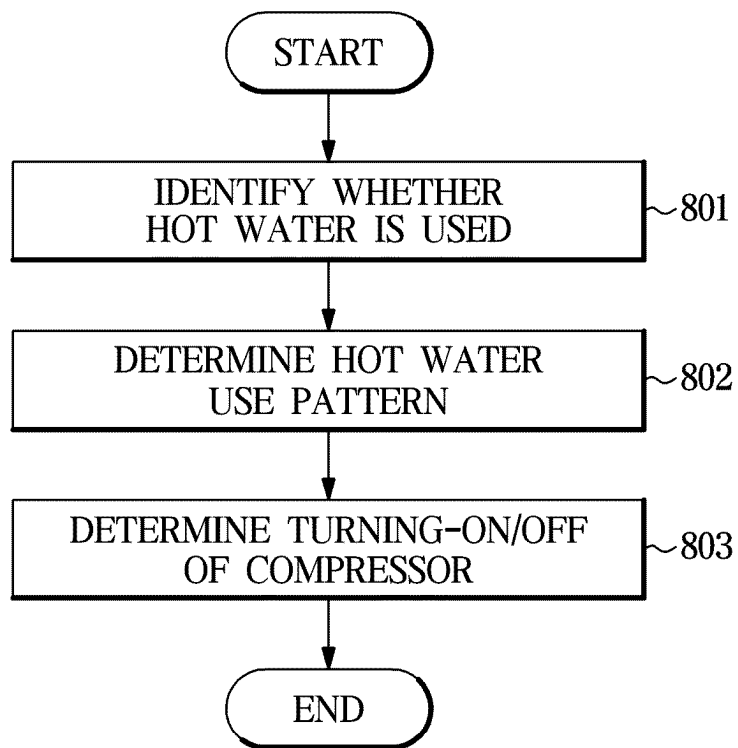


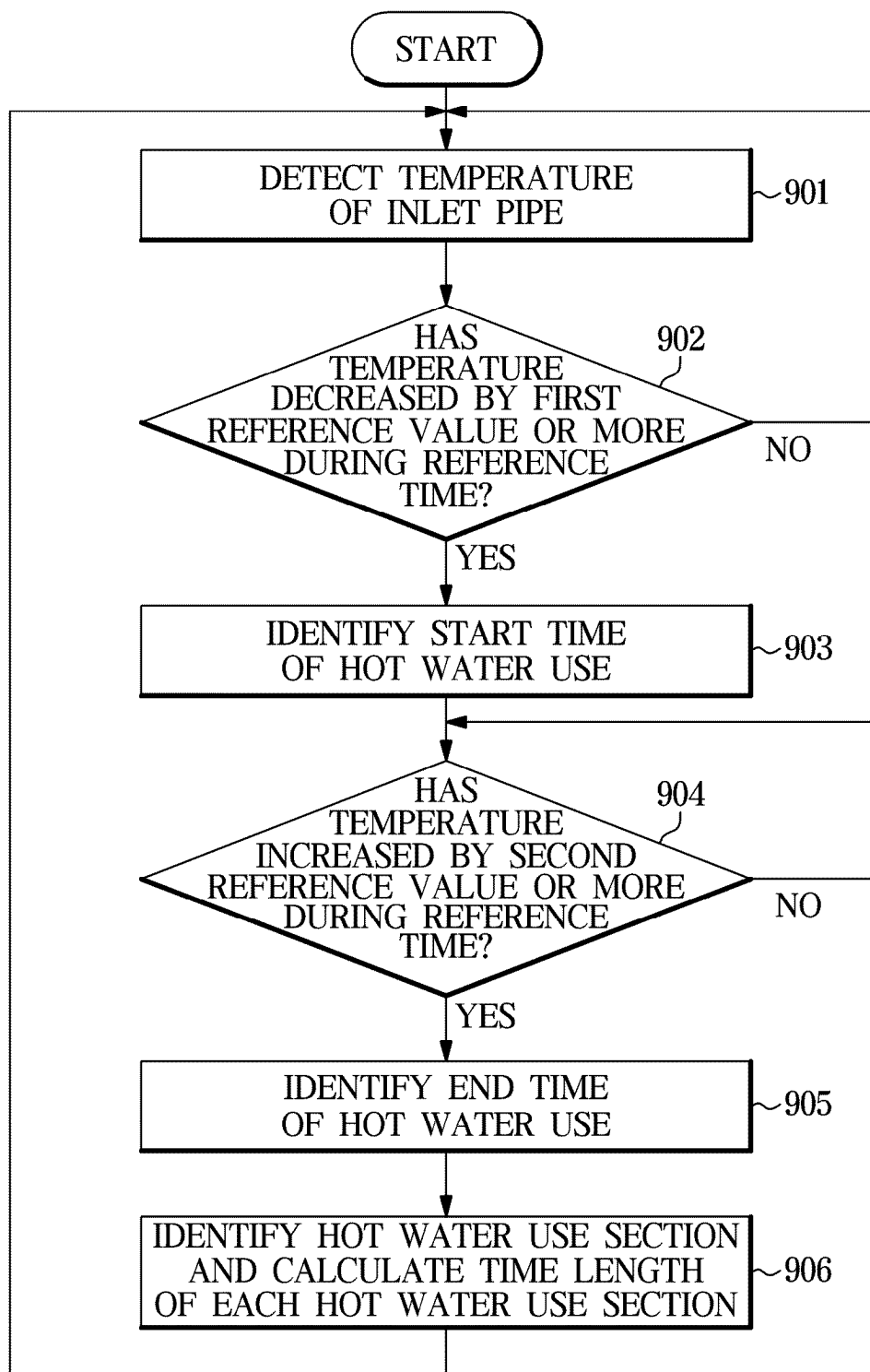
FIG. 9

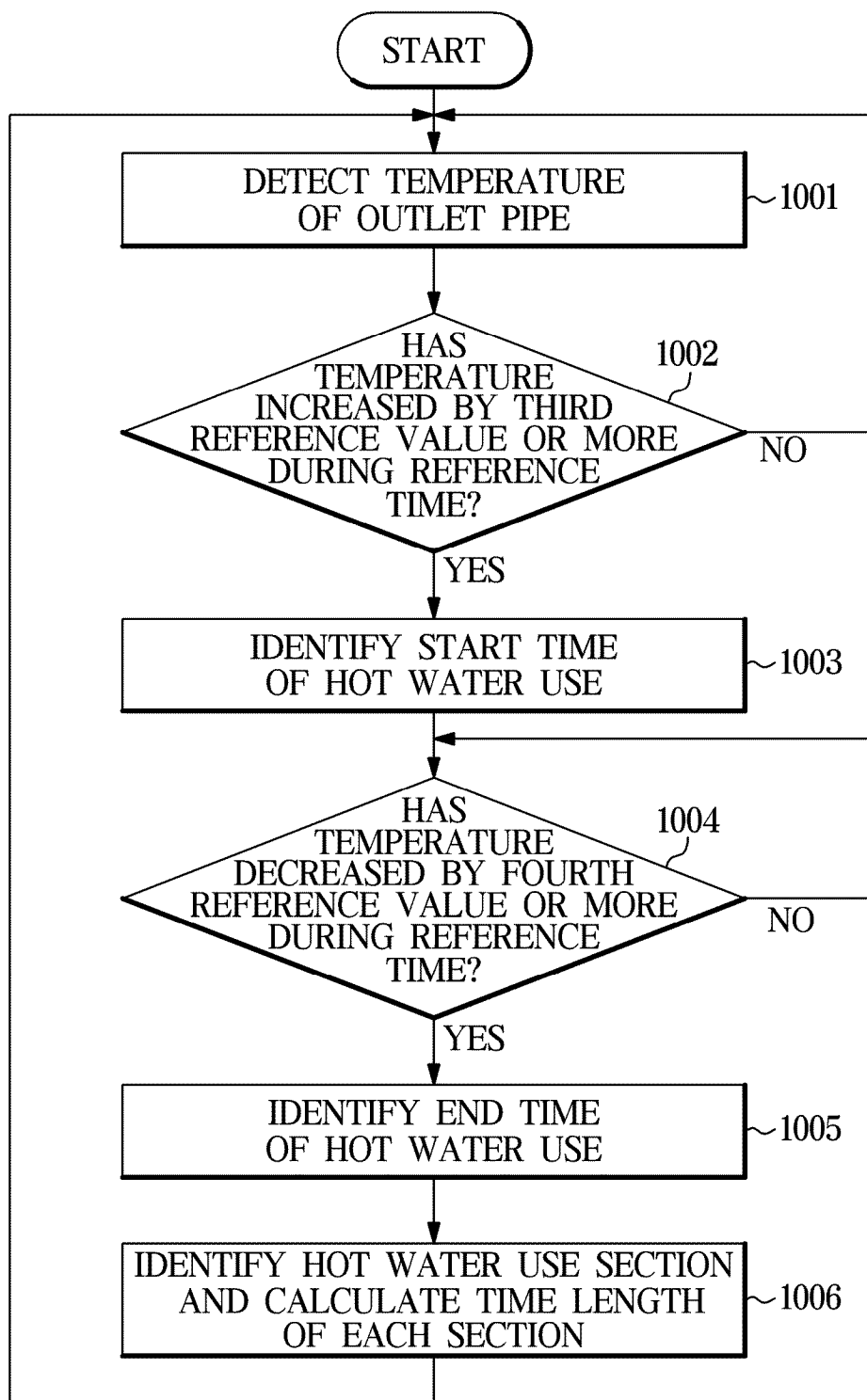
FIG. 10

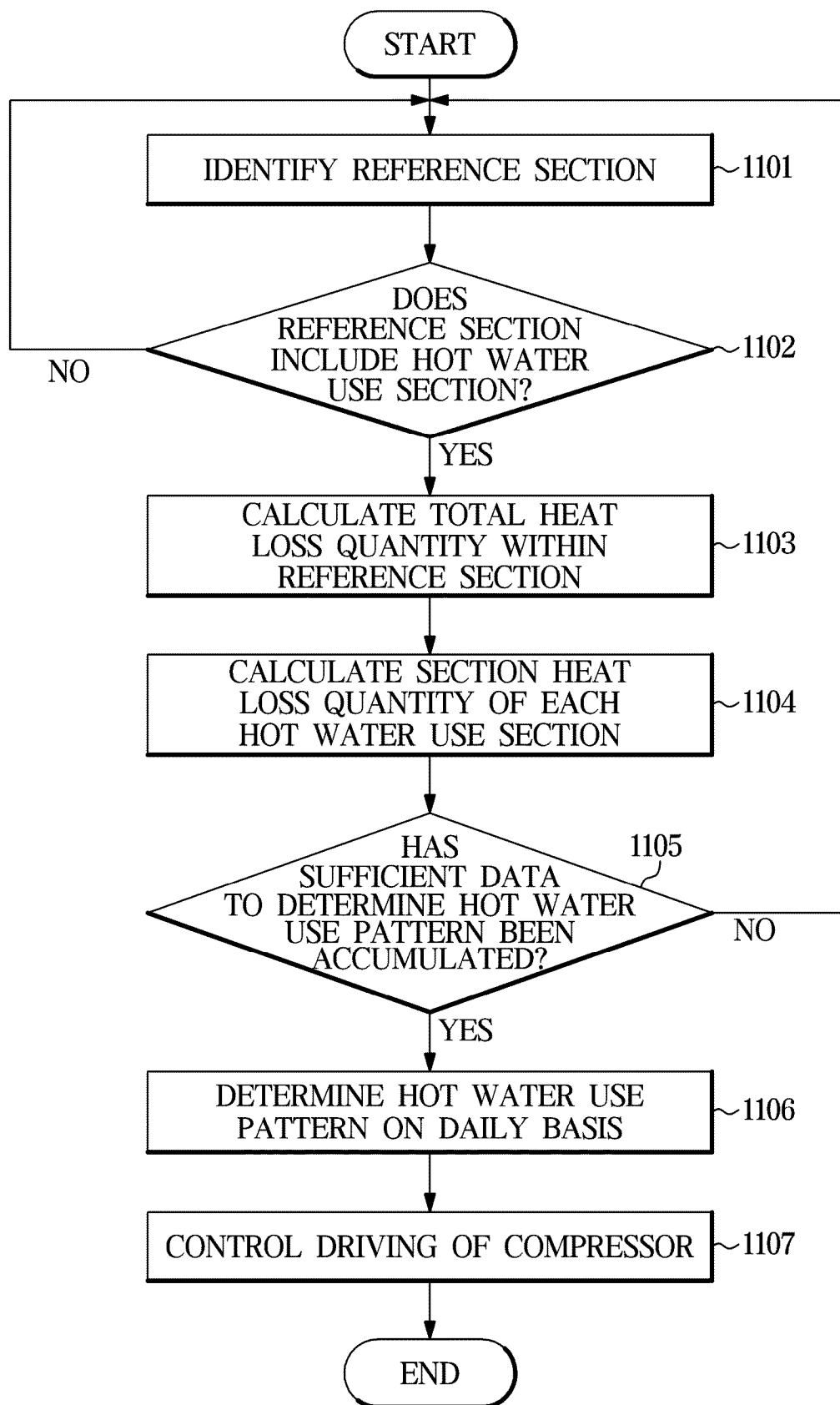
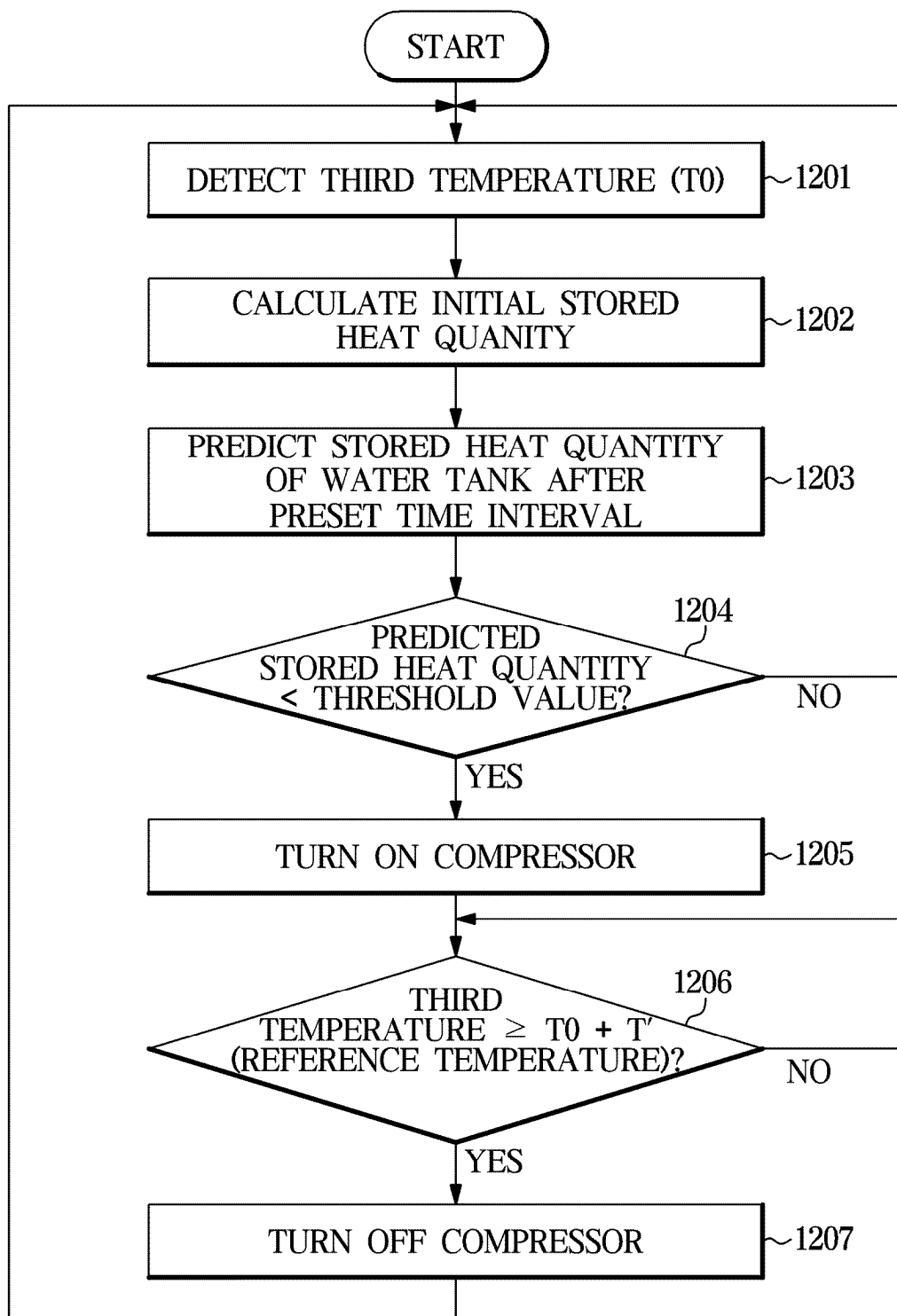
FIG. 11

FIG. 12

INTERNATIONAL SEARCH REPORT

International application No.

PCT/KR2024/005977

A. CLASSIFICATION OF SUBJECT MATTER

F24H 15/38(2022.01)i; F24H 15/156(2022.01)i; F24H 15/223(2022.01)i; F24H 15/254(2022.01)i; F24H 15/40(2022.01)i;
F24H 4/02(2006.01)i; F24D 17/02(2006.01)i; F24D 3/18(2006.01)i; F25B 49/02(2006.01)i; F25B 30/02(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)

F24H 15/38(2022.01); F24D 19/10(2006.01); F24H 1/00(2006.01); F24H 1/18(2006.01); F24H 4/04(2006.01);
F24H 9/20(2006.01); F25B 30/02(2006.01)

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

Korean utility models and applications for utility models: IPC as above

Japanese utility models and applications for utility models: IPC as above

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

eKOMPASS (KIPO internal) & keywords: 히트 펌프(heat pump), 물탱크(water tank), 열교환기(heat exchanger), 히팅 코일
(heating coil), 배관온도센서(pipe temperature sensor), 온수(hot water), 사용 패턴(usage pattern), 압축기(compressor)

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 2004-069196 A (MATSUSHITA ELECTRIC IND. CO., LTD.) 04 March 2004 (2004-03-04) See paragraphs [0021]-[0022] and [0039]-[0040] and figure 1.	1-2,11-12 3-10,13-15
Y	KR 10-2207327 B1 (KYUNG DONG NAVIEN CO., LTD.) 25 January 2021 (2021-01-25) See paragraphs [0015] and [0044], claim 1 and figure 1.	1-2,11-12
A	JP 2017-053526 A (DENSO CORP.) 16 March 2017 (2017-03-16) See paragraphs [0031]-[0066] and figures 1-4.	1-15
A	KR 10-0944590 B1 (HITACHI APPLIANCES, INC.) 25 February 2010 (2010-02-25) See paragraph [0076].	1-15
A	WO 2013-168926 A1 (KYUNG DONG ONE CORPORATION) 14 November 2013 (2013-11-14) See paragraphs [0017]-[0054] and figures 1-2.	1-15

☐ 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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“E” earlier application or patent but published on or after the international filing date

“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

21 August 2024

Date of mailing of the international search report

21 August 2024

Name and mailing address of the ISA/KR

Korean Intellectual Property Office
Government Complex-Daejeon Building 4, 189 Cheongsaro, Seo-gu, Daejeon 35208

Facsimile No. +82-42-481-8578

Authorized officer

Telephone No.

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/KR2024/005977

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		CN 101191665 B	25 August 2010
		JP 2008-138925 A	19 June 2008
		JP 4875970 B2	15 February 2012
		KR 10-2008-0050324 A	05 June 2008
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		TW 201346195 A	16 November 2013
		TW I575204 B	21 March 2017

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