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(54) HOT WATER SUPPLY APPARATUS ASSOCIATED WITH HEAT PUMP

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(57) **ABSTRACT**

A hot water supply apparatus associated with a heat pump is provided. The hot water supply apparatus may employ a cascade heat pump including a two-stage cycle to perform a hot water supply operation. Refrigerants flowing through a heat side heat exchanger and a usage side heat exchanger may be heat-exchanged with water. Thus, the hot water supply operation may be continuously performed, without a defrosting operation, and hot water supply performance and heating performance may be improved.

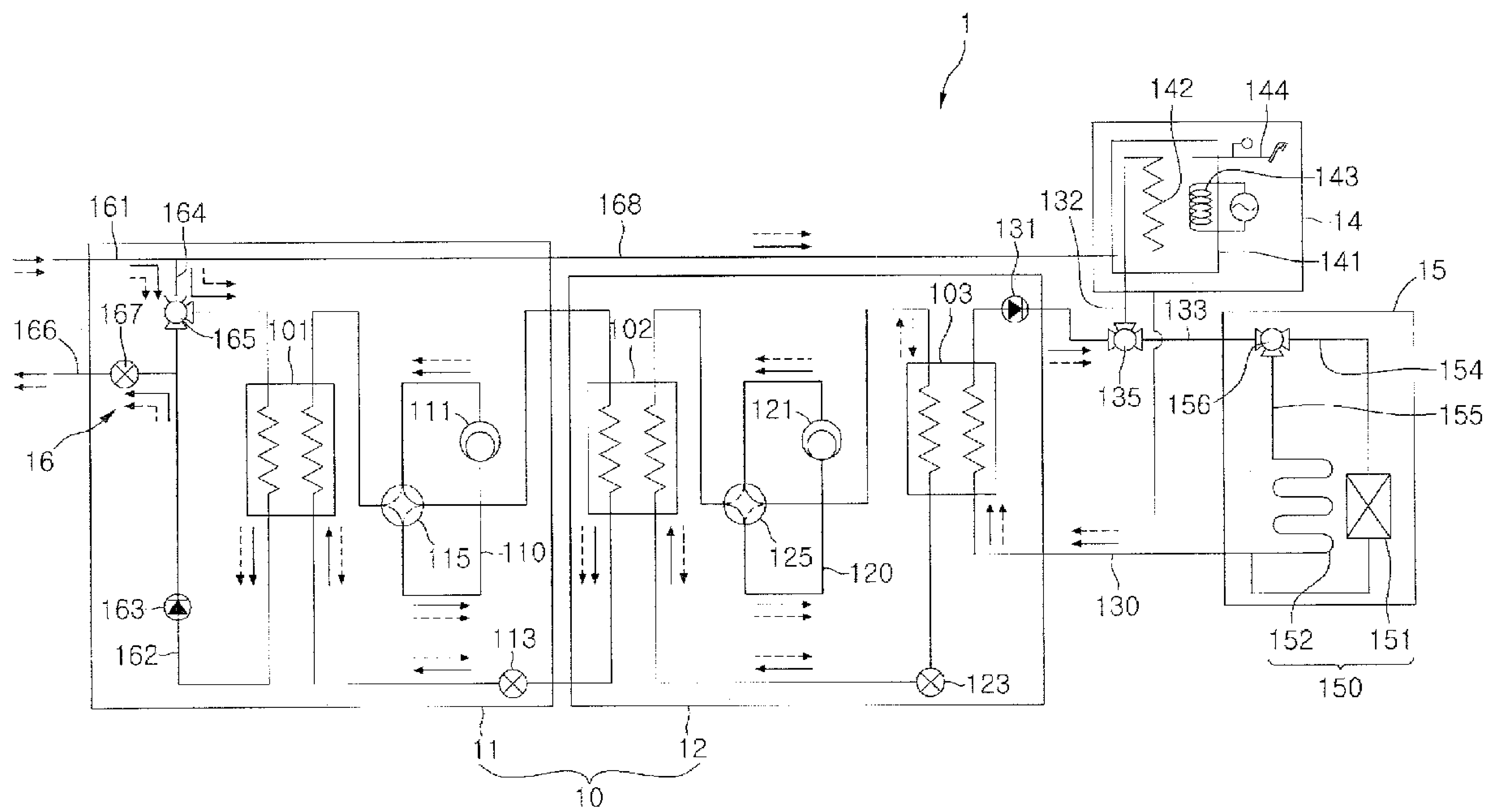

FIG.1

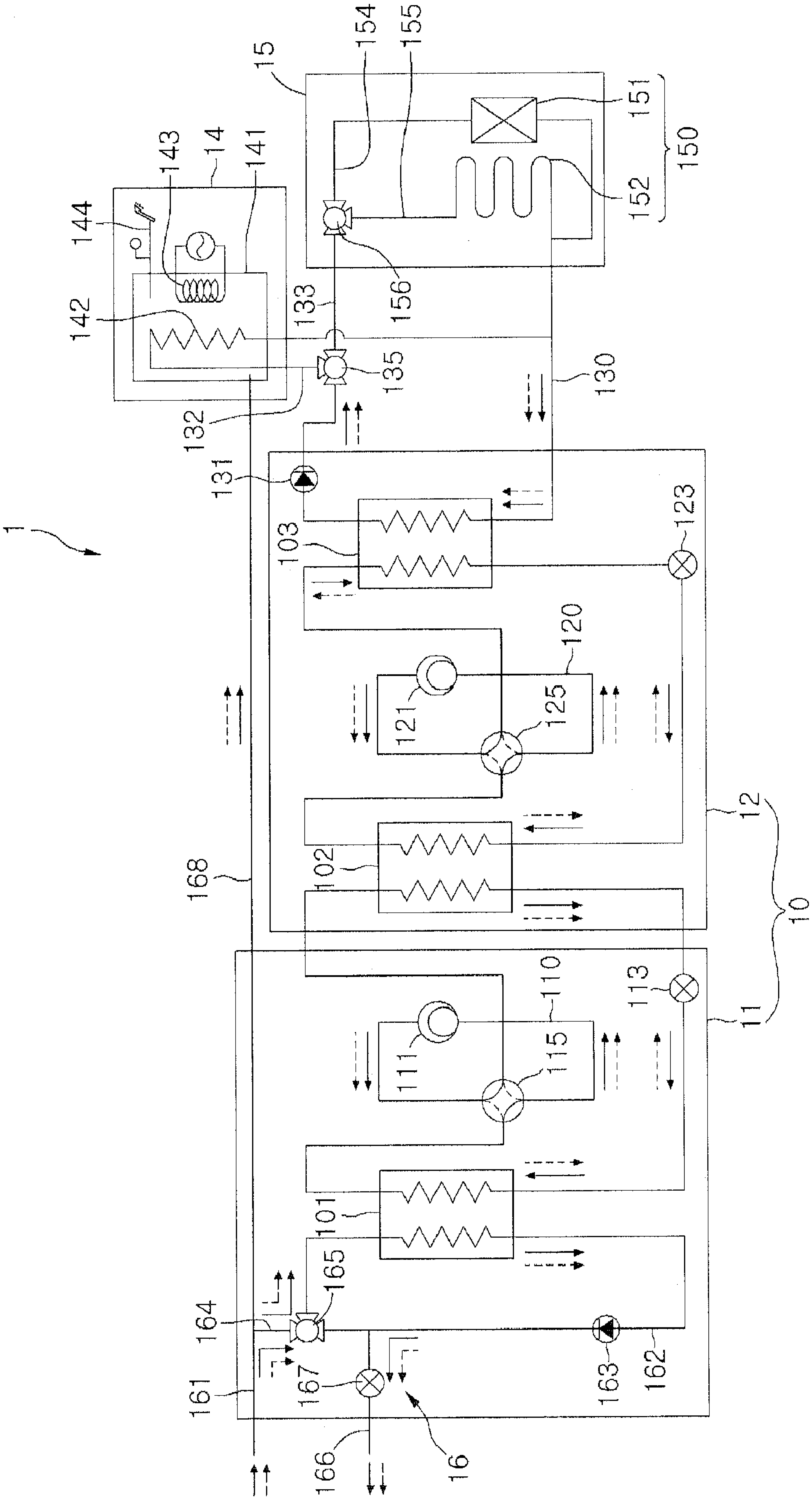
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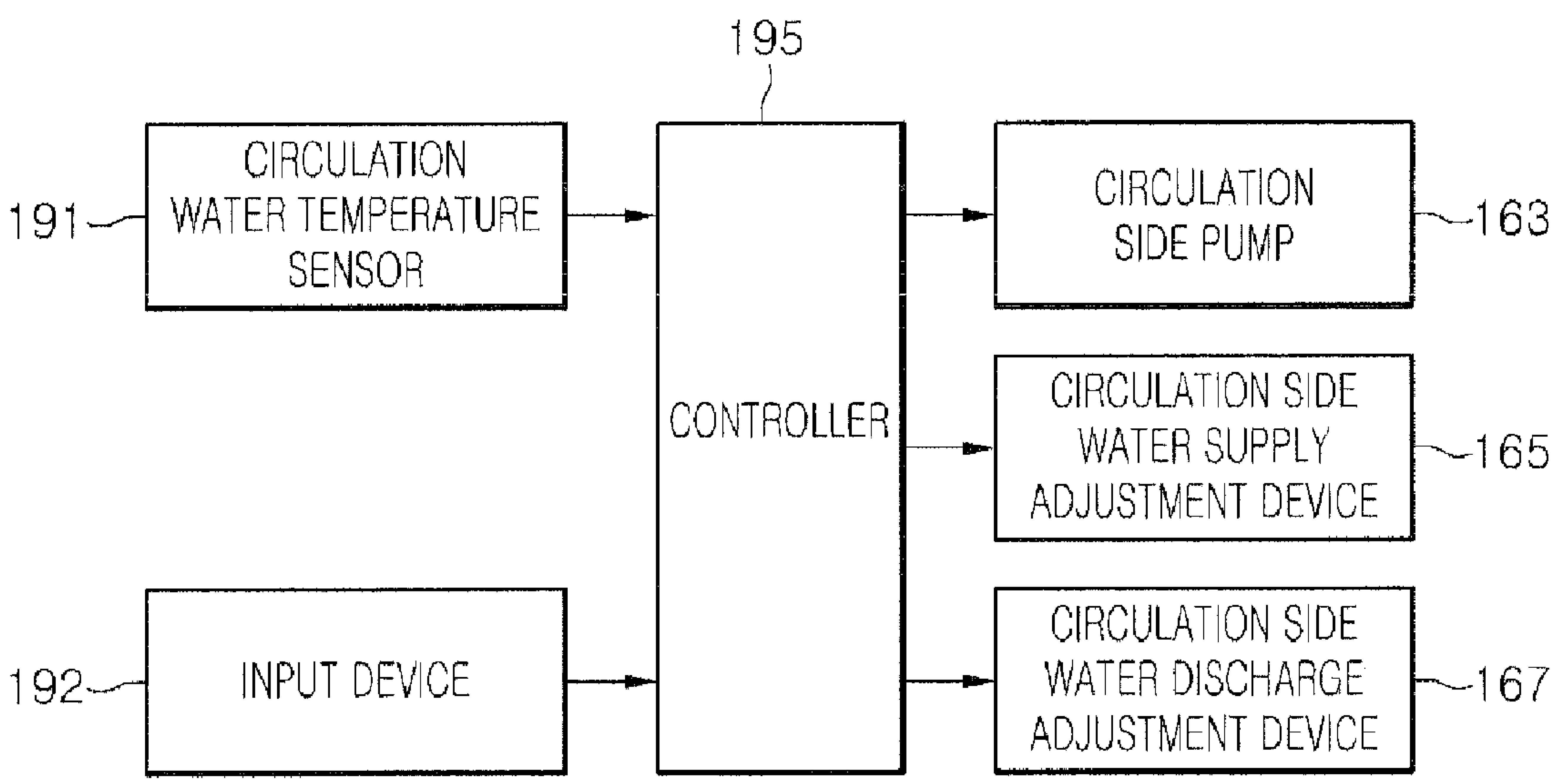
FIG.2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191
CIRCULATION WATER TEMPERATURE SENSOR
CONTROLLER
CIRCULATION SIDE PUMP
163
CIRCULATION SIDE WATER SUPPLY ADJUSTMENT DEVICE
165
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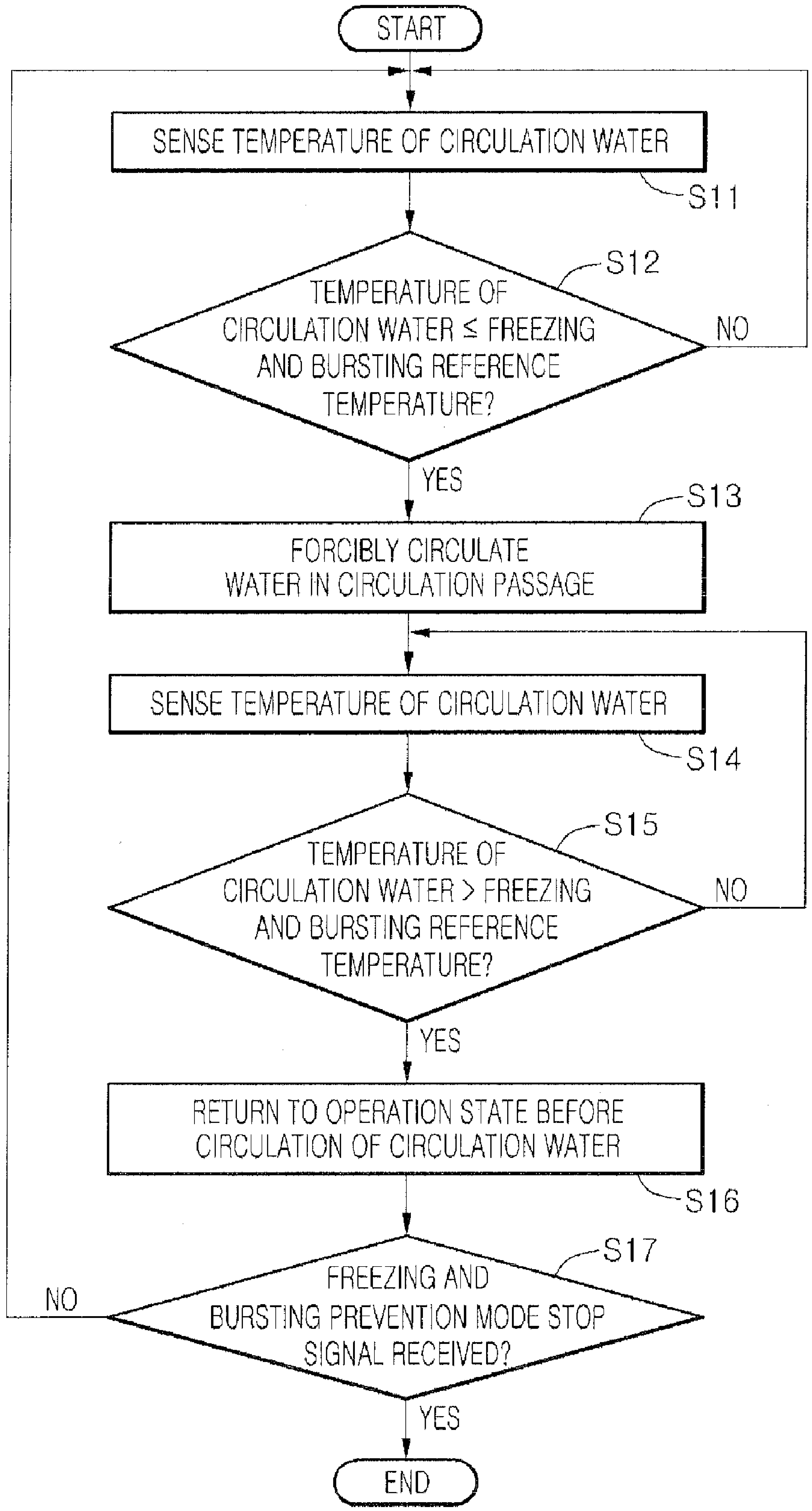
INPUT DEVICE
CIRCULATION SIDE WATER DISCHARGE ADJUSTMENT DEVICE
167

FIG.3


START
SENSE TEMPERATURE OF CIRCULATION WATER
S11
S12
TEMPERATURE OF CIRCULATION WATER ≤ FREEZING AND BURSTING REFERENCE TEMPERATURE?
NO
YES
S13
FORCIBLY CIRCULATE WATER IN CIRCULATION PASSAGE
SENSE TEMPERATURE OF CIRCULATION WATER
S14
S15
TEMPERATURE OF CIRCULATION WATER > FREEZING AND BURSTING REFERENCE TEMPERATURE?
NO
YES
RETURN TO OPERATION STATE BEFORE CIRCULATION OF CIRCULATION WATER
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S17
FREEZING AND BURSTING PREVENTION MODE STOP SIGNAL RECEIVED?
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YES
END

FIG.4

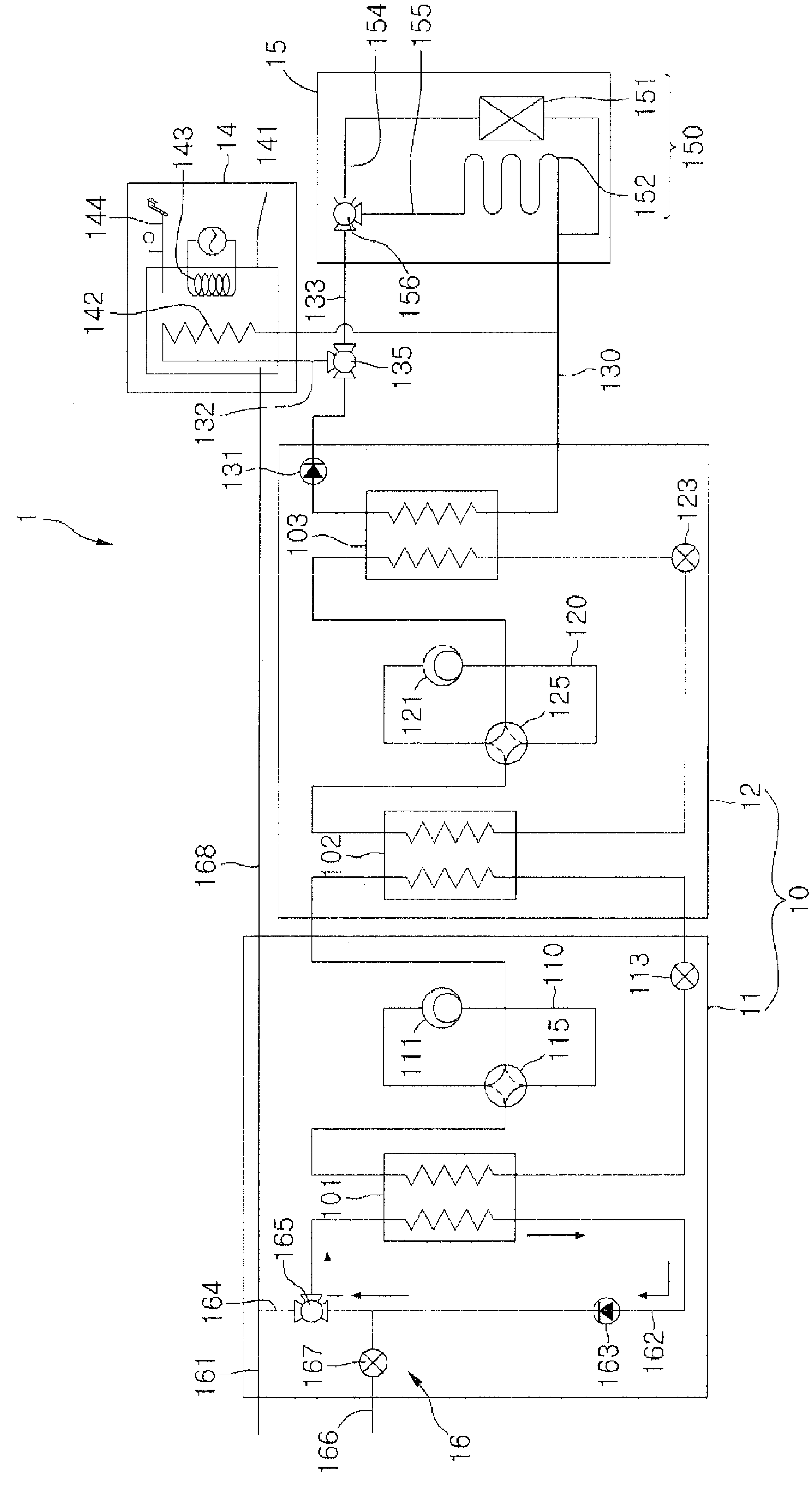
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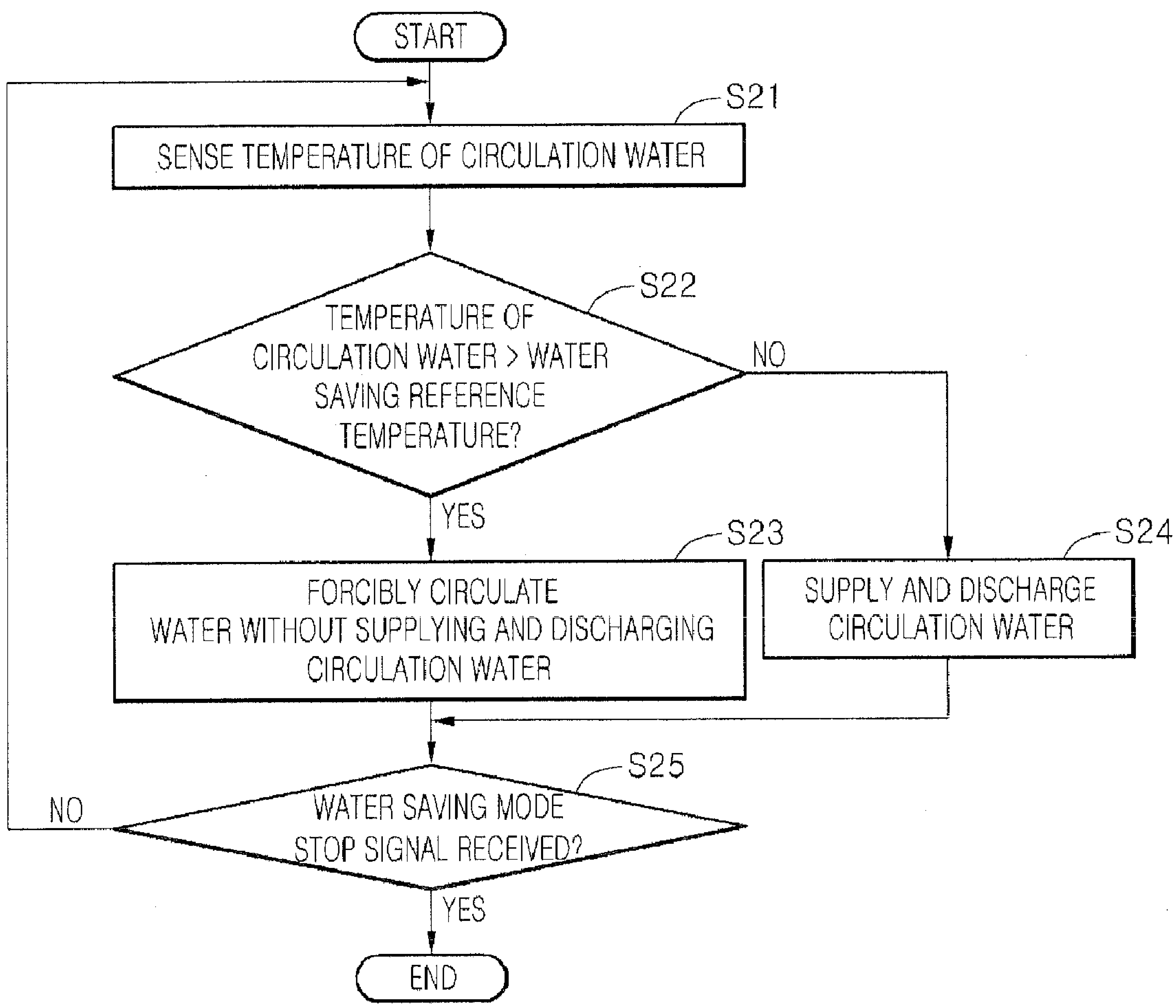
FIG.5


START
S21
SENSE TEMPERATURE OF CIRCULATION WATER
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TEMPERATURE OF CIRCULATION WATER > WATER SAVING REFERENCE TEMPERATURE?
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S23
FORCIBLY CIRCULATE WATER WITHOUT SUPPLYING AND DISCHARGING CIRCULATION WATER
S24
SUPPLY AND DISCHARGE CIRCULATION WATER
S25
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WATER SAVING MODE STOP SIGNAL RECEIVED?
YES
END

FIG.6

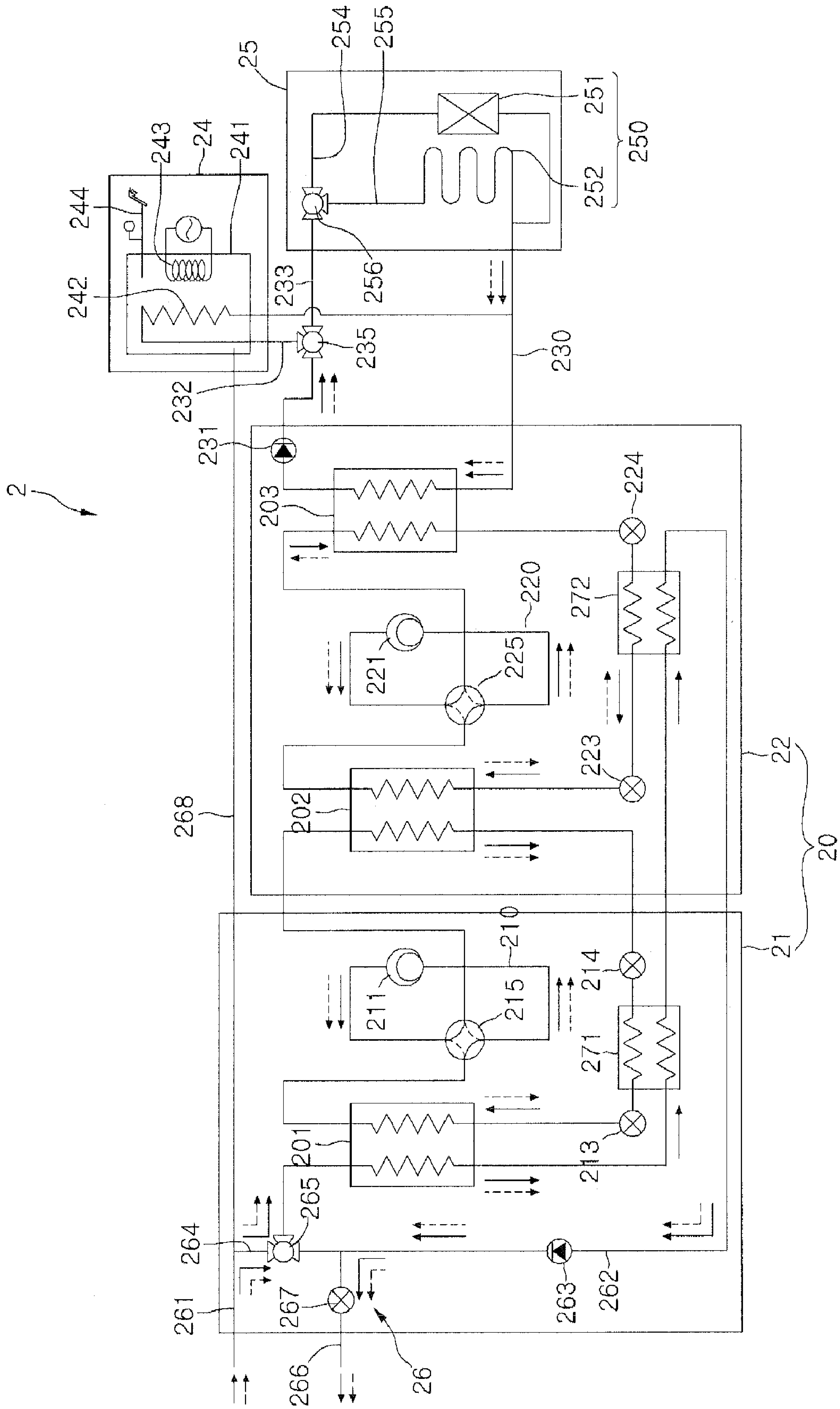
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FIG.7

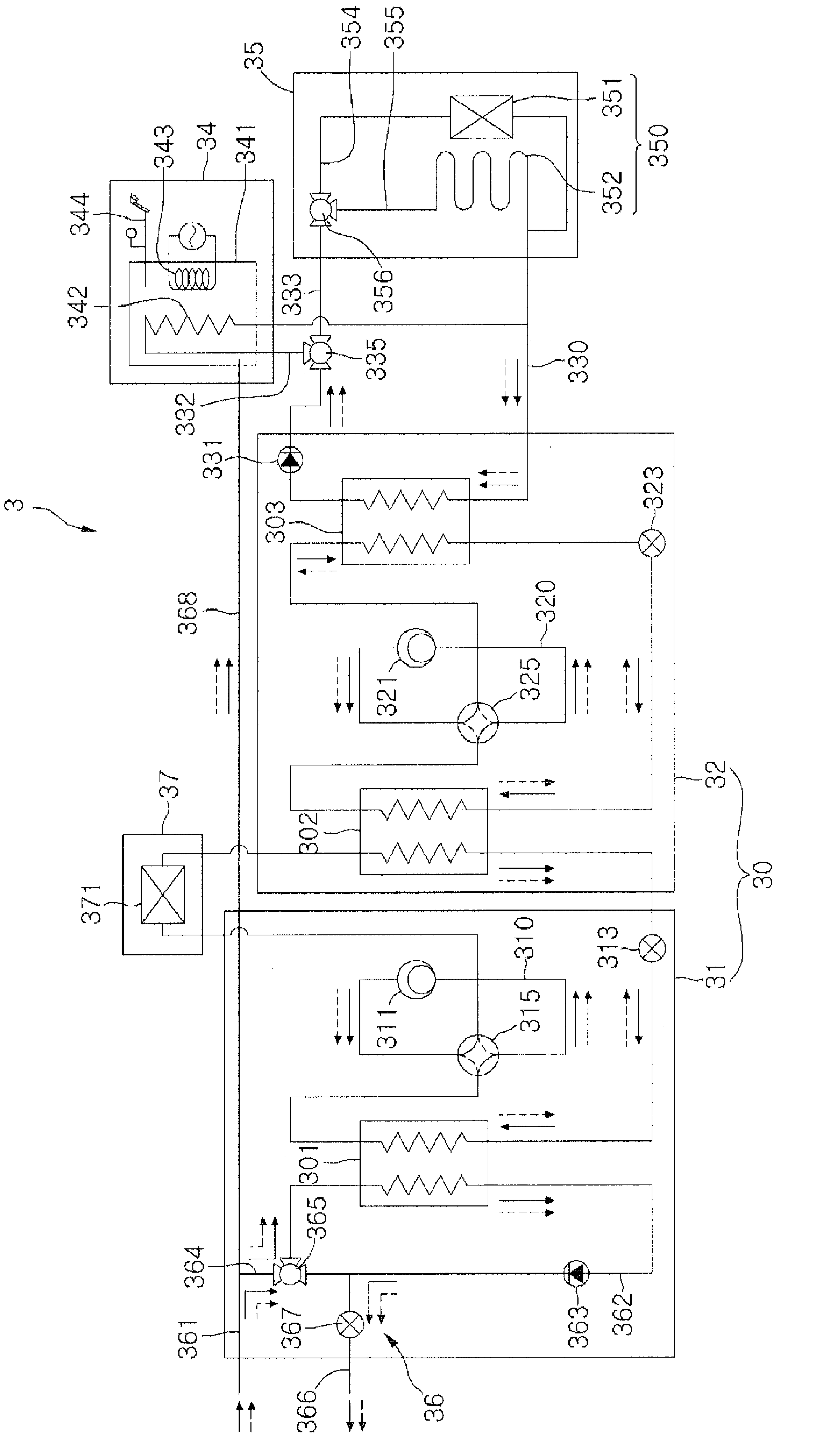

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FIG.8

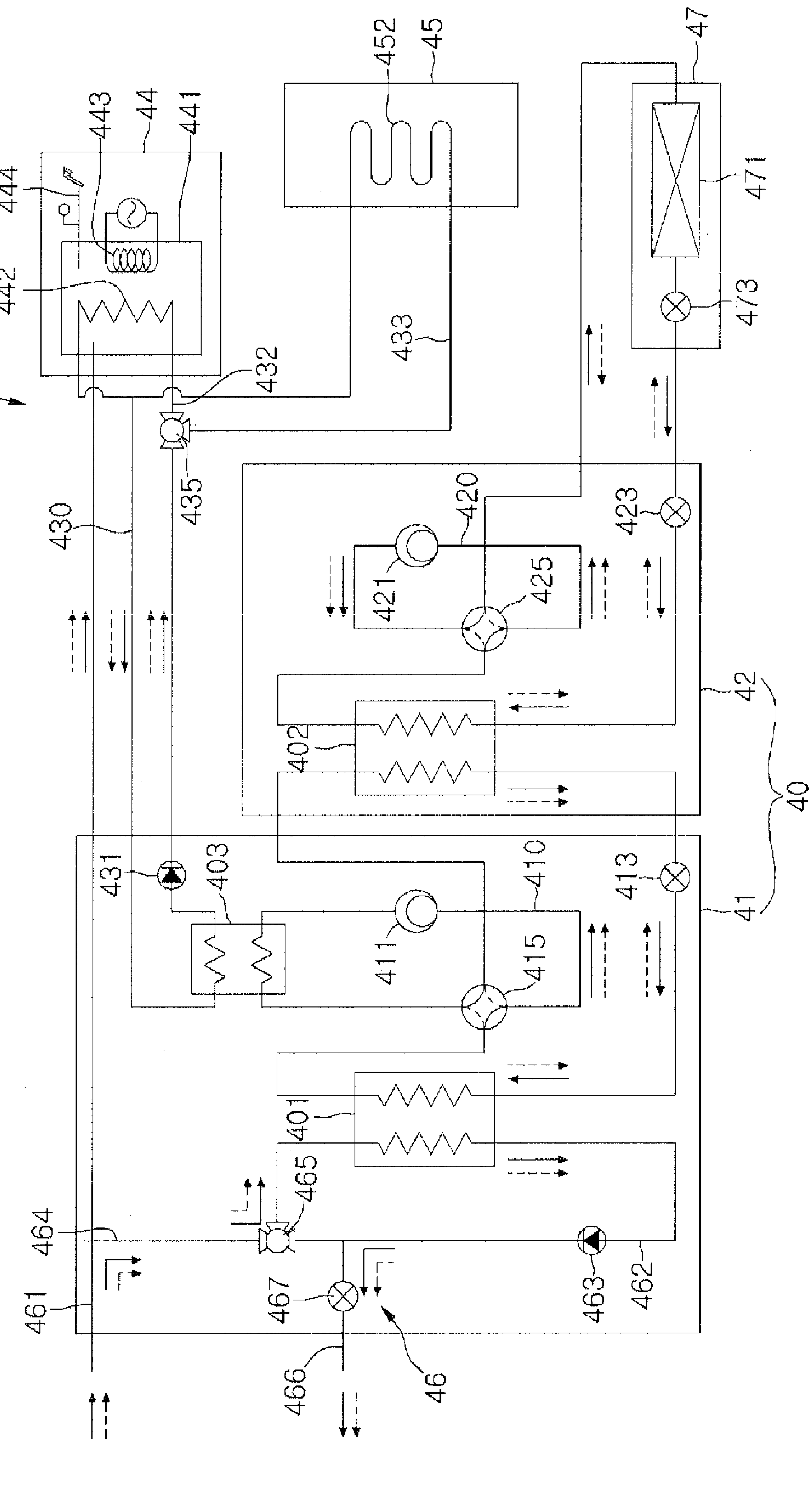
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FIG.9

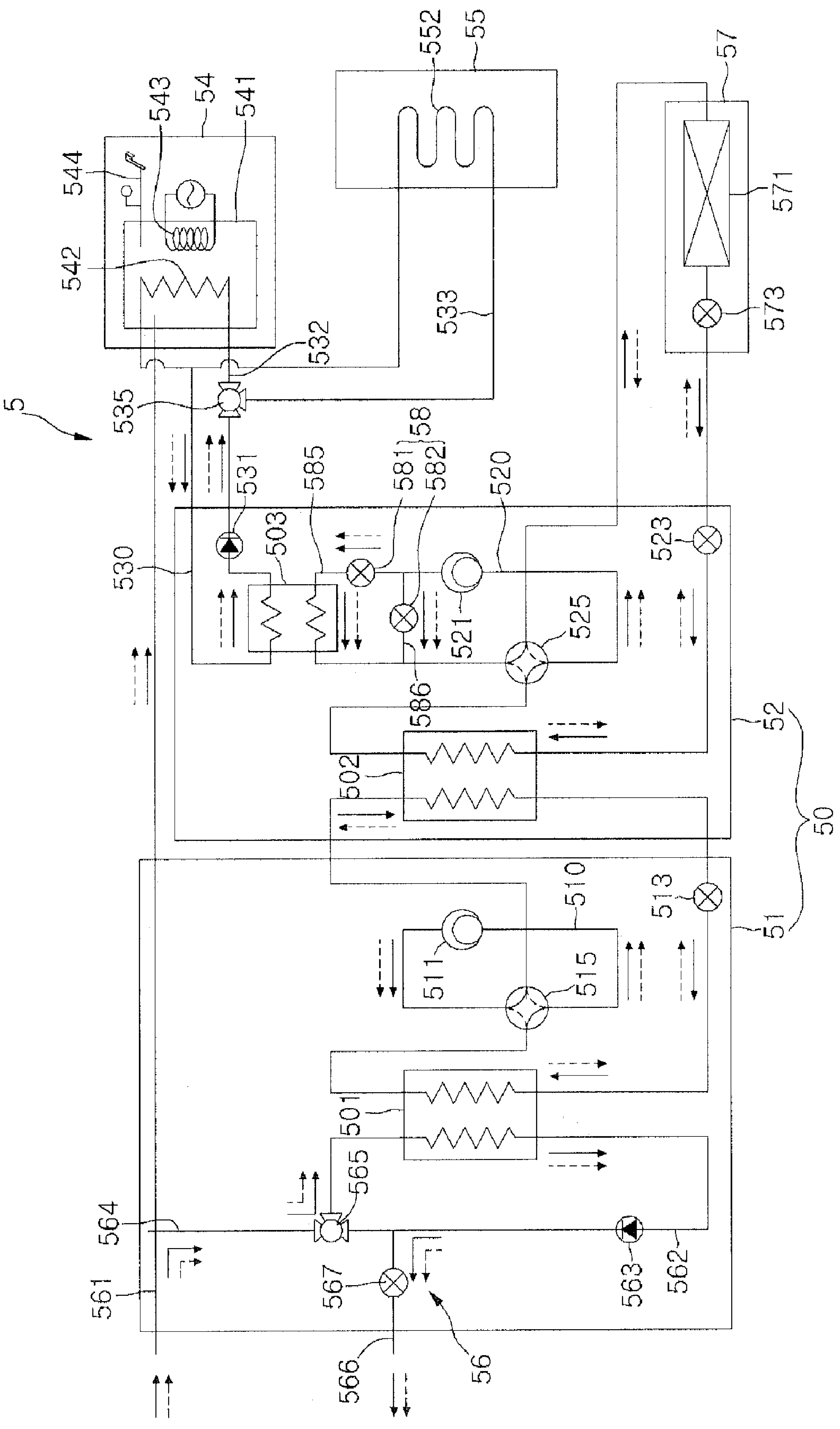
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FIG.10

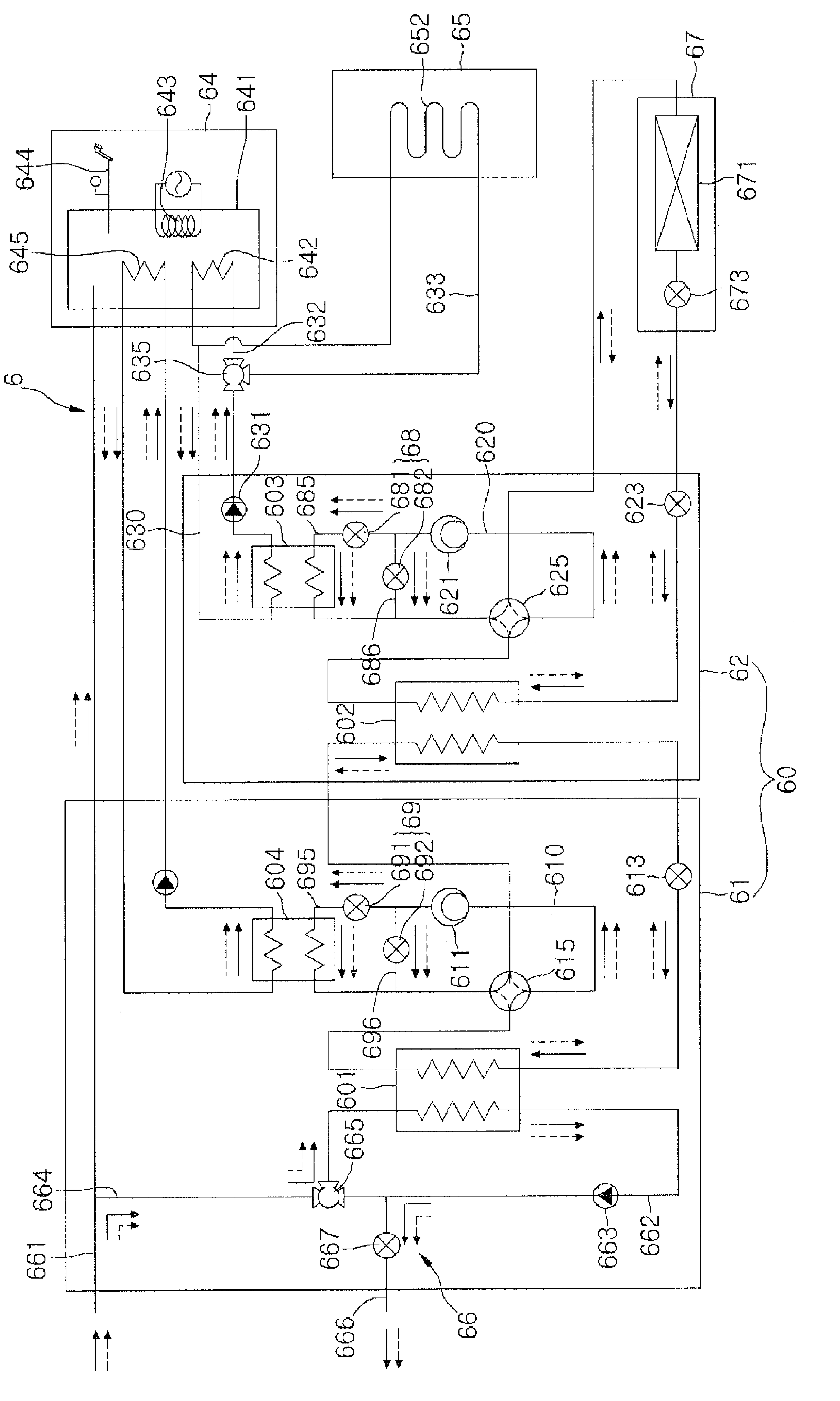
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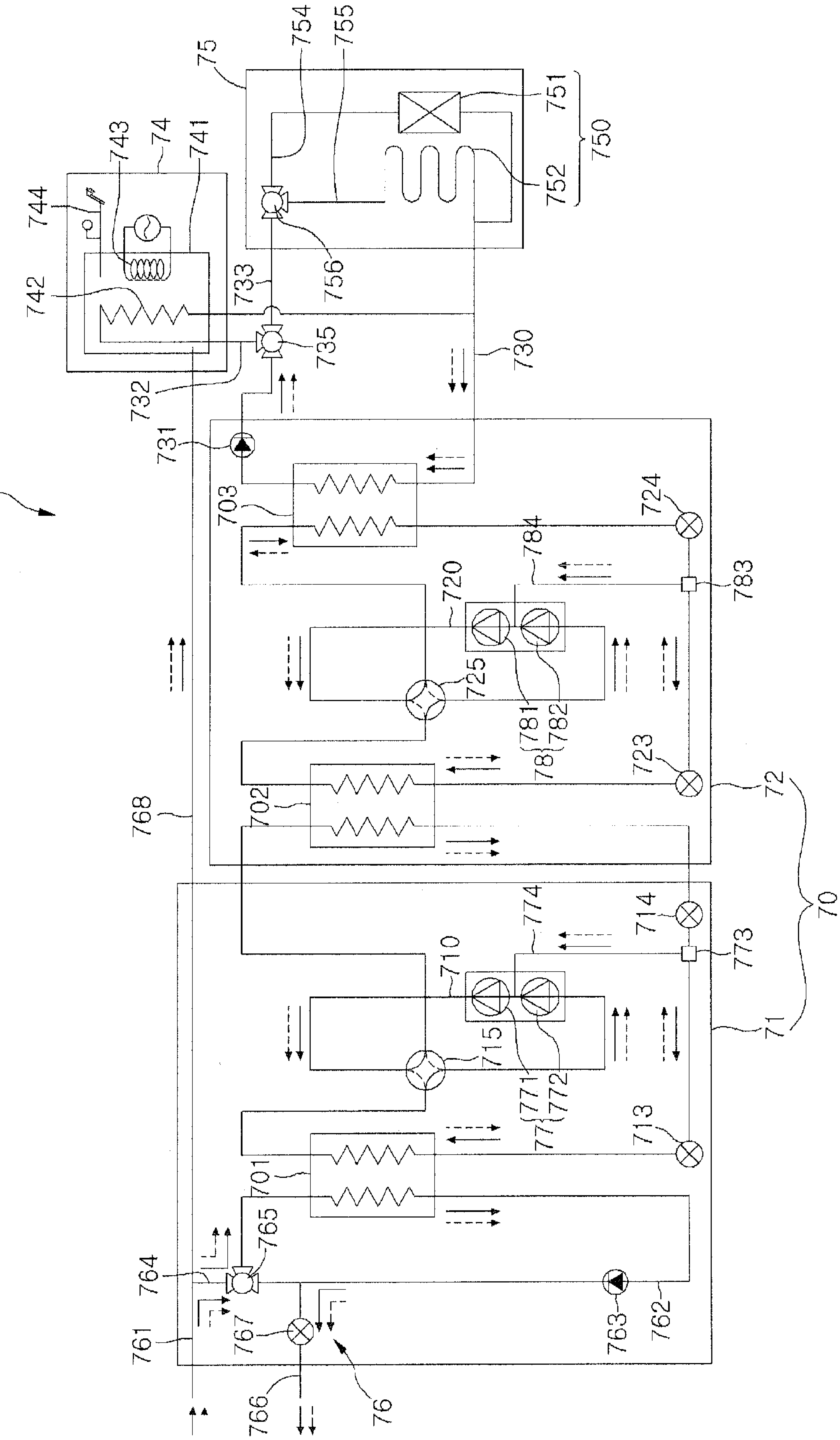
FIG.11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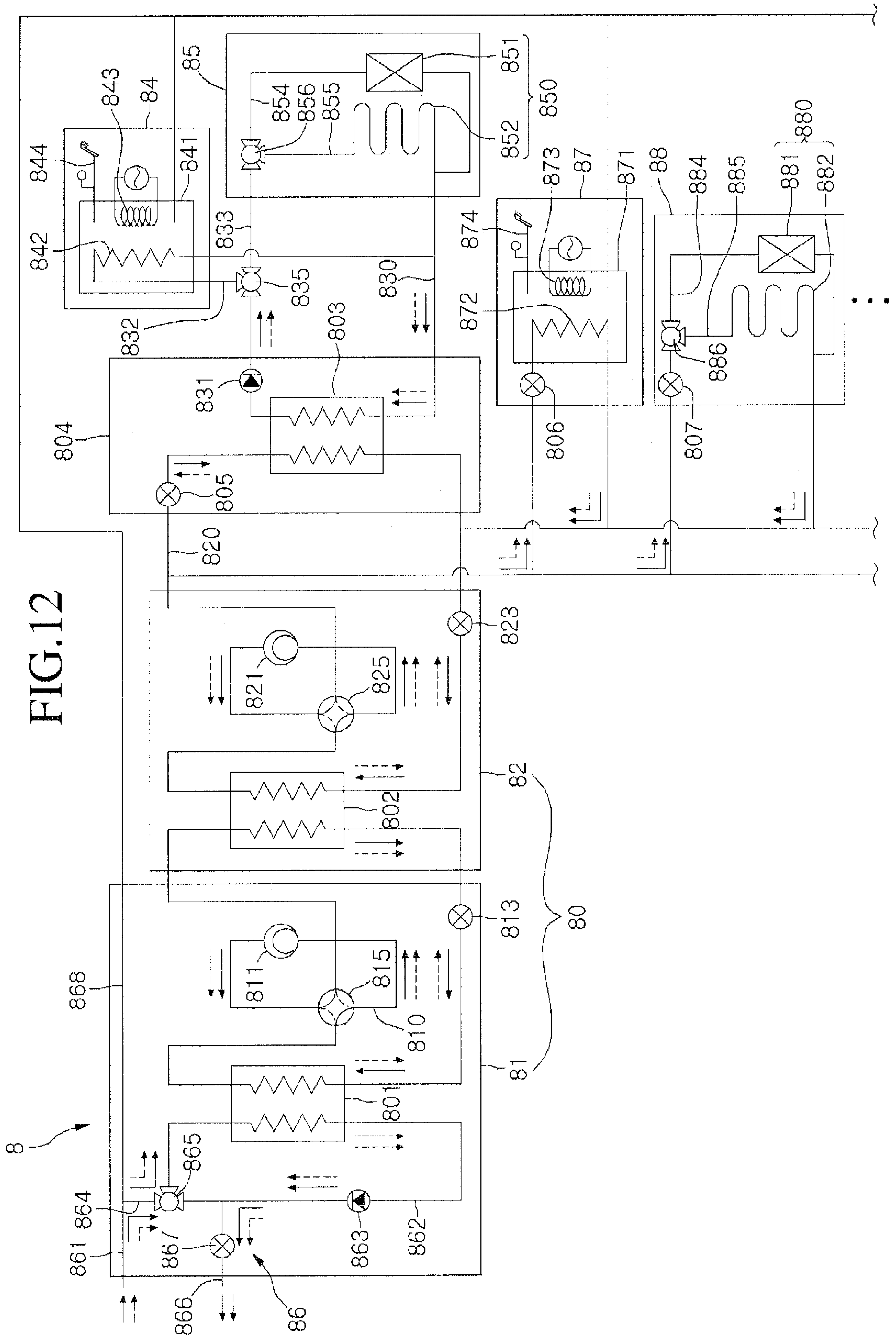
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FIG.12

HOT WATER SUPPLY APPARATUS ASSOCIATED WITH HEAT PUMP

CROSS-REFERENCE TO RELATED APPLICATION(S)

[0001] This application claims priority under 35 U.S.C. §119 to Korean Application No. 10-2010-0050322 filed on May 28, 2010, whose entire disclosure(s) is/are hereby incorporated by reference.

BACKGROUND

[0002] 1. Field

[0003] This relates to a hot water supply apparatus, and in particular, to a hot water supply apparatus associated with a heat pump.

[0004] 2. Background

[0005] In general, a hot water supply apparatus uses a heating source to heat water and supply the heated water to a user. An apparatus using a heat pump to heat water and supply the heated water to a user may be referred to as a hot water supply apparatus associated with a heat pump. Such a hot water supply apparatus may include a water supply passage for supplying water, a water storage part for storing the water supplied through the water supply passage, a heating source for heating the supplied water, and a water discharge passage for supplying the heated water to a user.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] The embodiments will be described in detail with reference to the following drawings in which like reference numerals refer to like elements wherein:

[0007] FIG. **1** is a schematic view of a hot water supply apparatus associated with a heat pump, according to an embodiment as broadly described herein.

[0008] FIG. **2** is a block diagram of a hot water supply apparatus associated with a heat pump, according to an embodiment as broadly described herein.

[0009] FIG. **3** is a flowchart of operation of a hot water supply apparatus associated with a heat pump in a freezing and bursting prevention operation, according to an embodiment as broadly described herein.

[0010] FIG. **4** is a schematic view of a circulation of heat source side water in a hot water supply apparatus associated with a heat pump, according to an embodiment as broadly described herein.

[0011] FIG. **5** is a flowchart of operation of, a hot water supply apparatus associated with a heat pump in a water saving operation, according to an embodiment as broadly described herein.

[0012] FIG. **6** is a schematic view of a hot water supply apparatus associated with a heat pump, according to another embodiment as broadly described herein.

[0013] FIG. **7** is a schematic view of a hot water supply apparatus associated with a heat pump, according to another embodiment as broadly described herein.

[0014] FIG. **8** is a schematic view of a hot water supply apparatus associated with a heat pump, according to another embodiment as broadly described herein.

[0015] FIG. **9** is a schematic view of a hot water supply apparatus associated with a heat pump, according to another embodiment as broadly described herein.

[0016] FIG. **10** is a schematic view of a hot water supply apparatus associated with a heat pump, according to another embodiment as broadly described herein.

[0017] FIG. **11** is a schematic view of a hot water supply apparatus associated with a heat pump, according to another embodiment as broadly described herein.

[0018] FIG. **12** is a schematic view of a hot water supply apparatus associated with a heat pump, according to another embodiment as broadly described herein.

DETAILED DESCRIPTION

[0019] Reference will now be made in detail to the embodiments of the present disclosure, examples of which are illustrated in the accompanying drawings.

[0020] In the following detailed description, reference is made to the accompanying drawings that form a part hereof, and in which is shown by way of illustration specific embodiments which may be practiced. These embodiments are described in sufficient detail to enable those skilled in the art, and it is understood that other embodiments may be utilized and that logical structural, mechanical, electrical, and chemical changes may be made without departing from the spirit or scope as embodied and broadly described herein. To avoid detail not necessary to enable those skilled in the art, the description may omit certain understood information. The following detailed description is, therefore, not to be taken in a limiting sense, and scope is defined by the appended claims.

[0021] A heat pump may include a compressor, a condenser in which compressed refrigerant discharged from the compressor is condensed, an expander in which refrigerant from the condenser is expanded, an evaporator in which refrigerant from the expander is evaporated, and a refrigerant pipe connecting the compressor, the condenser, the expander, and the evaporator to form a refrigerant cycle. As refrigerant flows through the heat pump, the refrigerant absorbs heat in the evaporator and emits heat in the condenser. It may be advantageous to transmit this heat to the water in the hot water supply device to heat the water, so that the hot water supply device can perform a hot water supply operation.

[0022] FIG. **1** is a schematic view of a hot water supply apparatus associated with a heat pump, according to an embodiment as broadly described herein.

[0023] Referring to FIG. **1**, a hot water supply apparatus **1** associated with a heat pump may include a cascade heat pump **10** including a first refrigerant circulation part **11** forming a first refrigerant cycle, and a second refrigerant circulation part **12** forming a second refrigerant cycle, together forming a two-stage refrigerant cycle, and a hot water supply device **14** using the cascade heat pump **10** to supply hot water.

[0024] In detail, the first refrigerant circulation part **11** may include a first compressor **111** compressing a first refrigerant, a cascade heat exchanger **102** exchanging heat between the first refrigerant and a second refrigerant, a first expander **113** expanding the first refrigerant, and a heat source side heat exchanger **101** configured such that the first refrigerant absorbs heat from and emits heat to a heat source.

[0025] The second refrigerant circulation part **12** may include a second compressor **121** compressing the second refrigerant, a usage side heat exchanger **103** using the second refrigerant to perform at least one of a hot water supply operation or a heating/cooling operation, a second expander **123** expanding the second refrigerant, and the cascade heat exchanger **102**. The cascade heat exchanger **102** may be included in both the first and second refrigerant circulation parts **11** and **12** for heat exchange between the first and second refrigerants.

[0026] The usage side heat exchanger **103**, the cascade heat exchanger **102**, and the heat source side heat exchanger **101** may function as condensers or evaporators based on particular operation conditions. For example, in a heating operation, the usage side heat exchanger **103** may be used as a condenser for the second refrigerant, the cascade heat exchanger **102** may be used as a condenser for the first refrigerant and an evaporator for the second refrigerant, and the heat source side heat exchanger **101** may be used as an evaporator for the first refrigerant. In a cooling operation, the usage side heat exchanger **103** may be used as an evaporator for the second refrigerant, the cascade heat exchanger **102** may be used as an evaporator for the first refrigerant and a condenser for the second refrigerant, and the heat source side heat exchanger **101** may be used as an condenser for the first refrigerant.

[0027] The first refrigerant circulation part **11** may also include a first flow switch **115** that switches a flow direction of the first refrigerant discharged from the first compressor **111** to one of the cascade heat exchanger **102** or the heat source side heat exchanger **101**, and a first refrigerant pipe **110** connecting the first compressor **111**, the first flow switch **115**, the cascade heat exchanger **102**, the first expander **113**, and the heat source side heat exchanger **101**. The second refrigerant circulation part **12** may also include a second flow switch **125** that switches a flow direction of the second refrigerant discharged from the second compressor **121** to one of the cascade heat exchanger **102** or the usage side heat exchanger **103**, and a second refrigerant pipe **120** connecting the second compressor **121**, the second flow switch **125**, the cascade heat exchanger **102**, the second expander **123**, and the usage side heat exchanger **103**.

[0028] The first and second refrigerants respectively flowing through the heat source side heat exchanger **101** and the usage side heat exchanger **103** may be heat-exchanged with water. That is, heat is exchanged between refrigerant and water at both the heat source side heat exchanger **101** and the usage side heat exchanger **103**. The heat source side heat exchanger **101** may be a water-refrigerant heat exchanger that exchanges heat between the first refrigerant and water, and the usage side heat exchanger **103** may be a water-refrigerant heat exchanger that exchanges heat between the second refrigerant and water. Thus, since a defrosting operation of the heat exchangers **101** and **103** may not be necessary, the hot water supply operation and the heating operation may be continuously performed.

[0029] The hot water supply apparatus **1** may also include a water pipe **130** in which water that has undergone heat-exchange with the second refrigerant in the usage side heat exchanger **103** flows, a usage side pump **131** that forcibly moves water in the water pipe **130**, the hot water supply device **14** using the water heated by the second refrigerant in the usage side heat exchanger **103** to supply the heated water, and a heating/cooling device **15** using the water heat-exchanged with the second refrigerant in the usage side heat exchanger **103** to perform a heating/cooling operation.

[0030] The water pipe **130** may be connected to the usage side heat exchanger **103** to move water that has undergone heat-exchange with the second refrigerant in the usage side heat exchanger **103**. The water pipe **130** forms a closed loop circuit such that water that has undergone heat-exchange with the second refrigerant in the usage side heat exchanger **103** returns to the usage side heat exchanger **103** through the hot water supply device **14** or the heating/cooling device **15**. That is, water passing through the usage side heat exchanger **103** circulates to pass through the hot water supply device **14** or the heating/cooling device **15** along the water pipe **130**. The usage side pump **131** may be installed on a side of the water pipe **130** to forcibly move water in the water pipe **130**.

[0031] The hot water supply device **14** may heat and supply water for various uses. In detail, the hot water supply device **14** includes a hot water supply tank **141** storing water supplied from an external source and heating the stored water, a hot water supply heat exchanger **142** exchanging heat between water passing through the usage side heat exchanger **103** and water stored in the hot water supply tank **141**, an auxiliary heater **143** provided in the hot water supply tank **141**, and a water discharge passage **144** that supplies hot water from the hot water supply tank **141** to a user.

[0032] The hot water supply heat exchanger **142** may be configured in a shape such that water in the hot water supply tank **141** may be heated by water flowing through the water pipe **130**. For example, at least a portion of the water pipe **130** may be accommodated in the hot water supply tank **141**.

[0033] The heating/cooling device **15** may include an indoor heat exchanger **150** that is adjacent to an indoor space to exchange heat between the second refrigerant and the indoor space. The indoor heat exchanger **150** may include an air-conditioning heat exchanger **151** in which heat is exchanged between indoor air and the second refrigerant, and a heat exchanger **152** in which heat is exchanged between an a bottom surface of the indoor space, such as, for example, the floor, and the second refrigerant.

[0034] The air-conditioning heat exchanger **151** may be, for example, a fan coil unit in which heat may be exchanged between water and indoor air. The floor heat exchanger **152** may be configured in a shape that allows heat to be exchanged between water and the floor. For example, at least a portion of the water pipe **130** may be installed in the floor.

[0035] The hot water supply device **14** may be connected to the heating/cooling device **15** in parallel along the water pipe **130**. The water pipe **130** may include a hot water supply pipe **132** branched from a discharge side of the usage side heat exchanger **103** and joining an introduction side of the usage side heat exchanger **103**, and a heating/cooling water pipe **133**. The hot water supply device **14** may be installed on the hot water supply pipe **132**, and the heating/cooling device **15** may be installed on the heating/cooling water pipe **133**. A point of the water pipe **130** from which the hot water supply pipe **132** and the heating/cooling water pipe **133** are branched may be provided with a usage side three-way valve **135** switching that switches a flow direction of water such that water passing through the usage side heat exchanger **103** is selectively introduced into one of the hot water supply device **14** or the heating/cooling device **15**.

[0036] The air-conditioning heat exchanger **151** may be connected to the floor heat exchanger **152** in parallel on the water pipe **130**. The heating/cooling water pipe **133** may include an air-conditioning water pipe **154** and a floor water pipe **155**, which are branched from each other. The air-conditioning heat exchanger **151** may be installed on the air-conditioning water pipe **154**, and the floor heat exchanger **152** may be installed in the floor water pipe **155**. A point of the heating/cooling water pipe **133** where the air-conditioning water pipe **154** and the floor water pipe **155** are branched from each other may be provided with a heating/cooling side three-way valve **156** that switches a flow direction of water such that water introduced into the floor water pipe **155** is selectively introduced into one of the air-conditioning heat exchanger **151** or the floor heat exchanger **152**.

[0037] The hot water supply apparatus **1** may also include a source water supply device **16** in which water to be heat-exchanged with the first refrigerant in the heat source side heat exchanger **101** flows. The source water supply device **16** may include a water supply passage **161** connected to a water supply source, a circulation passage **162** in which water to be heat-exchanged with the refrigerant in the heat source side heat exchanger **101** circulates, a circulation side pump **163** that forcibly moves water in the circulation passage **162**, a circulation side supply passage **164** that supplies water to the circulation passage **162**, a water supply adjustment device **165** that selectively restricts a supply of water through the circulation side supply passage **164**, a circulation side discharge passage **166** that discharges water from the circulation passage **162**, and a water discharge adjustment device **167** that selectively discharge of water from the circulation side discharge passage **166**.

[0038] Since the heat source side heat exchanger **101** is connected to both the circulation passage **162** and the first refrigerant pipe **110**, heat may be exchanged in the heat source side heat exchanger **101** between water flowing in the circulation passage **162** and the first refrigerant flowing in the first refrigerant pipe **110**.

[0039] The water supply passage **161** may be connected to a water supply source capable of continually supplying water, such as a water-supply facility. The circulation side supply passage **164** may connect the water supply passage **161** to the circulation passage **162** to supply water from the water supply source to the circulation passage **162**. The water supply adjustment device **165** may be installed on the circulation side supply passage **164** to selectively restrict a supply of water to the circulation passage **162**.

[0040] The circulation side discharge passage **166** is branched from a side of the circulation passage **162** to guide water flowing in the circulation passage **162** to the outside. The water discharge adjustment device **167** may be installed on the circulation side discharge passage **166** to selectively restrict discharge of water from the circulation passage **162** to the outside.

[0041] The circulation side pump **163** may be installed on the circulation passage **162** to forcibly circulate water in the circulation passage **162**.

[0042] The hot water supply apparatus **1** may also include a hot water supply side supply passage **168** to supply water to the hot water supply device **14**. The hot water supply side supply passage **168** connects the water supply passage **161** to the hot water supply device **14** to supply water from the water supply source to the hot water supply device **14**. The hot water supply side supply passage **168** may connect the water supply passage **161** to the hot water supply tank **141** to guide water from the water supply source to the hot water supply tank **141** through the water supply passage **161** and the hot water supply side supply passage **168**.

[0043] Since the circulation side supply passage **164** and the hot water supply side supply passage **168** may be connected to the water supply passage **161** and the water supply source, water may be simultaneously supplied from the water supply source to the circulation passage **162** and the hot water supply device **14** through the circulation side supply passage **164** and the hot water supply side supply passage **168**. That is, water flowing in the circulation passage **162** and water stored and heated in the hot water supply device **14** may be supplied from the same water supply source. Thus, the structure of the hot water supply apparatus **1** may be further simplified.

[0044] Hereinafter, flows of water and refrigerant in a hot water supply apparatus associated with a heat pump as embodied and broadly described herein will be described in detail with reference to the accompanying drawings.

[0045] Referring to FIG. **1**, when the hot water supply apparatus **1** is in a hot water supply operation or a heating operation, the first refrigerant discharged from the first compressor **111** is introduced in to the cascade heat exchanger **102**. The first refrigerant passing through the cascade heat exchanger **102** heats the second refrigerant and is condensed. The first refrigerant leaving the cascade heat exchanger **102** is expanded through the first expander **113**, and is then introduced into the heat source side heat exchanger **101**. The first refrigerant introduced into the heat source side heat exchanger **101** absorbs heat from water in the heat source, and is evaporated. The first refrigerant leaving the heat source side heat exchanger **101** is introduced again into the first compressor **111**. At this point, the first flow switch **115** communicates a portion of the first refrigerant pipe **110** at the discharge side of the first compressor **111** with a portion of the first refrigerant pipe **110** at the introduction side of the cascade heat exchanger **102**, and maintains communication between a portion of the first refrigerant pipe **110** at the discharge side of the heat source side heat exchanger **101** and a portion of the first refrigerant pipe **110** at the introduction side of the first compressor **111**.

[0046] The second refrigerant discharged from the second compressor **121** is introduced into the usage side heat exchanger **103**. The second refrigerant passing through the usage side heat exchanger **103** heats water at the usage side and is condensed. The second refrigerant discharged from the usage side heat exchanger **103** is expanded through the second expander **123**, and is then introduced into the cascade heat exchanger **102**. The second refrigerant introduced into the cascade heat exchanger **102** absorbs heat from the first refrigerant, and is evaporated. The second refrigerant discharged from the cascade heat exchanger **102** is introduced again into the second compressor **121**. At this point, the second flow switch **125** communicates a portion of the second refrigerant pipe **120** at the discharge side of the second compressor **121** with a portion of the second refrigerant pipe **120** at the introduction side of the usage side heat exchanger **103**, and maintains communication between a portion of the second refrigerant pipe **120** at the discharge side of the cascade heat exchanger **102** and a portion of the second refrigerant pipe **120** at the introduction side of the second compressor **121**.

[0047] Next, water discharged from the usage side pump **131** may be introduced into the hot water supply device **14** or the heating/cooling device **15**. The usage side three-way valve **135** may introduce the water into the hot water supply device **14** in the hot water supply operation, and may introduce the water into the heating/cooling device **15** in the heating operation.

[0048] Water introduced into the hot water supply device **14** flows in the hot water supply heat exchanger **142** along the water pipe **130** at the hot water supply side and heats water stored in the hot water supply tank **141**, and is then discharged from the hot water supply device **14**. The water discharged from the hot water supply device **14** passes through the usage side heat exchanger **103** along the water pipe **130** at the usage side and is heated to a high temperature by the refrigerant, and is then introduced again into the usage side pump **131**, and thus water may be continuously circulated.

[0049] The water introduced into the heating/cooling device **15** is introduced along the heating/cooling water pipe **133** to the indoor heat exchanger **150**. In more detail, the water introduced into the heating/cooling device **15** may be selectively introduced into one of the air-conditioning heat exchanger **151** or the bottom heat exchanger **152** by the heating/cooling side three-way valve **156**. The water introduced into the air-conditioning heat exchanger **151** heats indoor air, and the water introduced into the floor heat exchanger **152** heats the floor. The water passing through the one of the air-conditioning heat exchanger **151** or the floor heat exchanger **152** is introduced to the usage side heat exchanger **103** along the water pipe **130** at the usage side. The water passing through the usage side heat exchanger **103** is heated by the refrigerant, and is then introduced again into the usage side pump **131** so that the water may continuously circulate.

[0050] Water from the water supply source is introduced through the water supply passage **161** and the circulation side supply passage **164** into the circulation passage **162**. The water supply adjustment device **165** maintains communication between the circulation side supply passage **164** and the circulation passage **162**. The water introduced into the circulation passage **162** passes through the heat source side heat exchanger **101** and heats the refrigerant, and is then discharged through the circulation side pump **163** and the circulation side discharge passage **166** to the outside.

[0051] At this point, the water at the heat source side is forcibly circulated by the circulation side pump **163**. However, when the water supply source, such as a water supply facility, has its own pressure, the pressure of the water supply source may be sufficient to move the water in the circulation passage **162**.

[0052] A freezing and bursting prevention operation and a water saving operation may be performed during a heating or cooling operation. When at least one of the freezing and bursting prevention operation or the water saving operation is performed, water may flow in the circulation passage **162** while a water supply and a water discharge from the circulation passage **162** is prevented. In this case, the circulation side pump **163** is necessary.

[0053] When the hot water supply apparatus **1** is in the cooling operation, a flow direction of the refrigerant may be changed. In more detail, the first refrigerant discharged from the first compressor **111** may move sequentially through the cascade heat exchanger **102**, the first expander **113**, and the heat source side heat exchanger **101**, and then be introduced again into the first compressor **111**. The second refrigerant discharged from the second compressor **121** may move sequentially through the usage side heat exchanger **103**, the second expander **123**, and the cascade heat exchanger **102**, and then be introduced again into the second compressor **121**. The water flow at the heat source side is essentially the same as that in the heating operation, and the water at the usage side circulates through the heating/cooling device **15** and the usage side heat exchanger **103**. The hot water supply apparatus **1** may perform both the heating operation and the hot water supply operation.

[0054] A hot water supply apparatus **1** as embodied and broadly described herein may improve installation characteristics since refrigerant passing through the heat source side heat exchanger **101** and the usage side heat exchanger **103** are heat-exchanged with water. More specifically, both the heat source side heat exchanger **101** and the usage side heat exchanger **103** may be water-refrigerant heat exchangers in which heat is exchanged between water and refrigerant. In general, since a heat exchange density between water and refrigerant is higher than a heat exchange density between air and refrigerant, the volume of a water-refrigerant heat exchanger may be less than the volume of an air-refrigerant heat exchanger providing the same heat exchange capacity. Therefore, the water-refrigerant heat exchanger may occupy a relatively smaller installation space, and thus, may be installed in a relatively small space.

[0055] In addition, a water-refrigerant heat exchanger may be installed in indoor and/or outdoor spaces. Thus, the heat source side heat exchanger **101** and the usage side heat exchanger **103** may be installed in a variety of spaces.

[0056] Degradation due to operation in outdoor conditions may also be minimized. More specifically, since water has a higher specific heat than air, water is less affected by outdoor temperature. Thus, heat source side water, that is, circulation water, is affected less by temperature variation than outside air. Thus, degradation due to variations in outdoor conditions, such as outdoor temperatures, may be minimized.

[0057] In addition, in both the heat source side heat exchanger **101** and the usage side heat exchanger **103**, heat is exchanged between water and refrigerant, and thus frost may be prevented from forming on the surfaces of the heat source side heat exchanger **101** and the usage side heat exchanger **103**. Thus, a defrosting operation may be unnecessary, and the hot water supply operation and the heating operation may be continuously performed.

[0058] Since the heat pump **10** uses a two-stage refrigerant cycle, that is, a cascade method, hot water supply performance and heating performance may be further improved. In more detail, a refrigerant temperature at a condensation end in a two-stage refrigerant cycle is higher than a refrigerant temperature at a condensation end in a single-stage refrigerant cycle. Thus, the hot water supply operation using the condensation end in the two-stage refrigerant cycle may have better hot water supply performance than the hot water supply operation using the condensation end in the single-stage refrigerant cycle.

[0059] Furthermore, since a fan for forcibly moving outdoor air may be unnecessary, noise may be further reduced during operation.

[0060] Hereinafter, a freezing and bursting prevention operation and a water saving operation of a hot water supply apparatus associated with a heat pump as embodied and broadly described herein will be described in detail with reference to the accompanying drawings.

[0061] FIG. **2** is a block diagram of a hot water supply apparatus associated with a heat pump, according to an embodiment as broadly described herein, and FIG. **3** is a flowchart of a freezing and bursting prevention operation, according to an embodiment as broadly described herein. FIG. **4** is a schematic view of circulation of heat source side water in a hot water supply device associated with a heat pump, according to an embodiment as broadly described herein, and FIG. **5** is a flowchart of a water saving operation, according to an embodiment as broadly described herein.

[0062] Referring to FIG. **2**, the hot water supply apparatus **1** may also include a circulation water temperature sensor **191**

for sensing the temperature of heat source side water, that is, the temperature of circulation water, an input device **192** for inputting/receiving various signals/commands for operation control, and a controller **195** controlling the operation of the circulation side pump **163**, the operation of the water supply adjustment device **165** at the circulation side, and the operation of the water discharge adjustment device **167** at the circulation side based on a temperature sensed by the circulation water temperature sensor **191** and/or a signal received at the input device **192**. The circulation water temperature sensor **191**, the input device **192**, the controller **195**, the circulation side pump **163**, the water supply adjustment device **165**, and the water discharge adjustment device **167** are electrically connected to one another to transmit and receive control signals.

[0063] The circulation water temperature sensor **191** may be installed at the circulation passage **162** to sense the temperature of water flowing in the circulation passage **162**. The input device **192** may be provided, for example, at the heating/cooling device **15**, the hot water supply device **14**, a remote control or other location such that a user can easily input a signal/command.

[0064] Referring to FIG. **3**, when the hot water supply apparatus **1** is in the freezing and bursting prevention operation, first, the temperature of the circulation water is sensed, for example, by the circulation water temperature sensor **191** (S**11**).

[0065] If the temperature of the circulation water is greater than a freezing and bursting reference temperature (S**12**), the temperature of the circulation water is repeatedly sensed (S**11**) and compared with the freezing and bursting reference temperature (S**12**).

[0066] However, if the temperature of the circulation water is less than or equal to the freezing and bursting reference temperature (S**12**), the circulation water is forcibly moved to circulate through the circulation passage **162** by, for example, the circulation side pump **163** (S**13**). The freezing and bursting reference temperature may denote a threshold temperature at which circulation water may be frozen. For example, the freezing and bursting reference temperature may be approximately 0° C.

[0067] Referring to FIG. **4**, the circulation water circulates through the circulation passage **162**. First, water discharged from the circulation side pump **163** flows along the circulation passage **162** and is introduced into the usage side heat exchanger **103**. Then, the circulation water passing through the usage side heat exchanger **103** heats the refrigerant, and is then introduced again into the circulation side pump **163** so that water may continuously circulate through the circulation passage **162**.

[0068] The water discharge adjustment device **167** closes the circulation side discharge passage **166** to prevent the discharge of water from the circulation passage **162**, and the water supply adjustment device **165** closes the circulation side supply passage **164** to prevent the supply of water to the circulation passage **162**. Thus, the circulation water circulates in a closed loop along the circulation passage **162**. Even when the temperature of the circulation water is less than or equal to the freezing and bursting reference temperature, freezing of the circulation water may be minimized and/or delayed.

[0069] Next, referring back to FIG. **3**, the temperature of the circulation water is sensed again (S**14**). If the temperature of the circulation water is less than or equal to the freezing and bursting reference temperature (S**15**), the temperature of the circulation water is repeatedly sensed (S**14**) and compared with the freezing and bursting reference temperature (S**15**).

[0070] However, if the temperature of the circulation water is greater than the freezing and bursting reference temperature (S**15**), an operation state of the apparatus prior to the circulation of the circulation water (S**13**) in resumed (S**16**). For example, if the hot water supply apparatus **1** is stopped before the circulation water circulates (S**13**) to prevent freezing and bursting, when the temperature of the circulation water after the circulation water circulates is greater than the freezing and bursting reference temperature, the hot water supply apparatus **1** is once again stopped.

[0071] After the prior operation state is resumed (S**16**), the temperature of the circulation water is sensed (S**11**) until a signal for stopping the freezing and bursting prevention operation is received (S**17**).

[0072] Referring to FIG. **5**, when the hot water supply apparatus **1** is in the water saving operation, first, the temperature of the circulation water is sensed (S**21**). Then, if the temperature of the circulation water is greater than a water saving reference temperature (S**22**), the circulation water circulates through the circulation passage **162** without supply and discharging the circulation water (S**23**).

[0073] The water saving reference temperature may denote the minimum temperature value of the circulation water within a range where a given heating performance and a given hot water supply performance may be satisfied. For example, when the hot water supply apparatus **1** is in the heating and hot water supply operations, the circulation water heats the refrigerant through the usage side heat exchanger **103**, and thus the temperature of the circulation water continually decreases, reducing the temperature difference between the refrigerant and the circulation water passing through the usage side heat exchanger **103** and degrading heating and hot water supply performance. In this case, a minimum comfortable heating performance and a minimum comfortable hot water supply performance may be determined, and a corresponding minimum temperature of the circulation water may be determined such that a heating performance and a hot water supply performance produced by the apparatus **1** are greater than or equal to the minimum comfortable heating performance and the minimum comfortable hot water supply performance. That is, when the temperature of the circulation water is greater than the water saving reference temperature, the heating performance and the hot water supply performance may be maintained within a range where a user feels comfortable.

[0074] However, if the temperature of the circulation water is less than or equal to the water saving reference temperature in operation S**22**, the circulation water is supplied and discharged (S**24**). That is, since the water supply adjustment device **165** and the water discharge adjustment device **167** open the circulation side supply passage **164** and the circulation side discharge passage **166**, water from the water supply source is supplied to the circulation passage **162**, and simultaneously, the circulation water is discharged from the circulation passage **162** to the outside.

[0075] This allows circulation water circulating through the circulation passage **162** to be discharged, and new circulation water to circulate through the circulation passage **162**. The temperature of the new circulation water introduced into the circulation passage **162** is greater than that of the discharged water after circulating through the circulation passage **162**. Thus, the temperature of the circulation water may be maintained at greater than the water saving reference temperature. That is, the heating performance and the hot water supply performance may be maintained within a range where a user feels comfortable.

[0076] Finally, if a signal for stopping the water saving operation is not received (S**25**), the temperature of the circulation water is sensed again (S**21**).

[0077] The water saving operation may save water flowing in the circulation passage **162**. In more detail, if the temperature of the circulation water is greater than the water saving reference temperature, the circulation water circulates through the circulation passage **162** without supply and discharge of the circulation water, so that an amount of consumed circulation water per unit time is reduced. If the temperature of the circulation water is less than or equal to the water saving reference temperature, the circulation water is supplied and discharged, so that the temperature of the circulation water circulating through the circulation passage **162** may be maintained at greater than the water saving reference temperature. Thus, the amount of water flowing through the circulation passage **162** may be minimized, and simultaneously, heating performance and hot water supply performance may be maintained.

[0078] When the hot water supply apparatus **1** is in the cooling operation, if the temperature of the circulation water does not reach a reference temperature, the circulation water is circulated through the circulation passage **162**, and thus water may be saved, and simultaneously, cooling performance may be maintained. The reference temperature may denote the maximum temperature value of the circulation water within a range where a required cooling performance may be satisfied.

[0079] The freezing and bursting prevention operation may be performed when the hot water supply apparatus **1** is stopped. The water saving operation may be performed simultaneously with the hot water supply operation, the heating operation, or the cooling operation.

[0080] Hereinafter, a hot water supply apparatus associated with a heat pump according to another embodiment will now be described with respect to FIG. **6**. This embodiment is different from the embodiment shown in FIGS. **1** and **4** in that refrigerant may be excessively cooled, or sub-cooled. This embodiment may include elements similar to elements discussed above with respect to previous embodiment(s). Similar elements will be labeled with the same reference numerals and duplicative description thereof will be omitted wherever possible.

[0081] Referring to FIG. **6**, the hot water supply apparatus **2** may include a heat pump **20** including first and second refrigerant circulation parts **21** and **22**, and subcoolers **271** and **272** including a first subcooler **271** that subcools a first refrigerant, and a second subcooler **272** that subcools a second refrigerant. In such a subcooler, fluid may be subcooled, or compressed, to a temperature that is lower than a freezing temperature thereof for a given pressure, below its freezing point, without solidifying. Such a subcooler may be employed to improve energy efficiency of a system in which it is installed. The first subcooler **271** is installed between a cascade heat exchanger **202** and a first expander **213** on a first refrigerant cycle. The second subcooler **272** is installed between a usage side heat exchanger **203** and a second expander **223** on a second refrigerant cycle.

[0082] The subcoolers **271** and **272** are installed at points corresponding to a discharge side of a heat source side heat exchanger **201** on a circulation passage **262**. The subcoolers **271** and **272** may each be a water-refrigerant heat exchanger accommodating a water passage and a refrigerant passage that are adjacent to each other to exchange heat between water and refrigerant.

[0083] When the hot water supply device **2** is in a heating operation, the first refrigerant heating the second refrigerant through the cascade heat exchanger **202**, and the second refrigerant heating usage side water through the usage side heat exchanger **203** may heat the heat source side water, that is, circulation water through the subcoolers **271** and **272** and be subcooled.

[0084] Water, which heats refrigerant through the heat source side heat exchanger **201** and is cooled, may be heated by absorbing heat from refrigerant through the subcoolers **271** and **272**. Thus, when the hot water supply apparatus **2** is in a water saving operation, a temperature decrease rate of the circulation water may be decreased. That is, since circulation time of the circulation water may be increased in the water saving operation, the overall amount of water saved may increase, and a water saving effect may be improved.

[0085] A cooling expander **214** may be installed between the first subcooler **271** and the cascade heat exchanger **202**, and a cooling expander **224** may be installed between the second subcooler **272** and the usage side heat exchanger **203**. When the hot water supply apparatus **2** is in a cooling operation, the first expander **213** and the second expander **223** are completely opened, and refrigerants pass through the first and second subcoolers **271** and **272** and are expanded in the cooling expanders **214** and **224**. Thus, the refrigerant condensed through the heat source side heat exchanger **201** emits heat to the heat source side water in the subcoolers **271** and **272** and may be subcooled.

[0086] The hot water supply apparatus **2** associated with the heat pump in accordance with the embodiment shown in FIG. **6** may also include first and second refrigerant pipes **210/220**, first and second compressors **211/221**, first and second flow adjustment switches **215/225**, a hot water supply device **24** including a storage tank **241**, hot water supply heat exchanger **242**, auxiliary heater **243** and water discharge passage **244**, a heating/cooling device **25** including an indoor heat exchanger **250** having an air conditioning heat exchanger **251** and a floor heat exchanger **252**, an air conditioning water pipe **254** and a floor water pipe **255** and a heating/cooling side three way valve **256**, a source water supply device **26** including a water supply passage **261**, circulation side pump **263**, circulation side supply passage **264**, water supply adjustment device **265**, circulation side discharge passage **266**, water discharge adjustment device **267** and hot water supply side supply passage **268**, and a water pipe **230**, usage side pump **231**, hot water supply pipe **232**, heating/cooling water pipe **233** and usage side three way valve **235**. These components are similar to corresponding components discussed above with respect to previous embodiment(s), and thus further detailed description will be omitted.

[0087] Hereinafter, a hot water supply apparatus associated with a heat pump according to another embodiment will now be described with respect to FIG. **7**. This embodiment is different from the embodiment shown in FIGS. **1** and **4** in that an air-conditioning heat exchanger is connected onto a refrigerant pipe. This embodiment may include elements similar to elements discussed above with respect to previous embodiment(s). Similar elements will be labeled with the same reference numerals and duplicative description thereof will be omitted wherever possible.

[0088] Referring to FIG. **7**, the hot water supply apparatus **3** may include a heat pump **30** including first and second refrigerant circulation parts **31** and **32**, and an air-conditioning heat exchanger **371** connected to a refrigerant pipe **310** to heat or cool indoor air in a heating or cooling operation. The air-conditioning heat exchanger **371** may be installed between a first compressor **311** and a cascade heat exchanger **302** on a first refrigerant cycle. That is, the air-conditioning heat exchanger **371** may be installed at an upstream side of the cascade heat exchanger **302** along a flow direction of a first refrigerant. Thus, when the hot water supply apparatus **3** is in the heating operation, the first refrigerant discharged from the first compressor **311** heats indoor air through the air-conditioning heat exchanger **371** to heat an indoor space.

[0089] When the hot water supply apparatus **3** is in the cooling operation, the refrigerant passing through a heat source side heat exchanger **301** is expanded through an expander **313**, and then cools indoor air through the air-conditioning heat exchanger **371** to cool the indoor space. The air-conditioning heat exchanger **371** may be accommodated in an indoor device **37** in the indoor space so as to be exposed to the indoor air.

[0090] In this embodiment, heating performance and cooling performance may be improved. In more detail, the indoor air may be directly heated or cooled using the refrigerant, and thus a heat transfer amount between the refrigerant and the indoor air may be greater when compared to a method in which indoor air is heated or cooled using water heated or cooled by refrigerant.

[0091] In particular, heating performance and cooling performance may be improved simultaneously. The first refrigerant discharged from the first compressor **311** passes through the air-conditioning heat exchanger **371** first and is primarily condensed, and then, passes through the cascade heat exchanger **302**. Since the refrigerant is at a maximum temperature in the first refrigerant cycle during the heating operation, heating performance may be improved. The heat pump **30** may incorporate a two-stage refrigerant cycle, such as, for example, a cascade cycle, in which a condenser at a high stage, that is, a usage side heat exchanger **303** performs a hot water supply operation, and thus, hot water supply performance may be improved compared to a heat pump incorporating a single-stage refrigerant cycle. Thus, hot water supply performance and heating performance may be simultaneously improved.

[0092] The hot water supply apparatus **3** associated with the heat pump in accordance with the embodiment shown in FIG. **7** may also include a refrigerant pipe **320**, compressor **321**, expansion device **323**, flow adjustment switch **325**, a hot water supply device **34** including a storage tank **341**, hot water supply heat exchanger **342**, auxiliary heater **343** and water discharge passage **344**, a heating/cooling device **35** including an indoor heat exchanger **350** having an air conditioning heat exchanger **351** and a floor heat exchanger **352**, an air conditioning water pipe **354** and a floor water pipe **355** and a heating/cooling side three way valve **356**, a source water supply device **36** including a water supply passage **361**, circulation passage **362**, circulation side pump **363**, circulation side supply passage **364**, water supply adjustment device **365**, circulation side discharge passage **366**, water discharge adjustment device **367** and hot water supply side supply passage **368**, and a water pipe **330**, usage side pump **331**, hot water supply pipe **332**, heating/cooling water pipe **333** and usage side three way valve **335**. These components are similar to corresponding components discussed above with respect to previous embodiment(s), and thus further detailed description will be omitted.

[0093] Hereinafter, a hot water supply apparatus associated with a heat pump according to another embodiment will now be described with respect to FIG. **8**. This embodiment is different from the embodiment shown in FIGS. **1** and **4** in that a hot water supply device and a lower surface, or floor, heating/cooling device thereof may employ a desuperheater. This embodiment may include elements similar to elements discussed above with respect to previous embodiment(s). Similar elements will be labeled with the same reference numerals and duplicative description thereof will be omitted wherever possible.

[0094] Referring to FIG. **8**, the hot water supply apparatus **4** may include a hot water supply device **44** and a floor heating/cooling device **45** that employ a desuperheater. Such a desuperheater may function as a waste heat recovery device that recovers superheat from compressor discharge gas to supplement a heating or a hot water supply operation. Thus, a desuperheater heat exchanger **403** may function as a primary condenser in which the refrigerant at a discharge side of a first compressor **411** is primarily condensed, and a cascade heat exchanger **402** or a heat source side heat exchanger **401** may function as a secondary condenser in which the refrigerant at the discharge side of the first compressor **411** is secondarily condensed.

[0095] In this embodiment, a water pipe **430** guiding the water heated by the first refrigerant in the desuperheater heat exchanger **403** to the hot water supply device **44** or the floor heating/cooling device **45**, and a usage side pump **431** forcibly moving the water in the water pipe **430** may also be provided. A heat pump **40** may include a first refrigerant circulation part **41** including the desuperheater heat exchanger **403** in which the first refrigerant is heat-exchanged with water. That is, the desuperheater heat exchanger **403** may be connected simultaneously to a first refrigerant pipe **410** and the water pipe **430** such that the first refrigerant is heat-exchanged with the water.

[0096] The desuperheater heat exchanger **403** may be installed between the first compressor **411** and a first flow switch **415** on a first refrigerant cycle so as to perform a hot water supply operation and a floor heating operation regardless of switching between heating and cooling. Thus, even when a refrigerant flow direction is varied by the first flow switch **415** corresponding to heating or cooling, the first refrigerant at the discharge side of the first compressor **411** passes through the desuperheater heat exchanger **403**.

[0097] The hot water supply device **44** may be connected in parallel to the floor heating/cooling device **45** with respect to the water pipe **430**, and a usage side three-way valve **435** may direct the water passing through the desuperheater heat exchanger **403** to the hot water supply device **44** or the floor heating/cooling device **45**.

[0098] A second refrigerant circulation part **42** of the heat pump **40** may include a second compressor **421**, an indoor device **47** including an air-conditioning heat exchanger **471** in which a second refrigerant is heat-exchanged with indoor air, second expanders **423** and **473**, and the cascade heat exchanger **402**. The air-conditioning heat exchanger **471** may be installed separately from the floor heating/cooling device

45, and in particular, a floor heat exchanger **452**, and the air-conditioning heat exchanger **471** uses the second refrigerant to heat or cool the indoor space.

[0099] In the this embodiment, in the hot water supply operation or the floor heating operation, the first refrigerant at the discharge side of the first compressor **411** heats the usage side water through the desuperheater heat exchanger **403** and is primarily condensed, and then, is introduced into the cascade heat exchanger **402** or the heat source side heat exchanger **401** through the first flow switch **415**.

[0100] The hot water supply operation or the floor heating operation may be performed simultaneously with the air-conditioning heating or cooling operation. When the air-conditioning heating operation is performed simultaneously with the hot water supply operation or the floor heating operation, the first refrigerant passing through the desuperheater heat exchanger **403** is introduced into the cascade heat exchanger **402**, and heats the second refrigerant through the cascade heat exchanger **402** and is secondarily condensed, and is introduced again into the first compressor **411** through a first expander **413** and the heat source side heat exchanger **401**.

[0101] When the cooling operation is performed simultaneously with the hot water supply operation or the floor heating operation, the first refrigerant passing through the desuperheater heat exchanger **403** heats the heat source side water through the heat source side heat exchanger **401** and is secondarily condensed, and is then introduced into the cascade heat exchanger **402** through the first expander **413**. The first refrigerant passing through the cascade heat exchanger **402** cools the second refrigerant and is evaporated, and is then introduced again into the first compressor **411**.

[0102] The second refrigerant of the second refrigerant circulation part **42** flows sequentially through the second compressor **421**, the air-conditioning heat exchanger **471**, the second expanders **473** and **423**, and the cascade heat exchanger **402** in the air-conditioning heating operation, and flows sequentially through the second compressor **421**, the cascade heat exchanger **402**, the second expanders **423** and **473**, and the air-conditioning heat exchanger **471** in the air-conditioning cooling operation.

[0103] The usage side water is forcibly moved by the usage side pump **431**, and continually circulates between the desuperheater heat exchanger **403** and one of a hot water supply heat exchanger **442** or the floor heat exchanger **452**. At this point, the usage side water absorbs heat from the first refrigerant when passing through the desuperheater heat exchanger **403**, and heats water in a hot water supply tank **441** or the floor when passing through one of the hot water supply heat exchanger **442** or the floor heat exchanger **452**. Based on a position of the usage side three-way valve **435**, the usage side water may selectively flow to one of the hot water supply heat exchanger **442** or the floor heat exchanger **452**.

[0104] In this embodiment, hot water supply performance and heating performance may both be improved. Since the first refrigerant at the discharge side of the first compressor **411** at a maximum temperature state in the first refrigerant cycle is introduced directly into the desuperheater heat exchanger **403**, that is, since the hot water supply operation is performed using the first refrigerant at the maximum temperature on the first refrigerant cycle, hot water supply performance may be improved. Although heating performance may be degraded due to some removal condensation heat from the first refrigerant during the hot water supply operation, the two-stage cycle heat pump **40** may compensate for this degradation and further improve the heating performance.

[0105] The hot water supply operation may be continuously performed regardless of switching between heating and cooling. In more detail, the first refrigerant discharged from the first compressor **411** passes through the desuperheater heat exchanger **403** first, regardless of a refrigerant flow direction change by the first flow switch **415**. Thus, the hot water supply operation may be performed regardless of switching between heating and cooling.

[0106] In addition, the floor heating operation and the indoor cooling operation may be simultaneously performed. For example, it may be necessary to dry a floor and cool an indoor space in a wet and hot season, such as, for example a rainy season. In this case, the first refrigerant discharged from the first compressor **411** moves sequentially through the desuperheater heat exchanger **403**, the heat source side heat exchanger **401**, and the cascade heat exchanger **402** to perform both the floor heating operation and the indoor cooling operation. At this point, the usage side three-way valve **435** allows the usage side water discharged from the desuperheater heat exchanger **403** to be introduced into the floor heat exchanger **452**. Also, the second refrigerant circulation part **42** is operated for the air-conditioning cooling operation. Thus, the floor may be dried, and simultaneously, the indoor cooling operation may be performed.

[0107] The hot water supply apparatus **4** associated with the heat pump in accordance with the embodiment shown in FIG. **8** may also include a refrigerant pipe **420**, flow adjustment switch **425**, an auxiliary heater **443** and water discharge passage **444** provided in the hot water supply device **44**, a source water supply device **46** including a water supply passage **461**, circulation passage **462**, circulation side pump **463**, circulation side supply passage **464**, water supply adjustment device **465**, circulation side discharge passage **466**, water discharge adjustment device **467** and hot water supply side supply passage **468**, and a hot water supply pipe **432** and heating/cooling water pipe **433**. These components are similar to corresponding components discussed above with respect to previous embodiment(s), and thus further detailed description will be omitted.

[0108] Hereinafter, a hot water supply apparatus associated with a heat pump according to another embodiment will now be described with respect to FIG. **9**. This embodiment is different from the embodiment shown in FIGS. **1** and **4** in that a desuperheater heat exchanger is connected to a second refrigerant circulation part and the amount of refrigerant introduced to the desuperheater heat exchanger and the amount of refrigerant bypassing the desuperheater heat exchanger may be varied. This embodiment may include elements similar to elements discussed above with respect to previous embodiment(s). Similar elements will be labeled with the same reference numerals and duplicative description thereof will be omitted wherever possible.

[0109] Referring to FIG. **9**, the hot water supply apparatus **5** may include a heat pump **50** having a first refrigerant circulation part **51**, a second refrigerant circulation part **52**, and a desuperheater heat exchanger **503** connected to the second refrigerant circulation part **52**. The amount of refrigerant introduced into the desuperheater heat exchanger **503** and the amount of refrigerant bypassing the desuperheater heat exchanger **503** may be varied.

[0110] The second refrigerant circulation part **52** may include the desuperheater heat exchanger **503** in which usage side water is heat-exchanged with a second refrigerant discharged from a second compressor **521**, a desuperheater pipe **585** guiding the second refrigerant at a discharge side of the second compressor **521** to the desuperheater heat exchanger **503**, a bypass pipe **586** guiding the second refrigerant at the discharge side of the second compressor **521** to bypass the desuperheater heat exchanger **503**, and a flow rate adjustment device **58** for adjusting the amount of refrigerant introduced into the desuperheater heat exchanger **503** and the amount of refrigerant bypassing the desuperheater heat exchanger **503**. The flow rate adjustment device **58** may include a desuperheater flow rate adjustment device **581** installed on the desuperheater pipe **585** to adjust the amount of refrigerant introduced from the second compressor **521** to the desuperheater heat exchanger **503**, and a bypass flow rate adjustment device **582** installed on the bypass pipe **586** to adjust the amount of refrigerant discharged from the second compressor **521** and bypassing the desuperheater heat exchanger **503**.

[0111] The desuperheater heat exchanger **503** may be installed between the second compressor **521** and a second flow switch **525** on a second refrigerant cycle, to perform a hot water supply operation and a floor heating operation regardless of switching between air-conditioning heating and cooling modes. Thus, after passing through the desuperheater heat exchanger **503**, the discharge side refrigerant of the second compressor **521** may selectively flow to one of an air-conditioning heat exchanger **571** provided, for example, in an indoor device **57** along with an expander **573**, a cascade heat exchanger **502**, based on a position of the second flow switch **525**.

[0112] The amount of refrigerant introduced to the desuperheater heat exchanger **503** and the amount of refrigerant bypassing the desuperheater heat exchanger **503** may be adjusted based on a hot water supply load and/or a heating/cooling load. For example, when the hot water supply load is greater than the heating/cooling load, the amount of refrigerant introduced into the desuperheater heat exchanger **503** may be increased, and the amount of refrigerant bypassing the desuperheater heat exchanger **503** may be decreased. When the heating/cooling load is greater than the hot water supply load, the amount of refrigerant introduced into the desuperheater heat exchanger **503** may be decreased, and the amount of refrigerant bypassing the desuperheater heat exchanger **503** may be increased.

[0113] The hot water supply load may represent a difference between a water discharge temperature of a hot water supply device **54** and a target temperature thereof, and the heating/cooling load may represent a difference between a current temperature of an indoor space, which is a heating/cooling target of the air-conditioning heat exchanger **571**, and a target temperature of the indoor space.

[0114] In this embodiment, regardless of whether the indoor space is being heated or cooled, the hot water supply operation may be continuously performed. In this embodiment, the hot water supply or floor heating operation and the air-conditioning heating/cooling operation may be simultaneously performed.

[0115] In this embodiment, an operation state of the hot water supply apparatus **5** may be optimized based on the hot water supply load and/or the heating/cooling load. In detail, when the hot water supply operation and the heating/cooling operation are simultaneously performed, the amount of hot water supply side refrigerant flowing through the desuperheater heat exchanger **503** and the amount of heating/cooling side refrigerant bypassing the desuperheater heat exchanger **503** and flowing directly into the air-conditioning heat exchanger **571** or the cascade heat exchanger **502** may be adjusted based on the hot water supply load and/or the heating/cooling load.

[0116] In particular, when the hot water supply load is greater than the heating/cooling load, the amount of refrigerant passing through the desuperheater heat exchanger **503** may be increased, that is, as the amount of heat transmitted to water in a hot water supply tank **541** of the hot water supply device **54** through a hot water supply heat exchanger **542** increases, a hot water supply target condition may be achieved more quickly. In addition, when the heating/cooling load is greater than the hot water supply load, the amount of refrigerant bypassing the desuperheater heat exchanger **503** may increase, and thus, the amount of refrigerant discharged from the second compressor **521** to the air-conditioning heat exchanger **571** may increase in the heating operation. Thus, the amount of heat transmitted to the indoor space through the air-conditioning heat exchanger **571** may increase, further improving heating performance. Thus, the operation state of the hot water supply apparatus **5** may be optimized based on the hot water supply load, that is, operation conditions.

[0117] The hot water supply apparatus **5** associated with the heat pump in accordance with the embodiment shown in FIG. **9** may also include a heat source side heat exchanger **501**, refrigerant pipes **510/520**, compressor **511**, expansion devices **513/523**, flow adjustment switch **515**, an auxiliary heater **543** and water discharge passage **544** provided in the hot water supply device **54**, a floor heating/cooling device **55** including a floor heat exchanger **552**, a source water supply device **56** including a water supply passage **561**, circulation passage **562**, circulation side pump **563**, circulation side supply passage **564**, water supply adjustment device **565**, circulation side discharge passage **566** and water discharge adjustment device **567**, and a water pipe **530**, usage side pump **531**, hot water supply pipe **532**, heating/cooling water pipe **533** and usage side three way valve **535**. These components are similar to corresponding components discussed above with respect to previous embodiment(s), and thus further detailed description will be omitted.

[0118] Hereinafter, a hot water supply apparatus associated with a heat pump according to another embodiment will be described with respect to FIG. **10**. This embodiment is different from the embodiment shown in FIG. **9** in that a desuperheater heat exchanger connected to a first refrigerant circulation part is also included. This embodiment may include elements similar to elements discussed above with respect to previous embodiment(s). Similar elements will be labeled with the same reference numerals and duplicative description thereof will be omitted wherever possible.

[0119] Referring to FIG. **10**, desuperheater heat exchangers **603** and **604** connected to the first and second refrigerant circulation parts **61** and **62** of a heat pump **60**.

[0120] The first refrigerant circulation part **61** includes the first desuperheater heat exchanger **604** in which usage side water is heat-exchanged with a first refrigerant discharged from a first compressor **611**, a desuperheater pipe **695** guiding the first refrigerant at a discharge side of the first compressor **611** to the first desuperheater heat exchanger **604**, a first bypass pipe **696** guiding the first refrigerant at the discharge side of the first compressor **611** to bypass the first desuperheater heat exchanger **604**, and a first flow rate adjustment device **69** for adjusting the amount of refrigerant introduced into the first desuperheater heat exchanger **604** and the amount of refrigerant bypassing the first desuperheater heat exchanger **604**. The first flow rate adjustment device **69** includes a first desuperheater flow rate adjustment device **691** installed on the first desuperheater pipe **695** to adjust the amount of refrigerant introduced from the first compressor **611** into the first desuperheater heat exchanger **604**, and a first bypass flow rate adjustment device **692** installed on the first bypass pipe **696** to adjust the amount of refrigerant discharged from the first compressor **611** and bypassing the first desuperheater heat exchanger **604**.

[0121] A second refrigerant circulation part **62** may include the second desuperheater heat exchanger **603** in which usage side water is heat-exchanged with a second refrigerant discharged from a second compressor **621**, a second desuperheater pipe **685** guiding the second refrigerant at a discharge side of the second compressor **621** into the second desuperheater heat exchanger **603**, a second bypass pipe **686** guiding the second refrigerant at the discharge side of the second compressor **621** to bypass the second desuperheater heat exchanger **603**, and a second flow rate adjustment device **68** for adjusting the amount of refrigerant introduced into the second desuperheater heat exchanger **603** and the amount of refrigerant bypassing the second desuperheater heat exchanger **603**. The second flow rate adjustment device **68** includes a second desuperheater flow rate adjustment device **681** installed on the second desuperheater pipe **685** to adjust the amount of refrigerant introduced from the second compressor **621** into the second desuperheater heat exchanger **603**, and a second bypass flow rate adjustment device **682** installed on the second bypass pipe **686** to adjust the amount of refrigerant discharged from the second compressor **621** and bypassing the second desuperheater heat exchanger **603**.

[0122] The first desuperheater heat exchanger **604** is connected simultaneously to the first refrigerant circulation part **61** and a hot water supply device **64**, and the second desuperheater heat exchanger **603** is connected simultaneously to the second refrigerant circulation device **62**, the hot water supply device **64**, and a floor heating device **65** including a floor heat exchanger **652**.

[0123] In this embodiment, the hot water supply operation and the floor heating operation may be simultaneously performed. In more detail, the usage side water passing through the first desuperheater heat exchanger **604** flows to the hot water supply device **64**, and simultaneously, the usage side water passing through the second desuperheater heat exchanger **603** flows to the floor heating device **65**. A usage side three-way valve **635** may continually guide the water discharged from the second desuperheater heat exchanger **603** to the floor heating device **65**. Thus, the hot water supply operation and the floor heating operation may be simultaneously performed. In addition, the respective amounts of refrigerants passing through and bypassing the first desuperheater heat exchanger **604** and the second desuperheater heat exchanger **603** may be varied.

[0124] In this embodiment, an operation state of the hot water supply apparatus **6** may be optimized based on the hot water supply load and/or the heating/cooling load. In the hot water supply operation and the heating/cooling operation, the amount of hot water supply side refrigerant flowing through the first and second desuperheater heat exchangers **604** and **603** and the amount of heating/cooling side refrigerant bypassing the first and second desuperheater heat exchangers **604** and **603** may be adjusted based on the hot water supply load and the heating/cooling load. For example, when the hot water supply load is greater than the heating/cooling load, the amount of refrigerant introduced into the first and second desuperheater heat exchangers **604** and **603** may be increased, and the amount of refrigerant bypassing the first and second desuperheater heat exchangers **604** and **603** may be decreased. When the heating/cooling load is greater than the hot water supply load, the amount of refrigerant introduced into the first and second desuperheater heat exchangers **604** and **603** may be decreased, and the amount of refrigerant bypassing the first and second desuperheater heat exchangers **604** and **603** may be increased.

[0125] The hot water supply load may be a difference between a current water discharge temperature of the hot water supply device **64** and a target temperature thereof, and the heating/cooling load may be a difference between a current temperature of an indoor space, which is a heating/cooling target of an air-conditioning heat exchanger **671** provided together with an expansion device **673** in an indoor device **67**, and a target temperature of the indoor space.

[0126] The hot water supply apparatus **6** associated with the heat pump in accordance with the embodiment shown in FIG. **10** may also include first and second refrigerant pipes **610** and **620**, expansion devices **613**/**623**, flow adjustment switches **615**/**625**, a storage tank **641**, hot water supply heat exchangers **642** and **645**, auxiliary heater **643** and water discharge passage **644** provided in the hot water supply device **64**, a source water supply device **66** including a water supply passage **661**, circulation passage **662**, circulation side pump **663**, circulation side supply passage **664**, water supply adjustment device **665**, circulation side discharge passage **666** and water discharge adjustment device **667**, a heat source side heat exchanger **601**, water pipe **630**, usage side pump **631**, hot water supply pipe **632** and heating/cooling water pipe **633**. These components are similar to corresponding components discussed above with respect to previous embodiment(s), and thus further detailed description will be omitted.

[0127] Hereinafter, a hot water supply apparatus associated with a heat pump according to another embodiment will now be described with respect to FIG. **11**. This embodiment is different from the embodiment shown in FIGS. **1** and **4** in that vapor refrigerants of refrigerants condensed in a refrigerant cycle may be injected into compressors. This embodiment may include elements similar to elements discussed above with respect to previous embodiment(s). Similar elements will be labeled with the same reference numerals and duplicative description thereof will be omitted wherever possible.

[0128] The hot water supply apparatus **7** shown in FIG. **11** may include a heat pump **70** including first and second refrigerant circulation parts **71** and **72** in which vapor refrigerants of refrigerants condensed in a refrigerant cycle may be injected into compressors **77** and **78**.

[0129] In detail, a first compressor **77** may be a multi-stage compressor that includes a first low stage compression part **772** for primary compression of a first refrigerant and a first middle compression part **771** for secondary compression of the first refrigerant compressed in the first low stage compression part **772**. A second compressor **78** may be a multi-stage compressor that includes a second low stage compression part **782** for primary compression of a second refrigerant and a second middle compression part **781** for secondary compression of the second refrigerant compressed in the second low stage compression part **782**.

[0130] A first phase divider **773** may divide the first refrigerant condensed in a cascade heat exchanger **702** or a heat source side heat exchanger **701** in a first refrigerant cycle into a vapor refrigerant and a liquid refrigerant. A first injection pipe **774** may inject the vapor refrigerant from the first phase divider **773** into the first middle compression part **771** of the first compressor **77**. A second phase divider **783** may divide the second refrigerant condensed in the cascade heat exchanger **702** or a usage side heat exchanger **703** in a second refrigerant cycle into a vapor refrigerant and a liquid refrigerant. A second injection pipe **784** may inject vapor refrigerant from the second phase divider **783** into the second middle compression part **781** of the second compressor **78**.

[0131] A first expander **713** and a second expander **714** may be provided at two opposite sides of the first phase divider **773** in the first refrigerant cycle, and a third expander **723** and a fourth expander **724** may be provided at two opposite sides of the second phase divider **783** in the second refrigerant cycle.

[0132] In a heating operation, the first refrigerant flowing between the cascade heat exchanger **702** and the heat source side heat exchanger **701** may be injected into the first compressor **77** in the first refrigerant circulation part **71** of the heat pump **70**, and the second refrigerant flowing between the cascade heat exchanger **702** and the usage side heat exchanger **703** may be injected into the second compressor **78** in the second refrigerant circulation part **72** of the heat pump **70**, thus increasing the amount of refrigerant flowing to the usage side heat exchanger **703** and further improving hot water supply and heating performance. In particular, although an evaporation heat amount of the first refrigerant may decrease in the heat source side heat exchanger **701** and degrade overall heating performance when the temperature of the heat source side water is relatively low, injection of the first and second refrigerants as described above counteract this effect to improve heating performance.

[0133] First and second injection valves selectively close first and second injection pipes **774** and **784** to selectively inject the first and second refrigerants into the first and second compressors **77** and **78** based on outside temperatures. For example, when a temperature of the heat source side water, that is, circulation water, is greater than or equal to a reference temperature, the first and second injection valves may be continually closed. When a temperature of the heat source side water is less than the reference temperature, the first and second injection valves may be continually opened.

[0134] The hot water supply apparatus **7** associated with the heat pump in accordance with the embodiment shown in FIG. **11** may also include first and second refrigerant pipes **710**/**720**, first and second flow adjustment switches **715**/**725**, a hot water supply device **74** including a storage tank **741**, hot water supply heat exchanger **742**, auxiliary heater **743** and water discharge passage **744**, a heating/cooling device **75** including an indoor heat exchanger **750** having an air conditioning heat exchanger **751** and a floor heat exchanger **752**, an air conditioning water pipe **754** and a floor water pipe **755** and a heating/cooling side three way valve **756**, a source water supply device **76** including a water supply passage **761**, circulation passage **762**, circulation side pump **763**, circulation side supply passage **764**, water supply adjustment device **765**, circulation side discharge passage **766**, water discharge adjustment device **767** and hot water supply side supply passage **768**, and a water pipe **730**, usage side pump **731**, hot water supply pipe **732**, heating/cooling water pipe **733** and usage side three way valve **735**. These components are similar to corresponding components discussed above with respect to previous embodiment(s), and thus further detailed description will be omitted.

[0135] Hereinafter, a hot water supply apparatus associated with a heat pump according to another embodiment will now be described with respect to FIG. **12**. This embodiment is different from the embodiment shown in FIGS. **1** and **4** in that the hot water supply apparatus is configured as a multi-system apparatus including a plurality of hot water supply devices and a plurality of heating/cooling devices. This embodiment may include elements similar to elements discussed above with respect to previous embodiment(s). Similar elements will be labeled with the same reference numerals and duplicative description thereof will be omitted wherever possible.

[0136] Referring to FIG. **12**, the hot water supply apparatus **8** configured as a multi-system apparatus may include a plurality of hot water supply devices **84** and **87** and a plurality of heating/cooling devices **85** and **88**. That is, a single heat pump **80** having first and second refrigerant circulation parts **81** and **82** may perform a hot water supply operation of the hot water supply devices **84** and **87** and a heating/cooling operation of the heating/cooling devices **85** and **88**. The heat pump **80** may employ a two-stage refrigerant cycle, that is, a cascade method.

[0137] In this hot water supply apparatus **8**, the heat pump **80** performs heat exchange between heat source side water and the second refrigerant, and a relay **804** performs heat exchange between usage side water and the second refrigerant received from the heat pump **80**. The first hot water supply device **84** uses water discharged from the relay **804** to perform a hot water supply operation, the first heating/cooling device **85** uses water discharged from the relay **804** to heat and cool an indoor space, the second hot water supply device **87** uses the second refrigerant discharged from the heat pump **80** to perform a hot water supply operation, and the second heating/cooling device **88** uses the second refrigerant discharged from the heat pump **80** to heat and cool the indoor space.

[0138] The heat pump **80** and the relay **804** may be connected to a second refrigerant pipe **820**, and the first hot water supply device **84** and the first heating/cooling device **85** may be connected through a water pipe **830** to the relay **804**. That is, the first hot water supply device **84** and the first heating/cooling device **85** may be indirectly connected to the heat pump **80** through the relay **804**. The second hot water supply device **87** and the second heating/cooling device **88** may be directly connected to the heat pump **80** through the second refrigerant pipe **820**. At this point, the relay **804**, the second hot water supply device **87**, and the second heating/cooling device **88** may be connected to the heat pump **80** in parallel. That is, the second refrigerant discharged from the heat pump **80** may be distributed to the relay **804**, the second hot water supply device **87**, and the second heating/cooling device **88**.

[0139] The usage side water may be heat-exchanged with water of a hot water supply tank **841** in a hot water supply heat exchanger **842** of the first hot water supply device **84**, and the second refrigerant may be heat-exchanged with water of a hot water supply tank **871** in a hot water supply heat exchanger **872** of the second hot water supply device **87**.

[0140] Thus, the first hot water supply device **84** and the first heating/cooling device **85** indirectly receive, through the usage side water, heat from the second refrigerant heated by the heat source side water, and the second hot water supply device **87** and the second heating/cooling device **88** directly receive heat from the second refrigerant heated by the heat source side water.

[0141] A hot water supply side supply passage **832** may be connected to the hot water supply tank **841** of the first hot water supply device **84** and the hot water supply tank **872** of the second hot water supply device **87**, so that water may be continually supplied to the hot water supply tanks **841** and **872** of the first and second hot water supply devices **84** and **87**.

[0142] The second refrigerant pipe **820** connected to the relay **804**, the second hot water supply device **87**, and the second heating/cooling device **88** may be provided with flow rate adjustment devices **805**, **806**, and **807** corresponding respectively to the relay **804**, the second hot water supply device **87**, and the second heating/cooling device **88**, so that the amount of refrigerant introduced into the relay **804**, the second hot water supply device **87**, and the second heating/cooling device **88** may be adjusted. The amount of refrigerant introduced into the relay **804**, the second hot water supply device **87**, and the second heating/cooling device **88** may be adjusted based on hot water supply loads and heating/cooling loads of the first hot water supply device **84**, the first heating/cooling device **85**, the second hot water supply device **87**, and the second heating/cooling device **88**.

[0143] In this embodiment, the single heat pump **80** may perform a hot water supply operation and a heating/cooling operation on a plurality of designated spaces. For example, the first hot water supply device **84** and the first heating/cooling device **85** may be installed at a first location, and the second hot water supply device **87** and the second heating/cooling device **88** may be installed at a second location, so that a hot water supply operation and a heating/cooling operation may be simultaneously or selectively performed at the first and second locations.

[0144] The hot water supply apparatus **8** associated with the heat pump in accordance with the embodiment shown in FIG. **12** may also include heat exchangers **801/802/803**, first and second refrigerant pipes **810/820**, first and second compressors **811/821**, first and second expansion devices **813/823**, first and second flow adjustment switches **815/825**, auxiliary heaters **843/873** and water discharge passages **844/874** provided in hot water supply devices **84/87**, indoor heat exchangers **850/880** having air conditioning heat exchangers **851/881** and floor heat exchangers **852/882**, air conditioning water pipes **854/884**, floor water pipes **855/885** and heating/cooling side three way valves **856/886** provided in heating/cooling devices **85/88**, a source water supply device **86** including a water supply passage **861**, circulation passage **862**, circulation side pump **863**, circulation side supply passage **864**, water supply adjustment device **865**, circulation side discharge passage **866**, water discharge adjustment device **867** and hot water supply side supply passage **868**, and a usage side pump **831**, hot water supply pipe **332**, heating/cooling water pipe **833** and usage side three way valve **835**. These components are similar to corresponding components discussed above with respect to previous embodiment(s), and thus further detailed description will be omitted.

[0145] A hot water supply device associated with a heat pump is provided which may minimize degradation due to an outdoor condition variation and continuously perform a hot water supply operation and a heating operation without a defrosting operation.

[0146] A hot water supply device associated with a heat pump and using the heat pump to perform a hot water supply operation as embodied and broadly described herein may include a first refrigerant circulation part including a first compressor, a cascade heat exchanger in which heat exchanged between a first refrigerant and a second refrigerant, a first expander, a heat source side heat exchanger in which a first refrigerant absorbs or emit heat, so as to form a first refrigerant cycle, and a second refrigerant circulation part including a second compressor, a usage side heat exchanger using a second refrigerant to perform at least one of the hot water supply operation and a heating/cooling operation, a second expander, and the cascade heat exchanger, so as to form a second refrigerant cycle, wherein the refrigerants flowing through the heat source side heat exchanger and the usage side heat exchanger are heat-exchanged with water to continuously perform the hot water supply operation without a defrosting operation. Therefore, according to the present invention, degradation due to the variation in an outdoor condition such as outdoor temperature can be minimized and defrosting operation is unnecessary, and the hot water supply operation and the heating operation can be continuously performed.

[0147] Any reference in this specification to "one embodiment," "an embodiment," "example embodiment," etc., means that a particular feature, structure, or characteristic described in connection with the embodiment is included in at least one embodiment of the invention. The appearances of such phrases in various places in the specification are not necessarily all referring to the same embodiment. Further, when a particular feature, structure, or characteristic is described in connection with any embodiment, it is submitted that it is within the purview of one skilled in the art to effect such feature, structure, or characteristic in connection with other ones of the embodiments.

[0148] Although embodiments have been described with reference to a number of illustrative embodiments thereof, it should be understood that numerous other modifications and embodiments can be devised by those skilled in the art that will fall within the spirit and scope of the principles of this disclosure. More particularly, various variations and modifications are possible in the component parts and/or arrangements of the subject combination arrangement within the scope of the disclosure, the drawings and the appended claims. In addition to variations and modifications in the component parts and/or arrangements, alternative uses will also be apparent to those skilled in the art.

What is claimed is:

1. A hot water supply apparatus associated with a heat pump that performs a hot water supply operation, comprising:

a first refrigerant circuit tha circulates a first refrigerant, including a first compressor, a cascade heat exchanger in which heat is exchanged between the first refrigerant and a second refrigerant, a first expander, and a heat source side heat exchanger in which the first refrigerant absorbs or emits heat; and

a second refrigerant circuit that circulates the second refrigerant, including a second compressor, a usage side heat exchanger that performs at least one of the hot water supply operation or a heating/cooling operation using the second refrigerant, a second expander, and the cascade heat exchanger, wherein refrigerant flowing through the heat source side heat exchanger and the usage side heat exchanger are heat-exchanged with water so as to continuously perform the hot water supply operation without a defrosting operation.

2. The hot water supply apparatus of claim **1**, further comprising:

a hot water supply device that performs the hot water supply operation using at least one of the first refrigerant or the second refrigerant;

a circulation passage that circulates water flowing through the heat source side heat exchanger;

a hot water supply side supply passage that guides water from a water supply source to the hot water supply device; and

a circulation side supply passage connected to the circulation passage so as to to guide water from the water supply source to the heat source side heat exchanger.

3. The hot water supply apparatus of claim **2**, wherein the hot water supply device comprises:

a hot water supply tank that receives and stores water;

an auxiliary heater that selectively heats water in the hot water supply tank; and

a water discharge passage that supplies hot water from the hot water supply tank, wherein the water stored in the hot water supply tank and the water that is heat-exchanged with the first refrigerant in the heat source side heat exchanger are initially supplied from the same water supply source.

4. The hot water supply apparatus of claim **1**, further comprising a source water supply device including a circulation passage through which water flowing through the heat source side heat exchanger circulates, and a circulation side pump that forcibly circulates water in the circulation passage,

wherein the apparatus is configured to circulate water in the circulation passage when a temperature of water supplied by the source water supply device is less than or equal to a freezing and bursting reference temperature, and

wherein the apparatus is configured to resume an operation state thereof prior to the forcible circulation of water in the circulation passage when the temperature of the water supplied by the source water supply device is greater than the freezing and bursting reference temperature.

5. The hot water supply apparatus of claim **1**, further comprising:

a circulation passage that circulates water flowing through the heat source side heat exchanger;

a circulation side supply passage that supplies water to the circulation passage;

a water supply adjustment device that selectively restricts a supply of water to the circulation side supply passage; and

a water discharge adjustment device that selectively restricts discharge of water from the circulation side discharge passage through a circulation side discharge passage.

6. The hot water supply apparatus of claim **5**, wherein the water supply adjustment device and the water discharge adjustment device close the circulation side supply passage and the circulation side discharge passage, respectively, when a temperature of the water in the circulation passage is greater than a circulation reference temperature, and

the water supply adjustment device and the water discharge adjustment device open the circulation side supply passage and the circulation side discharge passage, respectively, when the temperature of the water in the circulation passage is less than or equal to the circulation reference temperature.

7. The hot water supply apparatus of claim **1**, further comprising a first subcooler in which water passing through the heat source side heat exchanger uncergoes heat-exchange with the first refrigerant condensed in one of the cascade heat exchanger or the heat source side heat exchanger, so as to subcool and condense the first refrigerant; and

a second subcooler in which water passing through the heat source side heat exchanger undergoes heat-exchange with the second refrigerant condensed in one of the usage side heat exchanger or the cascade heat exchanger, so as to subcool and condense the second refrigerant.

8. The hot water supply apparatus of claim **1**, further comprising:

an air-conditioning heating/cooling device that performs an indoor heating/cooling operation using the first refrigerant or the second refrigerant;

a hot water supply device that performs the hot water supply operation; and

an air-conditioning heat exchanger installed at an upstream side of the cascade heat exchanger along a flow direction of the first refrigerant, wherein the air-conditioning heat exchanger receives high temperature refrigerant from a discharge side of the first compressor when the hot water supply operation and a heating operation are simultaneously performed.

9. The hot water supply apparatus of claim **8**, wherein the hot water supply device is connected to the usage side heat exchanger and employs a cascade cycle.

10. The hot water supply apparatus of claim **1**, further comprising:

a hot water supply device that performs the hot water supply operation using a high temperature refrigerant received from at least one of the first compressor or the second compressor; and

a first flow switch and a second flow switch that respectively switch a refrigerant flow direction of the first refrigerant circuit and a refrigerant flow direction of the second refrigerant circuit based on operation in a heating mode or a cooling mode.

11. The hot water supply apparatus of claim **10**, wherein the hot water supply device is connected between the compressor and the flow switch of a respective refrigerant cycle of a respective refrigerant circuit so as to perform the hot water supply operation during operation in both the heating mode and the cooling mode.

12. The hot water supply apparatus of claim **10**, further comprising a desuperheater heat exchanger in which high temperature refrigerant received from at least one of the first compressor or the second compressor flows,

wherein the apparatus performs the hot water supply operation using water that has undergone heat-exchange with refrigerant in the desuperheater heat exchanger to heat water held in the hot water supply device,

and wherein an amount of refrigerant discharged from the at least one of the first compressor of the second compressor and flowing to the desuperheater heat exchanger and an amount of refrigerant bypassing the desuperheater heat exchanger are varied based on a hot water supply load and a heating/cooling load.

13. The hot water supply apparatus claim **1**, wherein the hot water supply apparatus is a multi-system apparatus comprising:

a first hot water supply device that genrates hot water using water that has undergone heat-exchange with refrigerant in the usage side heat exchanger;

a first heating/cooling device that heats or cools a first designated space using water that has undergone heat-exchange with refrigerant in the usage side heat exchanger;

a second hot water supply that directly heats water for the hot water supply operation using at least one of the first refrigerant or the second refrigerant; and

a second heating/cooling device that directly heats or cools a second designated space using at least one of the first refrigerant or the second refrigerant.

14. A hot water supply apparatus associated with a heat pump that performs a hot water supply operation, comprising:

a cascade heat pump, including:

a first refrigerant circuit including a heat source side heat exchanger in which a first refrigerant absorbs or emits heat; and

a second refrigerant circuit connected to the first refrigerant circuit so as to form a two-stage refrigerant cycle;

a hot water supply device coupled to the cascade heat pump so as to perform the hot water supply operation; and

a desuperheater heat exchanger simultaneously connected to the hot water supply device and to at least one of the first refrigerant circuit or the second refrigerant circuit so as to perform the hot water supply operation using a high temperature refrigerant received from a compressor of the at least one of the first refrigerant circuit or the second refrigerant circuit,

wherein refrigerant flowing through the heat source side heat exchanger and the desuperheater heat exchanger are heat-exchanged with water so as to continuously perform the hot water supply operation without a defrosting operation.

15. The hot water supply apparatus of claim **14**, wherein an amount of refrigerant discharged from the compressor and flowing to the desuperheater heat exchanger and an amount of refrigerant bypassing the desuperheater heat exchanger are varied based on a hot water supply load and a heating/cooling load,

wherein the apparatus is configured to increase the amount of refrigerant flowing to the desuperheater heat exchanger and to decrease the amount of refrigerant bypassing the desuperheater heat exchanger when the hot water supply load is greater than the heating/cooling load, and

the apparatus is configured to decrease the amount of refrigerant flowing to the desuperheater heat exchanger and to increase the amount of refrigerant bypassing the desuperheater heat exchanger when the heating/cooling load is greater than the hot water supply load.

16. The hot water supply apparatus of claim **14**, further comprising a flow switch that switches a refrigerant flow direction between a heating mode and a cooling mode,

wherein the desuperheater heat exchanger is installed between the compressor and the flow switch of the one of the first or second refrigerant circuit to which the desuperheater heat exchanger is connected so as to continuously perform the hot water supply operation in both the heating and the cooling modes.

17. The hot water supply apparatus of claim **14**, wherein the compressor is a multi-stage compressor including a low stage compression part coupled to a middle compression part that compresses refrigerant received from the low stage compression part, wherein the hot water supply apparatus further comprises:

a phase divider that divides condensed refrigerant into a vapor refrigerant and a liquid refrigerant; and

an injection pipe that guides the vapor refrigerant from the phase divider to the middle compression part of the multi-stage compressor.

18. The hot water supply apparatus of claim **14**, further comprising an air-conditioning heat exchanger connected to the second refrigerant circuit to heat or cool indoor air using refrigerant flowing through the second refrigerant circuit.

19. The hot water supply apparatus of claim **14**, further comprising a cascade heat exchanger in which heat is exchanged between the first refrigerant circulated in the first refrigerant circuit and a second refrigerant circulated in the second refrigerant circuit.

20. The hot water supply apparatus of claim **14**, wherein the desuperheater heat exchanger comprises:

a first desuperheater heat exchanger connected to the first refrigerant circcircuit and the hot water supply device; and

a second desuperheater heat exchanger connected to the second refrigerant circuit and the hot water supply device,

wherein the apparatus is configured to vary amounts of refrigerant passing respectively through the first and second desuperheater heat exchangers and amounts of refrigerant respectively bypassing the first and second desuperheater heat exchangers based on a hot water supply load and a heating/cooling load.

21. The hot water supply apparatus of claim **20**, wherein the apparatus is configured to increase the amounts of refrigerant passing respectively through the first and second desuperheater heat exchangers and to decrease the amounts of refrigerant respectively bypassing the first and second desuperheater heat exchangers when the hot water supply load is greater than the heating/cooling load, and

wherein the apparatus is configured to decrease the amounts of refrigerant passing respectively through the first and second desuperheater heat exchangers and to increase the amounts of refrigerant respectively bypassing the first and second desuperheater heat exchangers when the heating/cooling load is greater than the hot water supply load.

22. The hot water supply apparatus of claim **14**, further comprising a source water supply device including a circulation passage that circulates water flowing through the heat source side heat exchanger, and a circulation side pump that forcibly circulates water through the circulation passage,

wherein the apparatus is configured to circulate the water in the circulation passage when a temperature of the water in the water supply device is less than or equal to a freezing and bursting reference, and

wherein the apparatus is configured to resume an operation state thereof prior to the forcible circulation of the water in the circulation passage when the temperature of the water of the water supply device is greater than the freezing and bursting reference temperature.

23. The hot water supply apparatus of claim **14**, further comprising a circulation passage that circulates water flowing through the heat source side heat exchanger,

wherein the apparatus is configured to circulate the water in the circulation passage without supplying water to and discharging water from the circulation passage when a temperature of the water of the circulation passage is greater than a circulation reference temperature, and

wherein the apparatus is configured to supply water to and discharge water from the circulation passage when the temperature of the water of the circulation passage is less than or equal to the circulation reference temperature.

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