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**Kim et al.**(10) **Pub. No.: US 2007/0289319 A1**(43) **Pub. Date: Dec. 20, 2007**(54) **GEOTHERMAL AIR CONDITIONING  
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**F24F 5/00** (2006.01)(52) **U.S. Cl.** ..... **62/175**(57) **ABSTRACT**(76) Inventors: **In Kyu Kim**, Jinhae-si (KR); **Jung  
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Provided is a geothermal air conditioning system. The system includes a plurality of indoor units, at least one outdoor unit, a ground heat exchanger, and an auxiliary heat source. The plurality of indoor units condition indoor air, the at least one outdoor unit communicates with the indoor units via, a plurality of pipes, and includes an outdoor heat exchanger where heat exchange occurs, and a plurality of compressors for compressing coolant. The ground heat exchanger is connected with the outdoor heat exchanger of the outdoor unit, and laid under the ground to allow heat to be exchanged between ground heat and a circulating medium circulating through the ground heat exchanger. The auxiliary heat source is installed on one side of the outdoor unit to assist heat exchange of the outdoor heat exchanger.

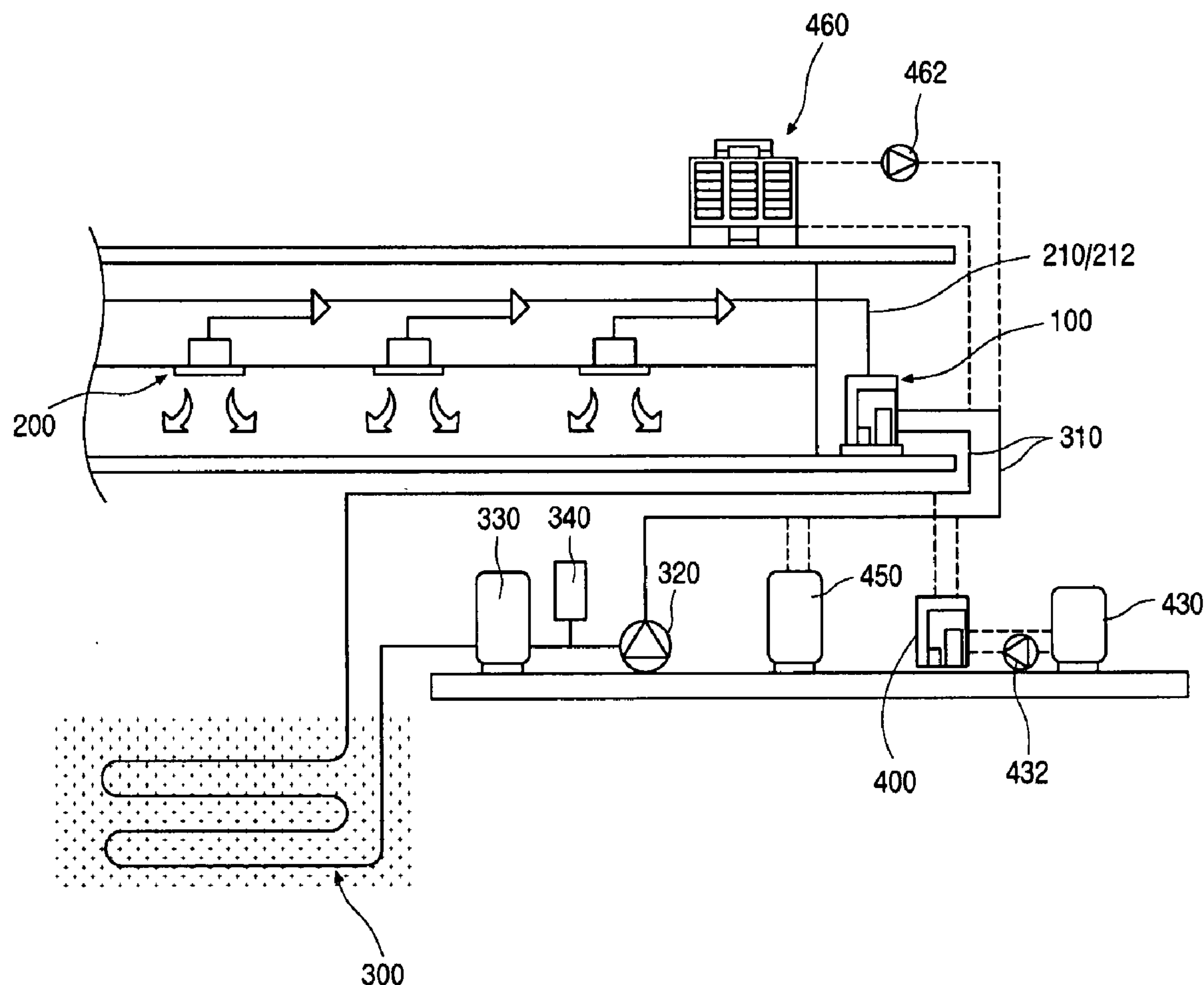




FIG. 1

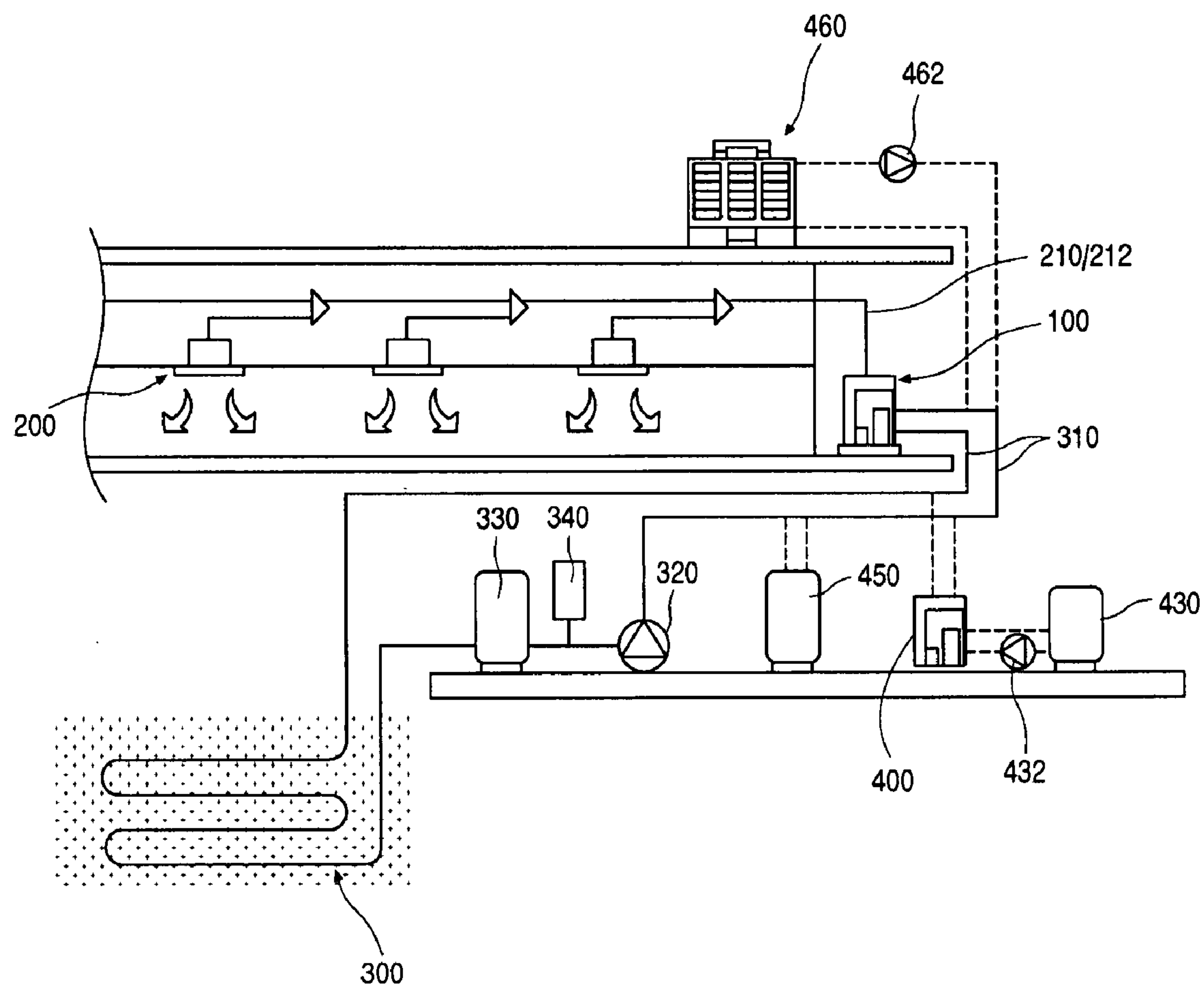




FIG.2

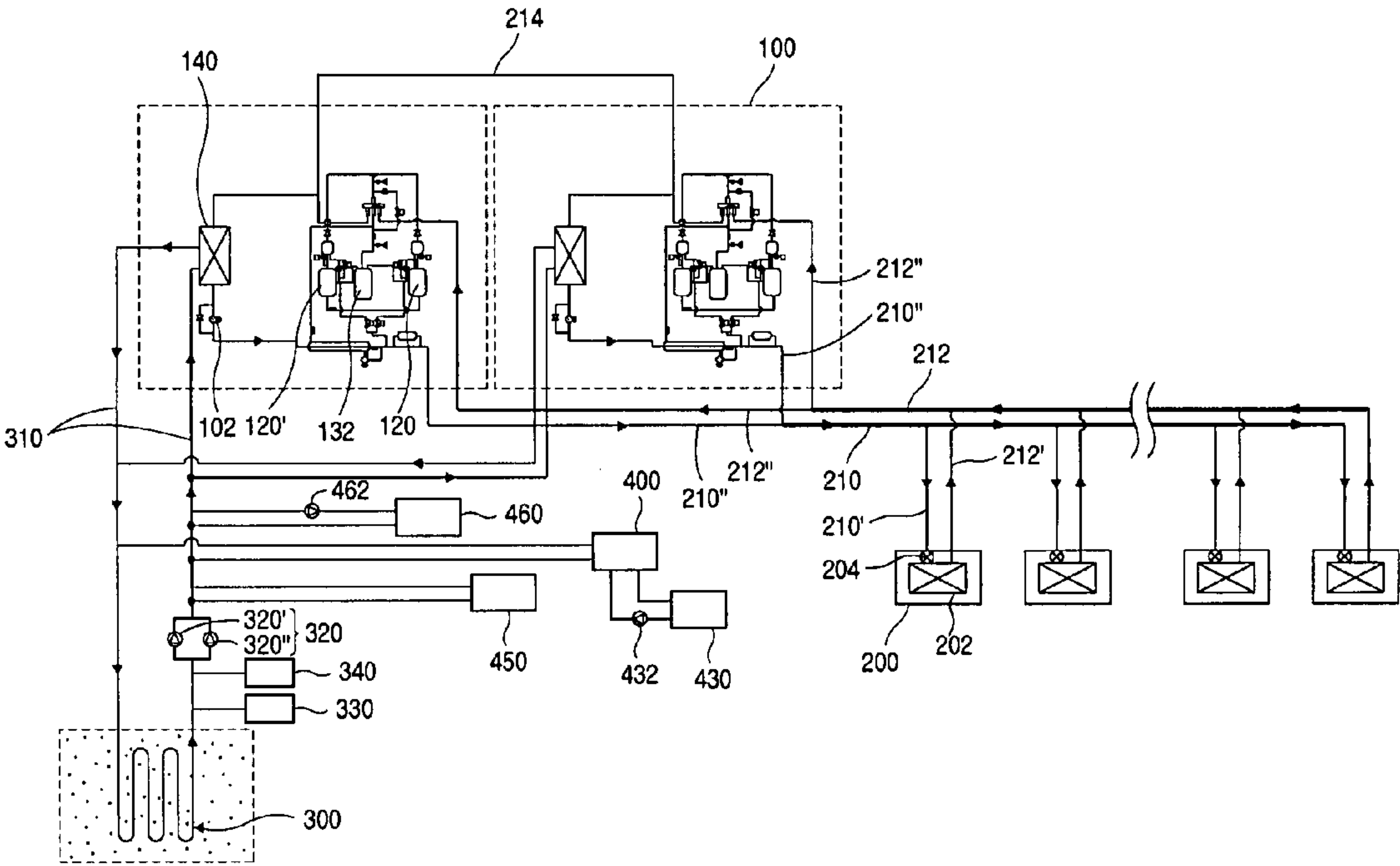




FIG.3

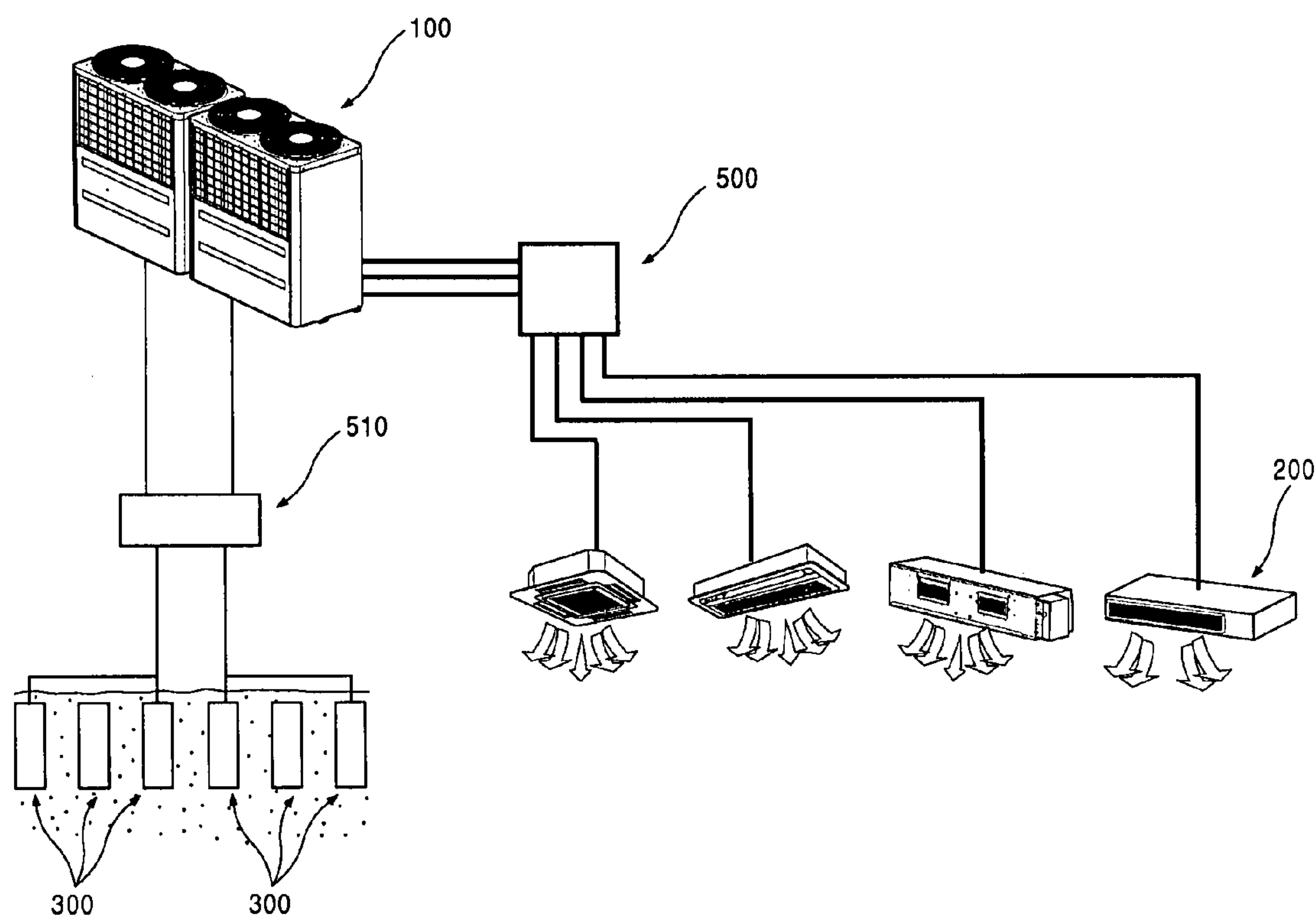




FIG. 4

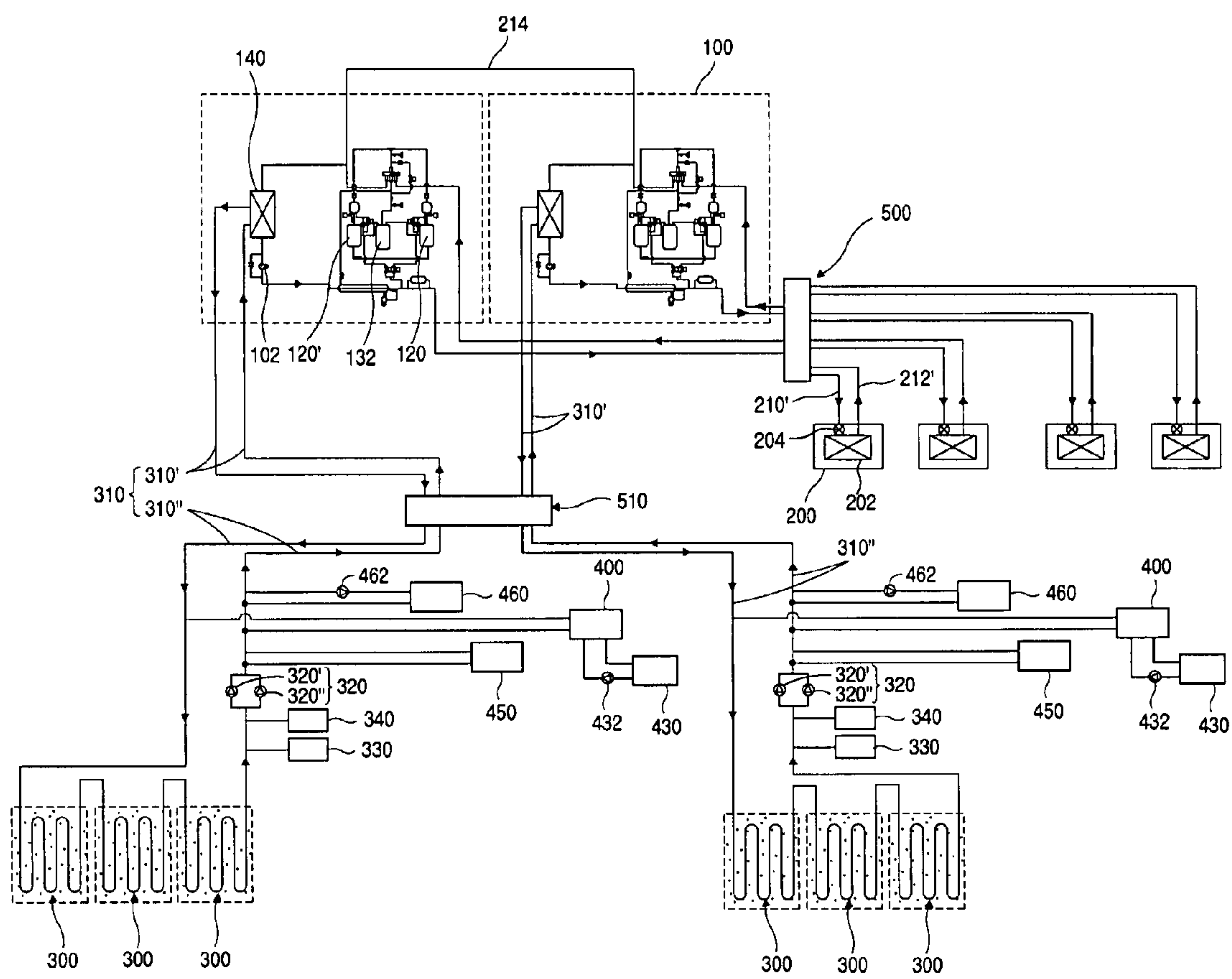




FIG. 5

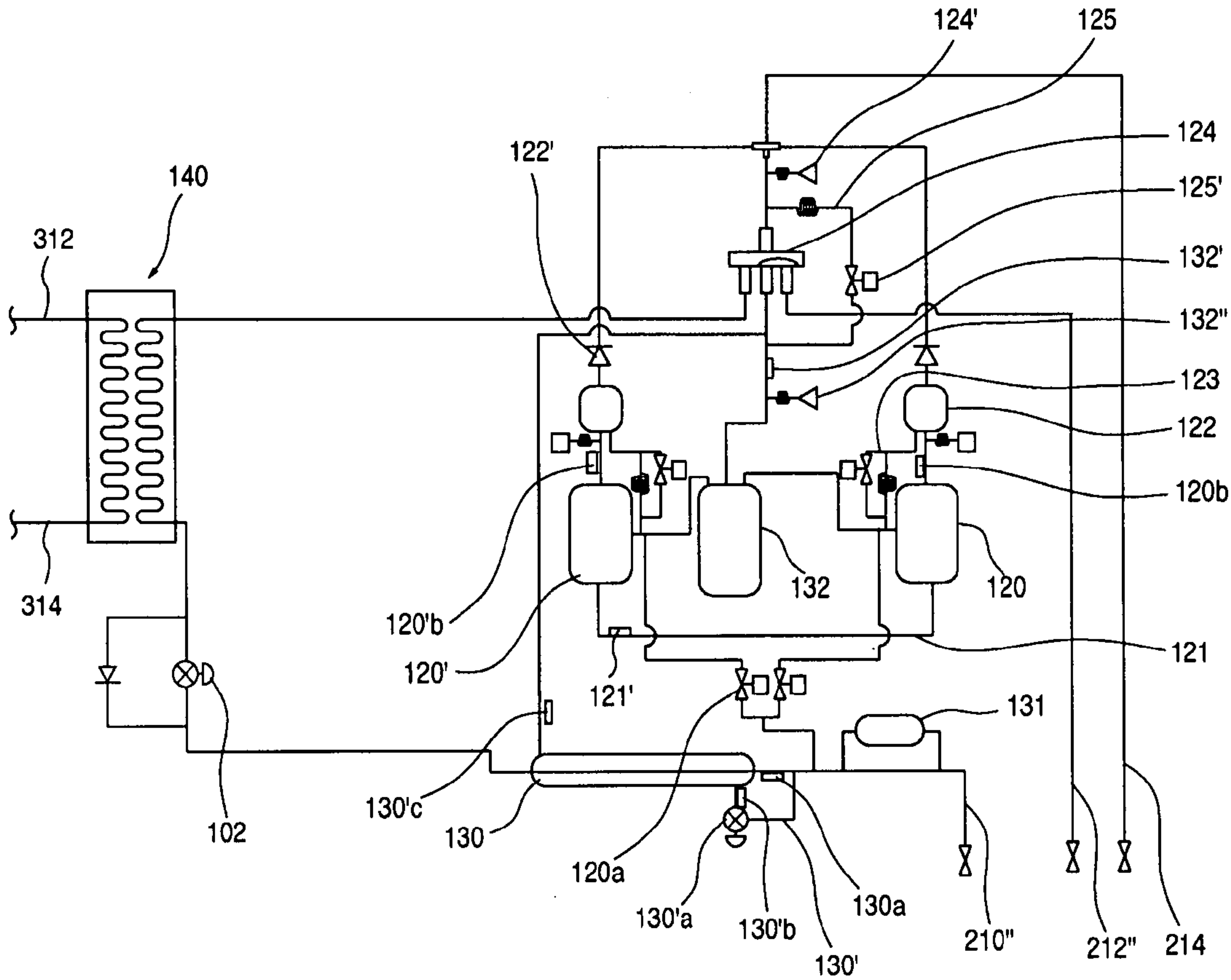




FIG. 6

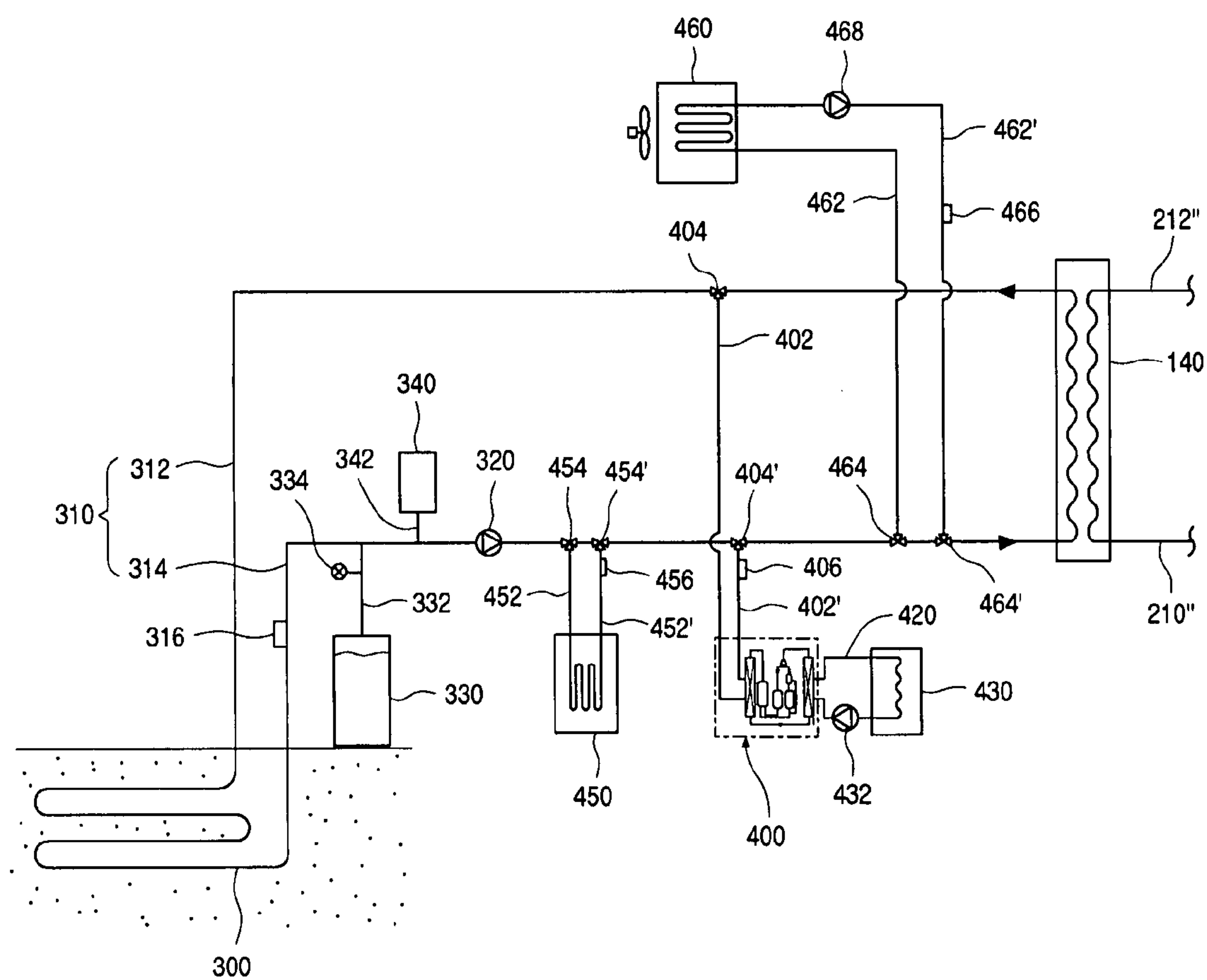




FIG. 7

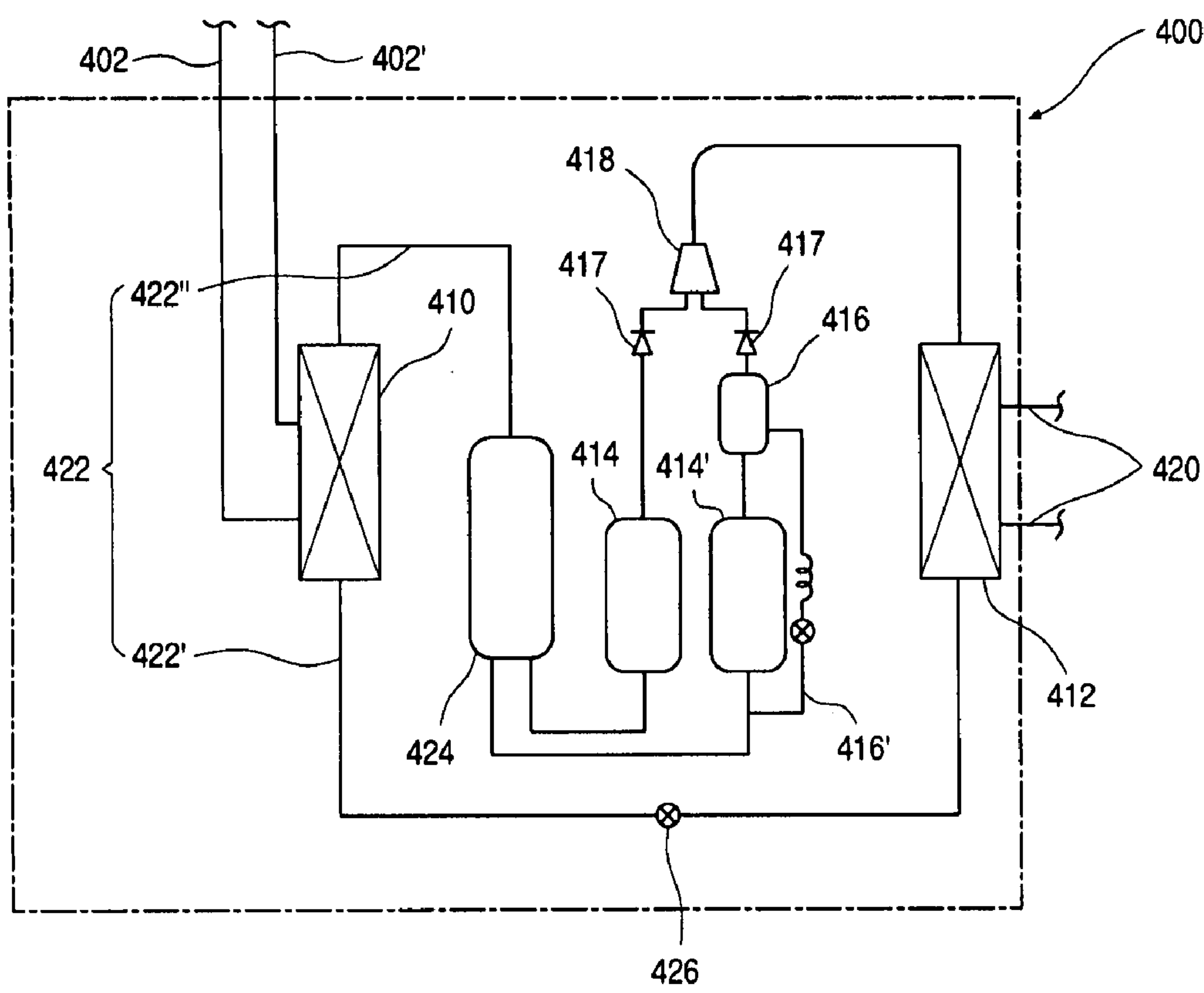




FIG. 8

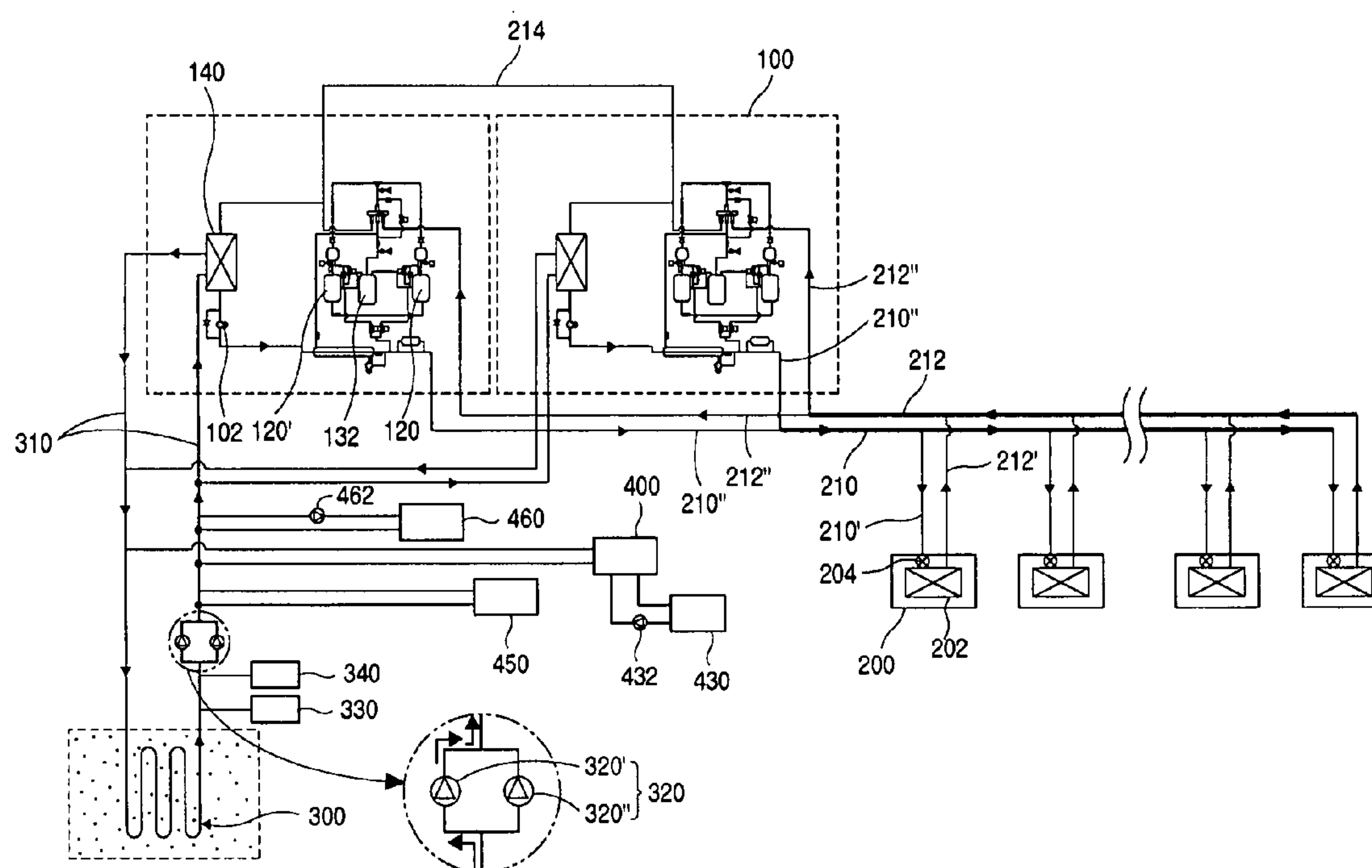




FIG. 9

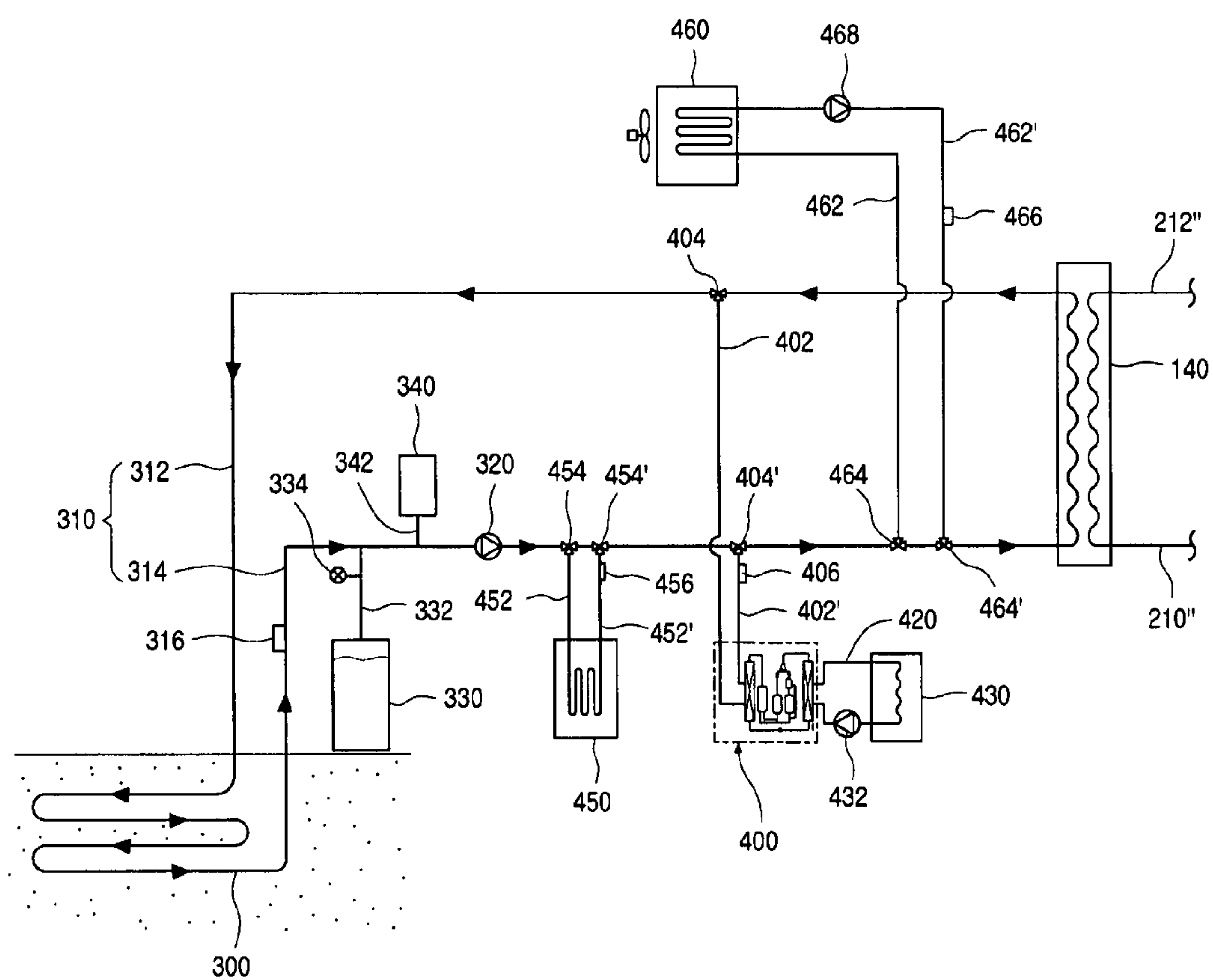




FIG. 10

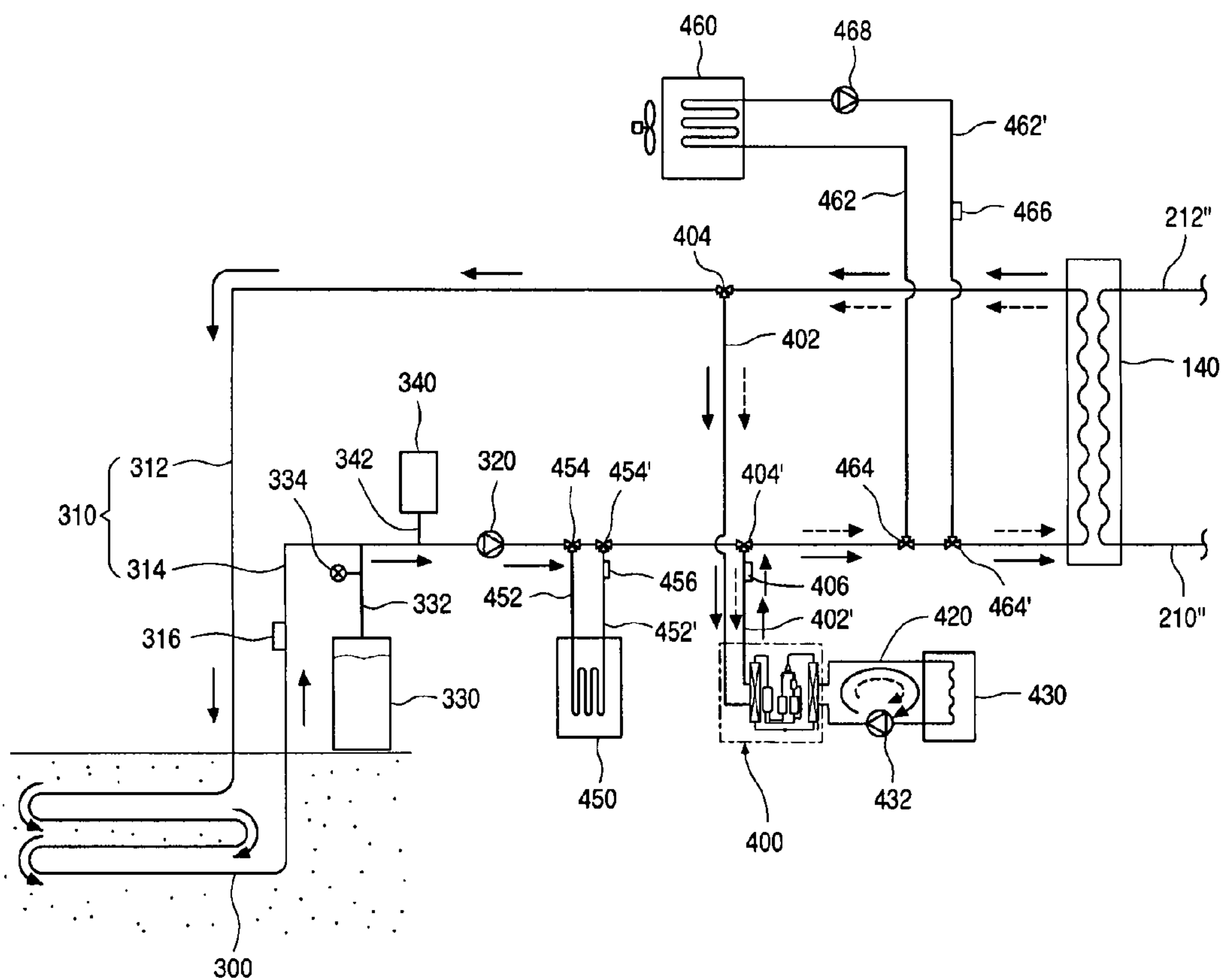




FIG. 11

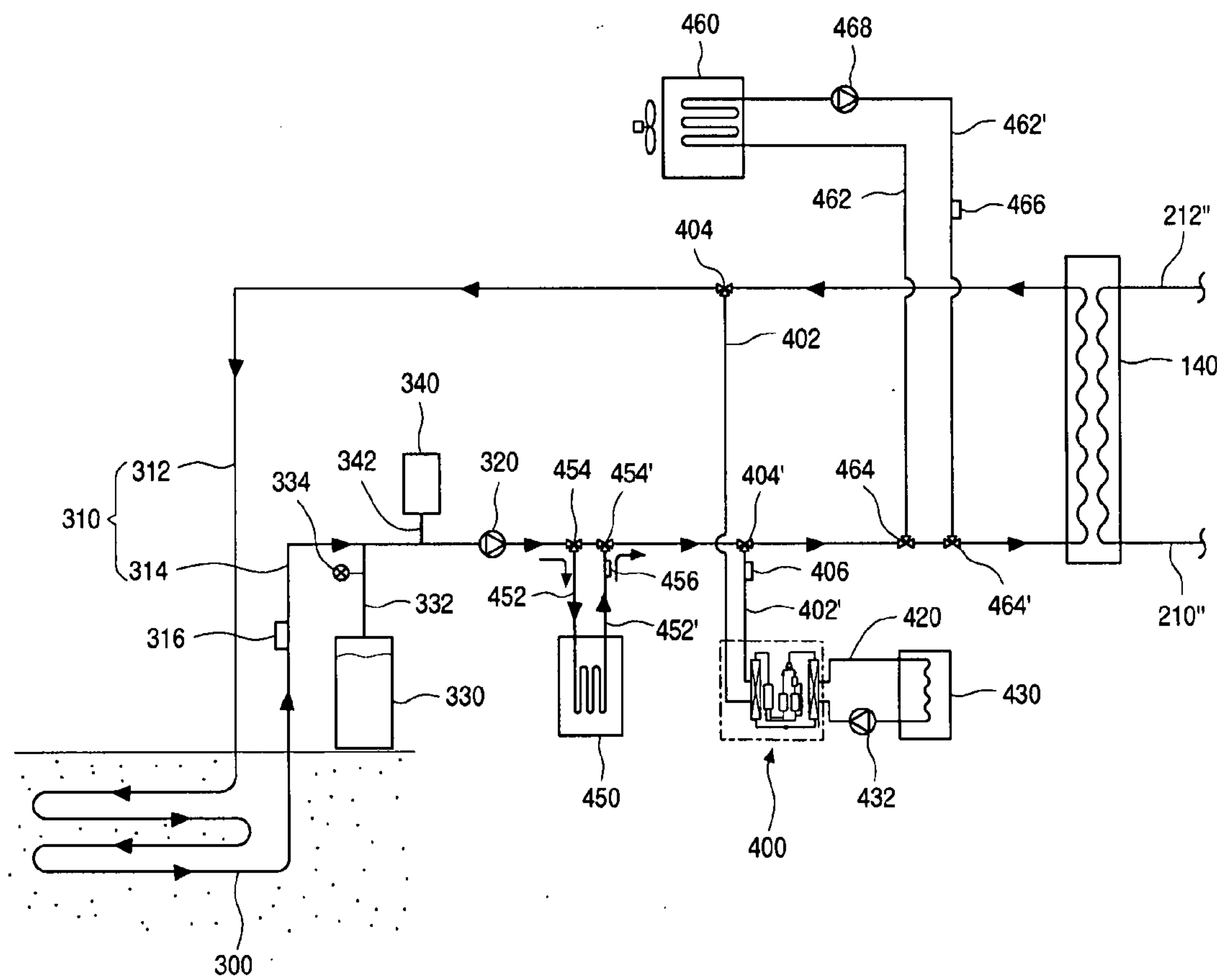




FIG. 12

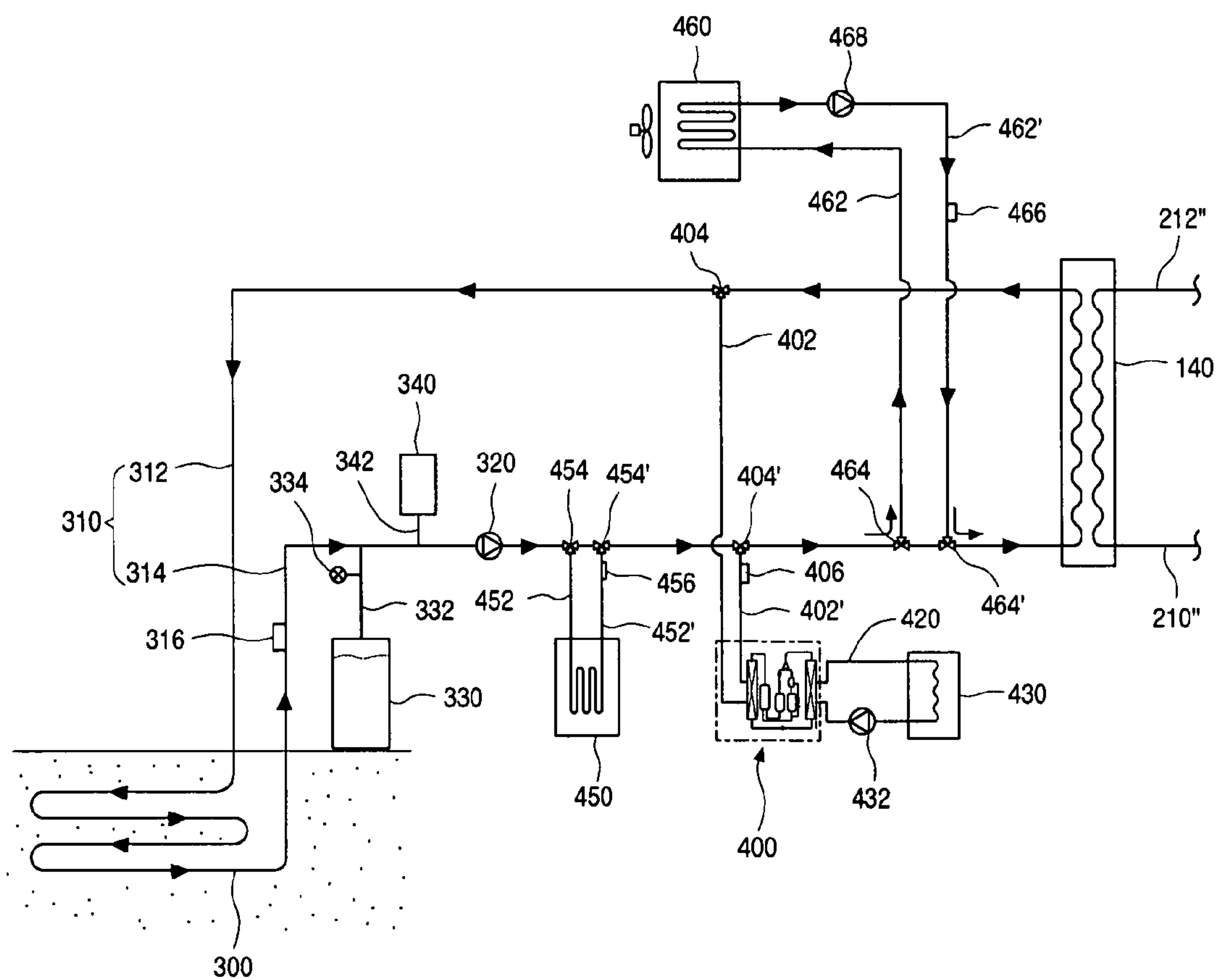




FIG. 13

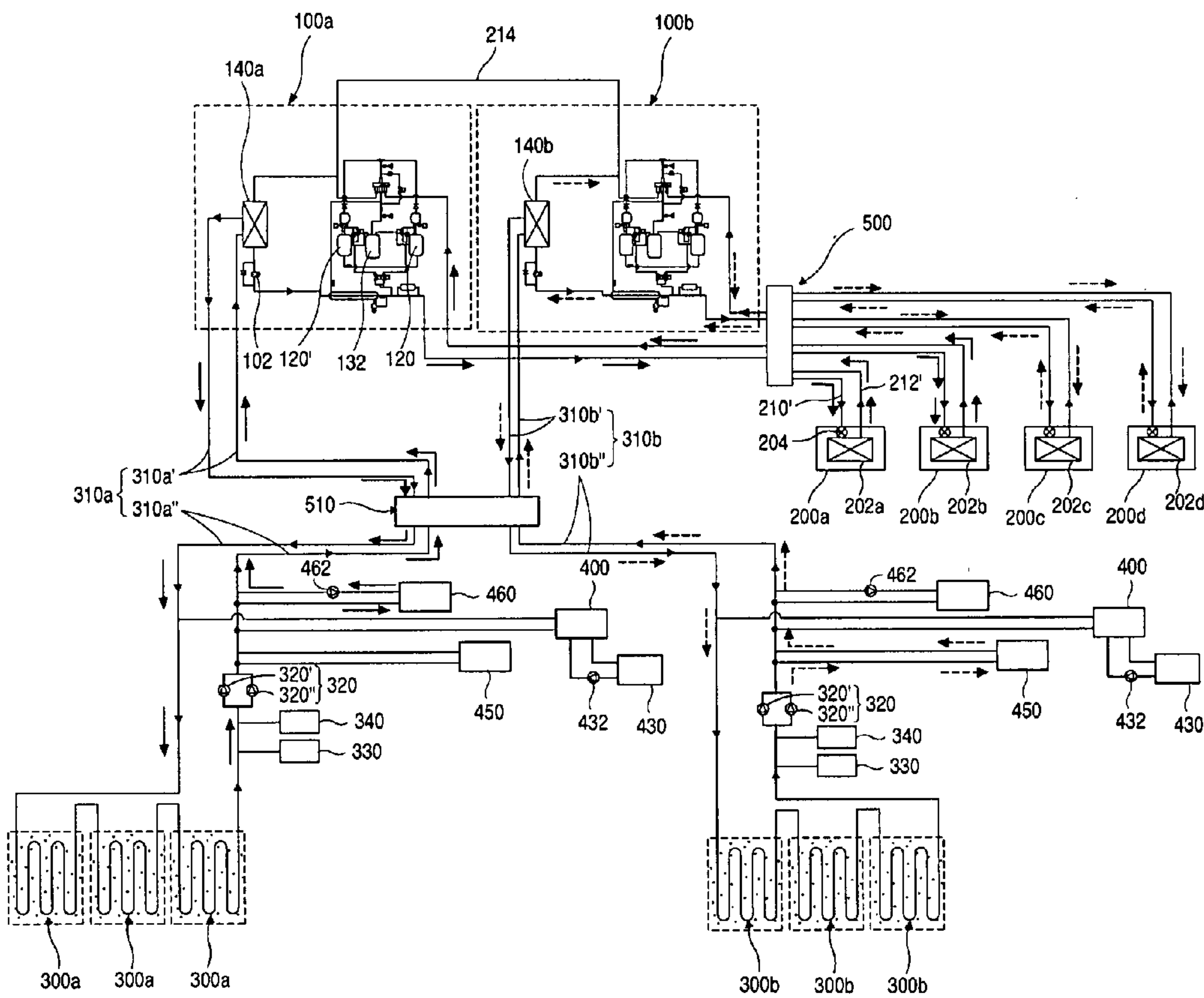




FIG. 14

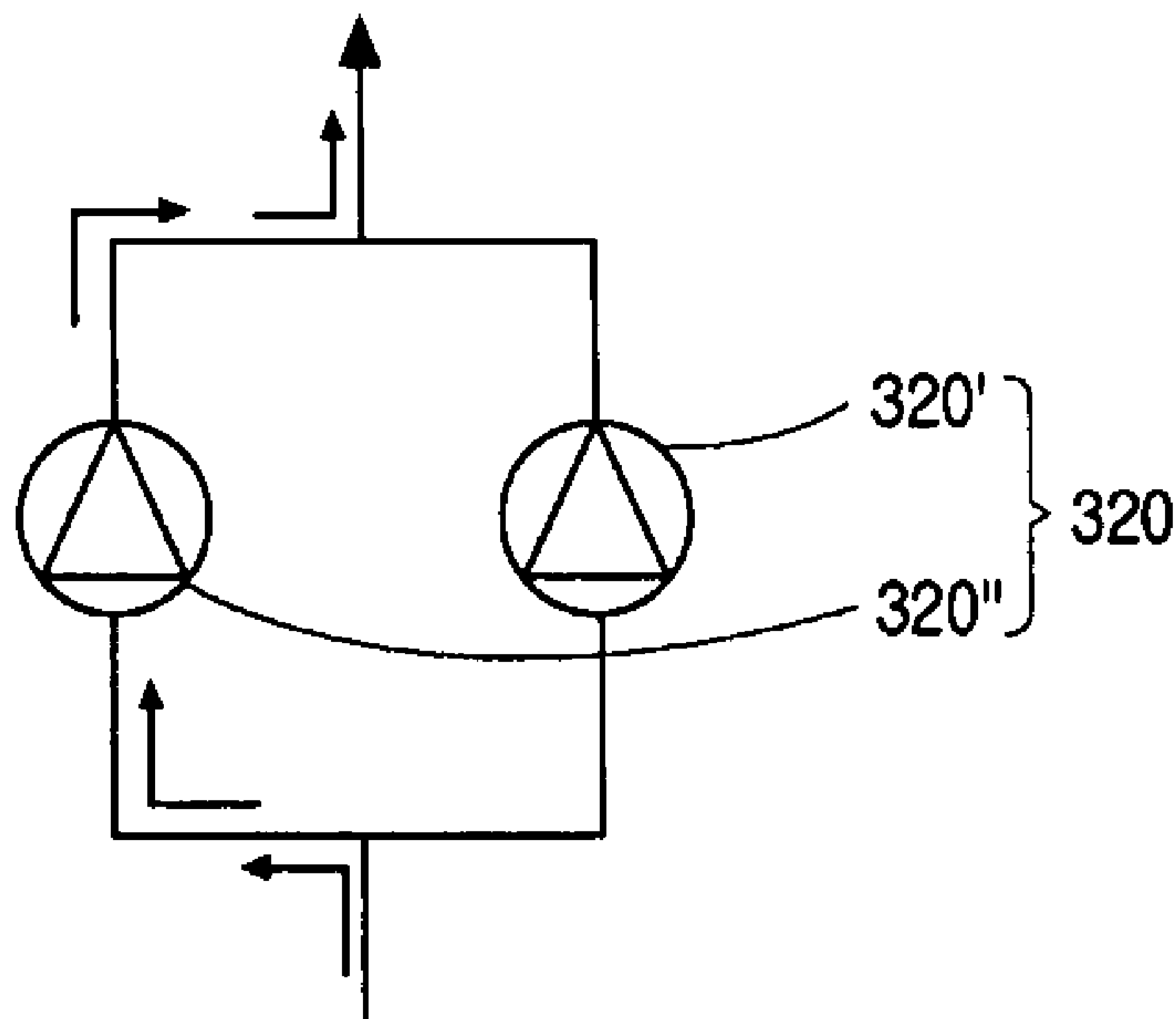
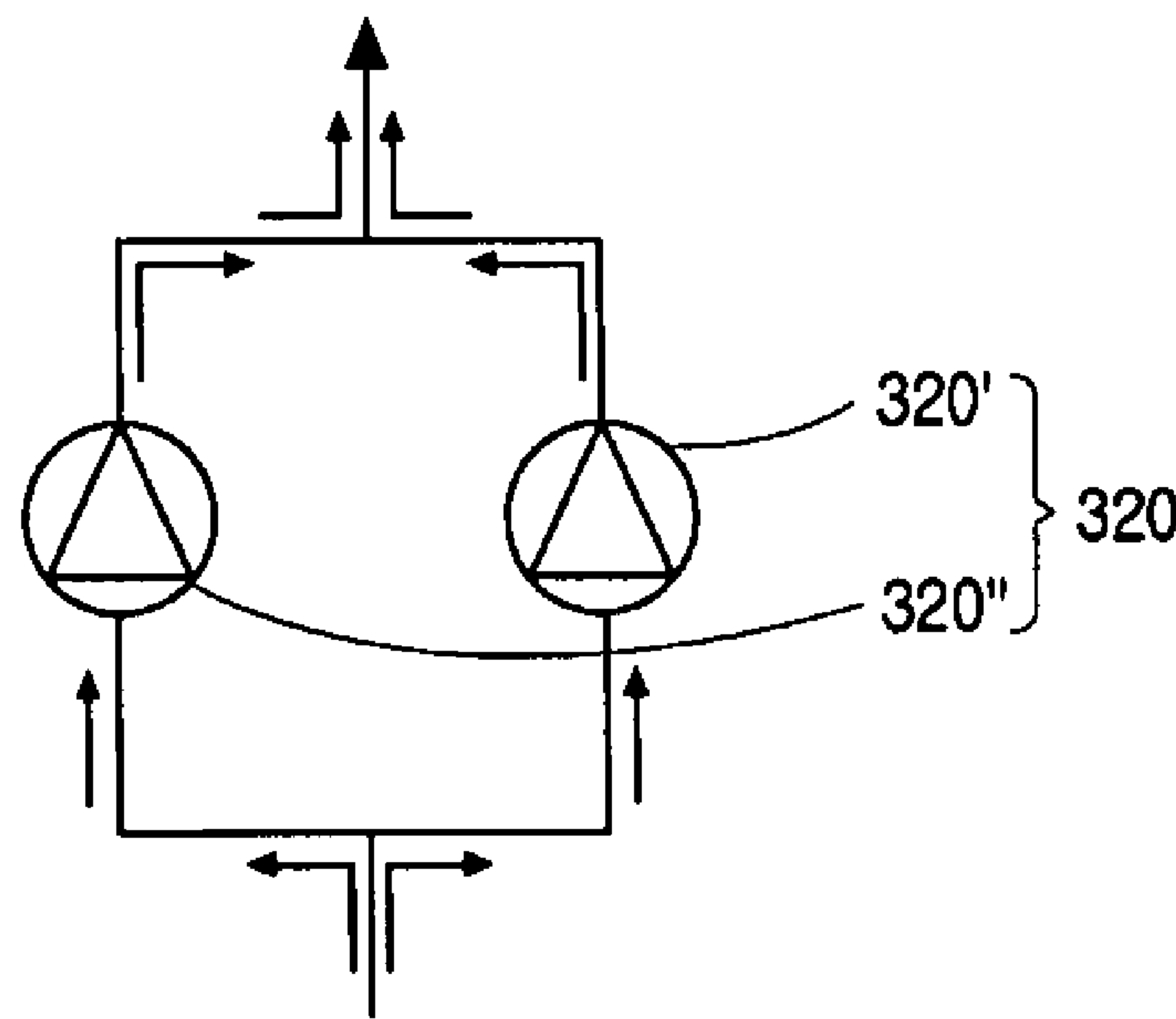


FIG. 15





## GEOTHERMAL AIR CONDITIONING SYSTEM

### BACKGROUND OF THE INVENTION

#### [0001] 1. Field of the Invention

[0002] The present invention relates to a geothermal air conditioning system, and more particularly, to an air conditioning system including a plurality of ground heat exchangers having a plurality of circulating pumps that can operate individually and selectively to perform heat exchange using ground heat, and including a plurality of compressors provided to an outdoor unit and selectively used depending on a load.

#### [0003] 2. Description of the Related Art

[0004] Generally, an air conditioning system called an air conditioner a cooling/heating system for cooling an indoor space through repetition of sucking warm indoor air, exchanging heat with coolant of low temperature, and discharging the indoor space, or for heating the indoor space through a reverse operation. The air conditioning system provides a series of cycles of a compressor-condenser-expansion valve-evaporator.

[0005] Also, recently, the air conditioning system also provides an air conditioning function of sucking and filtering polluted air of the indoor space, purifying the polluted air into clean air, and supplying the clean air back to the indoor space, and a variety of additional functions such as a dehumidifying function of changing humid air into dry air and supplying the dry air back to the indoor space.

[0006] Meanwhile, as is generally known in the art, an air conditioner is roughly classified into a separation type air conditioner where an outdoor unit and an indoor unit are separately installed, and an integral type air conditioner where the outdoor unit and the indoor unit are integrally installed.

[0007] However, a related art air conditioner maintains an indoor space at an appropriate state through a heat exchange operation between coolant of the inside of the air conditioner and outside air. Therefore, temperature of outside air is too low during a heating cycle, and too high during a cooling cycle in a heat exchange system using the air.

[0008] Therefore, great energy is consumed in absorbing and exhausting heat from coolant. When temperature of outside air is not constant, it is difficult to stably operate a cooling cycle and a heating cycle due to abnormality of a heat source required for the heating/cooling cycles.

[0009] Meanwhile, to solve problems of a heat exchange system using outside air, there recently emerges a basic air conditioning system performing outside heat exchange using ground heat as a heat source. Therefore, since the air conditioning system using the ground heat exchanges heat using ground heat as a heat source without an influence caused by temperature of outside air, it provides higher thermal efficiency (coefficient-of-performance (COP) and energy efficiency ratio (EER)) than that of an air conditioning system using air.

[0010] However, an air conditioning system using ground heat has lots of problems. That is, despite advantages such as thermal efficiency improvement, the air conditioning system using ground heat still has a problem that stability and reliability of cooling/heating cycles decreases when coolant that has flowed through an outdoor heat exchanger

after it exchanges heat in an indoor space does not sufficiently exhaust/absorb heat to/from the ground during cooling/heating cycles.

[0011] Also, since a related art air conditioning system uses only one compressor or pump for flowing of fluid such as coolant, the compressor or pump cannot be selectively used depending on capacity of a load. Therefore, a high capacity compressor or pump with consideration of a maximum load should be always used. Accordingly, power is wasted in the case where a relatively low load is required.

### SUMMARY OF THE INVENTION

[0012] Accordingly, the present invention is directed to a geothermal air conditioning system that substantially obviates one or more problems due to limitations and disadvantages of the related art.

[0013] An object of the present invention is to provide a geothermal air conditioning system for exchanging heat using ground heat.

[0014] Another object of the present invention is to provide a geothermal air conditioning system including a plurality of outdoor heat exchangers and ground heat exchangers, wherein circulation distributors are provided between the outdoor heat exchangers and the ground heat exchangers to control flow of circulating media.

[0015] A further another object of the present invention is to provide a geothermal air conditioning system including a plurality of circulating pumps that can be selectively used depending on a load condition.

[0016] A still further another object of the present invention is to provide a geothermal air conditioning system including an auxiliary heat source for allowing heat to be sufficiently exchanged at an outdoor heat exchanger.

[0017] An even further another object of the present invention is to provide a geothermal air conditioning system including a plurality of compressors, wherein an extra compressor is selectively used depending on load capacity.

[0018] Additional advantages, objects, and features of the invention will be set forth in part in the description which follows and in part will become apparent to those having ordinary skill in the art upon examination of the following or may be learned from practice of the invention. The objectives and other advantages of the invention may be realized and attained by the structure particularly pointed out in the written description and claims hereof as well as the appended drawings.

[0019] To achieve these objects and other advantages and in accordance with the purpose of the invention, as embodied and broadly described herein, there is provided a geothermal air conditioning system including: a plurality of indoor units for conditioning indoor air; at least one outdoor unit communicating with the indoor units via a plurality of pipes, and including an outdoor heat exchanger where heat exchange occurs, and a plurality of compressors for compressing coolant; a ground heat exchanger connected with the outdoor heat exchanger of the outdoor unit, and laid under the ground to allow heat to be exchanged between ground heat and a circulating medium circulating through the ground heat exchanger; and an auxiliary heat source installed on one side of the outdoor unit to assist heat exchange of the outdoor heat exchanger.

[0020] In another aspect of the present invention, there is provided a geothermal air conditioning system including: a plurality of indoor units for conditioning indoor air; a



plurality of outdoor units provided on one side of the indoor unit and including an outdoor heat exchanger where coolant circulating through the outdoor heat exchanger exchanges heat with outside air, and a compressor for compressing the coolant; a plurality of ground heat exchangers connected with the outdoor heat exchanger of the outdoor unit, and laid under the ground to allow heat to be exchanged between ground heat and a circulating medium circulating through the ground heat exchangers; and a circulation distributor installed between the plurality of outdoor heat exchangers and the ground heat exchangers to control flow of the circulating medium depending on an operating condition.

[0021] In further another aspect of the present invention, there is provided a geothermal air conditioning system including: a plurality of indoor units for conditioning indoor air; at least one outdoor unit communicating with the indoor units via a plurality of pipes, and including an outdoor heat exchanger where heat exchange occurs, and a plurality of compressors for compressing coolant; a ground heat exchanger connected with the outdoor heat exchanger of the outdoor unit, and laid under the ground to allow heat to be exchanged between ground heat and a circulating medium circulating through the ground heat exchanger; an auxiliary heat source installed on one side of the outdoor unit to assist heat exchange of the outdoor heat exchanger; a circulation distributor installed between the plurality of outdoor heat exchangers and the ground heat exchangers to control flow of the circulating medium depending on an operating condition; a circulating pipe installed between the outdoor heat exchanger and the ground heat exchanger to guide circulation of the circulating medium; and circulating pumps installed at the circulating pipe to force flowing of the circulating medium.

[0022] A geothermal air conditioning system of the present invention is used for improving an air conditioning performance.

[0023] First, coolant at an outdoor heat exchanger provided to an outdoor unit exchanges heat using circulating medium such as water. The circulating medium exchanges heat with ground heat at a ground heat exchanger laid deep under the ground. Since the outdoor heat exchanger is a water-cooled heat exchanger where heat is exchanged between a circulating medium (water) and ground heat as described above, the outdoor heat exchanger of the present invention provides relatively higher thermal efficiency of COP and EER than that of a related art heat exchanger using air. Therefore, an air conditioning performance of the air conditioning system improves.

[0024] Second, the present invention provides a system for cooling or heating a circulating medium using an auxiliary heat source besides a ground heat exchanger that uses ground heat. Therefore, in the case where ground heat is insufficient in condensing or evaporating coolant at an outdoor heat exchanger, the auxiliary heat source operates to assist heating or cooling of a circulating medium. Therefore, there is an advantage that coolant can be evaporated or condensed using the auxiliary heat source even under an environment where ground heat is insufficient for the outdoor heat exchanger to evaporate or condense the coolant. That is, an air conditioning system according to the present invention exhibits a stable air conditioning performance, not affected by ground heat.

[0025] Third, a constant-speed compressor and an inverter compressor are provided according to the present invention,

and selectively used depending on a size of a load. Therefore, since only the inverter compressor operates when a relatively low load is required, power is saved compared to the case where a high-capacity single compressor is used in a related art. That is, it is possible to prevent wasting power for driving a compressor in the case where a low load is required.

[0026] Fourth, a plurality of outdoor units, indoor units, and ground heat exchangers are provided, and a coolant distributor for distributing coolant and a circulation distributor for distributing a circulating medium are installed according to the present invention. Therefore, since only some of the indoor units, the outdoor units, and the ground heat exchangers can be used depending on a selection of a user or a set value of a control unit, energy is saved. That is, since an operation of unnecessary units is prevented, an energy efficiency improves.

[0027] Fifth, a plurality of circulating pumps for supplying a circulating medium are provided according to the present invention. Therefore, since some of the circulating pumps can be selectively used depending on a load, costs are saved in comparison with the case where a maximum capacity pump is installed uniformly and operated as in the related art.

[0028] It is to be understood that both the foregoing general description and the following detailed description of the present invention are exemplary and explanatory and are intended to provide further explanation of the invention as claimed.

#### BRIEF DESCRIPTION OF THE DRAWINGS

[0029] The accompanying drawings, which are included to provide a further understanding of the invention and are incorporated in and constitute a part of this application, illustrate embodiment(s) of the invention and together with the description serve to explain the principle of the invention. In the drawings:

[0030] FIG. 1 is a view illustrating a geothermal air conditioning system is installed according to a first embodiment of the present invention;

[0031] FIG. 2 is a block diagram illustrating a construction and a coolant flow of a geothermal air conditioning system according to the present invention;

[0032] FIG. 3 is a view illustrating a geothermal air conditioning system is installed according to a second embodiment of the present invention;

[0033] FIG. 4 is a block diagram illustrating a construction and a coolant flow of a geothermal air conditioning system according to a second embodiment of the present invention;

[0034] FIG. 5 is a view illustrating a construction of an outdoor unit, which is a crucial part of a geothermal air conditioning system according to the present invention;

[0035] FIG. 6 is a block diagram illustrating connections of an auxiliary heat source constituting a geothermal air conditioning system according to the present invention;

[0036] FIG. 7 is a block diagram illustrating a hot water heat pump according to an embodiment of the present invention;

[0037] FIG. 8 is a view illustrating flow of coolant and a circulating medium according to a first embodiment of the present invention;

[0038] FIG. 9 is a view illustrating a circulating medium circulates through a circulating pipe in a geothermal air conditioning system according to the present invention;



[0039] FIG. 10 is a view illustrating flow of a circulating medium when a hot water heat pump in a geothermal air conditioning system according to the present invention;

[0040] FIG. 11 is a view illustrating flow of a circulating medium when a boiler operates according to an embodiment of the present invention;

[0041] FIG. 12 is a view illustrating flow of a circulating medium when a cooling tower operates according to an embodiment of the present invention;

[0042] FIG. 13 is a view illustrating flow of coolant and a circulating medium when partial cooling and partial heating are performed according to a second embodiment of the present invention; and

[0043] FIGS. 14 and 15 are partial enlarged views illustrating flow of a circulating medium according to a second embodiment of the present invention.

#### DETAILED DESCRIPTION OF THE INVENTION

[0044] Reference will now be made in detail to the preferred embodiments of the present invention, examples of which are illustrated in the accompanying drawings. The present invention provides a geothermal air conditioning system that uses an outdoor unit also called ground source heat pumps (GSHPs). The geothermal air conditioning system is a system that uses ground heat as a heat source of an outdoor heat exchanger, wherein the outdoor heat exchanger exchanges heat using water (heat exchange water) having a predetermined temperature caused by the ground heat.

[0045] FIG. 1 is a view illustrating a geothermal air conditioning system is installed according to a first embodiment of the present invention, and FIG. 2 is a block diagram of a geothermal air conditioning system according to the present invention.

[0046] Referring to FIGS. 1 and 2, the geothermal air conditioning system includes one or more indoor units 200 for conditioning indoor air, one or more outdoor units 100 for communicating with the indoor units 100 via a plurality of pipes, a ground heat exchanger 300 laid under the ground to allow heat to be exchanged between ground heat and a circulating medium circulating through an inside of the ground heat exchanger; and a plurality of auxiliary heat sources 400, 450, and 460 for assisting heat exchange at an outdoor heat exchanger provided to the outdoor unit 100.

[0047] The outdoor unit 100 includes a constant-speed compressor 120, an inverter compressor 120', an accumulator 132, an outdoor heat exchanger 140, and an outdoor linear expansion valve (LEV) 102. The indoor unit 200 includes an indoor heat exchanger 202 and an expansion valve 204.

[0048] In an air conditioner, a plurality of indoor units 200 are connected to one or more outdoor units 100. A single common liquid pipe 210 through which liquid coolant flows and a single common gas pipe 212 through which gas coolant flows are installed between the outdoor units 100 and the indoor units 200 so that they communicate with each other. Also, a high-low pressure common pipe 214 for maintaining balance of coolant is installed between two or more outdoor units 100 so that the outdoor units 100 communicate with each other.

[0049] The high-low pressure common pipe 214 is installed such that entries of outdoor heat exchangers 140 provided to the plurality of outdoor units 100 communicate with each other to maintain balance of coolant among the

outdoor units 100. Meanwhile, the high-low pressure common pipe 214 allows coolant to flow into even an outdoor heat exchanger 140 of the outdoor unit 100 that is not used. Accordingly, a heat exchange efficiency improves on the whole. Also, high pressure coolant or low pressure coolant flows through a low the high-low pressure common pipe 214 depending on a cooling cycle and a heating cycle.

[0050] Branch liquid pipes 210' through which liquid coolant flows, and branch gas pipes 212' through which gas coolant flows are provided to the indoor units 200. The branch liquid pipes 210' and the branch gas pipes 212' communicate with the common liquid pipe 210 and the common gas pipe 212, respectively.

[0051] Also, the branch liquid pipes 210' and the branch gas pipes 212' have a different diameter depending on a capacity of the indoor unit 200 connected thereto.

[0052] Meanwhile, outdoor liquid pipes 210" through which liquid coolant flows, and outdoor gas pipes 212" through which gas coolant flows are provided to the outdoor units 100. The outdoor liquid pipes 210" and the outdoor gas pipes 212" communicate with the common liquid pipe 210 and the common gas pipe 212, respectively.

[0053] The plurality of auxiliary heat sources 400, 450, and 460 heat or cool a circulating medium flowing through the ground heat exchanger 300. Two or more of the auxiliary heat sources 400, 450, and 460 are simultaneously operated, or one of them is selectively used.

[0054] Referring to FIG. 2, the plurality of auxiliary heat sources 400, 450, and 460 include a hot water heat pump 400, a boiler 450, and a cooling tower 460. Of course, one of the hot water heat pump 400, the boiler 450, and the cooling tower 460 can be provided as the auxiliary heat sources 400, 450, and 460. Also, another apparatus can be further provided.

[0055] The hot water heat pump 400 is installed between the outdoor unit 100 and the ground heat exchanger 300 to allow the circulating medium circulating through the ground heat exchanger 300 to emit hot air through heat exchange with other exchange water.

[0056] The boiler 450 is installed between the outdoor unit 100 and the ground heat exchanger 300 to heat the circulating medium circulating through the ground heat exchanger 300.

[0057] The cooling tower 460 is installed between the outdoor unit 100 and the ground heat exchanger 300 to cool down the circulating medium circulating through the ground heat exchanger 300. A cooling pump 468 for forcing flowing of the circulating medium (water) that has passed through the cooling tower 460 is further installed inside or outside the cooling tower 460.

[0058] A circulating pipe 310 is provided between the outdoor heat exchanger 140 of the outdoor unit 100 and the ground heat exchanger 300 to guide circulation of the circulating medium. The circulating medium is formed of a material, preferably, water (H<sub>2</sub>O) having high specific heat than that of at least air.

[0059] A circulating pump 320 for forcing flowing of the circulating medium is installed in the circulating pipe 310. The circulating pump 320 allows the circulating medium contained inside the circulating pipe 310 to flow in one direction using power applied from the outside.

[0060] A plurality of circulating pumps 320 are provided. Preferably, the circulating pumps 320 include two or more pumps such as fixed delivery type circulating pumps having



a fixed volume to be delivered, and variable delivery type circulating pumps whose volume can change during an operation. In more detail, the circulating pumps **320** include a fixed delivery type circulating pump **320'** having a fixed volume to be delivered and a variable delivery type circulating pump **320"** whose volume to be delivered can change. [0061] The fixed delivery type circulating pump **320'** always supplies a predetermined volume of fluid (a circulating medium) in one direction, and the variable delivery type circulating pump **320"** has a variable rotational speed to variably supply a volume of the fluid.

[0062] Therefore, the variable delivery type circulating pump **320"** always operates when the ground heat exchanger **300** is used, and the fixed delivery type circulating pump **320'** is selectively used. That is, the fixed delivery type circulating pump **320'** additionally operates when a load of the outdoor heat exchangers **140** increases and only the variable delivery type circulating pump **320"** cannot process the increased load.

[0063] A supplementary tank **330** for supplementing a shortage of the circulating medium flowing through the circulating pipe **310** is further provided to the circulating pipe **310**. Also, a conservation tank **340** for controlling a pressure of the circulating medium flowing through the circulating pipe **310** is installed on one side of the supplementary tank **330**.

[0064] A hot water tank **430** is provided on one side of the hot water heat pump **400**. Water heated by heat exchange with the hot water heat pump **400** is stored in the hot water tank **430**. A hot water pump **432** is installed between the hot water heat pump **400** and the hot water tank **430** to force circulating water to flow.

[0065] Constructions and connections of the auxiliary heat sources **400**, **450**, and **460** will be described below in detail.

[0066] FIGS. 3 and 4 illustrate a geothermal air conditioning system according to a second embodiment of the present invention. That is, FIG. 3 is a view schematically illustrating a geothermal air conditioning system is installed according to a second embodiment of the present invention, and FIG. 4 is a block diagram of a geothermal air conditioning system according to a second embodiment of the present invention.

[0067] Referring to FIGS. 3 and 4, the geothermal air conditioning system according to the second embodiment of the present invention further includes a coolant distributor **500** and a circulation distributor **510** besides the construction of the geothermal air conditioning system according to the first embodiment of the present invention.

[0068] That is, unlike the first embodiment, the second embodiment includes a coolant distributor **500** provided to a connection portion between the branch liquid pipe **210'** and the branch gas pipe **212'**, and the outdoor liquid pipe **210"** and the outdoor gas pipe **212"** to control flow of coolant.

[0069] Also, a circulation distributor **510** for controlling flow of the circulating medium is installed between the outdoor heat exchanger **140** and the ground heat exchanger **300**. The circulating pipe **310** through which the circulating medium circulates is divided into an outdoor circulating pipe **310'** connected to the outdoor heat exchanger **140** and a ground circulating pipe **310"** connected to the ground heat exchanger **300**. That is, the outdoor circulating pipe **310'** is connected between the outdoor heat exchanger **140** and the circulating divider **510** to guide the circulating medium. On the other hand, the ground circulating pipe **310"** is connected

between the ground heat exchanger **300** and the circulation distributor **510** to guide the circulating medium.

[0070] In more detail, the geothermal air conditioning system according to the second embodiment of the present invention includes: a plurality of indoor units **200** for conditioning indoor air; a plurality of outdoor units **100** through which coolant circulates; a plurality of ground heat exchangers **300** laid under the ground to allow heat to be exchanged between ground heat and the circulating medium circulating through the inside of the ground heat exchangers **300**; a plurality of auxiliary heat sources **400**, **450**, and **460** for assisting heat exchange at outdoor heat exchangers of the outdoor units **100**; the coolant distributor **500** installed between the indoor units **200** and the outdoor units **100** to control coolant's flow depending on an operating condition; and the circulation distributor **510** installed between the outdoor units **100** and the ground heat exchanger **300** to control flow of the circulating medium (water).

[0071] The coolant distributor **500** is provided within the indoor units **200** or the outdoor units **100**, or separately installed in the outside. Also, though not shown, the coolant distributor **500** includes a plurality of valves to separately control coolant supplied to the plurality of indoor units **200** and outdoor units **100**.

[0072] In detail, the coolant distributor **500** controls coolant supplied to the indoor units **200** depending on a user's setting or respective conditions of indoor spaces requiring air conditioning.

[0073] Of course, though not shown, a control unit is provided on one side of the coolant distributor **500** to control respective valves (not shown) of the coolant distributor **500**, and control opening/closing of the branch liquid pipes **210'** and the branch gas pipes **212'** connected to the indoor units **200**. That is, the coolant distributor **500** controls coolant flowing into the indoor units **200** depending on a user's setting, or automatically controls coolant's flow depending on states of respective indoor spaces in which the indoor units **200** are installed.

[0074] Also, the coolant distributor **500** also controls coolant supplied to the outdoor units **100**. That is, all or some of the outdoor units **100** are selectively used depending on a load applied to the indoor unit **200**.

[0075] Meanwhile, according to the second embodiment, the outdoor units **100** are individually connected to the coolant distributor **500**. That is, the outdoor liquid pipes **210"** and the outdoor gas pipes **212"** are individually and directly connected to the coolant distributor **500**.

[0076] Therefore, the coolant distributor **500** controls opening/closing of the outdoor liquid pipes **210"** and the outdoor gas pipes **212"** to control coolant flowing through the outdoor units **100**. Also, a high-low pressure common pipe **214** is connected also between the outdoor units **100** such that the outdoor units **100** communicate with each other to maintain balance of coolant between two or more outdoor units **100**.

[0077] The circulation distributor **510** is provided within the outdoor unit **100** or separately installed in the outside. Also, the circulation distributor **510** includes a plurality of valves to individually control flow of the circulating medium supplied to the plurality of outdoor units **100** and ground heat exchangers **300**.



[0078] In more detail, the circulation distributor **510** controls coolant supplied to the ground heat exchangers **300** depending on a user's setting or load of the outdoor heat exchanger **140**.

[0079] Of course, though not shown, a circulation control unit is provided on one side of the circulation distributor **510** to control respective valves (not shown) of the circulation distributor **510** to the circulating medium (water) flowing through the outdoor circulating pipe **310'** and the ground circulating pipe **310"**. That is, the circulation distributor **510** controls a circulating medium flowing into the outdoor heat exchangers **140** depending on a user's setting, or individually controls the circulating medium flowing through the plurality of outdoor heat exchangers **140** depending on whether the outdoor heat exchangers **140** operate or not.

[0080] Also, the circulation distributor **510** controls also a circulating medium supplied to the plurality of ground heat exchangers **300**. That is, all or some of the ground heat exchangers **300** are selectively used depending on load applied to the outdoor heat exchangers **140**. In other words, the circulation distributor **510** controls flow of the circulating medium by controlling the ground circulating pipes **310"** connected to the ground heat exchangers **300** depending on loads of the outdoor heat exchangers **140**.

[0081] Since inner constructions of the outdoor units **100** and the indoor units **200**, and the plurality of the auxiliary heat sources **400**, **450**, and **460** are the same as those of the first embodiment, detailed descriptions thereof will be omitted.

[0082] FIG. 5 schematically illustrates a construction of an outdoor unit, which is a crucial part of a geothermal air conditioning system according to the present invention. One of plurality of outdoor units will be exemplarily described below for convenience.

[0083] Referring to FIG. 5, a plurality of compressors **120** and **120'** are installed inside the outdoor unit **100**. The compressors **120** and **120'** compress coolant to change the coolant to coolant of high temperature and high pressure. That is, a constant-speed compressor **120** operating in a constant speed, and an inverter compressor **120'** which is a variable speed heat pump, are installed.

[0084] A coolant sprayer **120a** is installed at an entry of the compressors **120** and **120'**. The coolant sprayer **120a** supplies a coolant when the compressors **120** and **120'** are overheated depending on their operating states to prevent damages of the compressors **120** and **120'**. The coolant used here may be the coolant discharged from the outdoor heat exchanger **140** that will be described below.

[0085] Also, a fluid uniform pipe **121** is installed between the constant-speed compressor **120** and the inverter compressor **120'** to allow the constant-speed compressor **120** to communicate with the inverter compressor **120'**. Therefore, when fluid shortage is generated at one compressor on either side, the fluid shortage is compensated for by the other compressor, so that damages of the compressors **120** and **120'** are prevented.

[0086] Scroll compressors having low noise and excellent efficiency are used as the compressors **120** and **120'**, and particularly, the inverter compressor **120'** is an inverter scroll compressor whose number of revolutions is controlled depending on a load. Therefore, when a few indoor units **200** are used and a small load is applied, the inverter compressor **120'** is operated first. Until the load gradually increases and

is not handled by the inverter compressor **120'** alone, the constant-speed compressor **120** is not operated.

[0087] Compressor discharge temperature sensors **120b** and **120'b** for measuring temperature of coolant discharged from the compressors **120** and **120'** and oil separators **122** are provided exits of the constant-speed compressor **120** and the inverter compressor **120'**, respectively. The oil separators **122** filter oil mixed in coolant discharged from the compressors **120** and **120'** to allow the filtered oil to be collected to the compressors **120** and **120'**.

[0088] That is, oil used for cooling down friction heat generated during operations of the compressors **120** and **120'** is discharged together with the coolant to the exits of the compressors **120** and **120'**. The oil included in the coolant is separated by the oil separator **122** and collected to the compressors **120** and **120'** via an oil collecting pipe **123**.

[0089] A check valve **122'** is further installed at an exit of the oil separator **122** to prevent coolant from flowing backward. That is, in the case where one of the constant-speed compressor **120** and the inverter compressor **120'** is operated, the check valve **122'** allows compressed coolant not to flow backward into the compressors **120** and **120'** not in use.

[0090] The oil separator **122** is formed to communicate with a four-way valve **124** via a pipe. The four-way valve **124** is installed to change a flowing direction of coolant depending on cooling/heating cycles. Respective ports of the four-way valve **124** are connected to exits (or the oil separators) of the compressors **120** and **120'**, entries (or the accumulators) of the compressors **120** and **120'**, the outdoor heat exchanger **140**, and the indoor heat exchanger **200**.

[0091] Therefore, coolant discharged from the constant-speed compressor **120** and the inverter compressor **120'** is collected to one place and flows into the four-way valve **124**. A high pressure sensor **124'** is installed at an entry of the four-way valve **124** to check pressure of coolant discharged from the compressors **120** and **120'**.

[0092] Meanwhile, a hot gas pipe **125** is installed across the four-way valve **124** to allow a portion of coolant flowing from the oil separator **122** to the four-way valve **124** to directly flow into the accumulator **132** which will be described below.

[0093] The hot gas pipe **125** allows high pressure coolant from discharge ports of the compressors **120** and **120'** to directly flow to the entries of the compressors **120** and **120'** in the case where pressure of low pressure coolant flowing to the accumulator **132** needs to be raised during an operation of the air conditioner. A hot gas valve **125'**, which is a bypass valve, is installed in the hot gas pipe **125** to open/close the hot gas pipe **125**.

[0094] Also, an overcooler **130** is provided inside the outdoor unit **100**. The overcooler **130** is an overcooling means for cooling down even more the coolant heat-exchanged at the outdoor heat exchanger **140** which will be described below. The overcooler **130** is formed at an arbitrary position of the outdoor liquid pipe **210"** connected to an exit of the outdoor heat exchanger **140**.

[0095] The overcooler **130** may be a double pipe. That is, the outdoor liquid pipe **210"** is provided inside the overcooler **130**, and a reverse transfer pipe **130'** is formed side the overcooler **130**. The reverse transfer **130'** branches from an exit of the overcooler **130**. An overcooling expansion valve **130'a** for cooling down coolant through expansion of the coolant is installed in the reverse transfer pipe **130'**.



[0096] With this construction, a portion of coolant discharged from the overcooler 130 flows into the reverse transfer pipe 130' and is cooled down while it passes through the overcooling expansion valve 130'a, and inner coolant is cooled down even more while the cooled coolant flows through the overcooler 130 backward. The coolant flowing backward from the overcooler 130 is supplied back to the accumulator 132 and circulated.

[0097] Meanwhile, a liquid pipe temperature sensor 130a is installed at an exit of the overcooler 130 to measure temperature of coolant discharged from the outdoor unit 100. An overcooling entry sensor 130'b is provided to an exit of the overcooling expansion valve 130'a to measure temperature of coolant flowing to the overcooler 130. An overcooling exit sensor 130'c is provided to the reverse transfer pipe 130' through which coolant flowing backward from the overcooler 130 flows.

[0098] Therefore, coolant that has passed through the outdoor heat exchanger 140 flows through a central portion, and low temperature coolant expanded by an expansion valve (not shown) flows in the outside to cool down temperature of coolant even more.

[0099] A drier 131 is installed on one side of the overcooler 130, i.e., on one side of the outdoor liquid pipe 210" through which coolant discharged from the outdoor heat exchanger 140 is guided to the indoor unit 200. The drier 131 removes humidity contained in coolant flowing through the outdoor liquid pipe 210".

[0100] The accumulator 132 is installed between the constant-speed compressor 120 and the inverter compressor 120'. The accumulator 132 filters liquid coolant to allow only gas coolant to flow into the compressors 120 and 120'.

[0101] When a portion of coolant flowing from the indoor unit 200 that is not evaporated but remains in a liquid state directly flows into the compressors 120 and 120', a load applied to the compressors 120 and 120' changing coolant to high temperature and high pressure gas coolant increases to cause damages of the compressors 120 and 120'.

[0102] Therefore, since a portion of coolant flowing into the accumulator 132 that is not evaporated but remains in a liquid state is relatively heavier than gas coolant, the liquid coolant is stored in a lower portion of the accumulator 132, and only the gas coolant flows into the compressors 120 and 120'. Meanwhile, an inflow pipe temperature sensor 132' for measuring temperature of coolant flowing from the outside, and a low pressure sensor 132" for measuring pressure of coolant are provided to an entry of the accumulator 132.

[0103] The outdoor heat exchanger 140 is provided inside the outdoor unit 100. The outdoor heat exchanger 140 allows heat to be exchanged between coolant flowing through the outdoor heat exchanger 140 and the circulating medium flowing through the circulating pipe 310. The outdoor heat exchanger 140 may be a water-cooled heat exchanger.

[0104] Though not shown, the outdoor heat exchanger 140 that is a water-cooled heat exchanger may be a plate-type heat exchanger formed by stacking a plurality of thin plates alternately. Therefore, coolant flows through the inside of some of the thin plates, and the circulating medium flows through the inside of the rest of the thin plates. That is, since the thin plates through which the coolant and the circulating medium flow are stacked alternately, the coolant and the circulating medium exchange heat while they flow in directions intersecting each other in the inside of respective thin plates.

[0105] FIG. 6 illustrates in more detail a construction and connections of the auxiliary heat sources 400, 450, and 460. Here, one of ground heat exchangers is exemplarily described for convenience. Therefore, illustration of the circulation distributor 510 will be omitted.

[0106] Referring to FIG. 6, a coolant pipe and the circulating pipe 310 that communicate with the indoor heat exchanger 202 are connected to the outdoor heat exchanger 140 of the outdoor unit 100. That is, the outdoor liquid pipe 210", the outdoor gas pipe 212", and the circulating pipe 310 are connected to the outdoor heat exchanger 140.

[0107] Therefore, heat is exchanged between coolant flowing through the outdoor liquid pipe 210", the outdoor gas pipe 212", and a circulating medium (water) flowing through the circulating pipe 310. The circulating pipe 310 is formed to constitute a closed loop on the whole to allow the inner circulating medium to circulate constantly while it is isolated from the outside.

[0108] The ground heat exchanger 300 is laid deep under the ground to allow heat to be exchanged between ground heat and the circulating medium flowing through the circulating pipe 310. That is, the ground heat exchanger 300 may be laid under the ground up to 1-200 m. A depth at which the ground heat exchanger 300 is laid changes depending on climate of an installation area. The ground heat exchanger 300 may be laid at a depth that can always maintain an annual average temperature of that area.

[0109] A plurality of ground heat exchangers 300 can be provided. The ground heat exchanger 300 may be formed in a zigzag shape bent a plurality of number of times as illustrated.

[0110] As described above, the circulating pipe 310 is connected between the ground heat exchanger 300 and the outdoor heat exchanger 140 to allow the circulating medium (water) to flow. The circulating pipe 310 includes a supply pipe 312 allowing the circulating medium to flow into the ground heat exchanger 300, and a return pipe 314 allowing the circulating medium that has passed through the ground heat exchanger 300 to return to the outdoor heat exchanger 140.

[0111] The return pipe 314 is provided with a circulation temperature sensor 316. In more detail, the circulating temperature sensor 316 is installed at an exit of the ground heat exchanger 300 to measure temperature of the circulating medium that has passed through the ground heat exchanger 300. A temperature value measured by the circulating temperature sensor 316 is delivered to a control unit (not shown) controlling the system on the whole.

[0112] The hot water heat pump 400 is used in cooperation with the ground heat exchanger 300, or selectively used. That is, only the hot water heat pump 400 can be used for heat exchange of the outdoor heat exchanger 140 without use of the ground heat exchanger 300.

[0113] A heat pump supply pipe 402 and a heat pump return pipe 402' are connected between the circulating pipe 310 and the hot water heat pump 400 to guide flow of the circulating medium (water). In more detail, the heat pump supply pipe 402 branches from the supply pipe 312 to guide the circulating medium to the hot water heat pump 400. The heat pump return pipe 402' branches from the return pipe 314 to guide the circulating medium returning to the return pipe 314 after having passed through the hot water heat pump 400.



[0114] A heat pump supply valve **404** is provided to a connection portion between the supply pipe **312** and the heat pump supply pipe **402**. A hot water return valve **404'** is provided to a connection portion between the return pipe **314** and the heat pump return pipe **402'**. Each of the heat pump supply valve **404** and the hot water return valve **404'** is a three-way valve that can control fluid flow of three directions.

[0115] Therefore, the heat pump supply valve **404** controls the circulating medium coming from the outdoor heat exchanger **140** and flowing through the supply pipe **312** to be supplied to both the ground heat exchanger **300** and the hot water heat pump **400**, or to be supplied to one of the ground heat exchanger **300** and the hot water heat pump **400**.

[0116] A hot water temperature sensor **406** is installed in the heat pump return pipe **402'**. That is, the hot water temperature sensor **406** is installed at an exit of the hot water heat pump **400** to measure temperature of the circulating medium discharged from the hot water heat pump **400** via the heat pump return pipe **402'**. The hot water temperature sensor **406** is connected to a control unit (not shown) to provide the measured temperature to the control unit.

[0117] Heat exchange is performed in the inside of the hot water heat pump **400**. That is, not only heat exchange with the circulating medium, but also heat exchange with exchange water flowing through a hot water circulating pipe **420**, which will be described below, is performed.

[0118] The hot water tank **430** is connected to one side (the right side in FIG. 6) of the hot water heat pump **400**. Also, the hot water circulating pipe **420** constituting a closed loop is connected between a hot water condenser **412** and the hot water tank **430**. Exchange water circulates through the hot water circulating pipe **420**. Therefore, heat exchange is performed while the exchange water flowing through the hot water circulating pipe **420** passes through the hot water condenser **412**. Exchange water becomes hot by the heat exchange flows into the hot water tank **430** via the hot water circulating pipe **420** to exchange heat with water stored in the hot water tank **430**. In this way, the water stored in the hot water tank **430** is heated.

[0119] The hot water pump **432** is installed in the hot water circulating pipe **420**. The hot water pump **432** is operated by external power to allow exchange water flowing through the hot water circulating pipe **420** to flow constantly in one direction.

[0120] The boiler **450** is connected to the circulating pipe **310** to heat the circulating medium. That is, the boiler **450** is connected to the return pipe **314** of the circulating pipe **310**.

[0121] In more detail, the boiler **450** heats the circulating medium using energy supplied from the outside. A boiler supply pipe **452** and a boiler return pipe **452'** are formed between the boiler **450** and the return pipe **314** to communicate each other.

[0122] The boiler supply pipe **452** is a passage allowing the circulating medium flowing through the return pipe **314** to flow into the boiler **450**. The boiler return pipe **452'** is a passage allowing the circulating medium that has passed through the boiler **450** to return to the return pipe **314**.

[0123] A boiler supply valve **454** and a boiler return valve **454'** are installed at connection portions between the return pipe **314** and the boiler supply pipe **452**, and between the return pipe **314** and the boiler return pipe **452'**, respectively. Like the above-described heat pump supply valve **404** and

hot water return valve **404'**, each of the boiler supply valve **454** and the boiler return valve **454'** may be a three-way valve that can control fluid flow of three directions. Therefore, supply of the circulating medium to the boiler **450** is controlled depending on opening/closing of the boiler supply valve **454** and the boiler return valve **454'**.

[0124] A boiler temperature sensor **456** is installed in the boiler return pipe **452'**. That is, the boiler temperature sensor **456** measures temperature of the circulating medium that has passed through the boiler **450**. The temperature measured by the boiler temperature sensor **456** is delivered to the control unit.

[0125] The cooling tower **460** is connected to the return pipe **314**. The cooling tower **460** cools down the circulating medium using contact with air. Since the cooling tower **460** is a device used for cooling down cooling water in factories, detailed description thereof is omitted.

[0126] A cooling tower supply pipe **462** and a cooling tower return pipe **462'** are formed between the return pipe **314** and the cooling tower **460** to communicate with each other. The cooling tower supply pipe **462** is a passage allowing the circulating medium flowing through the return pipe **314** to flow into the cooling tower **460**. The cooling tower return pipe **462'** is a passage allowing the circulating medium that has passed through the cooling tower **460** to return to the return pipe **314**.

[0127] A cooling tower supply valve **464** and a cooling tower return valve **464'** are installed at connection portions between the return pipe **314** and the cooling tower supply pipe **462**, and between the return pipe **314** and the cooling tower return pipe **462'**, respectively. Like the above-described heat pump supply valve **404** and hot water return valve **404'**, each of the cooling tower supply valve **464** and the cooling tower return valve **464'** may be a three-way valve that can control fluid flow of three directions. Therefore, supply of the circulating medium to the cooling tower **460** is controlled depending on opening/closing of the cooling tower supply valve **464** and the cooling tower return valve **464'**.

[0128] A cooling temperature sensor **466** is installed in the cooling tower return pipe **462'**. That is, the cooling temperature sensor **466** measures temperature of the circulating medium that has passed through the cooling tower **460**. Temperature measured at the cooling temperature sensor **466** is delivered to the control unit.

[0129] Meanwhile, a cooling pump **468** is further installed in the cooling tower return pipe **462'**. The cooling pump **468** applies pressure in one direction (the right side in FIG. 6) so that the circulating medium that has passed through the cooling tower **460** to flow into the outdoor heat exchanger **140** via the return pipe **314**. That is, the circulating medium that has flowed into the cooling tower **460** is exposed to air for heat exchange with the air, and is collected again and allowed to flow through the cooling tower return pipe **462'**. As described above, the cooling pump **468** forces flowing of the circulating medium flowing through the cooling tower return pipe **462'**, and prevents the circulating medium from flowing backward.

[0130] The circulating pump **320** may be installed in the return pipe **314** to force flowing of the circulating medium flowing through the circulating pipe **310**. In more detail, a plurality of circulating pumps **320** are installed in parallel between the conservation tank **340** and the boiler **450** to



force flowing of the circulating medium in one direction (the right side in FIG. 6) as illustrated.

[0131] The supplementary tank 330 is a circulating medium storing device for supplying the circulating medium to the circulating pipe 310. That is, the supplementary tank 330 is designed for supplementing circulating medium that becomes insufficient by evaporation or leakage generated while the circulating medium passes through the circulating pipe 310.

[0132] The supplementary tank 330 is formed to communicate with other pipes by the return pipe 314 and the supplementary pipe 332. Also, a supplementary valve 334 is installed in the supplementary pipe 332 to open/close the supplementary pipe 332 to control the circulating medium supplied to the return pipe 314.

[0133] The supplementary valve 334 is manually opened/closed by a user, or automatically opened/closed under control of the control unit (not shown).

[0134] The conservation tank 340 is formed to communicate with other pipes by the return pipe 314 and a conservation pipe 342 to control pressure of the circulating medium flowing through the circulating pipe 310. That is, the conservation tank 340 serves as a buffer region for controlling pressure of the circulating medium flowing through the circulating pipe 310 that changes transiently. The conservation tank 340 is installed apart from the return pipe 314, or integrally formed in an intermediate portion of the return pipe 314.

[0135] FIG. 7 illustrates a block diagram of the hot water heat pump 400.

[0136] Referring to FIG. 7, a plurality of parts such as a hot water evaporator 410 and a hot water condenser 412 where heat exchange occurs are installed in the hot water heat pump 400. The hot water evaporator 410 and the hot water condenser 412 communicate with each other via a hot water pipe 422. Also, hot water coolant flows through the hot water pipe 422.

[0137] The hot water evaporator 410 and the hot water condenser 412 are heat exchangers corresponding to the outdoor heat exchanger 140 and the indoor heat exchanger 202, respectively. Each of the hot water evaporator 410 and the hot water condenser 412 is a water-cooled heat exchanger which exchanges heat using water, not air. Also, the hot water coolant may be the same as the coolant flowing between the indoor heat exchanger 202 and the outdoor heat exchanger 140.

[0138] In more detail, the hot water evaporator 410 allows heat to be exchanged between the circulating medium flowing through the circulating pipe 310 and hot water coolant flowing through the hot water pipe 422. Also, the hot water condenser 412 is a portion where hot water coolant flowing through the hot water pipe 422 exchanges heat with exchange water circulating through the hot water circulating pipe 420.

[0139] The hot water evaporator 410 serves as an evaporator. Therefore, heat is exchanged between a high temperature circulating medium and low temperature hot water coolant at the hot water evaporator 410. Therefore, the high temperature circulating medium is cooled down and condensed, and the low temperature hot water coolant receives heat and evaporates to change into high temperature coolant (preferably gas coolant).

[0140] On the other hand, the hot water condenser 412 serves as a condenser. Therefore, heat is exchanged between

high temperature hot water coolant and low temperature exchange water at the hot water condenser 412.

[0141] Therefore, the high temperature hot water coolant is cooled down and condensed, and the low temperature exchange water receives heat and evaporates to change into, preferably, high temperature gas state.

[0142] The hot water pipe 422 is divided into a hot water liquid pipe 422' and a hot water gas pipe 422". Relatively high temperature hot water coolant flows through the hot water liquid pipe 422', and is introduced into the hot water evaporator 410 via the hot water liquid pipe 422'. Also, relatively low pressure hot water coolant flows through the hot water gas pipe 422". Hot water coolant that has passed through the hot water evaporator 410 flows through the hot water gas pipe 422".

[0143] The hot water gas pipe 422" is provided with a plurality of hot water compressors 414 and 414'. The hot water compressors 414 and 414' compress hot water coolant to change the coolant into high temperature and high pressure coolant. The hot water compressors 414 and 414' may be a hot water constant speed compressor 414 operating in a constant speed, and a hot water inverter compressor 414', which is a variable speed heat pump.

[0144] Scroll compressors having small noise and excellent efficiency may be used as the hot water compressors 414 and 414' as in the above-described compressors 120 and 120', and particularly, an inverter scroll compressor whose number of revolutions is controlled depending on a load of the hot water condenser 412 is used as the hot water inverter compressor 414'. Therefore, when a load applied to the hot water condenser 412 is relatively small, only the hot water inverter compressor 414' is operated first. Until the load gradually increases and only the hot water inverter compressor 414' cannot process the increased load, the hot water constant speed compressor 414 is operated.

[0145] Hot water oil separators 416 are provided to exits of hot water inverter compressors 414', respectively. The hot water oil separators 416 filter oil mixed in coolant discharged from the hot water inverter compressors 414' to allow the filtered oil to be collected to the hot water inverter compressors 414'. That is, oil used for cooling down friction heat generated during operations of the hot water inverter compressors 414' is discharged together with the coolant to the exits of the hot water inverter compressors 414'. The oil included in the coolant is separated by the hot water oil separators 416 and collected to the hot water inverter compressors 414' via a hot water oil collecting pipe 416'.

[0146] A hot water check valve 417 is further installed at exits of the hot water oil separators 416 and the hot water constant speed compressor 414 to prevent coolant from flowing backward. That is, the hot water check valve 417 prevents hot water coolant from flowing backward into the hot water compressors 414 and 414' that are not in use in the case where only one of the hot water constant speed compressor 414 and the hot water inverter compressor 414' operates.

[0147] Coolant discharged from the hot water constant speed compressor 414 and the hot water inverter compressor 414' joins together at a joining valve 418, and flows into the hot water condenser 412.

[0148] A hot water accumulator 424 is installed at entries of the hot water constant speed compressor 414 and the hot water inverter compressor 414' to filter liquid coolant and allow only gas coolant to flow into the hot water compress-



sors 414 and 414'. That is, since a portion of hot water coolant discharged after having passed through the hot water evaporator 410 that is not yet evaporated as a gas but remains in a liquid state is relatively heavier than gas hot water coolant, the liquid coolant is stored and filtered in a lower portion of the hot water accumulator 424, and only the gas hot water coolant in an upper portion flows into the hot water compressors 414 and 414'.

[0149] A hot water expansion valve 426 is installed at the hot water liquid pipe 422'. The hot water expansion valve 426 performs the same function as that of the expansion valve 204 provided to the indoor unit 200. The hot water expansion valve 426 reduces pressure of hot water coolant that flows into the hot water evaporator 410.

[0150] An operation of a geothermal air conditioning system having the above-described construction according to the present invention will be described below.

[0151] An operation of a geothermal air conditioning system according to a first embodiment of the present invention will be described.

[0152] First, flow of coolant and a circulating medium according to the first embodiment of the present invention will be described on the whole with reference to FIG. 8.

[0153] Since a closed loop through which coolant flows is formed between the indoor unit 200 and the outdoor unit 100, coolant exchanges heat while it circulates through the outdoor unit 100 and the indoor unit 200 as illustrated in arrows.

[0154] At this point, the outdoor heat exchanger 140 is a water-cooled heat exchanger. Therefore, heat is exchanged between coolant circulating through the indoor unit 200 and the outdoor unit 100, and a circulating medium (water) circulating through the outdoor unit 100 and the ground heat exchanger 300 at the outdoor heat exchanger 140.

[0155] In more detail, a circulating medium flowing through the circulating pipe 310 is flowed in one direction by the circulating pumps 320. Also, the plurality of circulating pumps 320 are selectively used depending on an amount of a circulating medium flowing through the circulating pipe 310 or an applied load. That is, referring to FIG. 8, in the case where only one of the plurality of outdoor heat exchangers 140 is used or large heat exchange at the outdoor heat exchanger 140 is not required even when two heat exchangers 140 are used, a load applied to the circulating pump 320 is relatively small. Accordingly, only the variable delivery type circulating pump 320" of the plurality of circulating pumps 320 is preferentially operated.

[0156] Also, the variable delivery type circulating pump 320" discharges a different amount of a circulating medium depending on a load. That is, as a load increases, a rotation speed of the variable delivery type circulating pump 320" gradually increases. Only when the increased load is too large and the variable delivery type circulating pump 320" cannot process the increased load, the fixed delivery type circulating pump 320' is operated. FIG. 8 exemplarily illustrates only the fixed delivery type circulating pump 320' is used.

[0157] Meanwhile, coolant flowing through the indoor unit 200 and the outdoor unit 100 flows in opposite directions depending on cooling/heating cycles performed for indoor space. On the other hand, a direction of the circulating medium (water) flowing through the circulating pipe 310 is always constant and does not need to be switched in a reverse direction. That is, the circulating medium flowing

through the circulating pipe 310 constantly flows in a direction illustrated by arrows in FIG. 2.

[0158] Next, flow and operations of coolant flowing through the outdoor unit 100 and the indoor unit 200 will be described in more detail with reference to FIGS. 5 and 8.

[0159] As described above, a plurality of indoor units 200 are connected to one outdoor unit 100 in air conditioning system according to the present invention, and all or some of the indoor units 200 are operated depending on a user's selection. Also, all of the plurality of indoor units 200 operate for cooling or heating the indoor space.

[0160] When the air conditioning system operates (for cooling the indoor space), the outdoor LEV 102 is opened to allow coolant to flow between the outdoor unit 100 and the indoor unit 200.

[0161] First, coolant flowing at the outdoor unit 100 will be described. Gas coolant flowing from the indoor unit 200 passes through the four-way valve 124 and flows into the accumulator 132. Gas coolant from the accumulator 132 flows into the compressors 120 and 120'. Meanwhile, when coolant supplied to the compressors 120 and 120' is insufficient, or the compressors 120 and 120' are overheated, coolant is supplied from the coolant sprayer 120a.

[0162] Coolant compressed by the compressors 120 and 120' is discharged via a discharge port to pass through the oil separator 122. Oil contained in coolant is separated by the oil separator 122 and collected to the compressors 120 and 120' through the oil collecting pipe 123.

[0163] That is, while coolant is compressed by the compressors 120 and 120', oil is mixed into coolant. Since the oil is in a liquid state and coolant is in a gas state, the oil is separated by the oil separator 122, which is a gas-liquid separator.

[0164] Meanwhile, balance of oil contained inside the both compressors 120 and 120' is maintained by the fluid uniform pipe 121 connecting the constant-speed compressor 120 with the inverter compressor 120'.

[0165] Coolant that has passed through the oil separator 122 passes through the four-way valve 124 and flows into the outdoor heat exchanger 140. Since the outdoor heat exchanger 140 serves as a condenser (during a cooling cycle), coolant is cooled down and changes into liquid coolant through heat exchange with the circulating medium. The coolant that has passed through the outdoor heat exchanger 140 is cooled down even more while it passes through the overcooler 130.

[0166] The coolant that has passed through the overcooler 130 passes through the drier 131 for removing humidity contained in the coolant, and flows into the indoor unit 200 via the common liquid pipe 210. Meanwhile, a portion of coolant that has passed through the compressors 120 and 120' may flow into other outdoor unit 100 via the high-low pressure common pipe 214.

[0167] The coolant supplied to other outdoor unit 100 via the high-low pressure common pipe 214 flows into the outdoor heat exchanger 140 of the outdoor unit 100 that is not in use to make coolant pressure balanced on the whole, and allows predetermined heat exchange to be performed even at the outdoor heat exchanger 140 of the outdoor unit 100 that is not in use.

[0168] When coolant is supplied to the indoor unit 200 via the common liquid pipe 210, the coolant is supplied to respective indoor units 200 in operation via the branch liquid pipes 210' branching from the common liquid pipe 210.



Also, the coolant is reduced in pressure at the expansion valve **204**, and exchanges heat at the indoor heat exchanger **202**. At this point, since the indoor heat exchanger **202** serves as an evaporator, the coolant changes into a low pressure gas through the heat exchange.

[0169] The coolant discharged from the indoor heat exchangers **202** passes through the branch pipes **212'**, and is collected at the common gas pipe **212**, and then flows into the outdoor unit **100**. The coolant that has flowed into the outdoor unit **100** via the common gas pipe **212** and the outdoor gas pipes **212"** passes through the four-way valve **124** and flows into the accumulator **132**.

[0170] Liquid coolant that is not yet evaporated is filtered at the accumulator **132**. Only gas coolant is selected and supplied to the compressors **120** and **120'**. The above-described processes complete one cycle.

[0171] Meanwhile, in the case where the air conditioning system operates in a heating cycle, coolant flows in an opposite direction, and an amount of coolant is controlled at the outdoor LEV **102**.

[0172] Next, an operation of a geothermal air conditioning system will be described according to a second embodiment of the present invention.

[0173] Flow of coolant and a circulating medium on the whole according to the second embodiment of the present invention is almost the same as that of coolant and a circulating medium according to the second embodiment of the present invention. A most particular difference is that coolant flowing between the plurality of indoor units **200** and the outdoor units **100** passes through the coolant distributor **500**, and the circulating medium (water) circulating between the outdoor heat exchanger **140** and the ground heat exchanger **300** passes through the circulating distributor **510**.

[0174] First, flow of coolant and a circulating medium according to the second embodiment of the present invention will be described on the whole with reference to FIG. 4.

[0175] As described above, since the coolant distributor **500** for controlling flow of coolant is installed between the plurality of indoor units **200** and the outdoor units **100**, coolant flowing between the indoor units **200** and the outdoor units **100** all passes through the coolant distributor **500**.

[0176] In the case where the plurality of indoor units **200** perform the same function (e.g., cooling cycle), directions of coolant flowing through the plurality of indoor units **200** are all the same, and directions of coolant flowing through the plurality of outdoor units **100** are also all the same.

[0177] At this point, the coolant distributor **500** selectively opens/closes the branch liquid pipes **210'** and the branch gas pipes **212'** communicating with the plurality of indoor units **200** according to a command of the control unit (not shown). That is, the coolant distributor **500** allows coolant to be supplied only to an indoor unit **200** that is in use, of the plurality of indoor units.

[0178] Also, the coolant distributor **500** controls coolant flowing to the plurality of outdoor units **100**. That is, in the case where all of the indoor units **200** are operated and all of the outdoor units **100** need to be operated, the coolant distributor **500** opens all of the respective outdoor liquid pipes **210"** and outdoor gas pipes **212"** so that coolant is supplied to all the outdoor units **100**. On the other hand, in the case where only some of the plurality of indoor units **200**

are used or a load applied to the indoor unit **200** is small, the coolant distributor **500** closes the outdoor liquid pipes **210"** and the outdoor gas pipes **212"** connected to the some of the outdoor units **200** so that only some of the plurality of outdoor units **100** are used.

[0179] Meanwhile, since the circulation distributor **510** is installed between the outdoor heat exchangers **140** and the ground heat exchangers **300**, the circulation distributor **510** controls flow of the circulating medium circulating through the plurality of outdoor heat exchangers **140** and ground heat exchangers **300**.

[0180] For example, the circulation distributor **510** selectively opens/closes the respective outdoor circulating pipes **310'** communicating with the plurality of outdoor heat exchangers **140** according to a command of the control unit (not shown). That is, the circulation distributor **510** allows the circulating medium not to be supplied to the outdoor unit **100** of the plurality of outdoor units **100**, that is not in use.

[0181] Also, the circulation distributor **510** controls the circulating medium supplied to the plurality of ground heat exchangers **300**. That is, in the case where all of the outdoor units **100** are operated and all of the ground heat exchangers **300** need to be operated, the circulation distributor **510** opens all of the ground circulating pipes **310"** so that coolant is supplied to all the ground heat exchangers **300**. On the other hand, in the case where only some of the plurality of ground heat exchangers **300** can sufficiently process a load, the circulation distributor **510** closes some of the ground circulating pipes **310"** so that the circulating medium is not supplied to the ground heat exchanger **300** that is not in use.

[0182] Meanwhile, coolant flowing through the indoor unit **200** and the outdoor unit **100** flows in opposite directions depending on cooling/heating cycles performed for indoor space. On the other hand, a direction of the circulating medium (water) flowing through the circulating pipe **310** is always constant and does not need to be switched in a reverse direction. That is, the circulating medium flowing through the circulating pipe **310** constantly flows in a direction illustrated by arrows in FIG. 4.

[0183] Flowing states of coolant contained in the outdoor units **100** and the indoor units **200** are the same as those of the first embodiment.

[0184] FIG. 9 illustrates a circulating medium (water) flows through the circulating pipe **310**, and is a basic circulation circuit of the case where a single ground heat exchanger **300** is used. That is, FIG. 9 illustrates the plurality of auxiliary heat sources **400**, **450**, and **460** are not used and the circulating medium (water) circulates between the outdoor heat exchanger **140** and the ground heat exchanger **300** in arrow directions.

[0185] At this point, flow of the circulating medium to the hot water heat pump **400**, the boiler **450**, and the cooling tower **460** is blocked by the heat pump supply pipe **402**, the heat pump return pipe **402'**, the boiler supply valve **454**, the boiler return valve **454'**, the cooling tower supply valve **464**, and the cooling tower return valve **464'**.

[0186] Therefore, the circulating medium flowing through the circulating pipe **310** circulates counterclockwise constantly as illustrated in arrows of FIG. 9. The flowing direction of the circulating medium maintains a constant direction regardless of cooling/heating cycles by the air conditioning system. That is, the circulating medium circu-



lates in a constant direction regardless of whether the outdoor heat exchanger **140** serves as a condenser or an evaporator.

[0187] In the case where the outdoor heat exchanger **140** is used as a condenser (cooling cycle), the circulating medium flowing through the circulating pipe **310** cools down coolant at the outdoor heat exchanger **140**. On the other hand, in the case where the outdoor heat exchanger **140** is used as an evaporator (heating cycle), the circulating medium flowing through the circulating pipe **310** heats coolant at the outdoor heat exchanger **140**.

[0188] Also, when the circulating medium flowing through the circulating pipe **310** is insufficient, a user manually opens the supplementary valve **334** to supplement a circulating medium according to a signal of the control unit (not shown), or the supplementary valve **334** is automatically opened/closed under control of the control unit.

[0189] Also, the circulating pump **320** is driven using power applied from the outside to allow the circulating medium flowing through the circulating pipe **310** not to flow backward but to flow in one direction (counterclockwise direction in FIG. 9) constantly.

[0190] This circulation mechanism is a simplest mechanism used by a geothermal air conditioning system according to the present invention. When temperature of the circulating medium measured by the circulation temperature sensor **316** does not reach required temperature, the auxiliary heat sources **400**, **450**, and **460** are operated. That is, when temperature does not reach temperature sufficient to cool down or heat coolant at the outdoor heat exchanger **140**, at least one of the auxiliary heat sources **400**, **450**, and **460** is operated to cool down or heat the circulating medium.

[0191] FIG. 10 illustrates flow of the circulating medium when the hot water heat pump **400** is operated. Referring to FIG. 10, the hot water heat pump **400** is primarily operated when an air conditioning system of the present invention operates in a cooling cycle.

[0192] First, a solid line arrow shows the case where a circulating medium is simultaneously supplied to both the ground heat exchanger **300** and the hot water heat pump **400**. Therefore, at this point, the heat pump supply valve **404** is completely opened to allow a circulating medium coming from the outdoor heat exchanger **140** to flow into both the ground heat exchanger **300** and the hot water heat pump **400**.

[0193] Also, at this point, since the hot water tank **430** operates, exchange water flows in an inside of the hot water circulating pipe **420**. Therefore, heat exchange is performed even at the hot water condenser **412**. That is, hot water coolant that passes through the hot water condenser **412** exchanges heat with the exchange water contained in the hot water circulating pipe **420**, and is cooled down. Accordingly, water of the hot water tank **430** is heated by the heated exchange water to change into high temperature water.

[0194] Meanwhile, the circulating medium cooled down while it passes through the ground heat exchanger **300** and the hot water heat pump **400** joins again and flows into the outdoor heat exchanger **140**. Also, the cooled down circulating medium and high temperature coolant exchange heat with each other at the outdoor heat exchanger **140**, so that the coolant is cooled down and the circulating medium is heated.

[0195] Next, a dotted line arrow shows a circulating medium passes through only the hot water heat pump **400**. That is, the circulating medium does not flow to the ground heat exchanger **300**.

[0196] At this point, the heat pump supply valve **404** blocks a passage to the ground heat exchanger **300**, and opens only a passage to the hot water heat pump **400** to control a circulating medium coming from the outdoor heat exchanger **140** to pass through only the hot water heat pump **400**.

[0197] Also, at this point, since the hot water tank **430** operates as described, heat is exchanged between the circulating medium and hot water coolant at the hot water evaporator **410**, and heat is exchanged between hot water coolant and exchange water at the hot water condenser **412**. Therefore, the circulating medium is cooled down while it passes through the hot water heat pump **400**. Circulation and heat exchange of hot water coolant performed inside the hot water heat pump **400** will be described below in detail.

[0198] Temperature of a circulating medium discharged after passing through the hot water heat pump **400** is measured by the hot water temperature sensor **406**, and the measured temperature is delivered to the control unit (not shown). Therefore, the control unit judges whether temperature of the circulating medium coming from the hot water heat pump **400** is sufficient temperature for cooling down coolant at the outdoor heat exchanger **140** to determine whether to operate other auxiliary heat source (cooling tower).

[0199] For example, when temperature of the circulating medium coming from the hot water heat pump **400** is greater than critical cooling temperature of coolant that should be cooled down at the outdoor heat exchanger **140**, the control unit controls the circulating medium to pass through the cooling tower **460** to cool down the circulating medium even more. Here, the critical cooling temperature is temperature set to an upper limit required for condensing gas coolant at the outdoor heat exchanger **140** during a cooling cycle of the air conditioning system.

[0200] Also, a process by which a circulating medium that has flowed into the outdoor heat exchanger **140** to exchange heat with coolant is the same as that described above.

[0201] FIG. 11 exemplarily illustrates the boiler **450** operates. That is, the boiler **450** operates in order to raise temperature of the circulating medium coming from the ground heat exchanger **300**. At this point, the air conditioning system according to the present invention operates in a heating cycle to heat indoor space.

[0202] As illustrated in FIG. 11, the boiler **450** operates in the case where temperature measured by the circulation temperature sensor **316** is not sufficiently high to heat coolant at the outdoor heat exchanger **140**, or in the case where a user intends to double heating ability of the air conditioning system. That is, the boiler **450** is used in the case where temperature of the circulating medium that has passed through the ground heat exchanger **300** is lower than critical heating temperature of coolant flowing into the outdoor heat exchanger **140**, or in the case where a user wants strong heating. Here, the critical heating temperature is temperature set to a lower limit required for evaporating liquid coolant at the outdoor heat exchanger **140** during a heating cycle of the air conditioning system.

[0203] Referring to FIG. 11, in this case, the boiler supply valve **454** opens a passage of the boiler **450** to allow a



circulating medium coming from the ground heat exchanger **300** to pass through the boiler **450**.

[0204] In more detail, the control unit (not shown) blocks a right passage of the boiler supply valve **454** and simultaneously opens a lower passage of the boiler supply valve **454** to allow the circulating medium that has passed through the ground heat exchanger **300** to flow into the boiler **450** in the case where the temperature of the circulating medium measured by the circulation temperature sensor **316** is lower than the critical heating temperature. Also, simultaneously, a lower passage of the boiler return valve **454'** is opened.

[0205] Also, at this point, flow of a circulating medium to the hot water heat pump **400** and the cooling tower **460** is blocked by the heat pump supply pipe **402**, the heat pump return pipe **402'**, the cooling tower supply valve **464**, and the cooling tower return valve **464'**.

[0206] The boiler **450** is heated by external power or energy to increase temperature of the circulating medium. Temperature of the circulating medium that has passed through the boiler **450** is measured by the boiler temperature sensor **456** and delivered to the control unit. Therefore, the control unit controls a level of heating the circulating medium at the boiler **450** depending on the temperature delivered from the boiler temperature sensor **456**. Therefore, temperature of the circulating medium measured at the boiler temperature sensor **456** should be greater than the critical heating temperature.

[0207] A circulating medium sufficiently heated (to the critical heating temperature or more) while it passes through the boiler **450** flows into the outdoor heat exchanger **140** to exchange heat with coolant that is to flow into the indoor unit **200**. Therefore, the circulating medium is cooled down and the coolant is heated.

[0208] FIG. 12 illustrates the cooling tower **460** is used as an auxiliary heat source. A circulating medium is cooled down while it passes through the cooling tower **460** when the air conditioning system according to the present invention operates in a cooling cycle. That is, the cooling tower **460** is used in the case where temperature of the circulating medium that has exchanged heat at the ground heat exchanger **300** is greater than the critical cooling temperature of coolant that is to exchange heat at the outdoor heat exchanger **140**, or in the case where a user intends to improve a cooling ability of the air conditioning system even more.

[0209] In more detail, the control unit controls an upper passage of the cooling tower supply valve **464** to be opened and controls a right passage of the cooling tower supply valve **464** to be closed, and simultaneously, controls an upper passage of the cooling tower return valve **464'** to be opened in the case where temperature of the circulating medium detected by the circulation temperature sensor **316** does not reach the critical cooling temperature.

[0210] Accordingly, a passage to the cooling tower **460** is opened and the circulating medium that has passed through the ground heat exchanger **300** flows into the cooling tower **460** via the cooling tower supply pipe **462** and is cooled down. Also, the circulating medium cooled down at the cooling tower **460** is flowed to the cooling tower return pipe **462'** by the cooling pump **468**, and subsequently, flows into the outdoor heat exchanger **140**. At this point, temperature of the circulating medium measured by the cooling temperature sensor **466** should be maintained lower than the critical cooling temperature.

[0211] A low temperature circulating medium that has flowed into the outdoor heat exchanger **140** exchanges heat with high temperature coolant. Therefore, the circulating medium is changed into a high temperature circulating medium by heat exchange. The coolant is changed into low temperature coolant by heat exchange and flows into the indoor unit **200** to cool down an indoor space (a space for air conditioning).

[0212] In the geothermal air conditioning system according to the present invention, the control unit operates the plurality of auxiliary heat sources **400**, **450**, and **460** on the basis of temperature measured by the circulation temperature sensor **316**. That is, the control unit selectively or simultaneously operates the hot water heat pump **400** or the cooling tower **460** when the circulating medium that has passed through the ground heat exchanger **300** needs to be further cooled down even more during a cooling cycle. Also, the control unit controls the circulating medium to pass through the boiler **450** when the circulating medium that has passed through the ground heat exchanger **300** needs to be further heated.

[0213] Meanwhile, all of the plurality of indoor units **200** can be uniformly used for cooling or heating an indoor space. Besides, the plurality of indoor units **200** can be operated to simultaneously perform a cooling cycle and a heating cycle. That is, some of the indoor units **200** can be operated for a heating cycle, and some of the indoor units **200** can be operated for a cooling cycle.

[0214] FIG. 13 exemplarily illustrates some of the indoor units are operated for a heating cycle, and some of the indoor units are operated for a cooling cycle. That is, a first indoor unit **200a** and a second indoor unit **200b** of indoor units illustrated in FIG. 13 are operated for a cooling cycle. A third indoor unit **200c** and a fourth indoor unit **200d** of the indoor units illustrated in FIG. 13 are operated for a heating cycle. A solid line of FIG. 13 shows flow of coolant and a circulating medium for a cooling cycle, and a dotted line of FIG. 13 shows flow of coolant and a circulating medium for a heating cycle.

[0215] At this point, a first outdoor unit **100a** of the plurality of outdoor units is used for a cooling cycle of the first indoor unit **200a** and the second indoor unit **200b**. A second outdoor unit **100b** of the plurality of outdoor units is used for a heating cycle of the third indoor unit **200c** and the fourth indoor unit **200d**.

[0216] First, cooling a space (an indoor space) for air conditioning will be described.

[0217] Coolant that has passed through the first indoor unit **200a** and the second indoor unit **200b** joins at the coolant distributor **500**, and flows into the first outdoor unit **100a**. The coolant that has flowed into the first outdoor unit **100a** flows into a first outdoor heat exchanger **140a** to exchange heat with a circulating medium. At this point, the coolant is cooled down and condensed by the circulating medium.

[0218] The coolant condensed by the first outdoor heat exchanger **140a** flows into the coolant distributor **500** again, and is distributed and supplied to the first indoor unit **200a** and the second indoor unit **200b**. The coolant that has flowed into the first indoor unit **200a** and the second indoor unit **200b** exchanges heat with air contained in an indoor space, and is evaporated (heated) at a first indoor heat exchanger **202a** and a second indoor heat exchanger **202b**. Therefore, the coolant emits cooling air to cool down the space for air conditioning (a first indoor space in which the first indoor



unit is installed, and a second indoor space in which the second indoor unit is installed) during above process.

[0219] Also, a circulating medium that has exchanged heat with coolant at the first outdoor heat exchanger **140a** flows into a plurality of first ground heat exchangers **300a** along a first circulating pipe **310a**. In more detail, the circulating medium that has passed through the first outdoor heat exchanger **140a** is guided along a first outdoor circulating pipe **310a'**, flows into the circulating distributor **510**, passes through the circulating distributor **510**, and is guided along a first ground circulating pipe **310a''** and flows into the plurality of first ground heat exchangers **300a**.

[0220] The circulating medium that has flowed into the first ground heat exchanger **300a** is cooled down by emitting heat to the ground, and flows into the cooling tower **460**. The circulating medium is cooled down even more by external air. The circulating medium that has passed through the cooling tower **460** flows along the first ground circulating pipe **310a''**, passes through the circulation distributor **510**, flows along the first outdoor circulating pipe **310a'**, and flows into the first outdoor heat exchanger **140a** again.

[0221] Therefore, a low temperature circulating medium that has flowed into the first outdoor heat exchanger **140a** cools down coolant that passes through the first outdoor heat exchanger **140a**, and the low temperature circulating medium itself is heated. Though the above-described processes, the circulating medium circulates through a complete one cycle.

[0222] Next, heating a space for air conditioning will be described.

[0223] Coolant that has passed through the third indoor unit **200c** and the fourth indoor unit **200d** joins at the coolant distributor **500**, and flows into the second outdoor unit **100b**. The coolant that has flowed into the second outdoor unit **100b** flows into a second outdoor heat exchanger **140b** to exchange heat with a circulating medium. At this point, the coolant is heated and evaporated by the circulating medium.

[0224] The coolant evaporated (heated) by the second outdoor heat exchanger **140b** flows into the coolant distributor **500** again, and is distributed and supplied to the third indoor unit **200c** and the fourth indoor unit **200d**. The coolant that has flowed into the third indoor unit **200c** and the fourth indoor unit **200d** exchanges heat with air contained in an indoor space, and is evaporated (heated) at a third indoor heat exchanger **202c** and a fourth indoor heat exchanger **202d**. Therefore, the coolant emits hot air to heat the space for air conditioning (a third indoor space in which the third indoor unit is installed, and a fourth indoor space in which the fourth indoor unit is installed) during above process.

[0225] Also, a circulating medium that has exchanged heat with coolant at the second outdoor heat exchanger **140b** flows into a plurality of second ground heat exchangers **300b** along a second circulating pipe **310b**. In more detail, the circulating medium that has passed through the second outdoor heat exchanger **140b** is guided along a second outdoor circulating pipe **310b'**, flows into the circulating distributor **510**, passes through the circulating distributor **510**, and is guided along a second ground circulating pipe **310b''**, and flows into the plurality of second ground heat exchangers **300b**.

[0226] The circulating medium that has flowed into the second ground heat exchanger **300b** is heated by receiving heat from the ground, and flows into the boiler **450**. The

circulating medium is heated even more at the boiler **450** and changed into a high temperature circulating medium. The high temperature circulating medium that has passed through the boiler **450** passes through the circulation distributor **510**, flows along the second outdoor circulating pipe **310b'**, and flows into the second outdoor heat exchanger **140b** again.

[0227] Therefore, the high temperature circulating medium that has flowed into the second outdoor heat exchanger **140b** heats coolant that passes through the second outdoor heat exchanger **140b**, and the high temperature circulating medium itself is cooled down. Though the above-described processes, the circulating medium circulates through another complete cycle.

[0228] Meanwhile, also according to the above-described second embodiment, the plurality of circulating pumps **320** are all or selectively used. That is, referring to FIG. 14, the variable delivery type circulating pump **320''** always operates in the case where the ground heat exchanger **300** is used, and changes its rotation speed depending on a load applied thereto.

[0229] Also, in the case where a load applied to the variable delivery type circulating pump **320''** gradually increases and only the variable delivery type circulating pump **320''** cannot process the increased load, the fixed delivery type circulating pump **320'** operates to supply a circulating medium.

[0230] As described above, according to the present invention, not only all of the plurality of indoor units **200** can be operated for a cooling cycle or a heating cycle, but also some of the plurality of indoor units **200** are operated for a heating cycle, and also some of the plurality of indoor units **200** are operated for a cooling cycle.

[0231] Also, the above-described partial cooling cycle and partial heating cycle can be performed by a user's selection/control, and can be automatically performed under control of the control unit (not shown).

[0232] That is, the control unit (not shown) determines whether to heat or cool down respective spaces (indoor spaces) for air conditioning according to a signal delivered from sensors (e.g., temperature sensors) installed at the indoor spaces. Coolant flowing into the plurality of indoor units **200** is individually controlled in response to a control signal from the control unit. Also, all or some of the plurality of outdoor units **100** and the ground heat exchangers **300** are selectively used depending on a load.

[0233] It will be apparent to those skilled in the art that various modifications and variations can be made in the present invention. Thus, it is intended that the present invention covers the modifications and variations of this invention provided they come within the scope of the appended claims and their equivalents.

[0234] For example, the number of the ground heat exchangers **300** described or illustrated in the above respective embodiments can be modified in various ways.

[0235] That is, though one ground heat exchanger **300** is used according to the first embodiment, two or more ground heat exchangers **300** can be installed in parallel or in series.

[0236] Also, the number of the ground heat exchangers **300** illustrated in FIG. 3 or 4 is not limited also in the second embodiment, but a various number of ground heat exchangers **300** can be connected and installed, and a separate



ground distributor can be further provided so that the plurality of ground heat exchangers 300 can be selectively used when needed.

What is claimed is:

1. A geothermal air conditioning system comprising:
  - a plurality of indoor units for conditioning indoor air;
  - at least one outdoor unit communicating with the indoor units via a plurality of pipes, and including an outdoor heat exchanger where heat exchange occurs, and a plurality of compressors for compressing coolant;
  - a ground heat exchanger connected with the outdoor heat exchanger of the outdoor unit, and laid under the ground to allow heat to be exchanged between ground heat and a circulating medium circulating through the ground heat exchanger; and
  - an auxiliary heat source installed on one side of the outdoor unit to assist heat exchange of the outdoor heat exchanger.
2. The system according to claim 1, wherein the compressor comprises:
  - a constant-speed compressor operating in a constant speed; and
  - an inverter compressor, which is a variable speed heat pump.
3. The system according to claim 2, wherein the constant-speed compressor is selectively used depending on the number of indoor units of the plurality of indoor units, that are required to operate for one of a cooling cycle and a heating cycle.
4. The system according to claim 2, wherein the constant-speed compressor is additionally operated when a load increases and is not handled by the inverter compressor alone.
5. A geothermal air conditioning system comprising:
  - a plurality of indoor units for conditioning indoor air;
  - a plurality of outdoor units provided on one side of the indoor unit and including an outdoor heat exchanger where coolant circulating through the outdoor heat exchanger exchanges heat with outside air, and a compressor for compressing the coolant;
  - a plurality of ground heat exchangers connected with the outdoor heat exchanger of the outdoor unit, and laid under the ground to allow heat to be exchanged between ground heat and a circulating medium circulating through the ground heat exchangers; and
  - a circulation distributor installed between the plurality of outdoor heat exchangers and the ground heat exchangers to control flow of the circulating medium depending on an operating condition.
6. The system according to claim 5, wherein a circulating pipe is provided between the outdoor heat exchanger and the ground heat exchanger to guide circulation of the circulating medium, and a circulating pump for forcing flowing of the circulating medium is installed at the circulating pipe.
7. The system according to claim 6, wherein the circulation distributor controls the circulating medium supplied to the plurality of ground heat exchangers depending on one of a user's setting and a load condition.
8. The system according to claim 6, wherein the circulation distributor controls the circulating medium to selectively flow to the outdoor heat exchangers depending on whether the plurality of outdoor heat exchangers operate.
9. The system according to claim 6, wherein a plurality of circulating pumps are installed.

10. The system according to claim 9, wherein the circulating pump comprises:

- a fixed delivery type circulating pump having a fixed volume to be delivered; and
- a variable delivery type circulating pump whose volume to be delivered is variable.

11. The system according to claim 10, wherein the fixed delivery type circulating pump is additionally operated when loads applied to the plurality of outdoor heat exchangers increase and are not handled by the variable delivery type circulating pump alone.

12. The system according to claim 5, further comprising a coolant distributor connected between the plurality of indoor units and outdoor units to control the coolant's flow depending on an operating condition.

13. A geothermal air conditioning system comprising:

- a plurality of indoor units for conditioning indoor air;
- at least one outdoor unit communicating with the indoor units via a plurality of pipes, and including an outdoor heat exchanger where heat exchange occurs, and a plurality of compressors for compressing coolant;
- a ground heat exchanger connected with the outdoor heat exchanger of the outdoor unit, and laid under the ground to allow heat to be exchanged between ground heat and a circulating medium circulating through the ground heat exchanger;
- an auxiliary heat source installed on one side of the outdoor unit to assist heat exchange of the outdoor heat exchanger;
- a circulation distributor installed between the plurality of outdoor heat exchangers and the ground heat exchangers to control flow of the circulating medium depending on an operating condition;
- a circulating pipe installed between the outdoor heat exchanger and the ground heat exchanger to guide circulation of the circulating medium; and
- circulating pumps installed at the circulating pipe to force flowing of the circulating medium.

14. The system according to claim 13, wherein the circulating pump comprises:

- a fixed delivery type circulating pump having a fixed volume to be delivered; and
- a variable delivery type circulating pump whose volume to be delivered is variable.

15. The system according to claim 14, wherein the fixed delivery type circulating pump is additionally operated when loads applied to the plurality of outdoor heat exchangers increase and are not handled by the variable delivery type circulating pump alone.

16. The system according to claim 13, wherein the compressor comprises:

- a constant-speed compressor operating in a constant speed; and
- an inverter compressor, which is a variable speed heat pump.

17. The system according to claim 16, wherein the constant-speed compressor is selectively used depending on the number of indoor units of the plurality of indoor units, that are required to operate for one of a cooling cycle and a heating cycle.

18. The system according to claim 16, wherein the constant-speed compressor is additionally operated when a load increases and is not handled by the inverter compressor alone.