US 20110042057A1

(19) **United States**

(12) **Patent Application Publication**

Li et al.

(10) **Pub. No.: US 2011/0042057 A1**

(43) **Pub. Date: Feb. 24, 2011**

(54) COOLING SYSTEM, CONTROL METHOD THEREOF AND EQUIPMENT ROOM

(75) Inventors: **Yuening Li**, Shenzhen (CN); **Yuping Hong**, Shenzhen (CN)

Correspondence Address:
Docket Clerk/HTCL
P.O. Drawer 800889
Dallas, TX 75380 (US)

(73) Assignee: **Huawei Technologies Co., Ltd.**

(21) Appl. No.: **12/917,262**

(22) Filed: **Nov. 1, 2010**

Related U.S. Application Data

(63) Continuation of application No. PCT/CN2009/071838, filed on May 18, 2009.

(30) **Foreign Application Priority Data**

May 23, 2008 (CN) 200810067334.5

Publication Classification

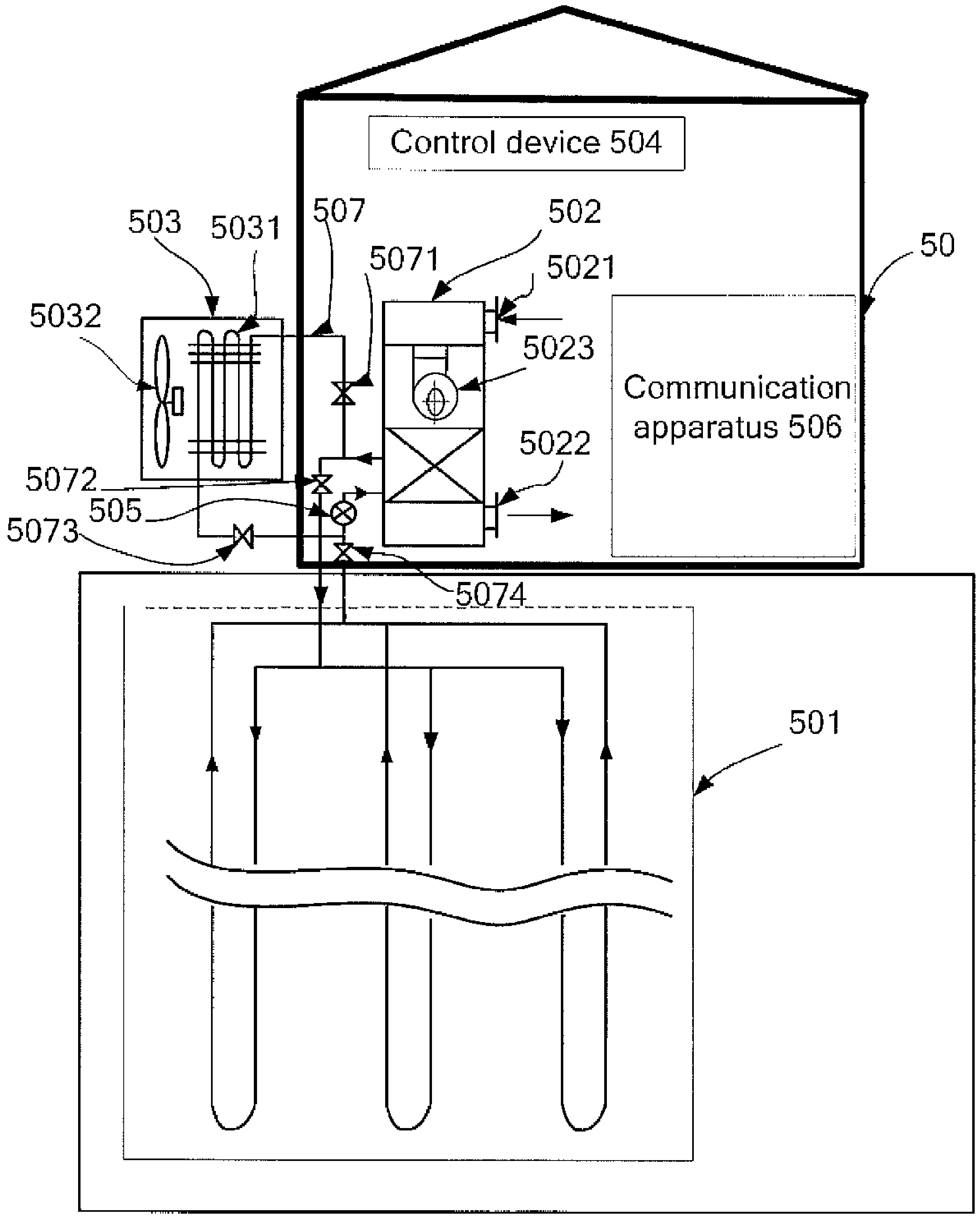
(51) **Int. Cl.**

F25B 29/00	(2006.01)
F24J 3/08	(2006.01)
F24F 7/00	(2006.01)
F28D 15/00	(2006.01)

(52) **U.S. Cl.** **165/253**; 165/45; 165/59; 165/104.13; 165/48.1

(57) **ABSTRACT**

A cooling system includes a buried heat exchange unit (**301**), a first air-liquid heat exchanger (**302**), a second air-liquid heat exchanger (**303**), a control device (**304**), a fluid conveying device (**305**), and connecting pipes (**307**). A control method applicable to the cooling system includes: acquiring environment information, where the environment information includes at least one of the following temperatures: an outdoor temperature of the equipment room and a temperature of the soil surrounding buried pipes; and controlling at least one of the at least two circulation pipelines to be in an open state according to a control policy and the acquired environment information, where a circulation fluid is driven by the fluid conveying device to flow in the open circulation pipeline. An equipment room using the cooling system is also provided.



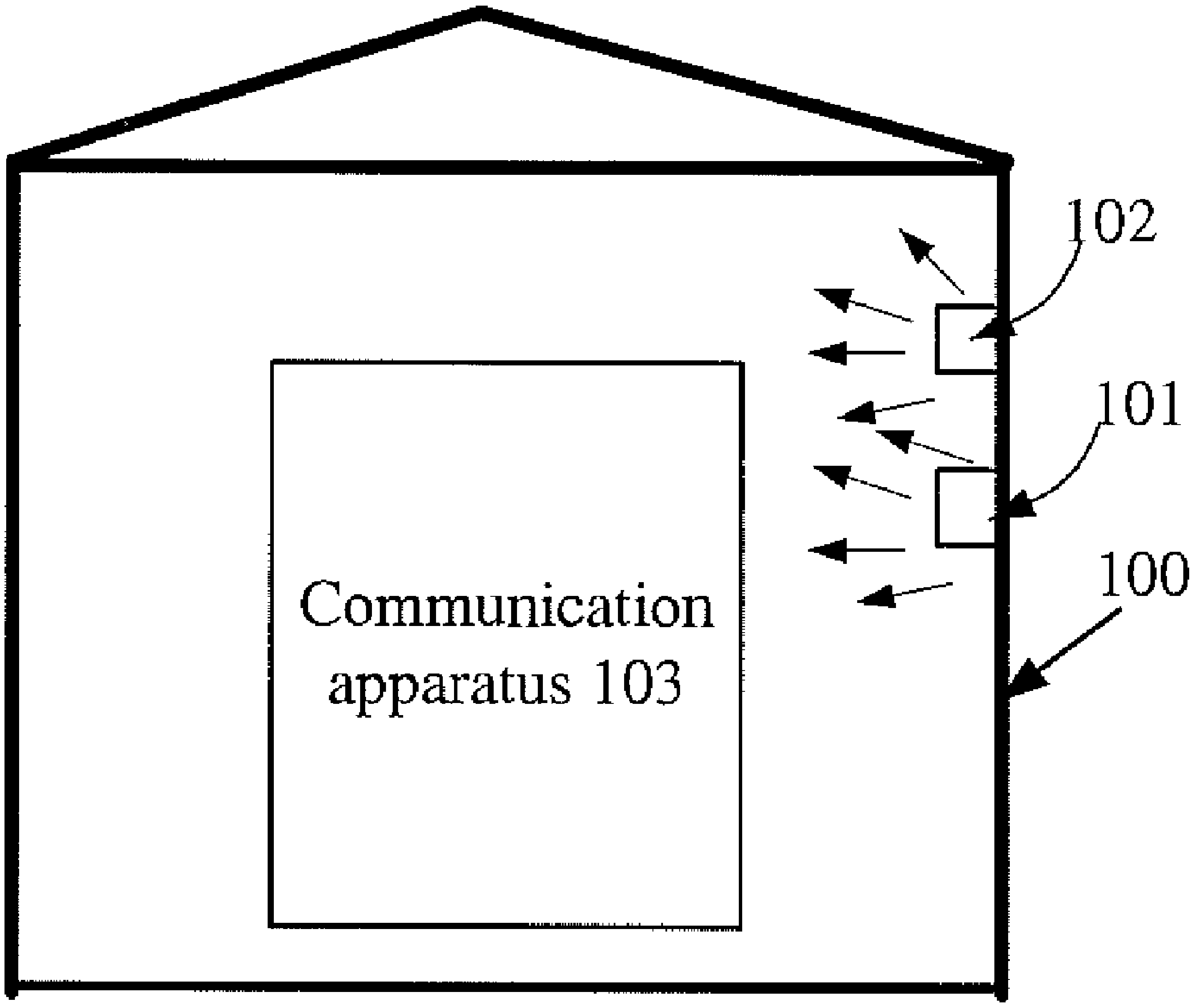

102
101
100
Communication apparatus 103

FIG. 1

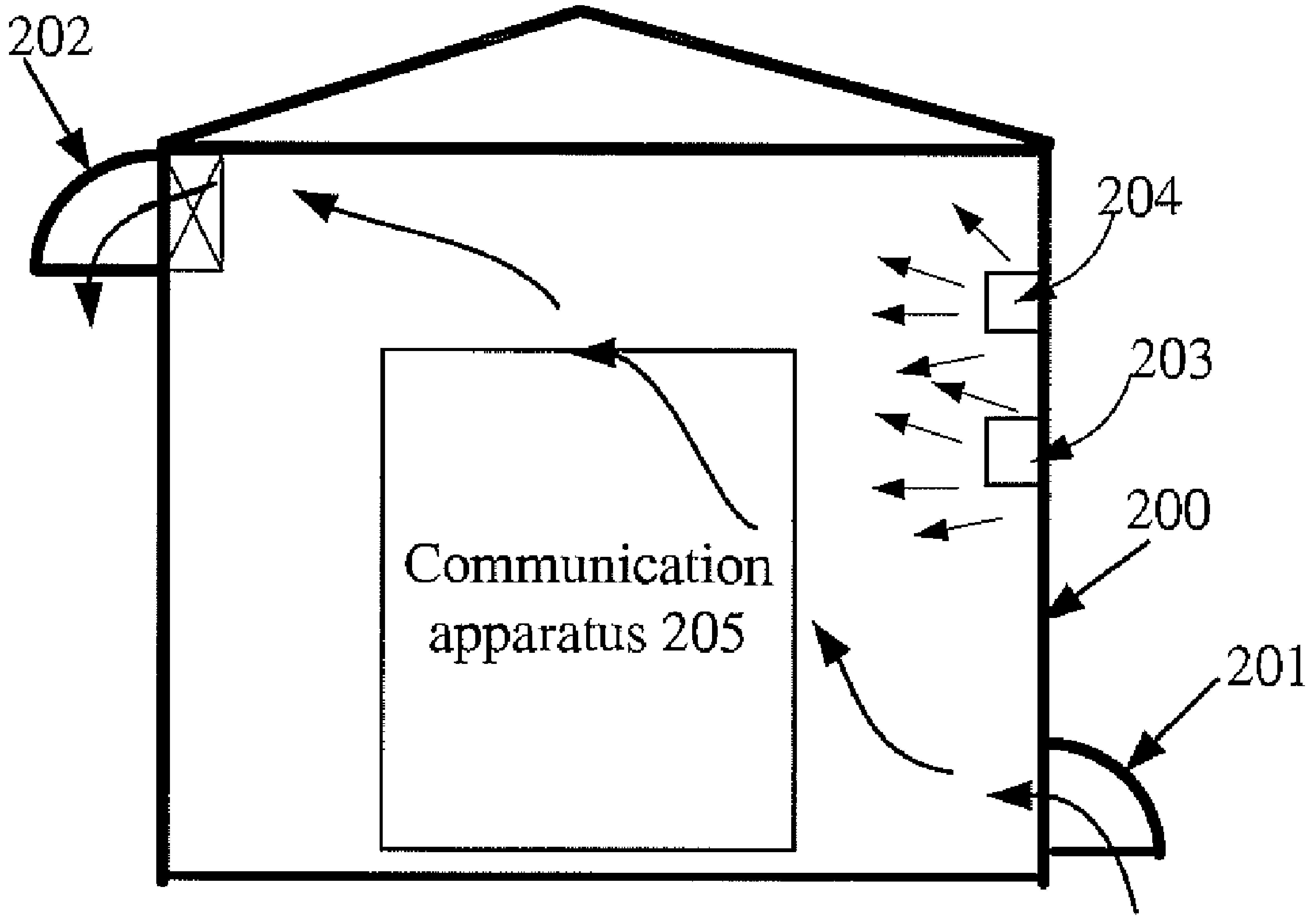

202
204
203
200
201
Communication apparatus 205

FIG. 2

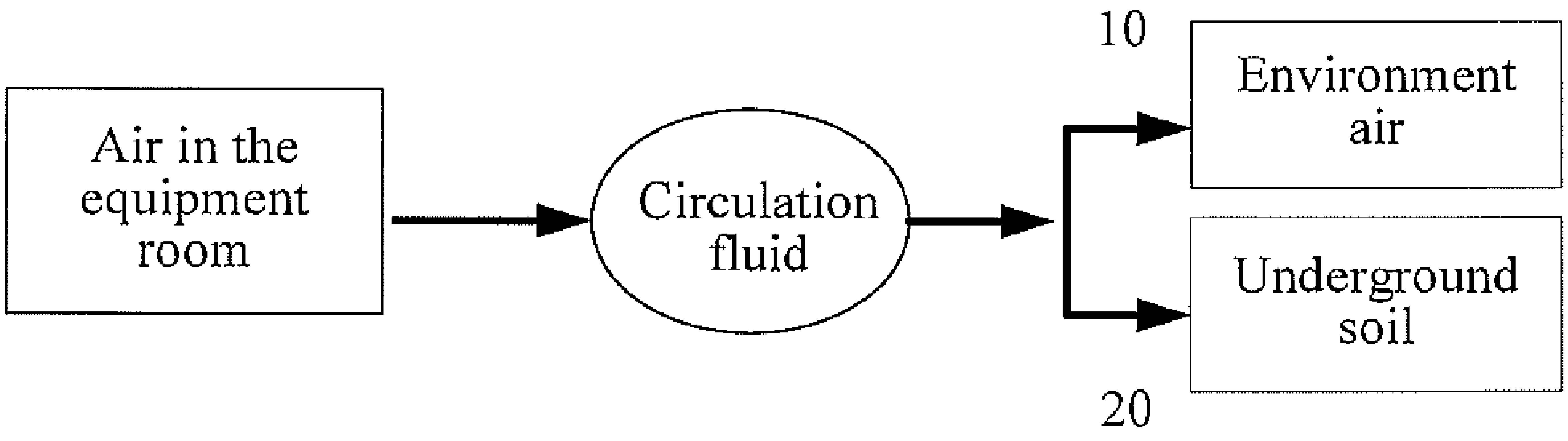

Air in the equipment room
Circulation fluid
10
Environment air
Underground soil
20

FIG. 3

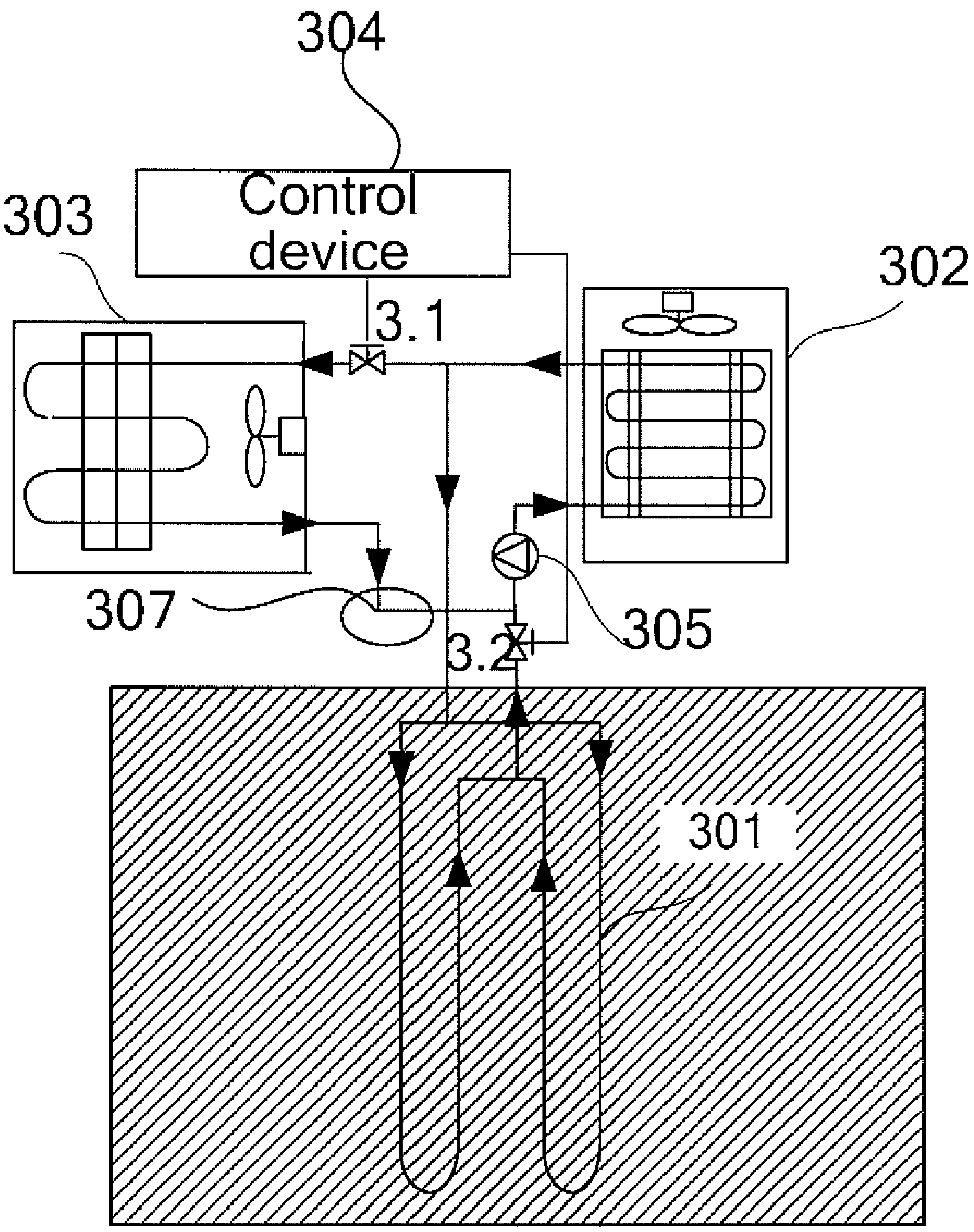

304
Control device
303
3.1
302
307
305
3.2
301

FIG. 4

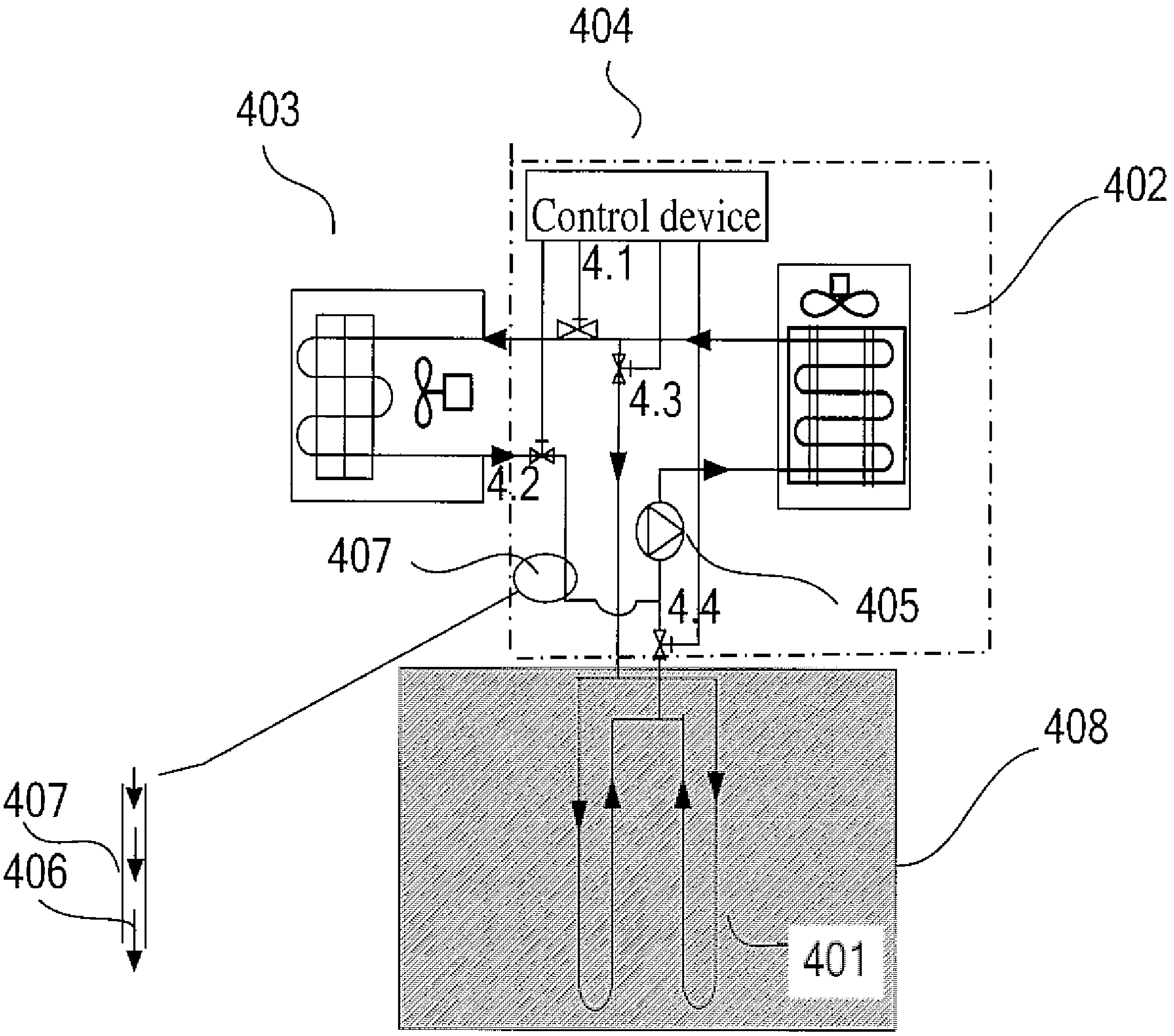


FIG. 5

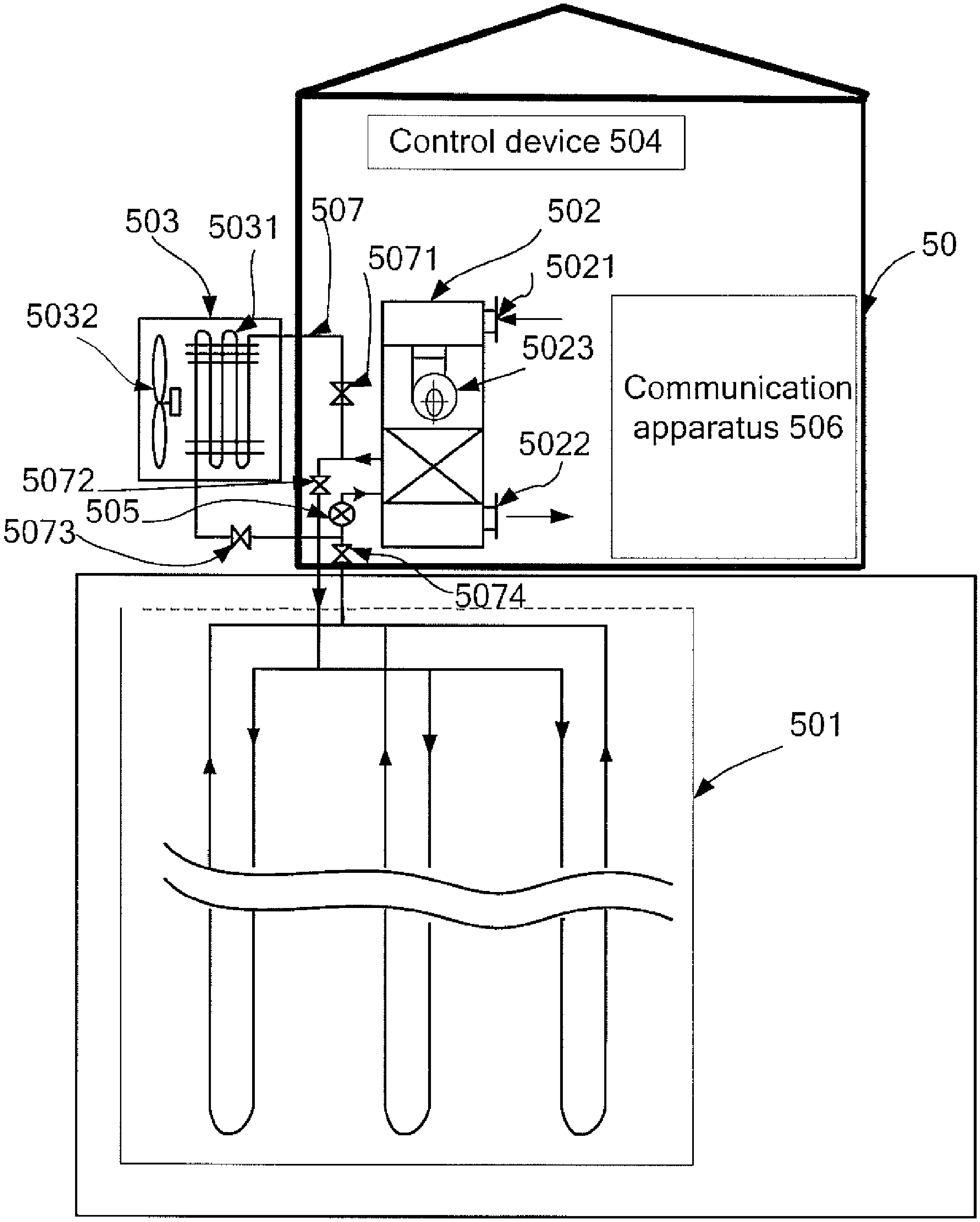

Control device 504
503
5031
507
502
5071
5021
50
5032
5023
Communication apparatus 506
5022
5072
505
5073
5074
501

FIG. 6

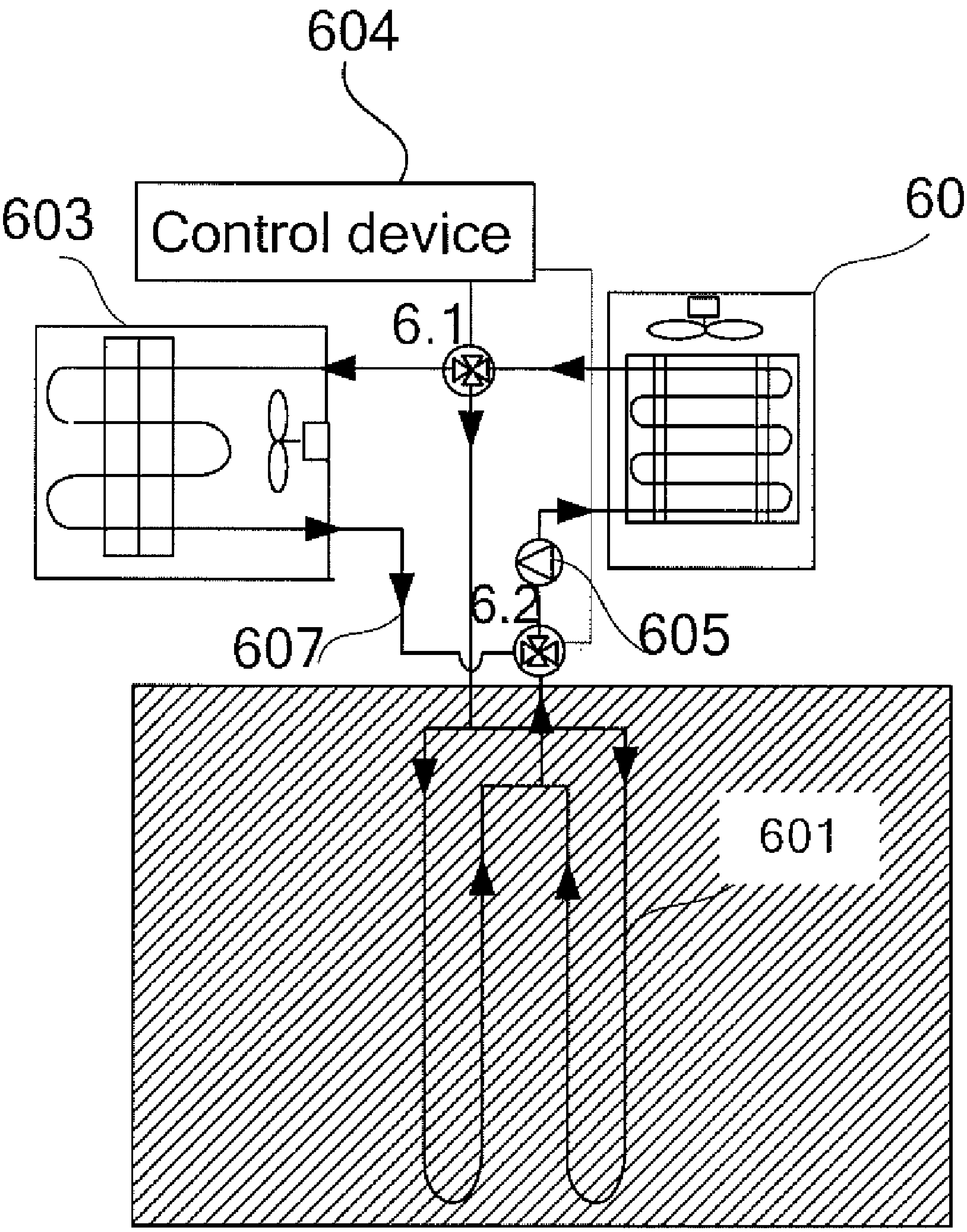


FIG. 7

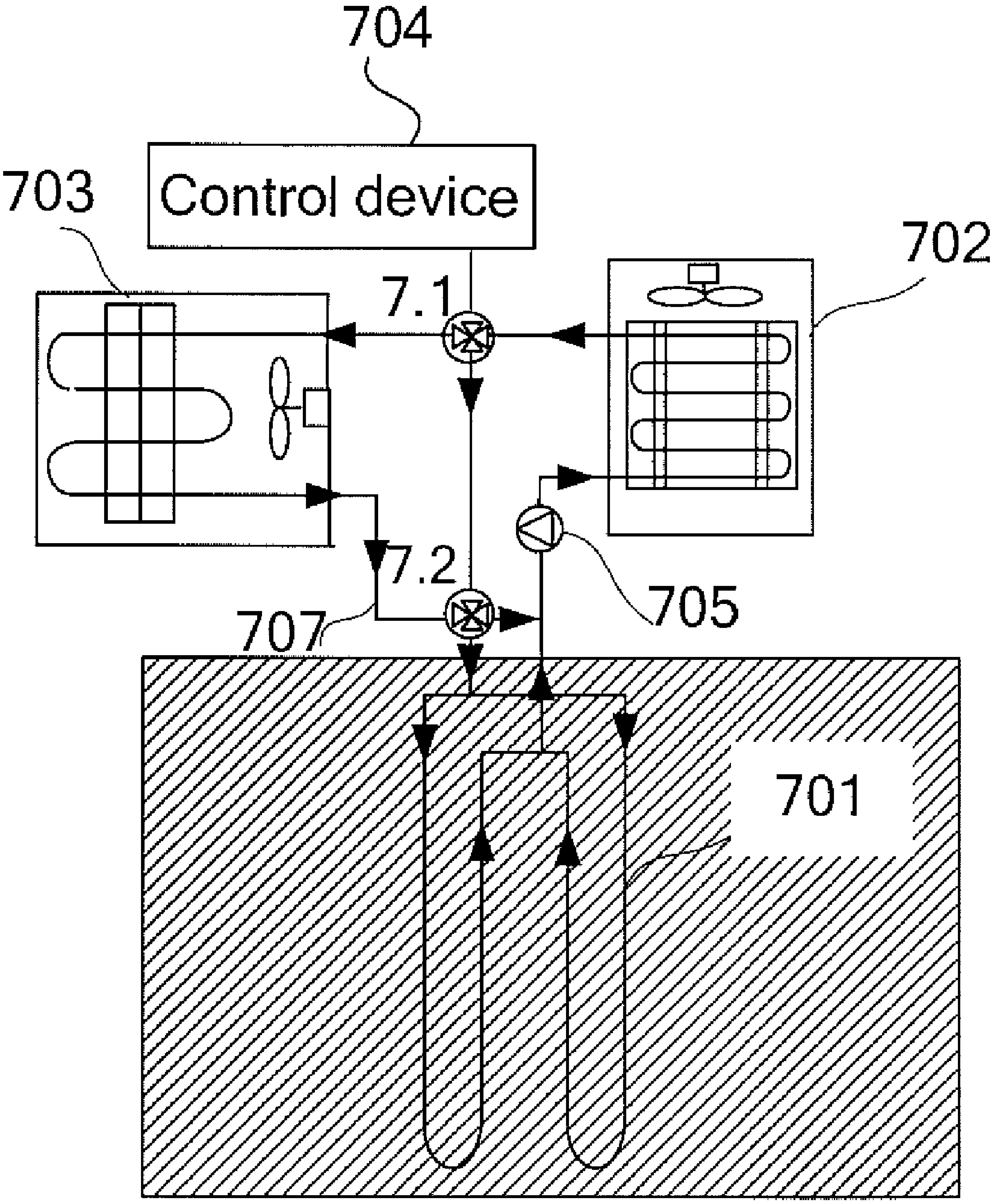


FIG. 8

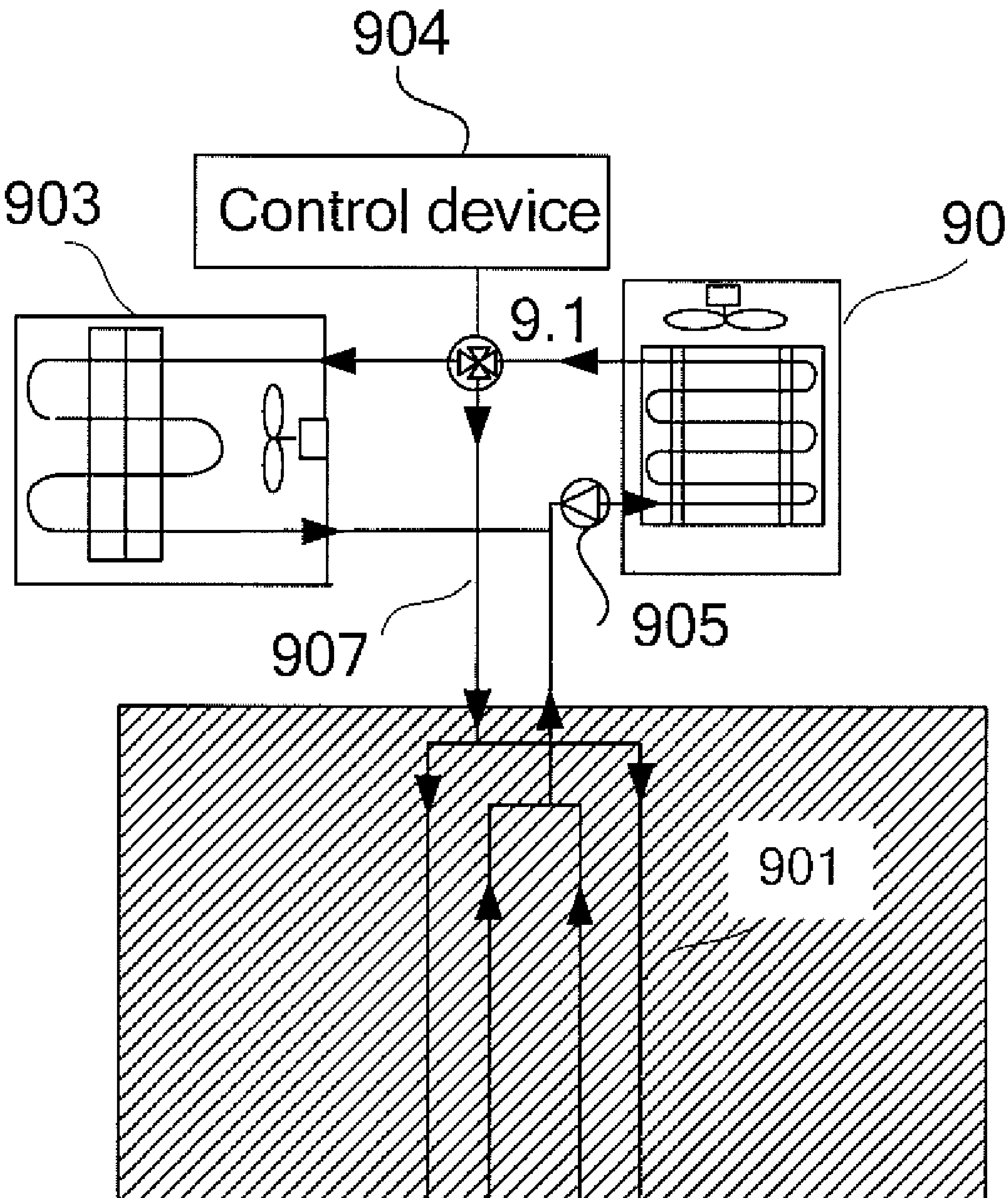


FIG. 9

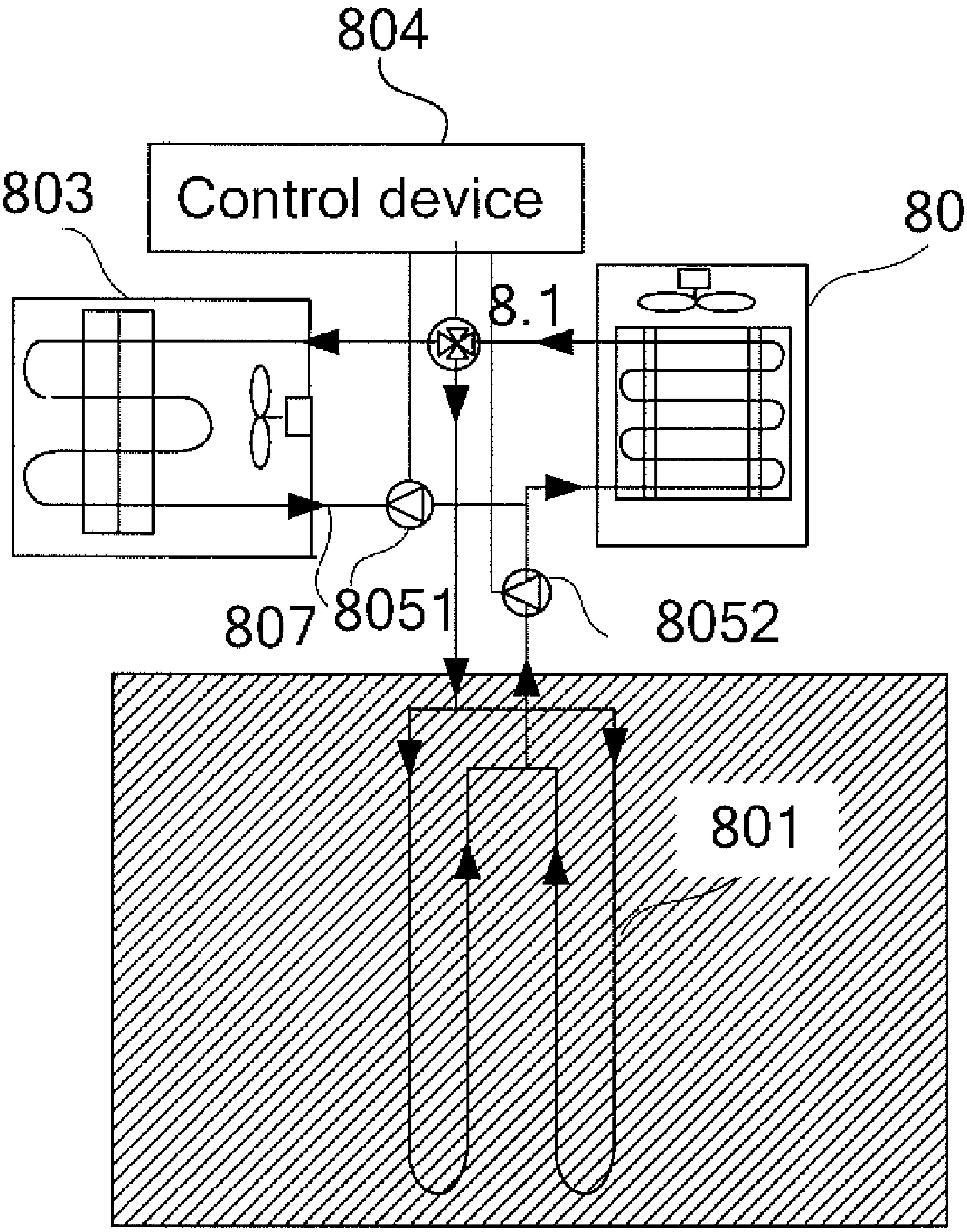


FIG. 10

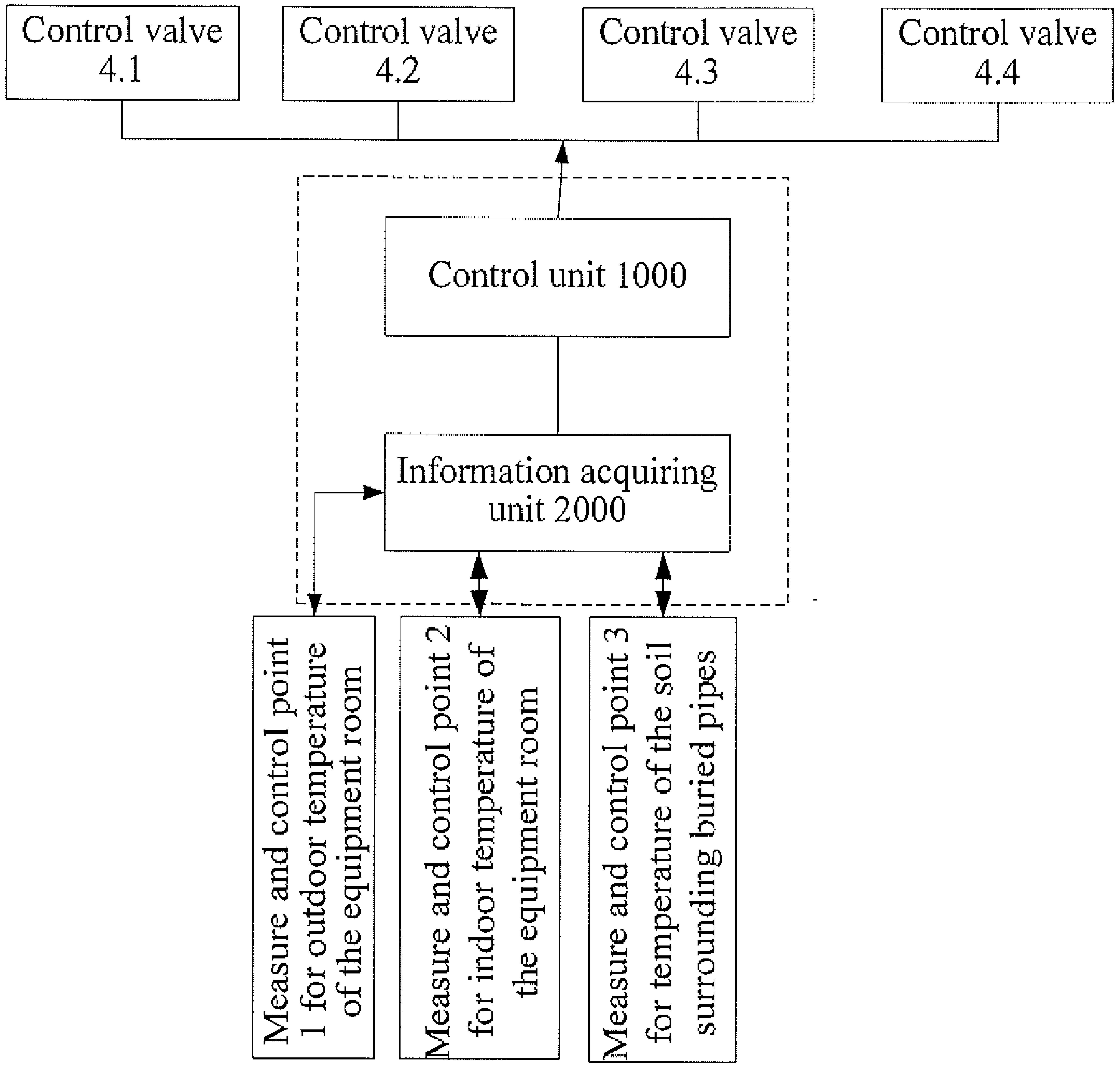

Control valve 4.1
Control valve 4.2
Control valve 4.3
Control valve 4.4
Control unit 1000
Information acquiring unit 2000
Measure and control point 1 for outdoor temperature of the equipment room
Measure and control point 2 for indoor temperature of the equipment room
Measure and control point 3 for temperature of the soil surrounding buried pipes

FIG. 11

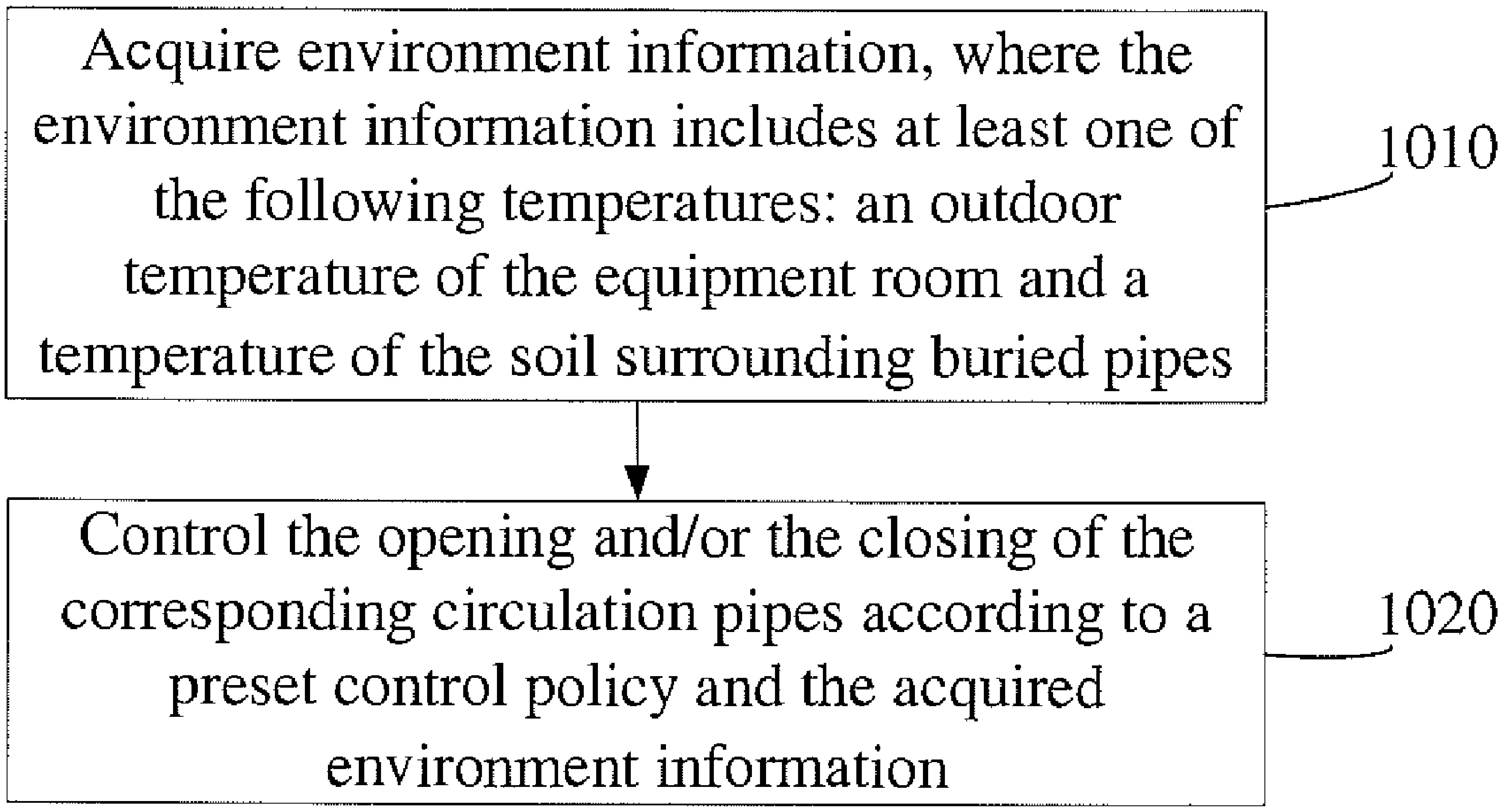

Acquire environment information, where the environment information includes at least one of the following temperatures: an outdoor temperature of the equipment room and a temperature of the soil surrounding buried pipes
1010
Control the opening and/or the closing of the corresponding circulation pipes according to a preset control policy and the acquired environment information
1020

FIG. 12

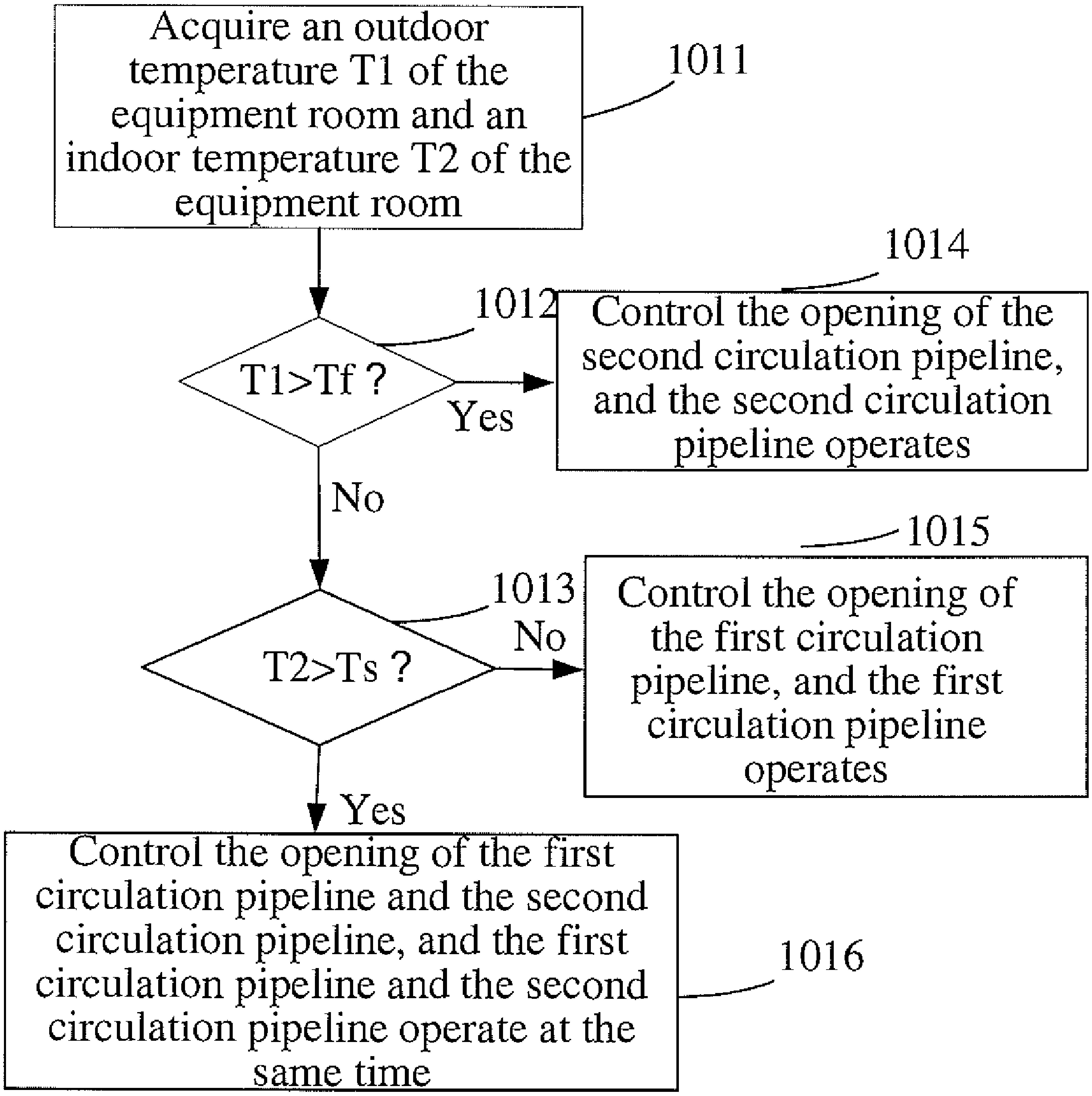

Acquire an outdoor temperature T1 of the equipment room and an indoor temperature T2 of the equipment room
1011
1014
1012
T1>Tf ?
Yes
Control the opening of the second circulation pipeline, and the second circulation pipeline operates
No
1015
1013
No
T2>Ts ?
Control the opening of the first circulation pipeline, and the first circulation pipeline operates
Yes
Control the opening of the first circulation pipeline and the second circulation pipeline, and the first circulation pipeline and the second circulation pipeline operate at the same time
1016

FIG. 13

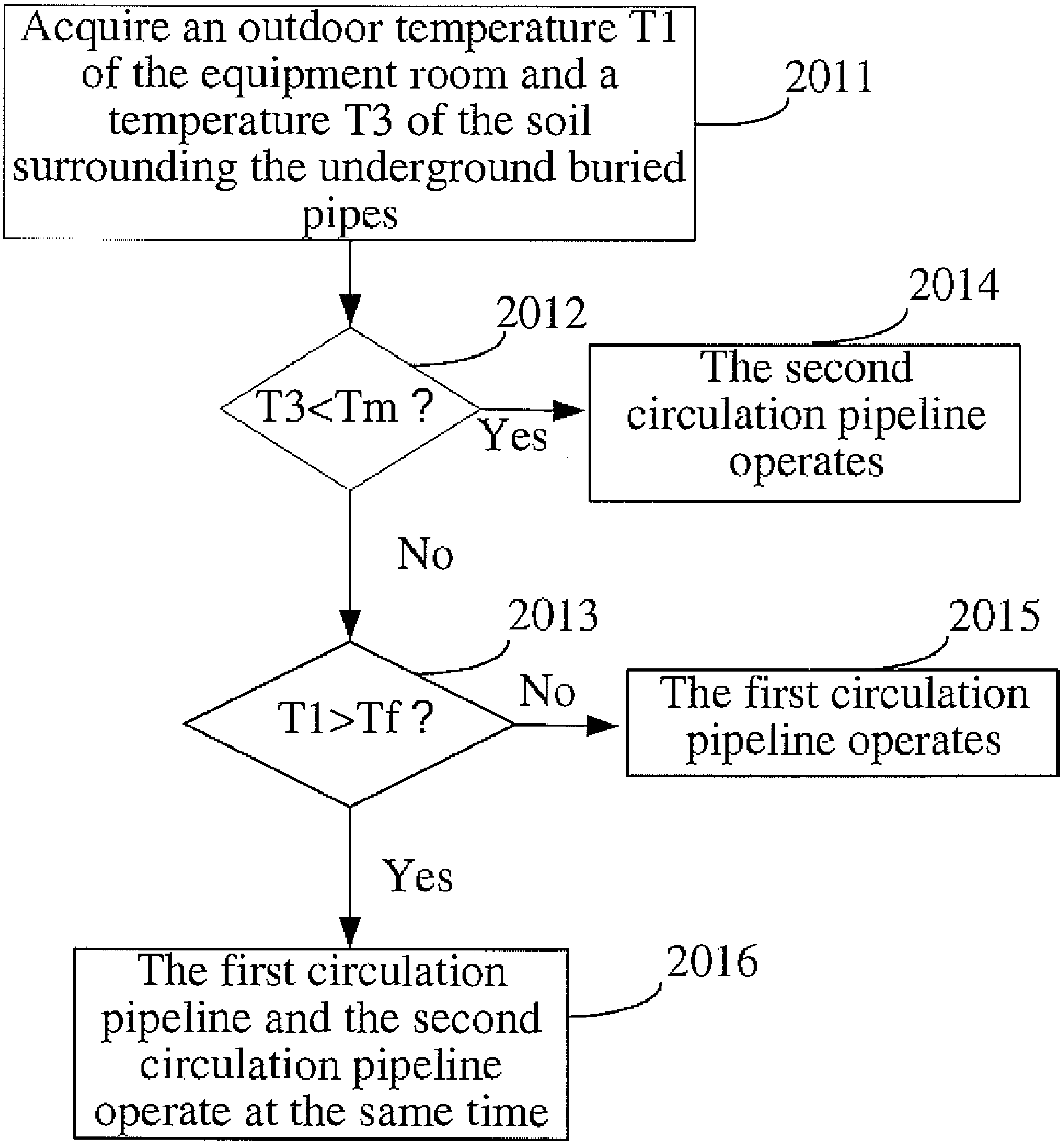

Acquire an outdoor temperature T1 of the equipment room and a temperature T3 of the soil surrounding the underground buried pipes
2011
2012
T3<Tm ?
Yes
2014
The second circulation pipeline operates
No
2013
T1>Tf ?
No
2015
The first circulation pipeline operates
Yes
The first circulation pipeline and the second circulation pipeline operate at the same time
2016

FIG. 14

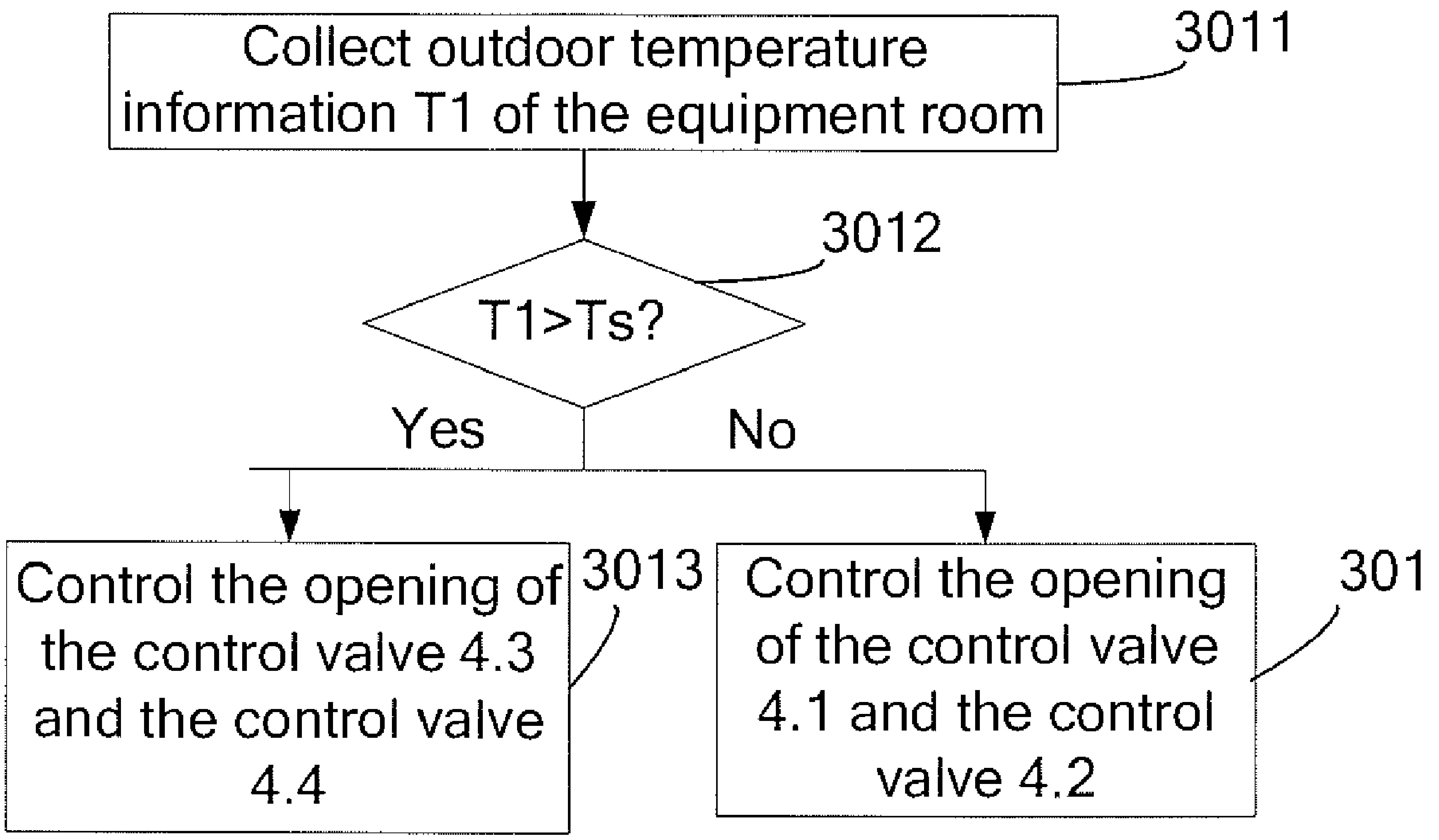

Collect outdoor temperature information T1 of the equipment room
3011
T1>Ts?
3012
Yes
No
Control the opening of the control valve 4.3 and the control valve 4.4
3013
Control the opening of the control valve 4.1 and the control valve 4.2
301

FIG. 15

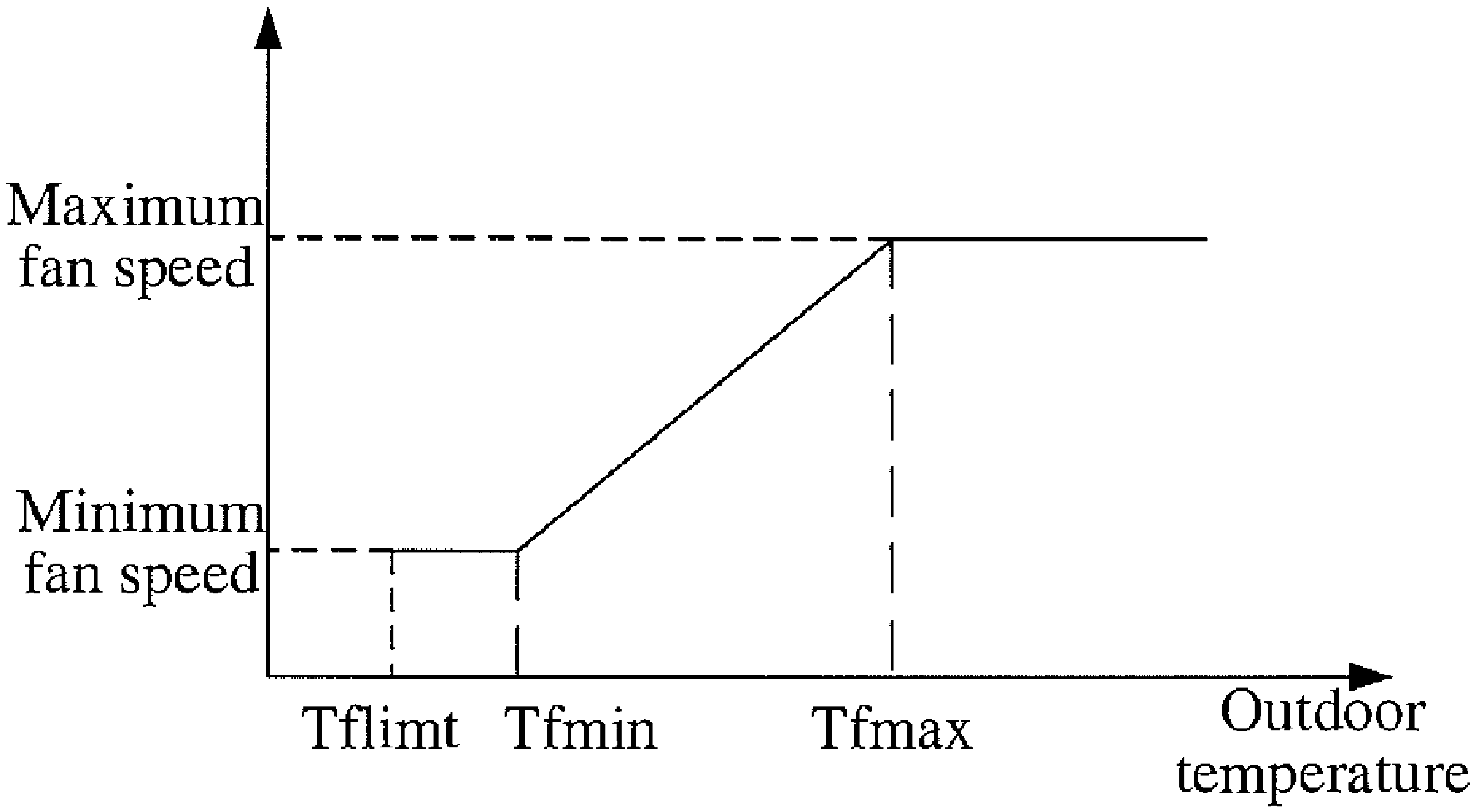

Maximum fan speed
Minimum fan speed
Tflimt
Tfmin
Tfmax
Outdoor temperature

FIG. 16

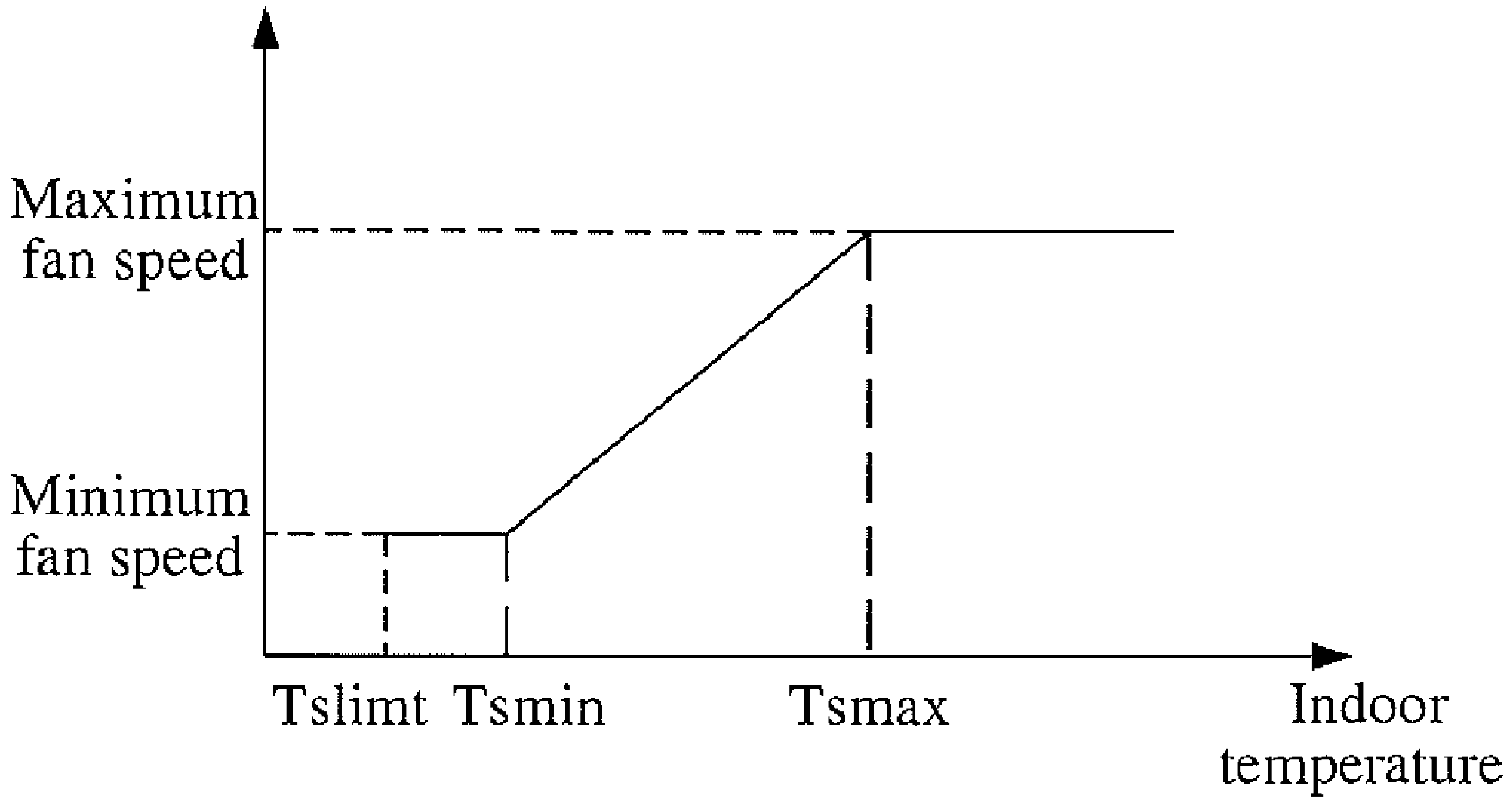

Maximum fan speed
Minimum fan speed
Tslimt
Tsmin
Tsmax
Indoor temperature

FIG. 17

COOLING SYSTEM, CONTROL METHOD THEREOF AND EQUIPMENT ROOM

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] The application is a continuation of International Application No. PCT/CN2009/071838, filed on May 18, 2009, which claims priority to Chinese Patent Application No. 200810067334.5, filed on May 23, 2008, both of which are hereby incorporated by reference in their entireties.

TECHNICAL FIELD

[0002] The present invention relates to the field of the cooling technology, and more particularly to a cooling system, a cooling method, and an equipment room based on ground source heat pump technology.

BACKGROUND

[0003] Currently, the ground source heat pump technology is applied to the field of building power-saving. A ground source heat pump is a high-efficiency power-saving system that utilizes simple layer of geothermal resources (also referred to as ground energy, including ground water, soil, and surface water) and provides both heating and cooling functions.

[0004] With the development of the communication technology, the communication apparatuses in an outdoor integrated equipment room are arranged at a higher density, and operate 24 hours a day without interruption, so a large amount of heat is generated. Because the communication apparatuses generate heat, and the environment temperature is also high sometimes, it is not good for cooling the apparatuses. In addition, the communication apparatuses in the equipment room are required to operate in a specific environment temperature range, and when the environment temperature is too high, the communication apparatuses may be damaged. Therefore, for the current outdoor integrated equipment room, it has become an urgent problem to be solved to cool down the equipment room.

[0005] FIG. **1** is a schematic diagram of an equipment room that uses air conditioners to cool the communication apparatuses in the equipment room in the prior art. Referring to FIG. **1**, at least one communication apparatus **103** is disposed in the equipment room **100**, and air conditioners **101** and **102** are installed on a side wall of the equipment room **100**. Here, the air conditioners **101** and **102** are generally window air conditioners or wall-mounted air conditioners, and are configured to control the air in the equipment room at a suitable temperature.

[0006] FIG. **2** is a schematic diagram of an equipment room that uses a cooling system including air conditioners and direct ventilation to cool the communication apparatuses in the equipment room in the prior art. Referring to FIG. **2**, at least one communication apparatus **205** is disposed in the equipment room **200**, and air conditioners **203** and **204** are installed on a side wall of the equipment room **200**. Here, the air conditioners **203** and **204** are generally window air conditioners or wall-mounted air conditioners. In addition, an air outlet control device **202** is opened at a top of a left side wall of the equipment room **200**, and an air inlet control device **201** is opened at a bottom of a right side wall of the equipment room **200**. The air conditioners **203** and **204** form an air conditioning system, and the ventilation control devices **201** and **202** form a direct ventilation system. As shown in FIG. **2**, the operating principles of the direct ventilation system are as follows: cold air out of the equipment room enters the equipment room from the air inlet control device **201**, and takes out the heat of the equipment room when passing through the equipment room, and hot air leaves the equipment room from the air outlet control device **202**. Normally, the direct ventilation system is used when the environment temperature outside the equipment room is low, and on the contrary, the air conditioning system is used when the environment temperature outside the equipment room is high.

[0007] During the research on the prior art, the inventors of the present invention find that the prior art at least has the following problems: the air conditioning cooling system used in the equipment room currently has high power consumption, and has an impact on the outdoor environment; the cooling system including air conditioners and direct ventilation consumes less power than the cooling system using only air conditioners, but the direct ventilation unit of the former system is affected by the air quality. Therefore, the application scenarios are limited.

SUMMARY

[0008] The embodiments of the present invention are directed to a cooling system, a control method, and an equipment room, which effectively cool the equipment room, and save power at the same time when controlling a temperature of air in the equipment room at a suitable temperature.

[0009] Embodiments of the present invention provide the following technical solutions:

[0010] A cooling system is provided. The cooling system is applied to an equipment room, and the system includes a first air-liquid heat exchanger, a second air-liquid heat exchanger, a buried heat exchange unit, a control device, a fluid conveying device, and connecting pipes. The first air-liquid heat exchanger is disposed in the equipment room, the second air-liquid heat exchanger is disposed outside the equipment room, and the buried heat exchange unit is buried underground. The second air-liquid heat exchanger and the buried heat exchange unit are connected by the connecting pipes to the first air-liquid heat exchanger to form at least two circulation pipelines.

[0011] The control device is configured to acquire environment information, and control at least one of the at least two circulation pipelines to be in an open state according to a control policy and the acquired environment information, where the environment information includes at least one of the following temperatures: an outdoor temperature of the equipment room and a temperature of the soil surrounding buried pipes. A circulation fluid is driven by the fluid conveying device to flow in the open circulation pipeline.

[0012] An equipment room is provided. A cooling system including a first air-liquid heat exchanger, a second air-liquid heat exchanger, a buried heat exchange unit, a control device, a fluid conveying device, and connecting pipes is applied to the equipment room. The first air-liquid heat exchanger is disposed in the equipment room. The second air-liquid heat exchanger disposed outside the equipment room and the buried heat exchange unit buried underground are connected by the connecting pipes to the first air-liquid heat exchanger to form at least two circulation pipelines.

[0013] The control device is configured to acquire environment information, and control at least one of the at least two circulation pipelines to be in an open state according to a control policy and the acquired environment information, where the environment information includes at least one of the following temperatures: an outdoor temperature of the equipment room and a temperature of the soil surrounding buried pipes. A circulation fluid is driven by the fluid conveying device to flow in the open circulation pipeline.

[0014] A control method is provided. The control method is applicable to a cooling system including a buried heat exchange unit, a first air-liquid heat exchanger, a second air-liquid heat exchanger, a control device, a fluid conveying device, and connecting pipes. The cooling system is applied to an equipment room. The second air-liquid heat exchanger and the buried heat exchange unit are connected by the connecting pipes to the first air-liquid heat exchanger to form at least two circulation pipelines. The control method includes:

[0015] acquiring environment information, where the environment information includes at least one of the following temperatures: an outdoor temperature of the equipment room and a temperature of the soil surrounding buried pipes; and

[0016] controlling at least one of the at least two circulation pipelines to be in an open state according to a control policy and the acquired environment information, where a circulation fluid flowing in the open circulation pipeline.

[0017] In the embodiments of the present invention, according to the preset control policy and the acquired environment information, the corresponding circulation pipelines are controlled to be in an open state and/or to be in a close state, so that heat in the equipment room is transferred to the circulation fluid through the first air-liquid heat exchanger, and the circulation fluid flows to the second air-liquid heat exchanger, and/or the buried heat exchange unit to perform the cooling. Thus, the air in the equipment room is controlled at the suitable temperature.

[0018] Moreover, in the embodiments of the present invention, the power is mainly consumed by the fluid conveying device and air conveying devices in the two air-liquid heat exchangers. Therefore, the present invention has better power-saving performance than conventional air conditioning systems.

[0019] Further, in the embodiments of the present invention, the buried heat exchange unit and the outdoor first air-liquid heat exchanger are used alternately and/or simultaneously, so as to prevent the possibility of continuously dissipating heat to the underground soil, and make the soil temperature to have time to recover. Thus, the problem of low cooling capabilities of the system caused by a high underground soil temperature is prevented, where the high underground soil temperature occurs because the underground soil receives the heat for a long time.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020] FIG. **1** is a schematic diagram of a common air conditioning cooling system for an equipment room in the prior art;

[0021] FIG. **2** is a schematic diagram of a common cooling system including air conditioners and direct ventilation for an equipment room in the prior art;

[0022] FIG. **3** is a schematic diagram of heat transfer of a cooling system for an equipment room according to an embodiment of the present invention;

[0023] FIG. **4** is a schematic diagram of a cooling system according to Embodiment 1 of the present invention;

[0024] FIG. **5** is a schematic diagram of a cooling system according to Embodiment 2 of the present invention;

[0025] FIG. **6** is a schematic diagram of a cooling system applied to an equipment room according to Embodiment 3 of the present invention;

[0026] FIG. **7** is a schematic diagram of a cooling system according to Embodiment 4 of the present invention;

[0027] FIG. **8** is a schematic diagram of a cooling system according to Embodiment 5 of the present invention;

[0028] FIG. **9** is a schematic diagram of a cooling system according to Embodiment 6 of the present invention;

[0029] FIG. **10** is a schematic diagram of a cooling system according to Embodiment 7 of the present invention;

[0030] FIG. **11** is a schematic diagram of internal modules of a control device of a cooling system according to an embodiment of the present invention;

[0031] FIG. **12** is a flow chart of a control method according to an embodiment of the present invention;

[0032] FIG. **13** is a detailed flow chart of a control method according to Embodiment 1 of the present invention;

[0033] FIG. **14** is a detailed flowchart of a control method according to Embodiment 2 of the present invention;

[0034] FIG. **15** is a detailed flow chart of a control method according to Embodiment 3 of the present invention;

[0035] FIG. **16** is a schematic diagram of a fan speed regulating policy of a second air-liquid heat exchanger in a cooling system according to an embodiment of the present invention; and

[0036] FIG. **17** is a schematic diagram of a fan speed regulating policy of a first air-liquid heat exchanger in a cooling system according to an embodiment of the present invention.

DETAILED DESCRIPTION

[0037] To make the objectives, technical solutions, and advantages of the present invention more comprehensible, the present invention is described in detail in the following with reference to the accompanying drawings and the embodiments.

[0038] FIG. **3** is a schematic diagram of heat transfer of a cooling system for an equipment room according to an embodiment of the present invention. As shown in FIG. **3**, as a medium, a circulation fluid transfers heat of air in the equipment room to outside environment air and/or underground soil. When the outdoor temperature of the equipment room is low, for example, when the outside environment temperature is low in winter, a heat transfer process **10** is adopted to transfer the heat in the equipment room to the outside environment air; and when the outdoor temperature of the equipment room is high, for example, when the outside environment temperature is high in summer, a heat transfer process **20** is adopted to transfer the heat in the equipment room to the underground soil. Thus, the heat in the equipment room can be dissipated to control the equipment room at a suitable temperature, the power-saving effect is achieved, and the problem of low cooling capabilities of the system caused by a high underground soil temperature is prevented, where the high underground soil temperature occurs because the underground soil receives the heat for a long time.

[0039] In an embodiment, the present invention provides a cooling system. The cooling system is applied to an equipment room, and includes a first air-liquid heat exchanger, a second air-liquid heat exchanger, a buried heat exchange unit, a control device, a fluid conveying device, and connecting pipes. The first air-liquid heat exchanger is disposed in the equipment room, the second air-liquid heat exchanger is disposed outside the equipment room, and the buried heat exchange unit is buried underground. The second air-liquid heat exchanger and the buried heat exchange unit are connected by the connecting pipes to the first air-liquid heat exchanger to form at least two circulation pipelines.

[0040] The control device is configured to acquire environment information, where the environment information includes at least one of the following temperatures: an outdoor temperature of the equipment room and a temperature of the soil surrounding buried pipes, and control the at least two circulation pipelines according to a preset control policy and the acquired environment information, to enable at least one of the circulation pipelines to be in an open state (that is, control at least one of the at least two circulation pipelines to be in an open state according to the preset control policy and the acquired environment information). A circulation fluid (specifically, a circulation liquid) is driven by the fluid conveying device to flow in the open circulation pipeline to complete the cooling.

[0041] It should be noted that to achieve that the control device controls at least one of the at least two circulation pipelines to be in an open state, in one implementation, at least one control valve needs to be disposed on each circulation pipeline, and at least one fluid conveying device needs to be disposed on each circulation pipeline. It is understood that when a control valve is disposed at the same pipe position of multiple circulation pipelines, there is one control valve which is needed to be disposed on (the connecting pipes of) the cooling system according to the embodiment of the present invention; and when a fluid conveying device is disposed at the same pipe position of multiple circulation pipelines, there is one fluid conveying device which is needed to be disposed on (the connecting pipes of) the cooling system according to the embodiment of the present invention.

[0042] FIG. **4** is a schematic diagram of a cooling system according to Embodiment 1 of the present invention. As shown in FIG. **4**, the cooling system is applied to an outdoor integrated equipment room, and includes a buried heat exchange unit **301**, a first air-liquid heat exchanger **302**, a second air-liquid heat exchanger **303**, a control device **304**, a fluid conveying device **305**, and connecting pipes **307**. The buried heat exchange unit **301** is buried underground, the first air-liquid heat exchanger **302** is disposed in the equipment room, and the second air-liquid heat exchanger **303** is disposed outside the equipment room. The buried heat exchange unit **301** and the second air-liquid heat exchanger **303** are connected by the connecting pipes **307** to the first air-liquid heat exchanger **302** to form two circulation pipelines. It should be noted that the first air-liquid heat exchanger **302** and the second air-liquid heat exchanger **303** are connected by the connecting pipes **307** to form a first circulation pipeline, and the first air-liquid heat exchanger **302** and the buried heat exchange unit **301** are connected by the connecting pipes **307** to form a second circulation pipeline. Specifically, pipes in the buried heat exchange unit **301**, coil pipes in the first air-liquid heat exchanger **302**, and the connecting pipes **307** form a loop; and coil pipes in the second air-liquid heat exchanger **303**, the coil pipes in the first air-liquid heat exchanger **302**, and the connecting pipes **307** form another loop.

[0043] The first air-liquid heat exchanger **302** is configured to suck in hot air in the equipment room. The hot air exchanges heat with the circulation fluid flowing in the coil pipes (that is, the heat of the air in the equipment room is transferred to the circulation fluid flowing in the coil pipes), the air with its heat released is returned into the equipment room, and the circulation fluid absorbing the heat (that is, the hot fluid) flows out of the first air-liquid heat exchanger **302**. Specifically, driven by the fluid conveying device **305**, the circulation fluid absorbing the heat flows out of the first air-liquid heat exchanger **302**.

[0044] When the circulation fluid flows out of the first air-liquid heat exchanger **302**, the control device **304** is configured to acquire environment information, and to control the first circulation pipeline and the second circulation pipeline, according to the preset control policy and the acquired environment information, to enable the first circulation pipeline and/or the second circulation pipeline to be open (that is, to control the first circulation pipeline and/or the second circulation pipeline to be in an open state), where the environment information includes at least one of the following temperatures: an outdoor temperature of the equipment room and a temperature of the soil surrounding buried pipes. It is understood that if the circulation pipelines are open in a default state, the corresponding circulation pipelines must be controlled to enter a closed state; and on the contrary, if the circulation pipelines are closed in a default state, the corresponding circulation pipelines must be controlled to enter the open state, and the outgoing circulation fluid flows to the second air-liquid heat exchanger **303** and/or the buried heat exchange unit **301** correspondingly through the open circulation pipeline.

[0045] When the circulation fluid flows into the second air-liquid heat exchanger **303** through the open first circulation pipeline, the second air-liquid heat exchanger **303** is configured to enable the circulation fluid flowing in the coil pipes therein to exchange heat with the air flowing outside the coil pipes, and the circulation fluid with its temperature lowered i.e. cold fluid circulates and flows into the first air-liquid heat exchanger **302** along the open first circulation pipeline. Specifically, driven by the fluid conveying device **305**, the circulation fluid with its temperature lowered (i.e., cold fluid) circulates and flows into the first air-liquid heat exchanger **302** along the open first circulation pipeline.

[0046] When the circulation fluid flows into the buried heat exchange unit **301** through the open second circulation pipeline, the buried heat exchange unit **301** is configured to enable the circulation fluid flowing in the pipes therein to exchange heat with the soil, and the circulation fluid with its temperature lowered (i.e., cold fluid) circulates and flows into the first air-liquid heat exchanger **302** along the open second circulation pipeline. Specifically, driven by the fluid conveying device **305**, the circulation fluid with its temperature lowered (i.e., cold fluid) circulates and flows into the first air-liquid heat exchanger **302** along the open second circulation pipeline. The buried heat exchange unit **301**, which may also be referred to as an underground buried pipe heat exchanger, is composed of a series of pipes buried in soil **408** (i.e., a group of buried pipe structures). The pipes may be buried horizontally or vertically, and are preferably buried vertically. A material of the buried pipes is preferably polyethylene (PE). The depth and number of the buried pipes are determined according to the actual application situation including exchanged heat quantity and local climate condition.

[0047] As shown in FIG. **4**, in one implementation, a control valve **3.1** is disposed on the first circulation pipeline (specifically, the control valve **3.1** may be disposed on a liquid inlet pipe of the second air-liquid heat exchanger **303**), and a control valve **3.2** is disposed on the second circulation pipeline (specifically, the control valve **3.2** may be disposed on a liquid outlet pipe of the buried heat exchange unit **301**). The control device **304** is a first control device, configured to control the opening of the control valve **3.1** and/or the control valve **3.2** according to the preset control policy and the acquired environment information. Specifically, when the control valve **3.1** is opened, the cooling is performed based on the first circulation pipeline; when the control valve **3.2** is opened, the cooling is performed based on the second circulation pipeline; and when the control valves **3.1** and **3.2** are both opened, the cooling is performed based on the first circulation pipeline and the second circulation pipeline at the same time in parallel.

[0048] It should be noted that in the cooling system according to Embodiment 1 of the present invention, the fluid conveying device **305** is disposed on the liquid inlet pipe of the first air-liquid heat exchanger **302**. It is understood that the fluid conveying device **305** may also be disposed on the liquid outlet pipe of the first air-liquid heat exchanger **302**.

[0049] As can be seen from the above, the cooling system according to Embodiment 1 of the present invention fully uses the underground soil and the outside air to dissipate heat according to local climate characteristics and soil temperature change characteristics of the equipment room. When the circulation fluid flows to the buried heat exchange unit **301**, the heat is transferred to the soil; and when the circulation fluid flows to the second air-liquid heat exchanger **303**, the heat is transferred to the outside air. Thus, through the alternate or simultaneous cooling in the two modes, the cooling system according to Embodiment 1 of the present invention achieves better power-saving performance than conventional air conditioning systems for the equipment room. In addition, the problem of system instability caused by a high underground soil temperature is prevented, where the high underground soil temperature occurs because the underground soil receives the heat for a long time. Therefore, the cooling (temperature control) system can operate more stably.

[0050] In addition, in the embodiment of the present invention, when the outside air is used for cooling, the outside air is not directly introduced into the equipment room, so the cooling system has low requirements for the air quality. Therefore, the application scenarios are not limited.

[0051] FIG. **5** is a schematic diagram of a cooling system according to Embodiment 2 of the present invention. Referring to FIG. **5**, the cooling system is applied to an outdoor integrated equipment room, and includes a buried heat exchange unit **401**, a first air-liquid heat exchanger **402**, a second air-liquid heat exchanger **403**, a control device **404**, a fluid conveying device **405**, and correcting pipes **407**. The buried heat exchange unit **401** is buried underground, the first air-liquid heat exchanger **402** is disposed in the equipment room, and the second air-liquid heat exchanger **403** is disposed outside the equipment room. The second air-liquid heat exchanger **403** and the first air-liquid heat exchanger **402** are connected by the connecting pipes **407** to form a first circulation pipeline, and the buried heat exchange unit **401** and the first air-liquid heat exchanger **402** are connected by the connecting pipes **407** to form a second circulation pipeline.

[0052] As shown in FIG. **5**, different from Embodiment 1, control valves **4.1** and **4.2** are disposed on the first circulation pipeline (which are respectively disposed on a liquid inlet pipe and a liquid outlet pipe of the second air-liquid heat exchanger **403**), and control valves **4.3** and **4.4** are disposed on the second circulation pipeline (which are respectively disposed on an inlet pipe and an outlet pipe of the buried heat exchange unit **401**).

[0053] The control device **404** is configured to acquire environment information, where the environment information includes at least one of the following temperatures: an outdoor temperature of the equipment room and a temperature of the soil surrounding buried pipes, and control the opening of the corresponding control valves **4.1**, **4.2** and/or control valves **4.3**, **4.4** according to a preset control policy and the acquired environment information, to enable the first circulation pipeline and/or the second circulation pipeline to be in an open state. Specifically, when the control valves **4.1** and **4.2** are opened, the first circulation pipeline which is formed by coil pipes of the first air-liquid heat exchanger **402**, coil pipes of the second air-liquid heat exchanger **403**, and a corresponding portion of the connecting pipes **407** is in an open state; and similarly, when the control valves **4.3** and **4.4** are opened, the second circulation pipeline which is formed by the coil pipes of the first air-liquid heat exchanger **402**, buried pipes of the buried heat exchange unit **401**, and a corresponding portion of the connecting pipes **407** is in an open state.

[0054] The control policy may be implemented in many ways. In one implementation, the control policy is as follows.

[0055] According to a comparison result between an outdoor temperature of the equipment room and a preset value, a flow direction of a circulation fluid flowing out of the first air-liquid heat exchanger **402** is controlled. The preset value, for example, is approximate to the local annual mean temperature of the equipment room, or a temperature value obtained by comprehensively considering the environment information including the indoor temperature and outdoor temperature of the equipment room and soil situation, or a designed maximum working temperature of the first air-liquid heat exchanger **402**.

[0056] Specifically, when the outdoor temperature of the equipment room is higher than the preset value, the control device **404** opens the control valve **4.3** and the control valve **4.4** (when the default state of the control valves **4.1**, **4.2**, **4.3**, and **4.4** are closed) and/or closes the control valve **4.2** and the control valve **4.1** (when the default state of the control valves **4.1**, **4.2**, **4.3**, and **4.4** are open), and the circulation fluid **406** absorbing the heat and flowing out of the first air-liquid heat exchanger **402** flows to the buried heat exchange unit **401** along the open second circulation pipeline. After transferring the heat to the soil **408** through the buried heat exchange unit **401**, the circulation fluid **406** has its temperature lowered, and the circulation fluid **406** (i.e., cold fluid) flows back to the first air-liquid heat exchanger **402** along the open second circulation pipeline. Therefore, one circulation is complete, and the heat in the equipment room is dissipated.

[0057] When the outdoor temperature of the equipment room is lower than the preset value, the control device **404** opens the control valve **4.1** and the control valve **4.2** and/or closes the control valve **4.3** and the control valve **4.4**, and the circulation fluid **406** absorbing the heat and flowing out of the first air-liquid heat exchanger **402** flows to the second air-liquid heat exchanger **403** along the first circulation pipeline (specifically, the pipe is in an open state because the control valve **4.1** is opened). After transferring the heat to the outside air through the second air-liquid heat exchanger **403**, the circulation fluid has its temperature lowered, and the circulation fluid **406** (i.e., cold fluid) flows back to the first air-liquid heat exchanger **402** along the first circulation pipeline (specifically, the pipe is in an open state because the control valve **4**.**2** is opened). Therefore, one circulation is complete, and the heat in the equipment room is dissipated.

[0058] It should be noted that the circulation fluid **406** is driven by the fluid conveying device **405** to circulate and flow in the connecting pipes **407**, and the fluid conveying device **405** is disposed on the liquid inlet pipe of the first air-liquid heat exchanger **402**. It is understood that the fluid conveying device **405** may also be disposed on the liquid outlet pipe of the first air-liquid heat exchanger **402**. In one implementation, the fluid conveying device **405** is a circulation pump for driving a liquid to flow.

[0059] As can be seen from the above, the cooling system according to Embodiment 2 of the present invention fully uses the underground soil and the outside air to dissipate heat according to local climate characteristics and soil temperature change characteristics of the equipment room. When the circulation fluid flows to the buried heat exchange unit **401**, the heat is transferred to the soil; and when the circulation fluid flows to the second air-liquid heat exchanger **403**, the heat is transferred to the outside air. Thus, through the alternate or simultaneous cooling in the two modes, the cooling system according to Embodiment 2 of the present invention achieves better power-saving performance than conventional air conditioning systems for the equipment room. In addition, the problem of system instability caused by a high underground soil temperature is prevented, where the high underground soil temperature occurs because the soil receives the heat for a long time. Therefore, the cooling (temperature control) system can operate more stably.

[0060] In addition, in the embodiment of the present invention, when the outside air is used for cooling, the outside air is not directly introduced into the equipment room, so the cooling system has low requirements for the air quality. Therefore, the application scenarios are not limited.

[0061] FIG. **6** is a schematic diagram of a cooling system applied to an equipment room according to Embodiment 3 of the present invention. Referring to FIG. **6**, the cooling system is applied to an equipment room **50**, and at least one communication apparatus **506** is disposed in the equipment room **50**. The cooling system includes a buried heat exchange unit **501**, a first air-liquid heat exchanger **502**, a second air-liquid heat exchanger **503**, a control device **504**, a fluid conveying device **505**, and connecting pipes **507**. The first air-liquid heat exchanger **502** is disposed in the equipment room **50**, the control device **504** and the fluid conveying device **505** are preferably disposed in the equipment room **50**, the second air-liquid heat exchanger **503** is disposed outside the equipment room **50**, and the buried heat exchange unit **501** is buried underground.

[0062] The second air-liquid heat exchanger **503** and the first air-liquid heat exchanger **502** are connected by the connecting pipes **507** to form a first circulation pipeline, and the buried heat exchange unit **501** and the first air-liquid heat exchanger **502** are connected by the connecting pipes **507** to form a second circulation pipeline. Control valves **5071** and **5073** are disposed on the first circulation pipeline, and control valves **5072** and **5074** are disposed on the second circulation pipeline.

[0063] The first air-liquid heat exchanger **502** mainly includes a coil pipe structure, an air inlet **5021**, an air outlet **5022**, and an air conveying device **5023**. The internal air conveying device **5023** sucks in hot air inside the equipment room **50** through the air inlet **5021**. The hot air exchanges heat with the circulation fluid flowing in the coil pipe structure. The hot air with its heat released flows back into the equipment room **50** through the air outlet **5022** as cold air, and the circulation fluid flowing inside the coil pipe structure is driven by the fluid conveying device **505** to flow out of the first air-liquid heat exchanger **502** after absorbing the heat of the hot air.

[0064] It should be noted that the first air-liquid heat exchanger **502** is preferably in a vertical structure. When the internal space of the equipment room **50** is small, the first air-liquid heat exchanger **502** may be in a horizontal structure and suspended on the ceiling. The internal structure of the first air-liquid heat exchanger **502** may vary according to actual situations, and the air conveying device **5023** in the first air-liquid heat exchanger **502** may be an axial fan or a centrifugal fan, and is preferably a centrifugal fan.

[0065] The control device **504** is configured to acquire environment information, where the environment information includes at least one of the following temperatures: an outdoor temperature of the equipment room and a temperature of the soil surrounding buried pipes, and control the opening of the first circulation pipeline and/or the second circulation pipeline according to a preset policy and the acquired environment information. The outgoing circulation fluid flows to the second air-liquid heat exchanger **503** or the buried heat exchange unit **501** through the open circulation pipeline.

[0066] In one implementation, the control device **504** is specifically configured to control the opening or closing of the control valve **5071** and the control valve **5073** and/or the opening or closing of the control valve **5072** and the control valve **5074**. When the control valve **5071** and the control valve **5073** are opened, the first circulation pipeline is in an open state; and similarly, when the control valve **5072** and the control valve **5074** are opened, the second circulation pipeline is in an open state. The circulation fluid flows to the second air-liquid heat exchanger **503** through the first circulation pipeline, and flows back to the first air-liquid heat exchanger **502**; and/or the circulation fluid flows to the buried heat exchange unit **501** through the second circulation pipeline, and flows back to the first air-liquid heat exchanger **502**.

[0067] According to a specific control policy, when the outdoor temperature of the equipment room is lower than a set value (the set value may be determined according to local climate conditions and local annual mean temperature), the control device **504** controls the opening of the control valves **5071** and **5073**, and the circulation fluid (hot fluid) enters the second air-liquid heat exchanger **503** outside the equipment room **50** along the first circulation pipeline.

[0068] The second air-liquid heat exchanger **503** mainly includes a coil pipe structure **5031** and an air conveying device **5032**. When the circulation fluid (i.e., hot fluid) flows in the coil pipe structure **5031**, the air conveying device **5032** drives the cold air in the environment to flow along an outer wall of the coil pipe structure **5031**, so as to cool the circulation fluid (i.e., hot fluid) flowing in the coil pipe structure **5031**. After the circulation fluid (i.e., hot fluid) has its temperature lowered, the circulation fluid circulates and flows into the first air-liquid heat exchanger **502** along the first circulation pipeline as a cold fluid. It should be noted that the air conveying device **5032** in the second air-liquid heat exchanger **503** is preferably an axial fan.

[0069] According to a specific control policy, when the outdoor temperature of the equipment room is higher than the set value, the control device **504** controls the opening of the control valves **5072** and **5074**, and the circulation fluid (hot fluid) flowing out of the first air-liquid heat exchanger **503** enters the buried heat exchange unit **501** along the second circulation pipeline.

[0070] The buried heat exchange unit **501** mainly includes a group of underground buried pipes. The circulation fluid (hot fluid) transfers its heat to the soil when flowing in the underground buried pipes, has its temperature lowered, and enters the first air-liquid heat exchanger **502** in the equipment room **50** along the second circulation pipeline as a cold fluid.

[0071] As can be seen from the above, the cooling system according to Embodiment 3 of the present invention fully uses the underground soil and the outside air to dissipate heat according to local climate characteristics and soil temperature change characteristics of the equipment room. When the circulation fluid flows to the buried heat exchange unit **501**, the heat is transferred to the soil; and when the circulation fluid flows to the second air-liquid heat exchanger **503**, the heat is transferred to the outside air. Thus, through the alternate cooling in the two modes, the cooling system according to Embodiment 3 of the present invention achieves better power-saving performance than conventional air conditioning systems for the equipment room. In addition, the problem of system instability caused by a high underground soil temperature is prevented, where the high underground soil temperature occurs because the soil receives the heat for a long time. Therefore, the cooling (temperature control) system can operate more stably.

[0072] In addition, in the embodiment of the present invention, when the outside air is used for cooling, the outside air is not directly introduced into the equipment room, so the cooling system has low requirements for the air quality. Therefore, the application scenarios are not limited.

[0073] FIG. **7** is a schematic diagram of a cooling system according to Embodiment 4 of the present invention. The cooling system is applied to an outdoor integrated equipment room, and includes a buried heat exchange unit **601**, a first air-liquid heat exchanger **602**, a second air-liquid heat exchanger **603**, a control device **604**, a fluid conveying device **605**, and connecting pipes **607**. The buried heat exchange unit **601** is buried underground, the first air-liquid heat exchanger **602** is disposed in the equipment room, and the second air-liquid heat exchanger **603** is disposed outside the equipment room. The second air-liquid heat exchanger **603** and the first air-liquid heat exchanger **602** are connected by the connecting pipes **607** to form a first circulation pipeline, and the buried heat exchange unit **601** and the first air-liquid heat exchanger **602** are connected by the connecting pipes **607** to form a second circulation pipeline.

[0074] As shown in FIG. **7**, different from Embodiment 2, three-way valves **6.1** and **6.2** are disposed on an intersection pipe of the first circulation pipeline and the second circulation pipeline. The three-way valves **6.1** and **6.2** have the same function as the control valves **4.1**, **4.2**, **4.3**, and **4.4** in Embodiment 2. The function of the three-way valves is to close the other pipe when opening one pipe, or to open both pipes at the same time.

[0075] The control device **604** is configured to acquire environment information, where the environment information includes at least one of the following temperatures: an outdoor temperature of the equipment room and a temperature of the soil surrounding buried pipes, and control the opening and/or the closing of the three-way valve **6.1** and the three-way valve **6.2** according to a preset control policy and the acquired environment information, to enable the first circulation pipeline and/or the second circulation pipeline to be in an open state, and the circulation fluid flows in the open circulation pipeline to complete cooling.

[0076] It should be noted that the circulation fluid is driven by the fluid conveying device **605** to circulate and flow in the connecting pipes, and the fluid conveying device **605** is disposed on a liquid inlet pipe of the first air-liquid heat exchanger **602**. It is understood that the fluid conveying device **605** may also be disposed on a liquid outlet pipe of the first air-liquid heat exchanger **602**.

[0077] As can be seen from the above, the cooling system according to Embodiment 4 of the present invention performs the cooling by using the circulation fluid flowing in the first circulation pipeline and/or the second circulation pipeline. Thus, through the alternate or simultaneous cooling in the two modes, the cooling system according to Embodiment 4 of the present invention achieves better power-saving performance than conventional air conditioning systems for the equipment room. In addition, the problem of system instability caused by a high underground soil temperature is prevented, where the high underground soil temperature occurs because the soil receives the heat for a long time. Therefore, the cooling (temperature control) system can operate more stably.

[0078] In addition, in the embodiment of the present invention, when the outside air is used for cooling, the outside air is not directly introduced into the equipment room, so the cooling system has low requirements for the air quality. Therefore, the application scenarios are not limited.

[0079] FIG. **8** is a schematic diagram of a cooling system according to Embodiment 5 of the present invention. The cooling system is applied to an outdoor integrated equipment room, and includes a buried heat exchange unit **701**, a first air-liquid heat exchanger **702**, a second air-liquid heat exchanger **703**, a control device **704**, a fluid conveying device **705**, and connecting pipes **707**. The buried heat exchange unit **701** is buried underground, the first air-liquid heat exchanger **702** is disposed in the equipment room, and the second air-liquid heat exchanger **703** is disposed outside the equipment room. The second air-liquid heat exchanger **703** and the first air-liquid heat exchanger **702** are connected by the connecting pipes **707** to form a first circulation pipeline, the buried heat exchange unit **701** and the first air-liquid heat exchanger **702** are connected by the connecting pipes **707** to form a second circulation pipeline, and the first air-liquid heat exchanger **702**, the second air-liquid heat exchanger **703**, and the buried heat exchange unit **701** are connected by the connecting pipes **707** to form a third circulation pipeline.

[0080] As shown in FIG. **8**, three-way valves **7.1** and **7.2** are disposed on an intersection pipe of the first circulation pipeline and the second circulation pipeline, and the position of the three-way valve **7.2** is different from the three-way valve **6.2** in Embodiment 4.

[0081] The control device **704** is configured to acquire environment information, where the environment information includes at least one of the following temperatures: an outdoor temperature of the equipment room and a temperature of the soil surrounding buried pipes, and control the opening and/or the closing of the valves in the corresponding three-way valves **7.1** and **7.2**, to enable at least one of the first circulation pipeline, the second circulation pipeline, and the third circulation pipeline to be in an open state (for example, only the first circulation pipeline is in an open state, only the second circulation pipeline is in an open state, two of the three circulation pipelines are in an open state, or all the three circulation pipelines are in an open state). The circulation fluid flows in the open circulation pipeline to complete the cooling. Specifically, when the first circulation pipeline is in an open state, the circulation fluid (i.e., hot fluid) flowing out of the first air-liquid heat exchanger **702** flows into the second air-liquid heat exchanger **703** through the horizontal connecting pipes on which the three-way valve **7.1** is arranged to perform heat exchange, and the circulation fluid (i.e., cold fluid) flowing out of the second air-liquid heat exchanger **703** flows back to the first air-liquid heat exchanger **702** through the horizontal connecting pipes on which the three-way valve **7.2** is arranged to complete the cooling.

[0082] When the second circulation pipeline is in an open state, the circulation fluid (i.e., hot fluid) flowing out of the first air-liquid heat exchanger **702** flows into the buried heat exchange unit **701** through the vertical connecting pipes on which the three-way valves **7.1** and **7.2** are arranged to perform heat exchange, and the circulation fluid (i.e., cold fluid) flowing out of the buried heat exchange unit **701** flows back to the first air-liquid heat exchanger **702** to complete the cooling.

[0083] When the third circulation pipeline is in an open state, the circulation fluid (i.e., hot fluid) flowing out of the first air-liquid heat exchanger **702** flows into the second air-liquid heat exchanger **703** through the horizontal connecting pipes on which the three-way valve **7.1** is arranged to perform heat exchange, the circulation fluid (i.e., cold fluid) flowing out of the second air-liquid heat exchanger **703** flows into the buried heat exchange unit **701** through the vertical connecting pipes on which the three-way valve **7.2** is arranged to perform heat exchange, and the circulation fluid (i.e., cold fluid) flowing out of the buried heat exchange unit **701** flows back to the first air-liquid heat exchanger **702** to complete the cooling.

[0084] It should be noted that the circulation fluid is driven by the fluid conveying device **705** to circulate and flow in the connecting pipes, and the fluid conveying device **705** is disposed on a liquid inlet pipe of the first air-liquid heat exchanger **702**. It is understood that the fluid conveying device **705** may also be disposed on a liquid outlet pipe of the first air-liquid heat exchanger **702**.

[0085] As can be seen from the above, in the cooling system according to Embodiment 5 of the present invention, the circulation fluid flows in at least one of the first circulation pipeline, the second circulation pipeline, and the third circulation pipeline to complete the cooling. Thus, the cooling system according to Embodiment 5 of the present invention achieves better power-saving performance than conventional air conditioning systems for the equipment room. In addition, the problem of system instability caused by a high underground soil temperature is prevented, where the high underground soil temperature occurs because the soil receives the heat for a long time. Therefore, the cooling (temperature control) system can operate more stably.

[0086] In addition, in the embodiment of the present invention, when the outside air is used for cooling, the outside air is not directly introduced into the equipment room, so the cooling system has low requirements for the air quality. Therefore, the application scenarios are not limited.

[0087] FIG. **9** is a schematic diagram of a cooling system according to Embodiment 6 of the present invention. The cooling system is applied to an outdoor integrated equipment room, and includes a buried heat exchange unit **901**, a first air-liquid heat exchanger **902**, a second air-liquid heat exchanger **903**, a control device **904**, a fluid conveying device **905**, and connecting pipes **907**. The buried heat exchange unit **901** is buried underground, the first air-liquid heat exchanger **902** is disposed in the equipment room, and the second air-liquid heat exchanger **903** is disposed outside the equipment room. The second air-liquid heat exchanger **903** and the first air-liquid heat exchanger **902** are connected by the connecting pipes **907** to form a first circulation pipeline, and the buried heat exchange unit **901** and the first air-liquid heat exchanger **902** are connected by the connecting pipes **907** to form a second circulation pipeline.

[0088] As shown in FIG. **9**, a three-way valve **9.1** is disposed on an intersection pipe of the first circulation pipeline and the second circulation pipeline.

[0089] The control device **904** is configured to acquire environment information, where the environment information includes at least one of the following temperatures: an outdoor temperature of the equipment room and a temperature of the soil surrounding buried pipes, and control the opening and/or the closing of the corresponding valves of the three-way valve **9.1**, to enable the first circulation pipeline and/or the second circulation pipeline to be in an open state. The circulation fluid flows in the open circulation pipeline to complete the cooling.

[0090] It should be noted that the circulation fluid is driven by the fluid conveying device **905** to circulate and flow in the connecting pipes, and the fluid conveying device **905** is disposed on a liquid inlet pipe of the first air-liquid heat exchanger **902**. It is understood that the fluid conveying device **905** may also be disposed on a liquid outlet pipe of the first air-liquid heat exchanger **902**.

[0091] As can be seen from the above, in the cooling system according to Embodiment 6 of the present invention, the circulation fluid flows in the first circulation pipeline and/or the second circulation pipeline to complete the cooling. Thus, the cooling system according to Embodiment 6 of the present invention achieves better power-saving performance than conventional air conditioning systems for the equipment room. In addition, the problem of system instability caused by a high underground soil temperature is prevented, where the high underground soil temperature occurs because the soil receives the heat for a long time. Therefore, the cooling (temperature control) system can operate more stably.

[0092] In addition, in the embodiment of the present invention, when the outside air is used for cooling, the outside air is not directly introduced into the equipment room, so the cooling system has low requirements for the air quality. Therefore, the application scenarios are not limited.

[0093] FIG. **10** is a schematic diagram of a cooling system according to Embodiment 7 of the present invention. The cooling system is applied to an outdoor integrated equipment room, and includes a buried heat exchange unit **801**, a first air-liquid heat exchanger **802**, a second air-liquid heat exchanger **803**, a control device **804**, fluid conveying devices **8051** and **8052**, and connecting pipes **807**. The buried heat exchange unit **801** is buried underground, the first air-liquid heat exchanger **802** is disposed in the equipment room, and the second air-liquid heat exchanger **803** is disposed outside the equipment room. The second air-liquid heat exchanger **803** and the first air-liquid heat exchanger **802** are connected by the connecting pipes **807** to form a first circulation pipeline, and the buried heat exchange unit **801** and the first air-liquid heat exchanger **802** are connected by the connecting pipes **807** to form a second circulation pipeline.

[0094] As shown in FIG. **10**, a three-way valve **8.1** is disposed on an intersection pipe of the first circulation pipeline and the second circulation pipeline. Different from Embodiment 6, the fluid conveying devices are controlled in this embodiment, that is, the fluid conveying device **8051** is disposed on the first circulation pipeline, and the fluid conveying device **8052** is disposed on the second circulation pipeline (the fluid conveying devices are not disposed at the same pipe position of the two circulation pipelines, for example, the liquid outlet pipe and liquid inlet pipe of the first air-liquid heat exchanger).

[0095] The control device **804** is configured to acquire environment information, where the environment information includes at least one of the following temperatures: an outdoor temperature of the equipment room and a temperature of the soil surrounding buried pipes, and control the opening and/or the closing of the corresponding valves of the three-way valve **8.1** and control the fluid conveying device **8051** and/or the fluid conveying device **8052** according to a preset control policy and the acquired environment information, to enable the first circulation pipeline and/or the second circulation pipeline to be in an open state. The circulation fluid flows in the open circulation pipeline to complete the cooling. For example, when the control device **804** controls the opening of all valves of the three-way valve **8.1** and controls the starting of the fluid conveying device **8051** and the fluid conveying device **8052**, the first circulation pipeline and the second circulation pipeline perform the cooling at the same time in parallel, that is, the circulation fluid flows in the open first circulation pipeline and the open second circulation pipeline to complete the cooling.

[0096] When the control device **804** controls the opening of the horizontal valves of the three-way valve **8.1** and controls the starting of the fluid conveying device **8051**, the circulation fluid is driven by the fluid conveying device **8051** to flow in the open first circulation pipeline to complete the cooling.

[0097] When the control device **804** controls the opening of the vertical valves of the three-way valve **8.1** and controls the starting of the fluid conveying device **8052**, the circulation fluid is driven by the fluid conveying device **8052** to flow in the open second circulation pipeline to complete the cooling.

[0098] As can be seen from the above, in the cooling system according to Embodiment 7 of the present invention, the circulation fluid flows in the first circulation pipeline and/or the second circulation pipeline to perform the cooling. Thus, the cooling system according to Embodiment 7 of the present invention achieves better power-saving performance than conventional air conditioning systems for the equipment room. In addition, the problem of system instability caused by a high underground soil temperature is prevented, where the high underground soil temperature occurs because the soil receives the heat for a long time. Therefore, the cooling (temperature control) system can operate more stably.

[0099] In addition, in the embodiment of the present invention, when the outside air is used for cooling, the outside air is not directly introduced into the equipment room, so the cooling system has low requirements for the air quality. Therefore, the application scenarios are not limited.

[0100] To achieve further objectives of saving power and reducing noise, for the first air-liquid heat exchanger and the second air-liquid heat exchanger according to the first to seventh embodiments, the control device can further regulate the speed of fans of the first air-liquid heat exchanger and the second air-liquid heat exchanger. For example, the first air-liquid heat exchanger has two types, one is the first air-liquid heat exchanger without fan speed regulation, and the other is the first air-liquid heat exchanger with fan speed regulation; and similarly, the second air-liquid heat exchanger also has two types, one is the second air-liquid heat exchanger without fan speed regulation, and the other is the second air-liquid heat exchanger with fan speed regulation.

[0101] Correspondingly, referring to FIG. **5**, for example, the first circulation pipeline has three combinations: 1. the first circulation pipeline formed by the connecting pipes between the second air-liquid heat exchanger with fan speed regulation and the first air-liquid heat exchanger without fan speed regulation; 2. the first circulation pipeline formed by the connecting pipes between the second air-liquid heat exchanger without fan speed regulation and the first air-liquid heat exchanger with fan speed regulation; and 3. the first circulation pipeline formed by the connecting pipes between the second air-liquid heat exchanger without fan speed regulation and the first air-liquid heat exchanger without fan speed regulation.

[0102] The second circulation pipeline has two combinations: 1. the second circulation pipeline formed by the connecting pipes between the buried heat exchange unit and the first air-liquid heat exchanger with fan speed regulation; and 2. the second circulation pipeline formed by the connecting pipes between the buried heat exchange unit and the first air-liquid heat exchanger without fan speed regulation.

[0103] Many fan speed regulation policies may be adopted, one of which is described in the following.

[0104] The fan speed regulation policy of the second air-liquid heat exchanger is as follows.

[0105] A temperature of a circulation fluid outlet of the second air-liquid heat exchanger remains unchanged, and different outdoor temperatures (for example, air inlet temperatures) are corresponding to different fan speeds. As shown in FIG. **16**, the full speed of the fan is corresponding to the maximum allowed outdoor temperature Tfmax, and when the cooling load is unchanged, Tfmax=Tf (where Tf is the designed maximum working temperature of the second air-liquid heat exchanger). The lowest fan speed is corresponding to a temperature Tfmin. When the outdoor temperature equals Tf, the fan rotates at full speed; when the outdoor temperature is lower than or equal to the lowest temperature Tfmin, the fan rotates at the lowest speed; and when the outdoor temperature is lower than a limit temperature Tflimit, the fan may even be stopped.

[0106] The fan speed regulation policy of the first air-liquid heat exchanger is as follows.

[0107] Preferably, the speed is regulated according to the indoor temperature or other parameters. The indoor temperature is one of a temperature at an outlet of the indoor fan coil pipes, an air temperature at an inlet of the indoor communication apparatus, and an indoor mean temperature. Next, the "air temperature at the inlet of the indoor communication apparatus" is taken as an example in the following description.

[0108] As shown in FIG. **17**, the full speed of the fan is corresponding to the indoor maximum allowed temperature Tsmax, and the lowest fan speed is corresponding to a temperature Tsmin.

[0109] When the air temperature at the inlet of the communication apparatus equals Tsmax, the fan rotates at full speed.

[0110] When the air temperature at the inlet of the communication apparatus is lower than or equal to Tsmin, the fan rotates at the lowest speed.

[0111] When the air temperature at the inlet of the communication apparatus is between Tsmax and Tsmin, the fan speed is regulated according to a set fan speed regulation curve.

[0112] When the air temperature at the inlet of the communication apparatus is lower than a limit temperature Tslimit, the fan may be stopped.

[0113] The implementations of the control device are described in the following.

[0114] In one implementation, at least one control valve is disposed on each circulation pipeline, and at least one fluid conveying device is disposed on each of the circulation pipelines. When there is a same fluid conveying device disposed on each of the circulation pipelines, the control device is a first valve control device, configured to control the opening or the closing of the corresponding control valve according to the preset control policy and the acquired environment information, to enable at least one circulation pipeline to be in an open state. The circulation fluid is driven by the fluid conveying device to flow in the open circulation pipeline to complete the cooling.

[0115] In another implementation, at least one control valve is disposed on each of the circulation pipelines, and at least one fluid conveying device is disposed on each of the circulation pipelines. When there is not a same fluid conveying device disposed on each of the circulation pipelines, the control device is a second valve control device, configured to control the opening or the closing of the corresponding control valve to enable at least one circulation pipeline to be in an open state, and to control the corresponding fluid conveying device to drive the circulation fluid to flow in the open circulation pipeline according to the preset control policy and the acquired environment information. The circulation fluid flows in the open circulation pipeline to complete the cooling.

[0116] In another implementation, the second air-liquid heat exchanger and the first air-liquid heat exchanger are connected by the connecting pipes to form the first circulation pipeline, and the buried heat exchange unit and the first air-liquid heat exchanger are connected by the connecting pipes to form the second circulation pipeline.

[0117] A first control valve and a second control valve are disposed on the first circulation pipeline, and a third control valve and a fourth control valve are disposed on the second circulation pipeline. The control device is a third valve control device, configured to control the opening of the first control valve and the second control valve and/or the third control valve and the fourth control valve according to the preset control policy and the acquired environment information. The circulation fluid flows in the first circulation pipeline and/or the second circulation pipeline on which the control valves are opened to complete the cooling.

[0118] Specifically, in one implementation, the control device is further configured to perform fan speed regulation control on the fan of the second air-liquid heat exchanger according to the acquired outdoor temperature and preset association information between the outdoor temperature information and the fan speed, and/or perform fan speed regulation control on the fan of the second air-liquid heat exchanger according to the acquired indoor temperature and preset association information between the indoor temperature information and the fan speed.

[0119] FIG. **11** is an internal structural view of a control device of a cooling system according to an embodiment of the present invention. As shown in FIG. **11**, the control device includes a control unit **1000** and an environment information acquiring unit **2000**.

[0120] The environment information acquiring unit **2000** is configured to acquire environment information, where the environment information includes at least one of the following temperatures: an outdoor temperature of the equipment room and a temperature of the soil surrounding buried pipes.

[0121] The control unit **1000** is configured to control the opening of at least one of the corresponding circulation pipelines according to the preset control policy and the environment information that is acquired by the environment information acquiring unit **2000**. That is, the control unit **1000** is configured to control at least one of the at least two circulation pipelines to be in an open state, where the circulation fluid is driven by the fluid conveying device to flow in the open circulation pipeline to complete the cooling.

[0122] To enable the control unit **1000** to control at least one circulation pipeline of the corresponding circulation pipelines to be in an open state, in one implementation, at least one control valve is disposed on each circulation pipeline, and at least one fluid conveying device is disposed on each circulation pipeline.

[0123] When there is a same fluid conveying device disposed on each of the circulation pipelines, the control unit **1000** is a first valve control unit, configured to control the opening or the closing of the corresponding control valves according to the preset control policy and the environment information that is acquired by the environment information acquiring unit **2000**, to enable at least one circulation pipeline to be in an open state. The circulation fluid is driven by the fluid conveying device to flow in the open circulation pipeline to complete the cooling.

[0124] When there is not a same fluid conveying device disposed on each of the circulation pipelines, the control unit **1000** is a second valve control unit. According to the preset control policy and the environment information that is acquired by the environment information acquiring unit **2000**, the control unit **1000** is configured to control the opening or the closing of the corresponding control valves to enable at least one circulation pipeline to be in an open state, and control the corresponding fluid conveying device to drive the circulation fluid to flow in the corresponding open circulation pipeline. The circulation fluid flows in the open circulation pipeline to complete the cooling.

[0125] The environment information acquiring unit **2000** is further configured to acquire the indoor temperature of the equipment room.

[0126] Correspondingly, the control unit **1000** is further configured to perform fan speed regulation control on the fan of the second air-liquid heat exchanger according to the acquired outdoor temperature and the preset association information between the outdoor temperature information and the fan speed of the second air-liquid heat exchanger, and/or perform fan speed regulation control on the fan of the first air-liquid heat exchanger according to the acquired indoor temperature and the preset association information between the indoor temperature information and the fan speed of the first air-liquid heat exchanger.

[0127] Next, a control method according to the embodiments of the present invention will be described in detail in the following. FIG. **12** is a flow chart of a control method according to an embodiment of the present invention. The method is applicable to a cooling system including a buried heat exchange unit, a first air-liquid heat exchanger, a second air-liquid heat exchanger, a control device, a fluid conveying device, and connecting pipes. The cooling system is applied to an equipment room. The second air-liquid heat exchanger and the buried heat exchange unit are connected by the connecting pipes to the first air-liquid heat exchanger to form at least two circulation pipelines. The control method includes the following steps.

[0128] In step **1010**, environment information is acquired, where the environment information includes at least one of the following temperatures: an outdoor temperature of the equipment room and a temperature of the soil surrounding buried pipes.

[0129] In step **1020**, according to a preset control policy and the acquired environment information, the opening and/or the closing of the corresponding circulation pipeline (s) is controlled, to enable at least one of the at least two circulation pipelines to be in an open state (that is, at least one of the at least two circulation pipelines is controlled to be in an open state), where a circulation fluid flows in the open circulation pipeline to complete cooling.

[0130] When the second air-liquid heat exchanger and the first air-liquid heat exchanger are connected by the connecting pipes to form the first circulation pipeline, and the buried heat exchange unit and the first air-liquid heat exchanger are connected by the connecting pipes to form the second circulation pipeline, step **1020** is specifically as follows: control the opening of the first circulation pipeline and/or the second circulation pipeline according to the preset control policy and the acquired environment information. The circulation fluid flowing out of the first air-liquid heat exchanger flows into the corresponding second air-liquid heat exchanger through the first circulation pipeline to perform the cooling, and circulates and flows back to the first air-liquid heat exchanger through the first circulation pipeline; and/or the circulation fluid flowing out of the first air-liquid heat exchanger flows into the corresponding buried heat exchange unit through the second circulation pipeline to perform the cooling, and flows back to the first air-liquid heat exchanger through the second circulation pipeline.

[0131] Referring to FIG. **5**, the circulation fluid flowing out of the first air-liquid heat exchanger flows into the corresponding second air-liquid heat exchanger through the first circulation pipeline to perform the cooling, and circulates and flows back to the first air-liquid heat exchanger through the first circulation pipeline; and/or the circulation fluid flowing out of the first air-liquid heat exchanger flows into the corresponding buried heat exchange unit through the second circulation pipeline to perform the cooling, and flows back to the first air-liquid heat exchanger through the second circulation pipeline.

[0132] To control at least one of the at least two circulation pipelines to be in an open state, in one implementation, at least one control valve is disposed on each of the circulation pipelines, and at least one fluid conveying device is disposed on each of the circulation pipelines.

[0133] When the control valves are disposed on the circulation pipelines and the circulation pipelines share one fluid conveying device, step **1020** is specifically as follows: control the opening or the closing of the corresponding control valves according to the preset control policy and the acquired environment information, to enable at least one circulation pipeline to be in an open state. The circulation fluid is driven by the fluid conveying device to flow in the open circulation pipeline to complete the cooling.

[0134] When the control valves are disposed on the circulation pipelines and there is not a shared fluid conveying device disposed on each of the circulation pipelines, step **1020** is specifically as follows: according to the preset control policy and the acquired environment information, control the opening or the closing of the corresponding control valves to enable at least one circulation pipeline to be in an open state and control the corresponding fluid conveying device to drive the circulation fluid to flow in the open circulation pipeline. The circulation fluid flows in the open circulation pipeline to complete the cooling.

[0135] In one implementation, the control policy involved in the control method according to the embodiment of the present invention may be as follows.

[0136] For ease of description, the control policy is illustrated with reference to FIG. **5**. When the outdoor temperature Tl of the equipment room is equal to or lower than a designed maximum working temperature Tf of the second air-liquid heat exchanger (specifically, the current working temperature of the second air-liquid heat exchanger is lower than or equal to the designed maximum working temperature Tf of the second air-liquid heat exchanger), the first circulation pipeline is opened, the circulation fluid flowing out of the first air-liquid heat exchanger enters the second air-liquid heat exchanger, and the system uses the first circulation pipeline to perform the cooling. In one implementation, the designed maximum working temperature Tf of the second air-liquid heat exchanger is calculated according to the cooling load inside the equipment room and parameters of the air-liquid heat exchanger.

[0137] When the outdoor temperature T**1** of the equipment room is higher than the designed maximum working temperature Tf of the second air-liquid heat exchanger, the first circulation pipeline is closed, the second circulation pipeline is opened, and the circulation fluid flowing out of the first air-liquid heat exchanger enters the buried heat exchange unit.

[0138] When the two circulation pipelines cannot satisfy the cooling requirements, that is, when the indoor temperature T**2** of the equipment room is higher than the indoor maximum allowed temperature of the equipment room (for example, the maximum allowed inlet temperature of the indoor communication apparatus in the equipment room), and the outdoor temperature T**1** of the equipment room is higher than the designed maximum working temperature Tf of the second air-liquid heat exchanger, the first circulation pipeline and the second circulation pipeline are both opened to perform the cooling. It is understood that the control policy is applicable to FIGS. **4** to **7**, FIG. **9**, and FIG. **10**.

[0139] FIG. **13** is a detailed flow chart of a control method according to Embodiment 1 of the present invention. Referring to FIG. **13**, the method is applicable to a cooling system including a buried heat exchange unit, a first air-liquid heat exchanger, a second air-liquid heat exchanger, a control device, a fluid conveying device, and connecting pipes. For ease of description, the control method is illustrated with reference to FIG. **5**. After the cooling system starts to operate, the method includes the following steps.

[0140] In step **1011**, an outdoor temperature T**1** of the equipment room and an indoor temperature T**2** of the equipment room are acquired.

[0141] Specifically, the outdoor temperature T**1** and the indoor temperature T**2** of the equipment room are acquired by using a temperature sensor.

[0142] In step **1012**, according to the control policy, the outdoor temperature T**1** is compared with the designed maximum working temperature Tf of the second air-liquid heat exchanger, and when T**1**>Tf, step **1014** is performed; otherwise, step **1013** is performed.

[0143] In step **1013**, according to the control policy, the indoor temperature T**2** of the equipment room is compared with the indoor maximum allowed temperature Ts of the equipment room (for example, the maximum allowed inlet temperature of the indoor communication apparatus of the equipment room), and when T**2**>Ts, step **1016** is performed; otherwise, step **1015** is performed.

[0144] In step **1014**, control the opening of the second circulation pipeline, and the second circulation pipeline operates.

[0145] Specifically, control the opening of the second circulation pipeline, and the circulation fluid is driven by the fluid conveying device to flow in the open second circulation pipeline to complete the cooling.

[0146] In step **1015**, control the opening of the first circulation pipeline, and the first circulation pipeline operates.

[0147] Specifically, control the opening of the first circulation pipeline, and the circulation fluid is driven by the fluid conveying device to flow in the open first circulation pipeline to complete the cooling.

[0148] In step **1016**, control the opening of the first circulation pipeline and the second circulation pipeline, and the first circulation pipeline and second circulation pipeline operate at the same time.

[0149] Specifically, control the opening of the first circulation pipeline and the second circulation pipeline at the same time, and the circulation fluid is driven by the fluid conveying device to flow in the open first circulation pipeline and the open second circulation pipeline to complete the cooling.

[0150] As can be seen from the above, in the control method according to the embodiment of the present invention, the circulation fluid flows in the first circulation pipeline and/or the second circulation pipeline to perform the cooling. Thus, the present invention achieves better power-saving performance than conventional air conditioning systems for the equipment room. In addition, the problem of system instability caused by a high underground soil temperature is prevented, where the high underground soil temperature occurs because the soil receives the heat for a long time. Therefore, the cooling (temperature control) system can operate more stably.

[0151] In addition, in the embodiment of the present invention, when the outside air is used for cooling, the outside air is not directly introduced into the equipment room, so the cooling system has low requirements for the air quality. Therefore, the application scenarios are not limited.

[0152] In another implementation, the control policy involved in the control method according to the embodiment of the present invention may also be as follows. An outdoor temperature T**1**, a temperature T**3** of the soil surrounding the underground buried pipes, a designed maximum working temperature Tf of the second air-liquid heat exchanger, and a designed maximum temperature Tm of the soil surrounding the underground buried pipes are discussed in the following.

[0153] For ease of description, the control method is described with reference to FIG. **5**. When the cooling system starts to operate, the second circulation pipeline is opened, so that the circulation fluid flowing out of the first air-liquid heat exchanger enters the buried heat exchange unit, and transfers heat to the underground soil. When the temperature T**3** of the soil surrounding the underground buried pipes gradually rises to Tm, T**1** is compared with Tf. When T**1** is lower than or equal to Tf, the first circulation pipeline is opened, and the second circulation pipeline is closed; and when T**1** is higher than Tf, the first circulation pipeline and the second circulation pipeline are opened at the same time, so that the two circulation pipelines share a certain part of the heat load. The control policy is applicable to FIGS. **4** to **7**, FIG. **9**, and FIG. **10**.

[0154] That is, when the temperature T**3** of the soil surrounding the underground buried pipes is lower than the designed maximum temperature Tm of the soil surrounding the underground buried pipes, control the opening of the second circulation pipeline, and the circulation fluid is driven by the fluid conveying device to flow in the open second circulation pipeline to complete the cooling.

[0155] When the temperature T**3** of the soil surrounding the underground buried pipes is higher than or equal to the designed maximum temperature Tm of the soil surrounding the underground buried pipes, and T**1** is lower than or equal to the designed maximum working temperature Tf of the second air-liquid heat exchanger, control the opening of the first circulation pipeline, and the circulation fluid is driven by the fluid conveying device to flow in the open first circulation pipeline to complete the cooling.

[0156] When the temperature T**3** of the soil surrounding the underground buried pipes is higher than or equal to the designed maximum temperature Tm of the soil surrounding the underground buried pipes, and T**1** is higher than the designed maximum working temperature Tf of the second air-liquid heat exchanger, control the opening of the first circulation pipeline and the second circulation pipeline. The circulation fluid is driven by the fluid conveying device to flow in the open first circulation pipeline and second circulation pipeline to complete the cooling.

[0157] FIG. **14** is a detailed flow chart of a control method according to Embodiment 2 of the present invention. The method is applicable to a cooling system including a buried heat exchange unit, a first air-liquid heat exchanger, a second air-liquid heat exchanger, a control device, a fluid conveying device, and connecting pipes. For ease of description, the control method is described with reference to FIG. **5**. After the cooling system starts to operate, the method includes the following steps.

[0158] An outdoor temperature T**1**, a temperature T**3** of the underground soil in which buried pipes are buried, a designed maximum working temperature Tf of the second air-liquid heat exchanger, and a designed maximum temperature Tm of the soil surrounding the underground buried pipes are discussed in the following.

[0159] In step **2011**, the outdoor temperature T**1** of the equipment room and the temperature T**3** of the soil surrounding the buried pipes are acquired.

[0160] Specifically, the outdoor temperature T**1** and the temperature T**3** of the soil surrounding the buried pipes are acquired by using a temperature sensor.

[0161] In step **2012**, according to a control policy, the temperature T**3** of the soil surrounding the buried pipes is compared with the designed maximum temperature Tm of the soil surrounding the underground buried pipes, and when T**3**<Tm, step **2014** is performed; otherwise, step **2013** is performed.

[0162] In step **2013**, according to the control policy, the outdoor temperature T**1** is compared with the designed maximum working temperature Tf of the second air-liquid heat exchanger, and when T**1**>Tf step **2016** is performed; otherwise, step **2015** is performed.

[0163] In step **2014**, control the opening of the second circulation pipeline, and the second circulation pipeline operates.

[0164] Specifically, control the opening of the second circulation pipeline, and the circulation fluid is driven by the fluid conveying device to flow in the open second circulation pipeline to complete the cooling.

[0165] In step **2015**, control the opening of the first circulation pipeline, and the first circulation pipeline operates.

[0166] Specifically, control the opening of the first circulation pipeline, and the circulation fluid is driven by the fluid conveying device to flow in the open first circulation pipeline to complete the cooling.

[0167] In step **2016**, control the opening of the first circulation pipeline and the second circulation pipeline, and the first circulation pipeline and the second circulation pipeline operate at the same time.

[0168] Specifically, control the opening of the first circulation pipeline and the second circulation pipeline at the same time, and the circulation fluid is driven by the fluid conveying device to flow in the open first circulation pipeline and second circulation pipeline to complete the cooling.

[0169] As can be seen from the above, in the control method according to the embodiment of the present invention, the circulation fluid flows in the first circulation pipeline and/or the second circulation pipeline to perform the cooling. Thus, the present invention achieves better power-saving performance than conventional air conditioning systems for the equipment room. In addition, the problem of system instability caused by a high underground soil temperature is prevented, where the high underground soil temperature occurs because the soil receives the heat for a long time. Therefore, the cooling (temperature control) system can operate more stably.

[0170] In addition, in the embodiment of the present invention, when the outside air is used for cooling, the outside air is not directly introduced into the equipment room, so the cooling system has low requirements for the air quality. Therefore, the application scenarios are not limited.

[0171] FIG. **15** is a detailed flow chart of a control method according to Embodiment 3 of the present invention. Referring to FIG. **15**, the method is applicable to a cooling system including a buried heat exchange unit, a first air-liquid heat exchanger, a second air-liquid heat exchanger, a control device, a fluid conveying device, and connecting pipes, and the cooling system is applied to an equipment room. As shown in FIG. **5**, control valves **4.3**, **4.4**, **4.2**, and **4.1** are disposed at different positions of the connecting pipes **407**. The control method includes the following steps.

[0172] In step **3011**, outdoor temperature information T**1** is collected from at least one measure and control point disposed outside the equipment room.

[0173] It should be noted that when the outdoor temperature information is collected from multiple measure and control points, an outdoor mean temperature can be obtained through calculation.

[0174] In step **3012**, according to the control policy, the collected outdoor temperature T**1** is compared with a preset value Ts, and when T**1**>Ts, step **3013** is performed; otherwise, step **3014** is performed.

[0175] That is, control the opening or the closing of the corresponding control value according to the comparison result.

[0176] The preset value, for example, is approximate to the local annual mean temperature of the equipment room, or a temperature value obtained by comprehensively considering the environment information including the indoor temperature and outdoor temperature of the equipment room and the soil situation.

[0177] In step **3013**, control the opening of the control valve **4.3** and the control valve **4.4**.

[0178] In step **3014**, control the opening of the control valve **4.2** and the control valve **4.1**.

[0179] The control method is described in detail below with reference to FIG. **5**. The specific description is illustrated in the following: when the outdoor temperature T**1** of the equipment room is higher than the set value Ts, control the opening of the control valve **4.3** and the control valve **4.4** and close the control valve **4.2** and the control valve **4.1**. The circulation fluid **406** flowing out of the first air-liquid heat exchanger **402** and absorbing the heat flows to the buried heat exchange unit **401** along the open second circulation pipeline, the buried heat exchange unit **401** transfers the heat to the soil **408**, and the temperature of the buried heat exchange unit **401** is lowered. The circulation fluid **406** (i.e., cold fluid) flows back to the first air-liquid heat exchanger **402** along the open second circulation pipeline to complete one circulation, so as to dissipate the heat in the equipment room.

[0180] When the outdoor temperature T**1** of the equipment room is lower than the set value Ts, control the opening of the control valve **4.1** and the control valve **4.2** and close the control valve **4.3** and the control valve **4.4**. The circulation fluid **406** flowing out of the first air-liquid heat exchanger **402** and absorbing the heat flows to the second air-liquid heat exchanger **403** along the open first circulation pipeline. In the second air-liquid heat exchanger **403**, the circulation fluid transfers the heat to the outside air, and has its temperature lowered. The circulation fluid **406** (i.e., cold fluid) flows back to the first air-liquid heat exchanger **402** along the open first circulation pipeline to complete one circulation, so as to dissipate the heat in the equipment room.

[0181] As can be seen from the above, the embodiments of the present invention fully use the underground soil and the outside air to dissipate heat according to local climate characteristics and soil temperature change characteristics of the equipment room. When the circulation fluid flows to the buried heat exchange unit, the heat is transferred to the soil; and when the circulation fluid flows to the second air-liquid heat exchanger, the heat is transferred to the outside air. Thus, through the alternate or simultaneous cooling in the two modes, the equipment room can reach a suitable temperature, and the communication apparatus in the equipment room can operate normally for a long period. Therefore, the present invention achieves better power-saving performance than conventional air conditioners for the equipment room, reduces the influence on the environment, and prevents the problem of system instability caused by high underground soil temperature as the soil receives the heat for a long time, so as to enable the cooling system to operate more stably.

[0182] In addition, in the embodiment of the present invention, when the outside air is used for cooling, the outside air is not directly introduced into the equipment room, so the cooling system has low requirements for the air quality. Therefore, the application scenarios are not limited.

[0183] Persons of ordinary skill in the art should understand that the process of the control method according to the embodiments of the present invention may be implemented by a program instructing relevant hardware. The program may be stored in a computer readable storage medium. When the program is run, the steps of the method according to the embodiments of the present invention are performed. The storage medium may be a ROM, a RAM, a magnetic disk, or an optical disk.

[0184] To sum up, the above descriptions are merely preferred embodiments of the present invention, but are not intended to limit the protection scope of the present invention. Any modification, equivalent replacement, or improvement made without departing from the spirit and principle of the present invention should fall within the scope of the present invention.

What is claimed is:

1. A cooling system, applied to an equipment room, and comprising a first air-liquid heat exchanger, a second air-liquid heat exchanger, a buried heat exchange unit, a control device, a fluid conveying device, and connecting pipes, wherein the first air-liquid heat exchanger is disposed in the equipment room, the second air-liquid heat exchanger is disposed outside the equipment room, the buried heat exchange unit is buried underground, and the second air-liquid heat exchanger and the buried heat exchange unit are connected by the connecting pipes to the first air-liquid heat exchanger to form at least two circulation pipelines; and

the control device is configured to acquire environment information, and control at least one of the at least two circulation pipelines to be in an open state according to a control policy and the acquired environment information, wherein a circulation fluid is driven by the fluid conveying device to flow in the open circulation pipeline, and the environment information comprises at least one of the following temperatures: an outdoor temperature of the equipment room and a temperature of the soil surrounding buried pipes.

2. The system according to claim **1**, wherein the first air-liquid heat exchanger comprises a coil pipe structure, an air inlet, an air outlet, and an air conveying device, and is configured to use the air conveying device to suck in hot air in the equipment room through the air inlet, wherein the hot air exchanges heat with the circulation fluid flowing in the coil pipe structure, the hot air returns to the equipment room as cold air after releasing the heat, and the circulation fluid flowing in the coil pipe structure is driven by the fluid conveying device to flow out of the first air-liquid heat exchanger after absorbing the heat of the hot air.

3. The system according to claim **1**, wherein the second air-liquid heat exchanger and the first air-liquid heat exchanger are connected by the connecting pipes to form a first circulation pipeline, and the buried heat exchange unit and the first air-liquid heat exchanger are connected by the connecting pipes to form a second circulation pipeline; and

the control device is a first control device, and is configured to acquire the environment information, and control the first circulation pipeline to be in an open state according to the control policy and the acquired environment information, wherein the circulation fluid is driven by the fluid conveying device to flow in the open first circulation pipeline, and the environment information includes at least one of the following temperatures: an outdoor temperature of the equipment room and a temperature of the soil surrounding buried pipes; or

the control device is a first control device, and is configured to acquire the environment information, and control the second circulation pipeline to be in an open state according to the control policy and the acquired environment information, wherein the circulation fluid is driven by the fluid conveying device to flow in the open second circulation pipeline, and the environment information includes at least one of the following temperatures: an outdoor temperature of the equipment room and a temperature of the soil surrounding buried pipes; or

the control device is a first control device, and is configured to acquire the environment information, and control the first circulation pipeline and the second circulation pipeline to be in an open state according to the control policy and the acquired environment information, wherein the circulation fluid is driven by the fluid conveying device to flow in the open first circulation pipeline and second circulation pipeline, and the environment information includes at least one of the following temperatures: an outdoor temperature of the equipment room and a temperature of the soil surrounding buried pipes.

4. The system according to claim **3**, wherein after the circulation fluid flows into the second air-liquid heat exchanger along the open first circulation pipeline, the second air-liquid heat exchanger is configured to enable the circulation fluid flowing in coil pipes of the second air-liquid heat exchanger to exchange the heat with the air flowing outside the coil pipes, wherein the circulation fluid with a lowered temperature is driven by the fluid conveying device to circulate and flow back to the first air-liquid heat exchanger along the open first circulation pipeline.

5. The system according to claim **3**, wherein the buried heat exchange unit comprises one or more groups of underground buried pipes; when the circulation fluid flows into the buried heat exchange unit along the open second circulation pipeline, the buried heat exchange unit is configured to enable the circulation fluid to transfer the heat to the soil when flowing in the underground buried pipes, wherein the circulation fluid with a lowered temperature is driven by the fluid conveying device to flow back to the first air-liquid heat exchanger along the open second circulation pipeline.

6. The system according to claim **1**, wherein at least one control valve is disposed on each of the circulation pipelines, and at least one fluid conveying device is disposed on each of the circulation pipelines and the at least one fluid conveying device is disposed at the same pipe position of the circulation pipelines,

the control device is a first valve control device, configured to control the opening or the closing of the corresponding control valves according to the control policy and the acquired environment information, to enable at least one circulation pipeline to be in an open state, wherein the circulation fluid is driven by the fluid conveying device to flow in the open circulation pipeline.

7. The system according to claim **1**, wherein at least one control valve is disposed on each of the circulation pipelines, and at least one fluid conveying device is disposed on each of the circulation pipelines separately, the control device is a second valve control device, configured to control the opening or the closing of the corresponding control valves, to enable at least one circulation pipeline to be in an open state, and control the corresponding fluid conveying device to drive the circulation fluid to flow in the open circulation pipeline, according to the control policy and the acquired environment information, wherein the circulation fluid flows in the open circulation pipeline.

8. An equipment room, wherein a cooling system is applied to the equipment room, the cooling system comprises a first air-liquid heat exchanger, a second air-liquid heat exchanger, a buried heat exchange unit, a control device, a fluid conveying device, and connecting pipes; the first air-liquid heat exchanger is disposed in the equipment room; the second air-liquid heat exchanger disposed outside the equipment room, and the buried heat exchange unit buried underground are connected by the connecting pipes to the first air-liquid heat exchanger to form at least two circulation pipelines; and

the control device is configured to acquire environment information, and control at least one of the at least two circulation pipelines to be in an open state according to a control policy and the acquired environment information, wherein a circulation fluid is driven by the fluid conveying device to flow in the open circulation pipeline, and the environment information includes at least one of the following temperatures: an outdoor temperature of the equipment room and a temperature of the soil surrounding buried pipes.

9. The equipment room according to claim **8**, wherein at least one control valve is disposed on each of the circulation pipelines, at least one fluid conveying device is disposed on each of the circulation pipelines, and the at least one fluid conveying device is disposed at the same pipe position of the circulation pipelines,

the control device is a first valve control device, configured to control the opening or the closing of the corresponding control valves according to the control policy and the acquired environment information, to enable at least one circulation pipeline to be in an open state, wherein the circulation fluid is driven by the fluid conveying device to flow in the open circulation pipeline.

10. The equipment room according to claim **8**, wherein at least one control valve is disposed on each of the circulation pipelines, and at least one fluid conveying device is disposed on each of the circulation pipelines separately,

the control device is a second valve control device, configured to control the opening or the closing of the corresponding control valves to enable at least one circulation pipeline to be in an open state, and control the corresponding fluid conveying device to drive the circulation fluid to flow in the open circulation pipeline according to the control policy and the acquired environment information, wherein the circulation fluid flows in the open circulation pipeline.

11. The equipment room according to claim **8**, wherein the second air-liquid heat exchanger and the first air-liquid heat exchanger are connected by the connecting pipes to form a first circulation pipeline, and the buried heat exchange unit and the first air-liquid heat exchanger are connected by the connecting pipes to form a second circulation pipeline; and

a first control valve and a second control valve are disposed on the first circulation pipeline, and a third control valve and a fourth control valve are disposed on the second circulation pipeline,

the control device is a third valve control device, configured to control the opening of the first control valve and the second control valve according to the control policy and the acquired environment information, wherein the circulation fluid flows in the first circulation pipeline on which the opened control valves are arranged; or

the control device is a third valve control device, configured to control the opening of the third control valve and the fourth control valve according to the control policy and the acquired environment information, wherein the circulation fluid flows in the second circulation pipeline on which the opened control valves are arranged; or

the control device is a third valve control device, configured to control the opening of the first control valve and the second control valve and the opening of the third control valve and the fourth control valve according to the control policy and the acquired environment information, wherein the circulation fluid flows in the first circulation pipeline and the second circulation pipeline on which the opened control valves are arranged.

12. The equipment room according to claim **8**, wherein the control device comprises:

an environment information acquiring unit, configured to acquire the environment information, wherein the environment information includes at least one of the following temperatures: an outdoor temperature of the equipment room and a temperature of the soil surrounding buried pipes; and

a control unit, configured to control at least one of the at least two circulation pipelines to be in an open state according to the control policy and the environment information that is acquired by the environment information acquiring unit, wherein the circulation fluid is driven by the fluid conveying device to flow in the open circulation pipeline.

13. The equipment room according to claim **12**, wherein the environment information acquiring unit is further configured to acquire an indoor temperature of the equipment room; and

the control unit is further configured to perform corresponding fan speed regulation control on a fan of the second air-liquid heat exchanger according to the acquired outdoor temperature of the equipment room and association information between the outdoor temperature information and fan speeds of the fan of the second air-liquid heat exchanger; or

the control unit is further configured to perform corresponding fan speed regulation control on a fan of the first air-liquid heat exchanger according to the acquired indoor temperature of the equipment room and association information between the indoor temperature information and fan speeds of the fan of the first air-liquid heat exchanger; or

the control unit is further configured to perform corresponding fan speed regulation control on a fan of the second air-liquid heat exchanger according to the acquired outdoor temperature of the equipment room and association information between the outdoor temperature information and fan speeds of the fan of the second air-liquid heat exchanger; and to perform corresponding fan speed regulation control on a fan of the first air-liquid heat exchanger according to the acquired indoor temperature of the equipment room and association information between the indoor temperature information and fan speeds of the fan of the first air-liquid heat exchanger.

14. A control method, applicable to a cooling system comprising a buried heat exchange unit, a first air-liquid heat exchanger, a second air-liquid heat exchanger, a control device, a fluid conveying device, and connecting pipes, the cooling system being applied to an equipment room, wherein the second air-liquid heat exchanger and the buried heat exchange unit are connected by the connecting pipes to the first air-liquid heat exchanger to form at least two circulation pipelines, the method comprising:

acquiring environment information, wherein the environment information comprises at least one of the following temperatures: an outdoor temperature of the equipment room and a temperature of the soil surrounding buried pipes; and

controlling at least one of the at least two circulation pipelines to be in an open state according to a control policy and the acquired environment information, wherein a circulation fluid is driven by the fluid conveying device to flow in the open circulation pipeline.

15. The method according to claim **14**, wherein when the second air-liquid heat exchanger and the first air-liquid heat exchanger are connected by the connecting pipes to form a first circulation pipeline, and the buried heat exchange unit and the first air-liquid heat exchanger are connected by the connecting pipes to form a second circulation pipeline,

the controlling at least one of the at least two circulation pipelines to be in an open state according to a control policy and the acquired environment information, wherein a circulation fluid is driven by the fluid conveying device to flow in the open circulation pipeline comprises:

controlling the opening of the first circulation pipeline according to the control policy and the acquired environment information, wherein the circulation fluid flowing out of the first air-liquid heat exchanger flows into the corresponding second air-liquid heat exchanger through the first circulation pipeline to perform the cooling, and circulates and flows back to the first air-liquid heat exchanger through the first circulation pipeline; or

controlling the opening of the second circulation pipeline according to the control policy and the acquired environment information, wherein the circulation fluid flowing out of the first air-liquid heat exchanger flows into the corresponding buried heat exchange unit through the second circulation pipeline to perform the cooling, and flows back to the first air-liquid heat exchanger through the second circulation pipeline; or

controlling the opening of the first circulation pipeline and the second circulation pipeline according to the control policy and the acquired environment information, wherein the circulation fluid flowing out of the first air-liquid heat exchanger flows into the corresponding second air-liquid heat exchanger through the first circulation pipeline to perform the cooling, and circulates and flows back to the first air-liquid heat exchanger through the first circulation pipeline; and, the circulation fluid flowing out of the first air-liquid heat exchanger flows into the corresponding buried heat exchange unit through the second circulation pipeline to perform the cooling, and flows back to the first air-liquid heat exchanger through the second circulation pipeline.

16. The method according to claim **14**, wherein at least one control valve is disposed on each of the circulation pipelines, and at least one fluid conveying device is disposed on each of the circulation pipelines, and the at least one fluid conveying device is disposed at the same pipe position of the circulation pipelines,

the controlling at least one of the at least two circulation pipelines to be in an open state according to a control policy and the acquired environment information, wherein a circulation fluid is driven by the fluid conveying device to flow in the open circulation pipeline comprises:

controlling the opening or the closing of the corresponding control valves according to the control policy and the acquired environment information, to enable at least one circulation pipeline to be in an open state, wherein the circulation fluid is driven by the fluid conveying device to flow in the open circulation pipeline.

17. The method according to claim **14**, wherein at least one control valve is disposed on each of the circulation pipelines, and at least one fluid conveying device is disposed on each of the circulation pipelines separately,

the controlling at least one of the at least two circulation pipelines to be in an open state according to a control policy and the acquired environment information, wherein a circulation fluid is driven by the fluid conveying device to flow in the open circulation pipeline comprises:

controlling the opening or the closing of the corresponding control valves to enable at least one circulation pipeline to be in an open state, and controlling the corresponding fluid conveying device to drive the circulation fluid in the open circulation pipeline to flow, according to the control policy and the acquired environment information, wherein the circulation fluid flows in the open circulation pipeline.

18. The method according to claim **14**, wherein the acquiring environment information, wherein the environment information comprises at least one of the following temperatures: an outdoor temperature of the equipment room and a temperature of the soil surrounding buried pipes comprises: acquiring the outdoor temperature T**1** of the equipment room and an indoor temperature T**2** of the equipment room;

when the second air-liquid heat exchanger and the first air-liquid heat exchanger are connected by the connecting pipes to form a first circulation pipeline, and the buried heat exchange unit and the first air-liquid heat exchanger are connected by the connecting pipes to form a second circulation pipeline, the controlling at least one of the at least two circulation pipelines to be in an open state according to a control policy and the acquired environment information comprises:

when the outdoor temperature T**1** of the equipment room is higher than a designed maximum working temperature Tf of the second air-liquid heat exchanger, controlling the opening of the second circulation pipeline, wherein the circulation fluid is driven by the fluid conveying device to flow in the open second circulation pipeline;

when the outdoor temperature T**1** of the equipment room is lower than or equal to the designed maximum working temperature Tf of the second air-liquid heat exchanger, controlling the opening of the first circulation pipeline, wherein the circulation fluid is driven by the fluid conveying device to flow in the open first circulation pipeline; and

when the indoor temperature T**2** of the equipment room is higher than an indoor maximum allowed temperature Ts of the equipment room and the outdoor temperature T**1** of the equipment room is higher than the designed maximum working temperature Tf of the second air-liquid heat exchanger, controlling the opening of the first circulation pipeline and the second circulation pipeline, wherein the circulation fluid is driven by the fluid conveying device to flow in the open first circulation pipeline and second circulation pipeline.

19. The method according to claim **14**, wherein the acquiring environment information, wherein the environment information comprises at least one of the following temperatures: an outdoor temperature of the equipment room and a temperature of the soil surrounding buried pipes comprises:

acquiring the outdoor temperature T**1** of the equipment room and the temperature T**3** of the soil surrounding the underground buried pipes;

when the second air-liquid heat exchanger and the first air-liquid heat exchanger are connected by the connecting pipes to form a first circulation pipeline, and the buried heat exchange unit and the first air-liquid heat exchanger are connected by the connecting pipes to form a second circulation pipeline, the controlling at least one of the at least two circulation pipelines to be in an open state according to a control policy and the acquired environment information comprises:

when the temperature T**3** of the soil surrounding the underground buried pipes is lower than a designed maximum temperature Tm of the soil surrounding the underground buried pipes, controlling the opening of the second circulation pipeline, wherein the circulation fluid is driven by the fluid conveying device to flow in the open second circulation pipeline;

when the temperature T**3** of the soil surrounding the underground buried pipes is higher than or equal to the designed maximum temperature Tm of the soil surrounding the underground buried pipes and the outdoor temperature T**1** of the equipment room is lower than or equal to a designed maximum working temperature Tf of the second air-liquid heat exchanger, controlling the opening of the first circulation pipeline, wherein the circulation fluid is driven by the fluid conveying device to flow in the open first circulation pipeline; and

when the temperature T**3** of the soil surrounding the underground buried pipes is higher than or equal to the designed maximum temperature Tm of the soil surrounding the underground buried pipes and the outdoor temperature T**1** of the equipment room is higher than the designed maximum working temperature Tf of the second air-liquid heat exchanger, controlling the opening of the first circulation pipeline and the second circulation pipeline, wherein the circulation fluid is driven by the fluid conveying device to flow in the open first circulation pipeline and second circulation pipeline.

20. A computer-readable storage medium having computer executable instructions for performing a control method, applicable to a cooling system comprising a buried heat exchange unit, a first air-liquid heat exchanger, a second air-liquid heat exchanger, a control device, a fluid conveying device, and connecting pipes, the cooling system being applied to an equipment room, wherein the second air-liquid heat exchanger and the buried heat exchange unit are connected by the connecting pipes to the first air-liquid heat exchanger to form at least two circulation pipelines, the method comprising:

acquiring environment information, wherein the environment information comprises at least one of the following temperatures: an outdoor temperature of the equipment room and a temperature of the soil surrounding buried pipes; and

controlling at least one of the at least two circulation pipelines to be in an open state according to a control policy and the acquired environment information, wherein a circulation fluid is driven by the fluid conveying device to flow in the open circulation pipeline.

* * * * *