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(71) Applicant(s):
Mitsubishi Electric Corporation
(Incorporated in Japan)
7-3, Marunouchi 2-chome, Chiyoda-ku,
Tokyo 100-8310, Japan

(72) Inventor(s):
Kosuke Kawano
Takuya Ito
Yoshio Yamano
Kimitaka Kadowaki

(74) Agent and/or Address for Service:
Mewburn Ellis LLP
Aurora Building, Counterslip, Bristol, BS1 6BX,
United Kingdom

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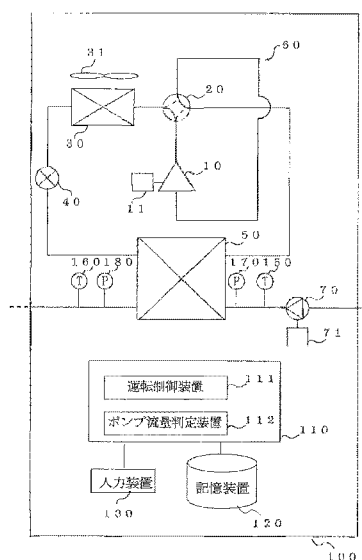
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(54) Title of the Invention: Chilling unit and cold/warm water system
Abstract Title: Chilling unit and cold/warm water system

(57) The chilling unit according to the present invention supplies heat to a heat load by heating or cooling a heating medium, which serves as a medium for carrying heat, and circulating the heating medium through a heating medium circulation circuit, the chilling unit comprising: a pump that includes a pump inverter drive device and that applies pressure to the heating medium; a heat-source-side device that includes a heating medium heat exchanger and that heats or cools the heating medium; and a control device that sets an upper-limit drive frequency and/or a lower-limit drive frequency of the pump on the basis of an upper-limit set flow rate and/or a lower-limit set flow rate of the heating medium passing through the heating medium heat exchanger.

[図2]



111 Operation control device
112 Pump flow rate determination device
120 Storage device
130 Input device

FIG. 1

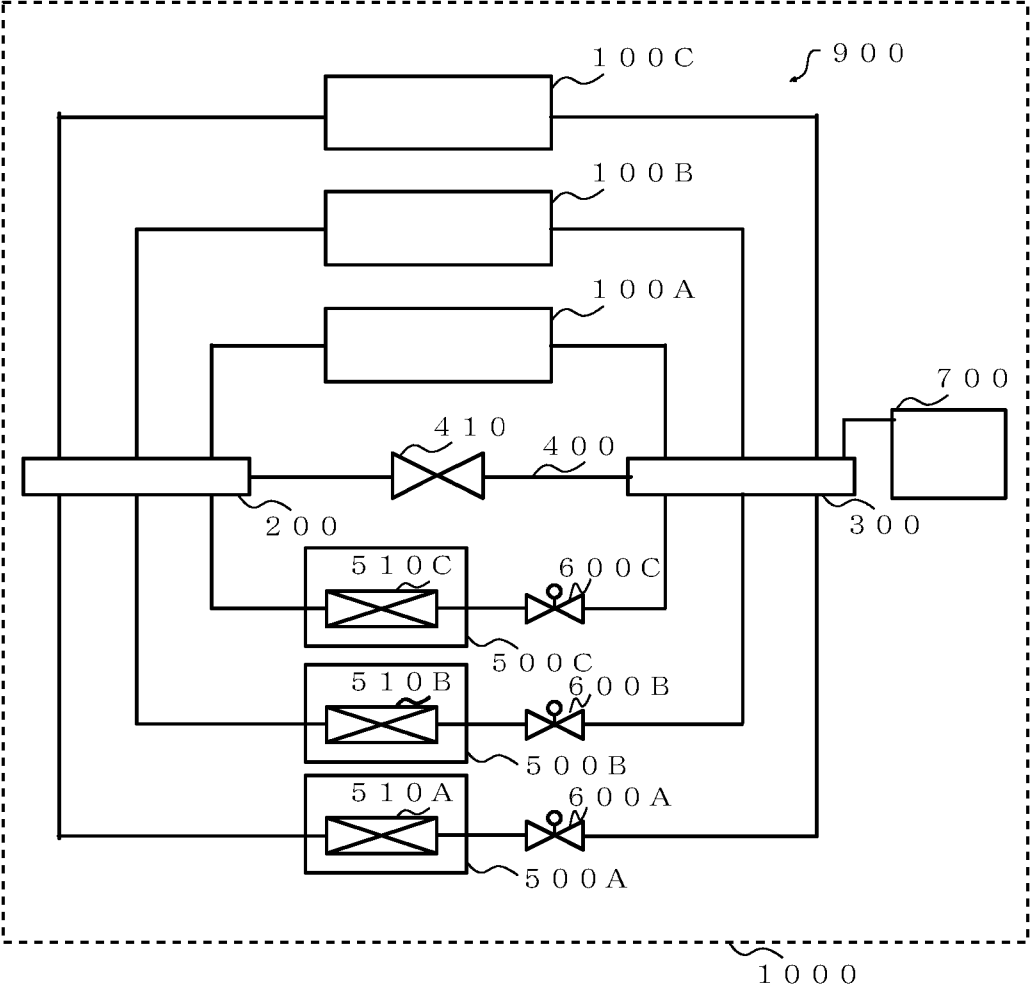


FIG. 2

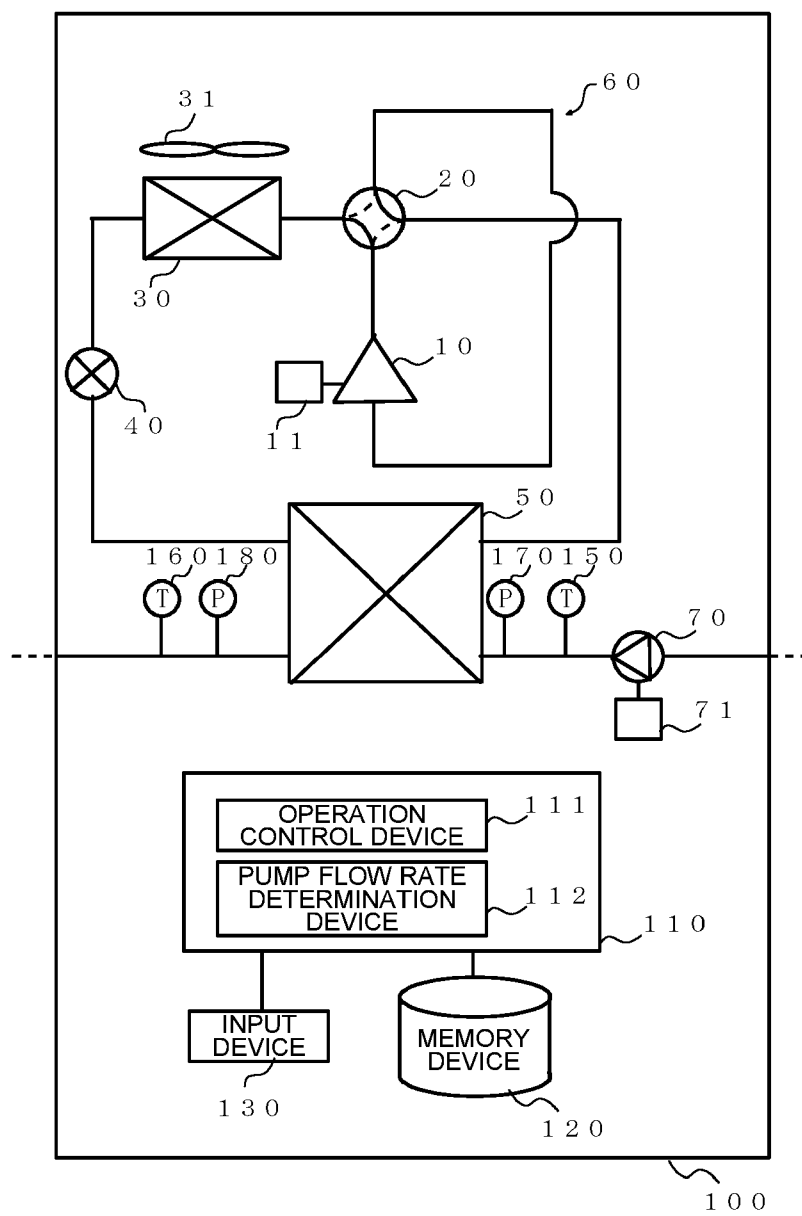


FIG. 3

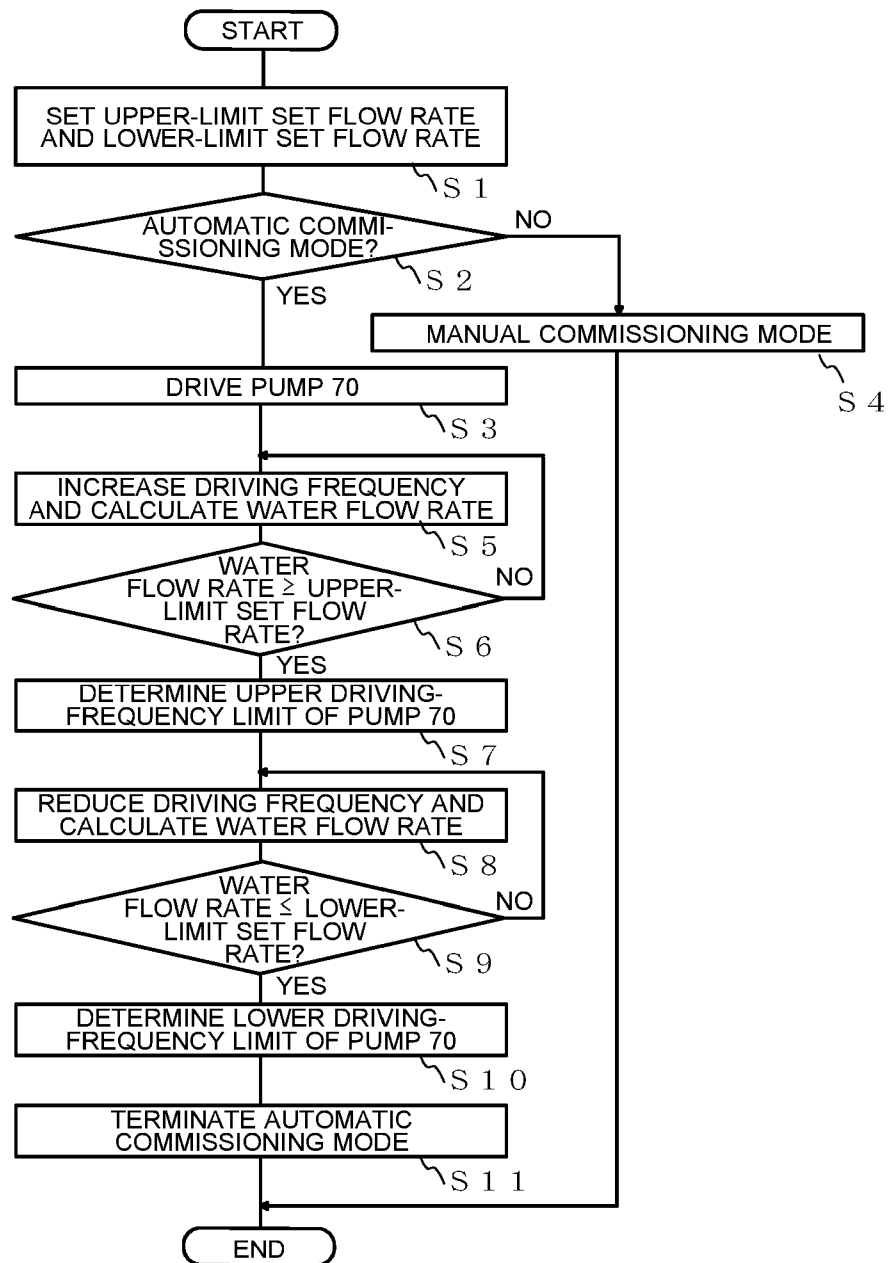


FIG. 4

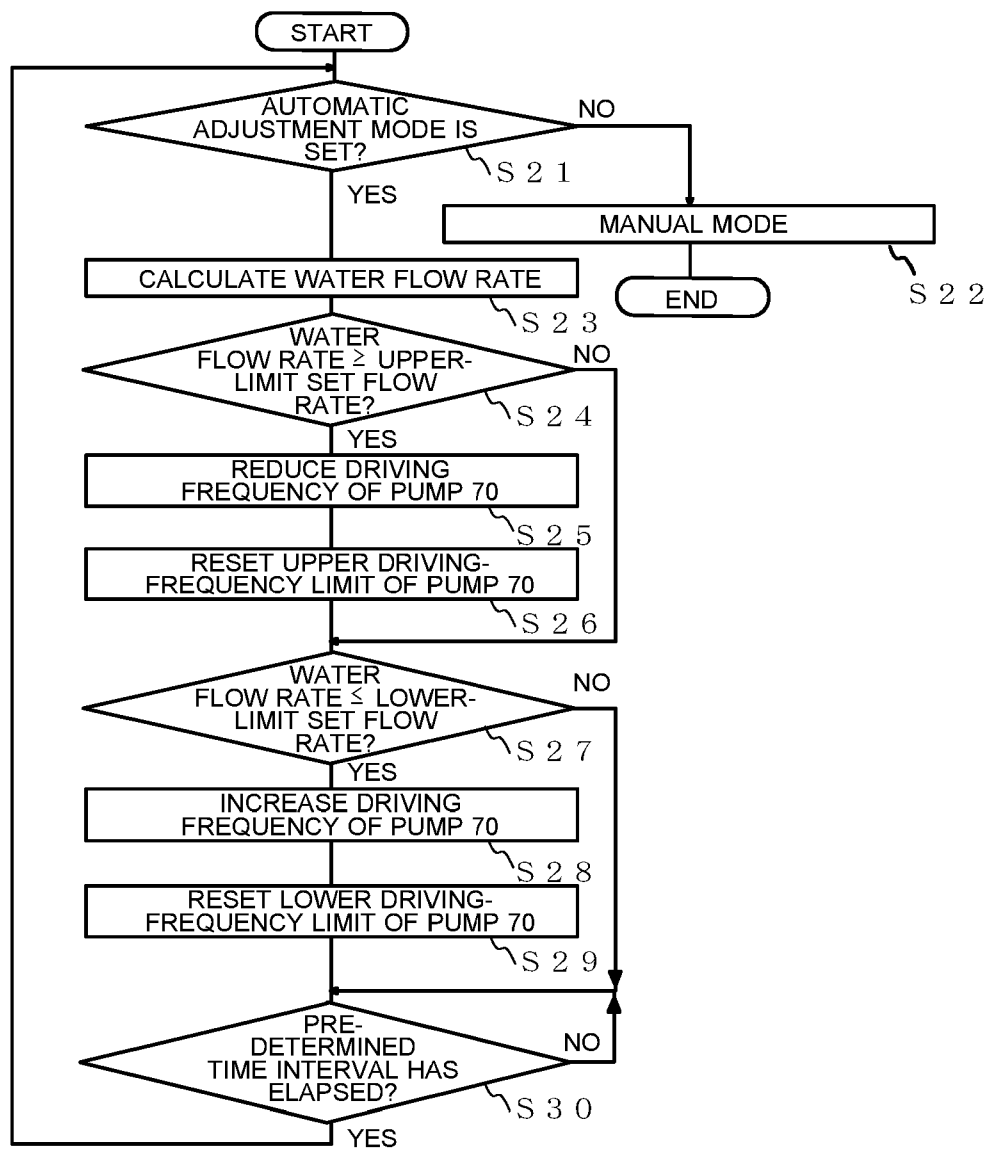


FIG. 5

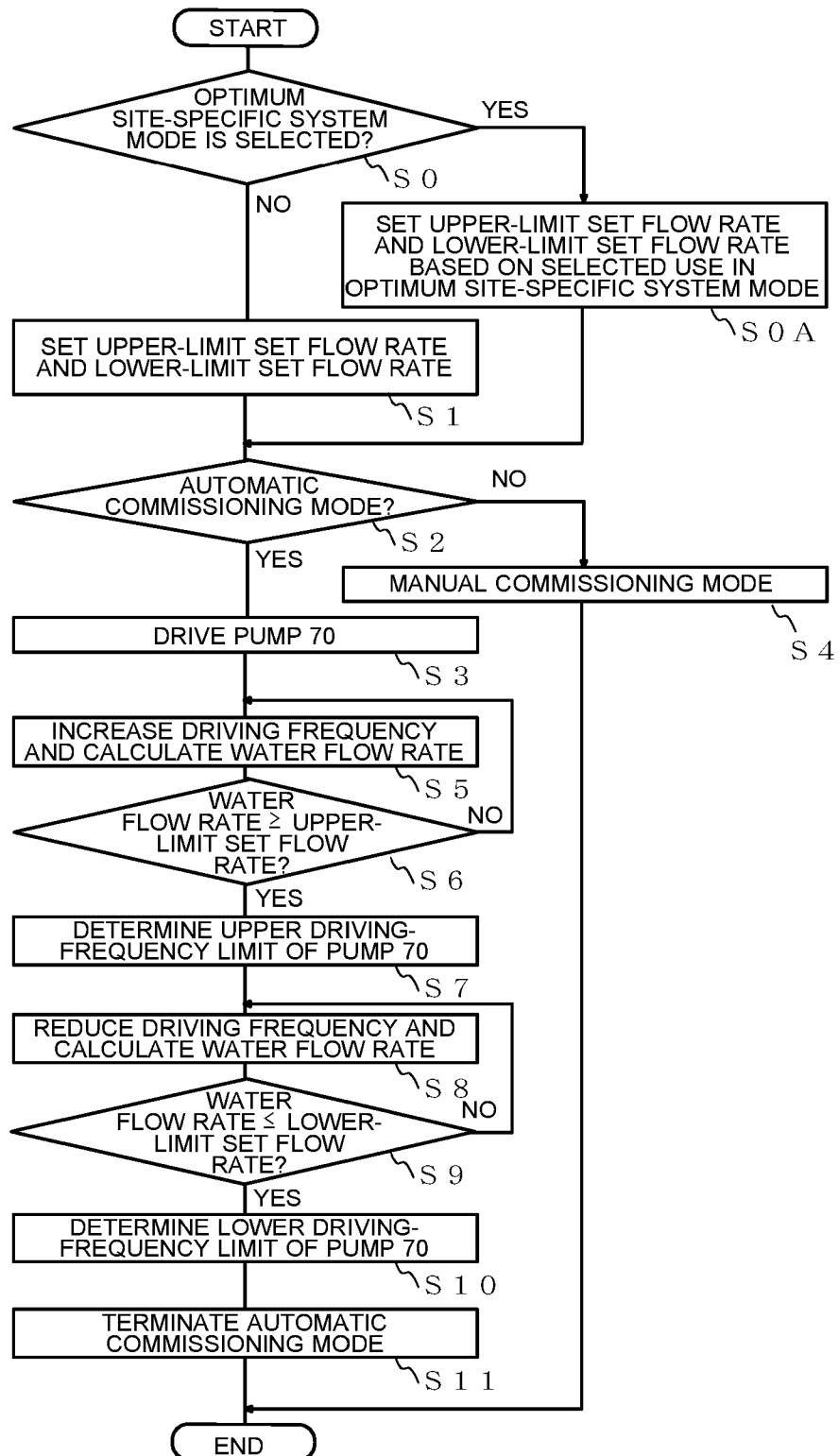


FIG. 6

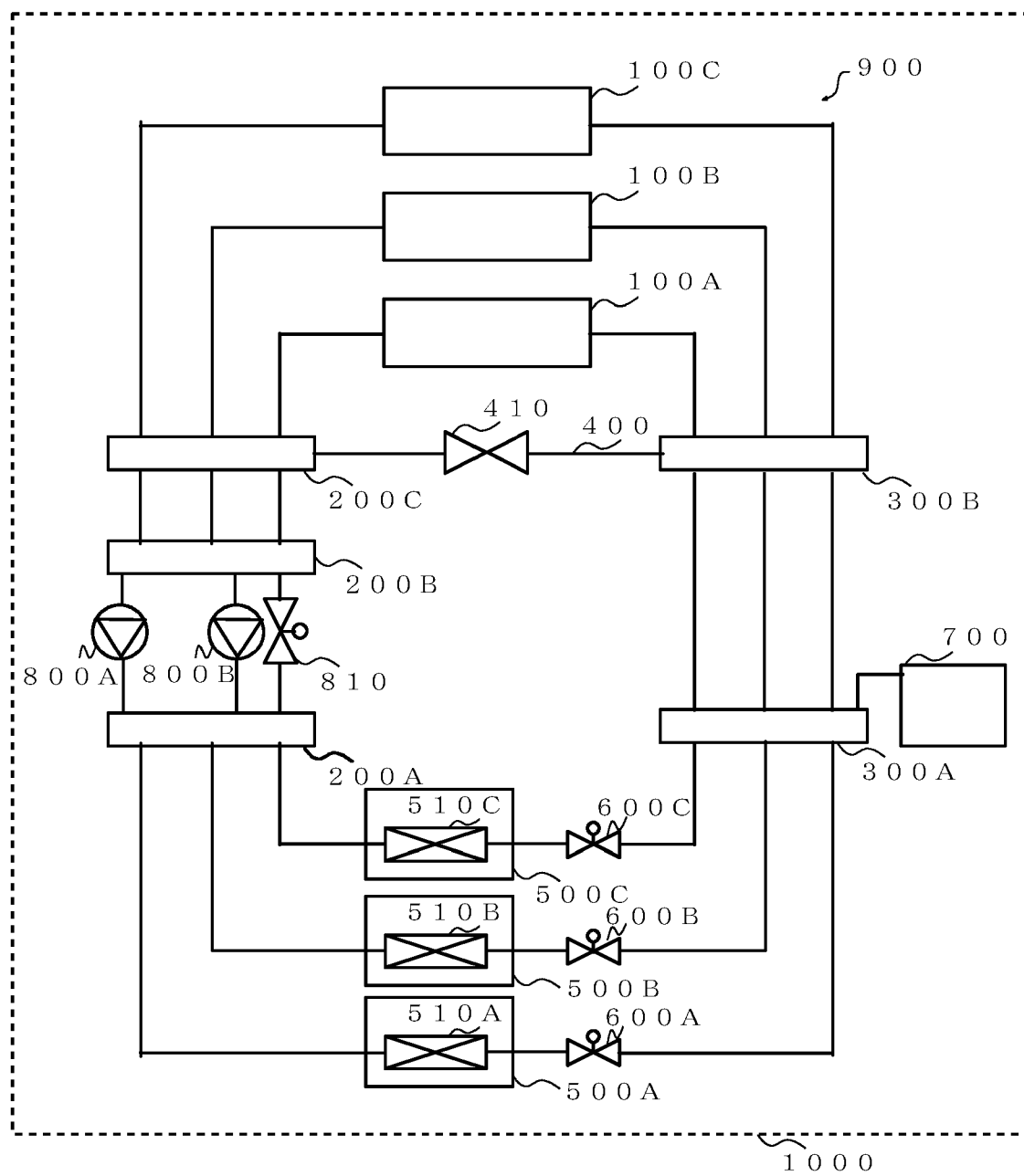
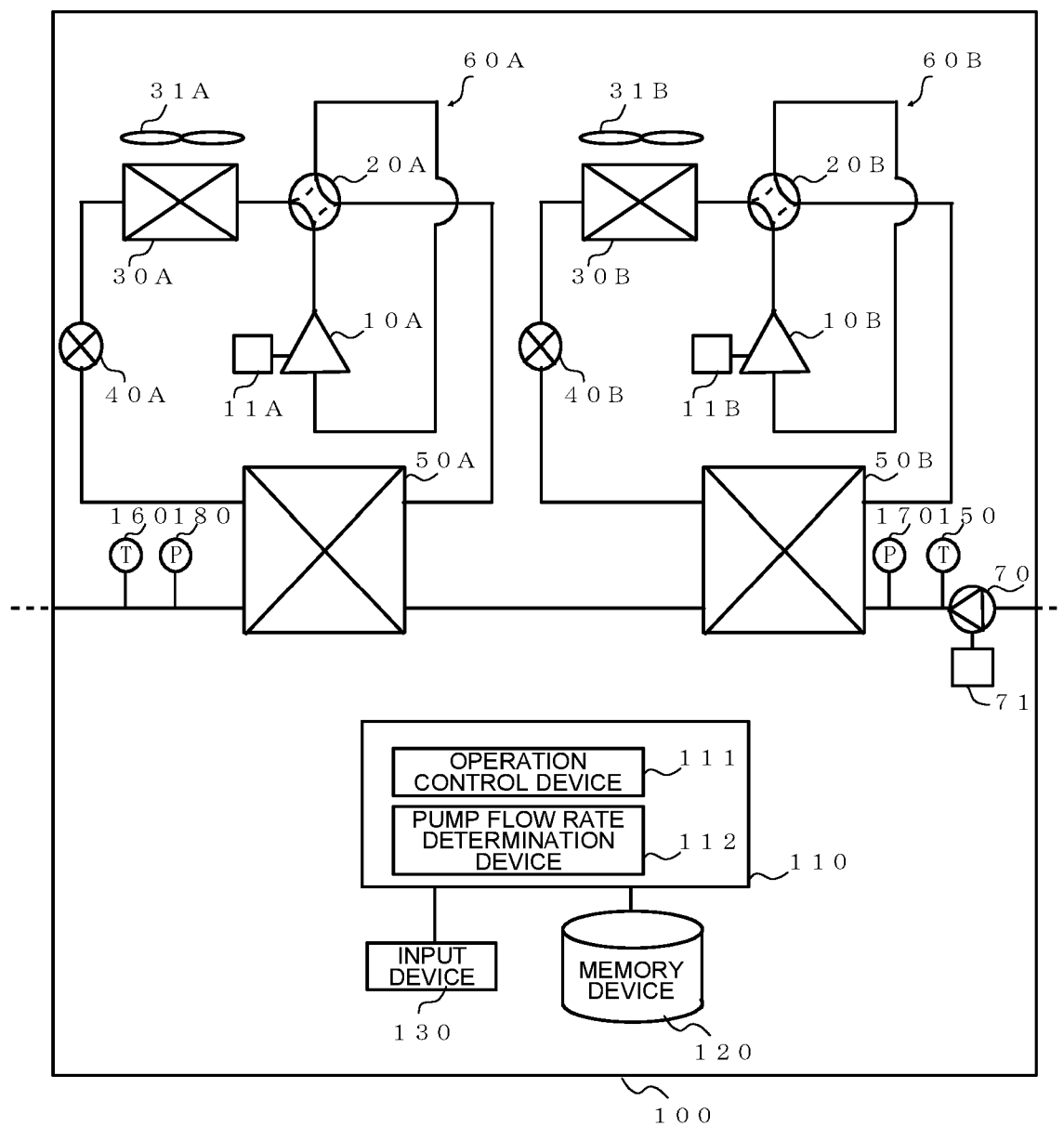


FIG. 7



DESCRIPTION

Title of Invention

CHILLING UNIT AND COLD/HOT WATER SYSTEM

Technical Field

5 [0001]

The present disclosure relates to a chilling unit and a cold/hot water system, and in particular, relates to a pump that causes a heat medium, such as water, to circulate through a heat medium circulation circuit.

Background Art

10 [0002]

In a building, such as an office building, a target space, for example, a room, is subjected to air-conditioning, such as heating or cooling. A cold/hot water system has been developed to cause a load side unit to heat or cool a target space with cold or hot water that is supplied from a chilling unit including a cooling/heating heat source unit through a water circulation circuit by driving a pump (refer to Patent Literature 1, for example). The cooling/heating heat source unit uses a refrigeration cycle to produce cold water or hot water in a water heat exchanger that exchanges heat between water and refrigerant.

Citation List

20 Patent Literature

[0003]

Patent Literature 1: Japanese Unexamined Patent Application Publication No. 2012-112557

Summary of Invention

25 Technical Problem

[0004]

The above-described Patent Literature 1 discloses a method of adjusting the driving frequency of a pump to improve coefficient of performance (COP). The pump is driven based on a temperature depending on a load in a water circulation circuit. However, the state of water, for example, the flow rate of water flowing through the

30

water circulation circuit, is not particularly taken into consideration. Consequently, an excess or lack of water passing through a water heat exchanger may occur depending on the state of a pipe in the water circulation circuit on site.

[0005]

5 The present disclosure has been made to solve the above-described problem and aims to provide a chilling unit and a cold/hot water system that achieve stable circulation of water in a water circulation circuit.

Solution to Problem

[0006]

10 An embodiment of the present disclosure provides a chilling unit that heats or cools a heat medium, serving as a medium to carry heat, and circulates the heat medium through a heat medium circulation circuit to supply heat to a heat load, the chilling unit including: a pump having a pump inverter drive and configured to pressurize the heat medium; a heat source side unit including a heat medium heat
15 exchanger and configured to heat or cool the heat medium; and a controller configured to set, based on at least one of an upper-limit set flow rate and a lower-limit set flow rate of the heat medium passing through the heat medium heat exchanger, at least one of an upper driving-frequency limit and a lower driving-frequency limit of the pump.

20 [0007]

 Another embodiment of the present disclosure provides a cold/hot water system including: a plurality of the chilling units; a load side unit configured to supply heat to a heat load through heat exchange with a heat medium; a water supply header pipe with which the plurality of the chilling units are connected in parallel and
25 through which streams of the heat medium heated or cooled by and flowing from the plurality of the chilling units are caused to join and the heat medium is then supplied to the load side unit; and a water return header pipe with which the plurality of the chilling units are connected in parallel and through which the heat medium flowing from the load side unit is distributed to the plurality of the chilling units, the plurality of

the chilling units, the load side unit, the water supply header pipe, and the water return header pipe being connected to form a heat medium circulation circuit.

Advantageous Effects of Invention

[0008]

5 In the chilling unit and the cold/hot water system according to the embodiments of the present disclosure, the controller sets, based on at least one of the upper-limit set flow rate and the lower-limit set flow rate of the heat medium passing through the heat medium heat exchanger, at least one of the upper driving-frequency limit and the lower driving-frequency limit of the pump. This prevents the chilling unit and the cold/hot water system from, for example, freezing because of a lack of the heat medium and enables the chilling unit and the cold/hot water system to stably circulate the heat medium through the heat medium circulation circuit without any reduction in efficiency caused by an excess of the heat medium passing through the circuit.

Brief Description of Drawings

15 [0009]

[Fig. 1] Fig. 1 is a diagram illustrating the configuration of a cold/hot water system 1000 according to Embodiment 1 of the present disclosure.

[Fig. 2] Fig. 2 is a diagram illustrating the configuration of a chilling unit 100 of the cold/hot water system 1000 according to Embodiment 1 of the present disclosure.

20 [Fig. 3] Fig. 3 is a flowchart illustrating a process for determination of a driving frequency of a pump 70 in commissioning of the cold/hot water system 1000 according to Embodiment 1 of the present disclosure.

[Fig. 4] Fig. 4 is a flowchart illustrating a process for adjustment of a driving frequency of a pump 70 in a normal operation of a cold/hot water system 1000 according to Embodiment 2 of the present disclosure.

25 [Fig. 5] Fig. 5 is a flowchart illustrating a process for determination of a driving frequency of a pump 70 in commissioning of a cold/hot water system 1000 according to Embodiment 3 of the present disclosure.

[Fig. 6] Fig. 6 is a diagram illustrating the configuration of a cold/hot water system 1000 according to Embodiment 4 of the present disclosure.

[Fig. 7] Fig. 7 is a diagram illustrating the configuration of a chilling unit 100 of a cold/hot water system 1000 according to Embodiment 5 of the present disclosure.

Description of Embodiments

[0010]

5 Hereinbelow, for example, cold/hot water systems according to embodiments of the present disclosure will be described with reference to the drawings. Note that components designated by the same reference signs in the following drawings are the same components or equivalents. This note applies to the entire description of the embodiments described below. Furthermore, note that the forms of components
10 described herein are intended to be illustrative only and the forms of the components are not intended to be limited to those described herein. In particular, combinations of the components are not intended to be limited only to those in the embodiments. A component in one embodiment can be used in another embodiment. For a plurality of devices of the same type, for example, distinguished from one another
15 using letters, if the devices do not have to be distinguished from one another or specified, the letters may be omitted. Additionally, note that the relationship between the sizes of the components in the drawings may differ from that between the actual sizes of the components. High and low values of, for example, temperature and pressure, are not determined in relation to particular absolute values, but are
20 relatively determined based on, for example, a state or an operation of, for example, the system or each device.

[0011]

Embodiment 1.

Fig. 1 is a diagram illustrating the configuration of a cold/hot water system 1000
25 according to Embodiment 1 of the present disclosure. For example, the configuration of the cold/hot water system 1000 will be described with reference to Fig. 1. The cold/hot water system 1000 is a system that supplies heat to a target heat load with a heat medium cooled or heated in chilling units 100, each serving as a heat source side unit. Examples of the heat medium, serving as a medium to carry
30 heat, include brine (antifreeze), water, a liquid mixture of brine and water, and a liquid

mixture of water and a highly anticorrosive additive. It is assumed herein that water is used as a heat medium. The cold/hot water system 1000 includes the chilling units 100, a water supply header pipe 200, a water return header pipe 300, a bypass pipe 400, a bypass valve 410, load side units 500, two-way valves 600, and a tank 700, which form a water circulation circuit 900, serving as a heat medium circulation circuit.

[0012]

Each chilling unit 100 heats or cools the water circulating through the water circulation circuit 900. The cold/hot water system 1000 according to Embodiment 1 includes the chilling units 100. The cold/hot water system 1000 of Fig. 1 includes three chilling units 100A to 100C. For example, the configuration of each chilling unit 100 will be described later. The water supply header pipe 200 causes streams of water flowing from the chilling units 100 to join and distributes the water to the load side units 500. The water return header pipe 300 causes streams of water flowing from the load side units 500 to join and distributes the water to the chilling units 100.

[0013]

The bypass pipe 400 is a pipe that connects the water supply header pipe 200 and the water return header pipe 300. The bypass pipe 400 causes water that is not sent to the load side units 500 to bypass the load side units 500, or flow from the water supply header pipe 200 to the water return header pipe 300. The bypass valve 410 regulates the flow rate of the water passing through the bypass pipe 400.

[0014]

Each load side unit 500, which includes a load side heat exchanger 510, is a device that heats or cools a target load. Examples of the load side unit 500 include a fan coil unit and an air handling unit. Fig. 1 illustrates three load side units 500A to 500C. The load side heat exchanger 510 of each load side unit 500 exchanges heat between water passing therethrough and the target load. Each two-way valve 600 is a valve that permits or inhibits passage of water to the load side heat exchanger 510 of the load side unit 500.

[0015]

The tank 700 holds water and supplies the water to the water circulation circuit 900 when there is not enough water in the water circulation circuit 900. Examples of the tank 700 include an open tank, a cushion tank, and a closed tank.

[0016]

Fig. 2 is a diagram illustrating the configuration of each chilling unit 100 in the cold/hot water system 1000 according to Embodiment 1 of the present disclosure. For example, the configuration and operation of the chilling unit 100 will now be described with reference to Fig. 2. The chilling unit 100 in Embodiment 1 includes a refrigeration cycle apparatus 60 having a refrigerant circuit through which refrigerant is circulated, and performs an operation of cooling or heating water, serving as a heat medium to carry heat, using a refrigeration cycle. It is assumed herein that the cold/hot water system 1000 according to Embodiment 1 conditions air in a target space with heat carried by the water. In the following description, therefore, a heating operation of the chilling unit 100 is referred to as a heating operation and a cooling operation thereof is referred to as a cooling operation. The cooling operation is an operation that meets at least one of a condition where a discharge side of a compressor 10 and an air heat exchanger 30 are connected by a four-way valve 20 and a condition where the temperature of water passing through a water heat exchanger 50, which exchanges heat between the refrigerant and the water, falls. The heating operation is an operation that meets at least one of a condition where the discharge side of the compressor 10 and the water heat exchanger 50 are connected by the four-way valve 20 and a condition where the temperature of the water passing through the water heat exchanger 50 rises.

[0017]

As illustrated in Fig. 2, the chilling unit 100 in Embodiment 1 includes the refrigeration cycle apparatus 60. The refrigeration cycle apparatus 60 includes the compressor 10, the four-way valve 20, the air heat exchanger 30, an expansion valve 40, and the water heat exchanger 50, which are connected by pipes to form the refrigerant circuit. Additionally, the chilling unit 100 includes a pump 70 disposed adjacent to the water circulation circuit 900. The chilling unit 100 further includes a

controller 110, which controls, for example, the components, a memory device 120, and an input device 130.

[0018]

The compressor 10 sucks, compresses, and discharges the refrigerant. The compressor 10 has a compressor inverter drive 11. In this case, the compressor inverter drive 11 can change a driving frequency of the compressor 10 to any value in response to an instruction from the controller 110 to change a capacity of the compressor 10 that is the amount of refrigerant sent per unit time. The four-way valve 20, serving as a flow switching device, switches between flow directions of the refrigerant in response to an instruction from the controller 110 depending on an operation to be performed. For example, in the cooling operation, the four-way valve 20 causes the refrigerant to flow such that high temperature, high pressure refrigerant discharged from the compressor 10 flows into the air heat exchanger 30. In the heating operation, the four-way valve 20 causes the refrigerant to flow such that the high temperature, high pressure refrigerant discharged from the compressor 10 flows into the water heat exchanger 50.

[0019]

The air heat exchanger 30 includes a plurality of heat transfer tubes and exchanges heat between the refrigerant passing through the heat transfer tubes and air (e.g., outdoor air). In the heating operation, the air heat exchanger 30 functions as an evaporator and exchanges heat between the air and low pressure refrigerant flowing from the expansion valve 40 to evaporate and gasify the refrigerant. In the cooling operation, the air heat exchanger 30 functions as a condenser and exchanges heat between the air and low pressure refrigerant flowing from the compressor 10 to condense and liquify the refrigerant. A fan 31 sends air to the air heat exchanger 30 to promote heat exchange between the refrigerant and the air.

[0020]

The water heat exchanger 50, serving as a heat medium heat exchanger, exchanges heat between the refrigerant and the water, serving as a heat medium. For example, in the heating operation, the water heat exchanger 50 functions as a

condenser and exchanges heat between the water and the refrigerant flowing from the compressor 10 such that the refrigerant is condensed into liquid or two-phase gas-liquid refrigerant, thus heating the water. In the cooling operation, the water heat exchanger 50 functions as an evaporator and exchanges heat between the water and the refrigerant flowing from the expansion valve 40 such that the refrigerant is evaporated and gasified, thus cooling the water. The expansion valve 40, serving as an expansion device, changes its opening degree to adjust, for example, a pressure of the refrigerant in the water heat exchanger 50. The expansion valve 40 may be a temperature-sensitive expansion valve whose opening degree is changed based on the temperature of refrigerant. In Embodiment 1, the expansion valve 40 is an electronic expansion valve that changes its opening degree in response to an instruction from the controller 110.

[0021]

The pump 70 sucks, pressurizes, and discharges the water in the water circulation circuit 900 such that the water is circulated through the circuit. A pump inverter drive 71 can change a driving frequency to any value in response to an instruction from the controller 110 to change the capacity of the pump 70.

[0022]

The chilling unit 100 in Embodiment 1 includes an inlet water temperature sensor 150 and an outlet water temperature sensor 160, which serve as a heat medium temperature sensor to detect a temperature of the water entering and leaving the water heat exchanger 50. The chilling unit 100 further includes an inlet water pressure sensor 170 and an outlet water pressure sensor 180, which serve as a heat medium pressure sensor to detect a pressure of the water entering and leaving the water heat exchanger 50.

[0023]

The controller 110 controls the chilling unit 100. The controller 110 in Embodiment 1 at least includes an operation control device 111 and a pump flow rate determination device 112. The operation control device 111 controls the operation of the entire chilling unit 100. The pump flow rate determination device 112 in

Embodiment 1 performs a process of determining an upper driving-frequency limit and a lower driving-frequency limit of the pump 70, particularly in commissioning including an operation with switching between the cooling operation and the heating operation. The memory device 120 stores a variety of data necessary for processes of the controller 110 temporarily or for a long time. In addition, the memory device 120 also stores data obtained through a process performed by the controller 110 temporarily or for a long time. The input device 130 sends a signal associated with an instruction from an operator to the controller 110.

[0024]

In the controller 110 in Embodiment 1, for example, the operation control device 111 and the pump flow rate determination device 112 can be implemented by different hardware components, for example. These devices can also be implemented by an arithmetic control processing unit, such as a computer including a central processing unit (CPU), such that processes of the devices are programmed and implemented by, for example, software or firmware. The arithmetic control unit runs the programs to execute the processes based on the programs, thus implementing the processes of the above-described devices. These programs may be stored as data in, for example, the memory device 120. The memory device 120 includes a volatile memory (not illustrated), such as a random access memory (RAM) in which data can be temporarily stored, a hard disk, and a non-volatile auxiliary memory (not illustrated), such as a flash memory in which data can be stored for a long time.

[0025]

For the cold/hot water system 1000 according to Embodiment 1, the controller 110 of the chilling unit 100 performs automatic commissioning of the cold/hot water system 1000 installed on site. In the commissioning, the controller 110 determines and sets, based on set upper and lower flow-rate limits of the water passing through the water heat exchanger 50, driving frequencies of the pump 70 corresponding to the upper and lower flow-rate limits of the water. In a normal operation, the pump 70 is driven within a set range of driving frequencies to ensure stable passage of the water through the water heat exchanger 50.

[0026]

Fig. 3 is a flowchart illustrating a process for determination of a driving frequency of the pump 70 in the commissioning of the cold/hot water system 1000 according to Embodiment 1 of the present disclosure. The controller 110 in each chilling unit 100 sets upper and lower driving-frequency limits of the pump 70 included in the chilling unit. The process performed by the controller 110 in the commissioning of the cold/hot water system 1000 installed on site will now be described with reference to Fig. 3.

[0027]

An operator sets and inputs, by using the input device 130, an upper limit and a lower limit of a flow rate of water that passes through the water heat exchanger 50 while the pump 70 is driven. The controller 110 sets data representing an upper-limit set flow rate and a lower-limit set flow rate on the basis of signals from the input device 130 (step S1). In this case, the upper-limit set flow rate and the lower-limit set flow rate are the upper and lower limits of the flow rate of the water passing through the water heat exchanger 50, particularly in each chilling unit 100.

[0028]

Furthermore, the controller 110 determines whether an automatic commissioning mode is set (step S2). In response to determining that the automatic commissioning mode is not set, the controller 110 determines that a manual commissioning mode is set and then performs commissioning based on an operator instruction (step S4).

[0029]

In response to determining that the automatic commissioning mode is set, the controller 110 drives the pump 70 to start circulation of the water in the water circulation circuit 900 (step S3). The controller 110 operates the pump inverter drive 71 to increase a driving frequency of the pump 70 by a predetermined set amount and then calculates the difference between a detection value of the inlet water pressure sensor 170 and that of the outlet water pressure sensor 180 to calculate a flow rate of the water (step S5). The controller 110 determines whether the

calculated water flow rate is greater than or equal to the upper-limit set flow rate (step S6). In response to determining that the calculated water flow rate is not greater than or equal to the upper-limit set flow rate, the controller 110 returns to step S5, where the controller 110 operates the pump inverter drive 71 to increase the driving frequency of the pump 70 and drives the pump 70 until the controller determines that the calculated water flow rate is greater than or equal to the upper-limit set flow rate. In response to determining in step S6 that the calculated water flow rate is greater than or equal to the upper-limit set flow rate, the controller 110 determines, as an upper driving-frequency limit, a driving frequency of the pump 70 obtained at the determination in step S6 and stores data representing the upper driving-frequency limit in the memory device 120 (step S7).

[0030]

Then, the controller 110 operates the pump inverter drive 71 to reduce the driving frequency of the pump 70 by a predetermined set amount and then calculates the difference between a detection value of the inlet water pressure sensor 170 and that of the outlet water pressure sensor 180 to calculate a water flow rate (step S8). Then, the controller 110 determines whether the calculated water flow rate is less than or equal to the lower-limit set flow rate (step S9). In response to determining that the calculated water flow rate is not less than or equal to the lower-limit set flow rate, the controller 110 returns to step S8, where the controller 110 operates the pump inverter drive 71 to reduce the driving frequency of the pump 70 and drives the pump 70 until the controller determines that the calculated water flow rate is less than or equal to the lower-limit set flow rate. In response to determining in step S9 that the calculated water flow rate is less than or equal to the lower-limit set flow rate, the controller 110 determines, as a lower driving-frequency limit, a driving frequency of the pump 70 obtained at the determination in step S9 and stores data representing the lower driving-frequency limit in the memory device 120 (step S10). Then, the controller 110 terminates an operation in the automatic commissioning mode (step S11).

[0031]

As described above, in the commissioning of the cold/hot water system 1000 according to Embodiment 1, the controller 110 controls driving of the pump 70 and determines the upper driving-frequency limit and the lower driving-frequency limit of the pump 70 corresponding to the upper-limit set flow rate and the lower-limit set flow rate. Determining the upper driving-frequency limit of the pump 70 keeps the water from passing through the water heat exchanger 50 at a flow rate greater than or equal to the upper-limit set flow rate, thus reducing or eliminating an excessive inflow of water. This can reduce or eliminate unnecessary driving of the pump 70. This enables efficient operation of the cold/hot water system 1000. The controller 110 may determine at least one of the upper driving-frequency limit and the lower driving-frequency limit of the pump 70 on the basis of at least one of the upper-limit set flow rate and the lower-limit set flow rate.

[0032]

Furthermore, determining the lower driving-frequency limit of the pump 70 allows the water to flow through the water heat exchanger 50 at a flow rate greater than or equal to the lower-limit set flow rate, reducing or eliminating a lack of flow through the water heat exchanger 50. Thus, the pump 70 can be driven with less energy. In addition, setting the driving frequency of the pump 70 to be greater than or equal to the lower driving-frequency limit prevents the water heat exchanger 50 from partly freezing due to a reduction in water flow rate resulting from a transient change, thus preventing breakage of the water heat exchanger 50.

[0033]

Furthermore, for the cold/hot water system 1000 according to Embodiment 1, the controller 110 of the chilling unit 100 performs the automatic commissioning of the cold/hot water system 1000 installed on site. This can reduce operator workload including setting, mistakes due to human error, and construction costs.

[0034]

Embodiment 2.

The process, which is performed by the controller 110 in commissioning, of determining the upper driving-frequency limit and the lower driving-frequency limit of

the pump 70 has been described in Embodiment 1. For example, continuous operation of the chilling unit 100 causes, for example, the devices and the pipes in the water circulation circuit 900 to undergo erosion, corrosion, and contamination by impurities, for example. The contamination of the pipes increases resistance to flow of water in the water circulation circuit 900, so that the relationship between the driving frequency of the pump 70 and the flow rate of the water in the water circulation circuit 900 may differ from that obtained in commissioning. For example, if the water flow rate is low in relation to the driving frequency of the pump 70, the water may freeze in the water heat exchanger 50.

[0035]

Fig. 4 is a flowchart illustrating a process for adjustment of a driving frequency of a pump 70 in a normal operation of a cold/hot water system 1000 according to Embodiment 2 of the present disclosure. A process, which is performed by a controller 110, for automatic adjustment of a driving frequency of the pump 70 will now be described with reference to Fig. 4. The controller 110 determines whether an automatic adjustment mode is set (step S21). In response to determining that the automatic adjustment mode is not set, the controller 110 enters a manual mode in which an upper driving-frequency limit and a lower driving-frequency limit are adjusted based on operator instructions (step S22).

[0036]

In response to determining that the automatic adjustment mode is set, the controller 110 calculates the difference between a detection value of an inlet water pressure sensor 170 and that of an outlet water pressure sensor 180 to calculate a water flow rate (step S23). The controller 110 determines whether the calculated water flow rate is greater than or equal to an upper-limit set flow rate (step S24). In response to determining that the calculated water flow rate is greater than or equal to the upper-limit set flow rate, the controller 110 controls a pump inverter drive 71 to reduce a driving frequency of the pump 70 by a predetermined set amount and drives the pump (step S25). Then, the controller 110 resets the upper driving-frequency limit of the pump 70 at which the flow rate does not exceed the upper-limit set flow

rate and stores data representing the upper driving-frequency limit in the memory device 120 (step S26).

[0037]

In response to determining that the calculated water flow rate is not greater than or equal to the upper-limit set flow rate, the controller 110 determines whether the calculated water flow rate is less than or equal to a lower-limit set flow rate (step S27). In response to determining that the calculated water flow rate is less than or equal to the lower-limit set flow rate, the controller 110 controls the pump inverter drive 71 to increase the driving frequency of the pump 70 by a predetermined set amount and drives the pump (step S28). Then, the controller 110 resets the lower driving-frequency limit of the pump 70 at which the flow rate does not fall below the lower-limit set flow rate and stores data representing the lower driving-frequency limit in the memory device 120 (step S29). The controller 110 periodically repeats the above-described process at regular time intervals (step S30). Examples of the predetermined time interval include, but are not limited to, one week and one month.

[0038]

As described above, for the cold/hot water system 1000 according to Embodiment 2, the controller 110 performs the automatic adjustment process of adjusting the upper driving-frequency limit and the lower driving-frequency limit of the pump 70 in the automatic adjustment mode. This can adjust a difference in the relationship between the driving frequency of the pump 70 and the water flow rate in a water circulation circuit 900 resulting from, for example, erosion, corrosion, and contamination by impurities that, for example, the devices and the pipes in the water circulation circuit 900 undergo. Therefore, the pump 70 can be controlled such that the water flows through a water heat exchanger 50 at a flow rate ranging from the lower-limit set flow rate to the upper-limit set flow rate, allowing the water to pass through the water heat exchanger 50 without an excess or lack of water. This can prevent the water in the water heat exchanger 50 from freezing because of an insufficient flow rate and prevent breakage of the water heat exchanger. Furthermore, this can avoid excessive supply of the water to the water heat

exchanger 50 and reduce power supplied to the pump 70 accordingly, thus saving energy. This leads to improved overall efficiency of the cold/hot water system 1000.
[0039]

Embodiment 3.

5 In the foregoing Embodiment 1, the controller 110 in each chilling unit 100 sets the data representing the upper-limit set flow rate and the lower-limit set flow rate in the water circulation circuit 900 on the basis of the signals from the input device 130 in commissioning as described above. In Embodiment 3, the upper-limit set flow rate and the lower-limit set flow rate can be set based on a use for the cold/hot water system 1000. This case will be described below.

10 [0040]

For the cold/hot water system 1000, operation details, such as a necessary amount of heat, are often determined depending on a use associated with installation of the system. In a chilling unit 100 in Embodiment 3, a memory device 120 stores data sets related to settings of, for example, a refrigeration cycle apparatus 60 and a pump 70, for predetermined uses. An optimum site-specific system mode in which a process is performed with the data can be selected. When an operation in the optimum site-specific system mode is selected in commissioning, a controller 110 performs a process for the pump 70 on the basis of data, stored in the memory device 120, representing an upper-limit set flow rate and a lower-limit set flow rate associated with a further selected one of the uses.

15 [0041]

Fig. 5 is a flowchart illustrating a process for determination of a driving frequency of the pump 70 in commissioning of a cold/hot water system 1000 according to Embodiment 3 of the present disclosure. For steps in Fig. 5 designated by the same reference numbers as those in Fig. 1, the controller 110 performs the same steps as those described in Embodiment 1.

20 [0042]

An operator determines whether to select the optimum site-specific system mode for setting, and inputs a determination result by using an input device 130 (step

30

S0). When the controller 110 determines that the optimum site-specific system mode is selected, the controller 110 sets data representing an upper-limit set flow rate and a lower-limit set flow rate in a water circulation circuit 900 on the basis of a use selected from, for example, a menu listing uses (step S0A). In response to determining that the optimum site-specific system mode is not selected, the controller 110 sets data representing an upper-limit set flow rate and a lower-limit set flow rate in the water circulation circuit 900 on the basis of signals from the input device 130 (step S1).

[0043]

As described above, in the cold/hot water system 1000 according to Embodiment 3, data sets each representing the upper-limit set flow rate and the lower-limit set flow rate are previously set for the uses. Thus, proper flow rates can be readily set regardless of the skill of the operator, for example.

[0044]

Embodiment 4.

Fig. 6 is a diagram illustrating the configuration of a cold/hot water system 1000 according to Embodiment 4 of the present disclosure. In the foregoing Embodiment 1, the cold/hot water system 1000, which is a single-pump system, has been described as an example. The present disclosure is not limited to this example and can also be applied to the cold/hot water system 1000 as a dual-pump system illustrated in Fig. 6. In Fig. 6, for example, devices designated by the same reference signs as those in, for example, Fig. 1, are the same as those in the cold/hot water system 1000 described in Embodiment 1. In Embodiment 4, a water supply header pipe 200A, a water supply header pipe 200B, and a water supply header pipe 200C are separately arranged as a plurality of water supply header pipes 200. Furthermore, a water return header pipe 300A and a water return header pipe 300B are separately arranged as a plurality of water return header pipes 300.

[0045]

In Fig. 6, a secondary pump 800A and a secondary pump 800B each pressurize water flowing from chilling units 100 and send the water to load side units

500. It is assumed herein that the secondary pumps 800A and 800B are, but not particularly limited to, fixed-capacity pumps. A differential pressure regulating valve 810 is a valve that regulates a flow rate of water to be sent to the load side units 500. [0046]

5 As described above, each controller 110 in the cold/hot water system 1000, which is configured as a dual-pump system, according to Embodiment 4 can perform the process of determining an upper driving-frequency limit and a lower driving-frequency limit of a pump 70 in commissioning and then perform the automatic adjustment process.

10 [0047]

Embodiment 5.

Fig. 7 is a diagram illustrating the configuration of a chilling unit 100 in a cold/hot water system 1000 according to Embodiment 5 of the present disclosure. In the foregoing Embodiment 1, each chilling unit 100 has a single refrigerant circuit. In 15 Embodiment 5, the chilling unit 100 includes a plurality of refrigeration cycle apparatuses 60 and has a configuration in which refrigerant circuits are connected in parallel with a water circulation circuit 900. Referring to Fig. 6, two refrigeration cycle apparatuses 60A and 60B are connected in parallel with the water circulation circuit 900.

20 [0048]

As illustrated in Fig. 7, the chilling unit 100 in Embodiment 4 includes the refrigeration cycle apparatus 60A and the refrigeration cycle apparatus 60B. The refrigeration cycle apparatus 60A includes a compressor 10A, a compressor inverter drive 11A, a four-way valve 20A, an air heat exchanger 30A, an expansion valve 40A, 25 and a water heat exchanger 50A, which form a refrigerant circuit. The refrigeration cycle apparatus 60A further includes a fan 31A. The refrigeration cycle apparatus 60B includes a compressor 10B, the compressor inverter drive 11A, a four-way valve 20B, an air heat exchanger 30B, an expansion valve 40B, and a water heat exchanger 50B, which form a refrigerant circuit. The refrigeration cycle apparatus 30 60B further includes a fan 31B. For operations of these devices, for example, the

operations are the same as those performed by the devices designated by the same reference signs with no letters described in Embodiment 1.

[0049]

The chilling unit 100 in Embodiment 5 includes an inlet water temperature sensor 150 and an inlet water pressure sensor 170 arranged at positions where the temperature and pressure of water entering the water heat exchanger 50A are detected and further includes an outlet water temperature sensor 160 and an outlet water pressure sensor 180 arranged at positions where the temperature and pressure of water leaving the water heat exchanger 50B are detected. Therefore, an upper driving-frequency limit and a lower driving-frequency limit of a pump 70 can be set to cause the water to pass through both the water heat exchanger 50A and the water heat exchanger 50B at a flow rate ranging from a lower-limit set flow rate to an upper-limit set flow rate.

[0050]

As described above, for the cold/hot water system 1000 according to Embodiment 5, the upper driving-frequency limit and the lower driving-frequency limit of the pump 70 can be set in the chilling unit 100 including the multiple refrigeration cycle apparatuses 60 connected in parallel.

[0051]

Embodiment 6.

Although each chilling unit 100 includes the pump 70 in the foregoing Embodiments 1 to 5 as described above, any other configuration may be used. The pump 70 may be a device separate from the chilling unit 100 in the cold/hot water system 1000.

[0052]

Furthermore, although each of the refrigeration cycle apparatuses 60 included in the chilling units 100 in the foregoing Embodiments 1 to 5 heats or cools the water in the water circulation circuit 900 as described above, any other configuration may be used. Another heating or cooling device may be used as a heat source side unit.

[0053]

In addition, although each of the refrigeration cycle apparatuses 60 in the chilling units 100 in the foregoing Embodiments 1 to 5 includes the four-way valve 20 to switch between heating and cooling of the water in the water heat exchanger 50, any other configuration may be used. The chilling unit 100 may be dedicated for heating or cooling.

[0054]

Furthermore, the process, which is performed by the controller 110, for automatic adjustment of the driving frequencies of the pump 70 described in Embodiment 2 can be performed in the configuration of each of the chilling units 100 in the foregoing Embodiments 4 and 5.

Reference Signs List

[0055]

10, 10A, 10B compressor 11, 11A, 11B compressor inverter drive 20, 20A, 20B four-way valve 30, 30A, 30B air heat exchanger 31, 31A, 31B fan 40, 40A, 40B expansion valve 50, 50A, 50B water heat exchanger 60, 60A, 60B refrigeration cycle apparatus 70 pump 71 pump inverter drive 100, 100A, 100B, 100C chilling unit 110 controller 111 operation control device 112 pump flow rate determination device 120 memory device 130 input device 150 inlet water temperature sensor 160 outlet water temperature sensor 170 inlet water pressure sensor 180 outlet water pressure sensor 200, 200A, 200B, 200C water supply header pipe 300, 300A, 300B water return header pipe 400 bypass pipe 410 bypass valve 500, 500A, 500B, 500C load side unit 510, 510A, 510B, 510C load side heat exchanger 600, 600A, 600B, 600C two-way valve 700 tank 800A, 800B secondary pump 810 differential pressure regulating valve 900 water circulation circuit 1000 cold/hot water system

CLAIMS

[Claim 1]

A chilling unit that heats or cools a heat medium, serving as a medium to carry heat, and circulates the heat medium through a heat medium circulation circuit to supply heat to a heat load, the chilling unit comprising:

a pump having a pump inverter drive and configured to pressurize the heat medium;

a heat source side unit including a heat medium heat exchanger and configured to heat or cool the heat medium; and

a controller configured to set, based on at least one of an upper-limit set flow rate and a lower-limit set flow rate of the heat medium passing through the heat medium heat exchanger, at least one of an upper driving-frequency limit and a lower driving-frequency limit of the pump.

[Claim 2]

The chilling unit of claim 1, wherein the heat source side unit is a refrigeration cycle apparatus having a refrigerant circuit, through which refrigerant circulates, including a compressor, an air heat exchanger, an expansion valve, and the heat medium heat exchanger connected by pipes.

[Claim 3]

The chilling unit of claim 1 or 2, further comprising:

a heat medium pressure sensor configured to detect a pressure of the heat medium entering and leaving the heat medium heat exchanger,

wherein the controller sets, based on a flow rate of the heat medium flowing through the heat medium heat exchanger calculated from the pressure detected by the heat medium pressure sensor, the upper driving-frequency limit and the lower driving-frequency limit.

[Claim 4]

The chilling unit of any one of claims 1 to 3, wherein the controller automatically performs, in commissioning of the heat medium circulation circuit, a process comprising: increasing a driving frequency of the pump to circulate the heat medium

through the heat medium circulation circuit; setting, to the upper driving-frequency limit, the driving frequency of the pump at which the heat medium flows at a flow rate greater than or equal to the upper-limit set flow rate; reducing the driving frequency of the pump to circulate the heat medium through the heat medium circulation circuit; and setting, to the lower driving-frequency limit, the driving frequency of the pump at which the heat medium flows at a flow rate less than or equal to the lower-limit set flow rate.

[Claim 5]

The chilling unit of any one of claims 1 to 4, wherein, during operation of the heat medium circulation circuit, the controller periodically performs, at regular time intervals, a process comprising: in response to determining that a flow rate of the heat medium passing through the heat medium heat exchanger is greater than the upper-limit set flow rate, reducing a driving frequency of the pump to reset, to the upper driving-frequency limit, the driving frequency of the pump obtained when determining that the flow rate is less than or equal to the upper-limit set flow rate; and, in response to determining that the flow rate of the heat medium passing through the heat medium heat exchanger is less than the lower-limit set flow rate, increasing the driving frequency of the pump to reset, to the lower driving-frequency limit, the driving frequency of the pump obtained when determining that the flow rate is less than or equal to the lower-limit set flow rate.

[Claim 6]

The chilling unit of any one of claims 1 to 5, further comprising:

a memory device configured to store data sets, each representing the upper-limit set flow rate and the lower-limit set flow rate, for uses of the chilling unit,

wherein the controller sets, based on the upper-limit set flow rate and the lower-limit set flow rate for a selected one of the uses, the upper driving-frequency limit and the lower driving-frequency limit of the pump.

[Claim 7]

A cold/hot water system comprising:

a plurality of the chilling units of any one of claims 1 to 6;

a load side unit configured to supply heat to a heat load through heat exchange with a heat medium;

5 a water supply header pipe with which the plurality of the chilling units are connected in parallel and through which streams of the heat medium heated or cooled by and flowing from the plurality of the chilling units are caused to join and the heat medium is then supplied to the load side unit; and

a water return header pipe with which the plurality of the chilling units are connected in parallel and through which the heat medium flowing from the load side unit is distributed to the plurality of the chilling units,

10 the plurality of the chilling units, the load side unit, the water supply header pipe, and the water return header pipe being connected to form a heat medium circulation circuit.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2019/001460

A. CLASSIFICATION OF SUBJECT MATTER Int.Cl. F25B49/02 (2006.01) i, F24F5/00 (2006.01) i According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) Int.Cl. F25B49/02, F24F5/00 Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Published examined utility model applications of Japan 1922-1996 Published unexamined utility model applications of Japan 1971-2019 Registered utility model specifications of Japan 1996-2019 Published registered utility model applications of Japan 1994-2019 Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	JP 2014-35101 A (DAIKIN INDUSTRIES, LTD.) 24 February 2014, paragraphs [0010]-[0011], [0026]-[0028], [0080], [0082], [0087], [0093], [0094], [0096], fig. 1-2 (Family: none)	1 1-3, 5-7
Y	JP 2017-48972 A (EBARA REFRIGERATION EQUIPMENT & SYSTEMS CO., LTD., EAST JAPAN RAILWAY COMPANY) 09 March 2017, paragraph [0038] (Family: none)	1-3, 5-7
Y	JP 2006-250443 A (SHIN NIPPON AIR TECHNOLOGIES CO., LTD.) 21 September 2006, paragraph [0006] (Family: none)	1-3, 5-7
A	JP 2014-126234 A (DAIKIN INDUSTRIES, LTD., DAIKIN APPLIED SYSTEMS CO., LTD.) 07 July 2014, paragraphs [0137], [0163] (Family: none)	1-7
A	JP 2012-112557 A (MITSUBISHI ELECTRIC CORP.) 14 June 2012, abstract (Family: none)	1-7
A	JP 2015-114074 A (ORION MACHINERY CO., LTD.) 22 June 2015, paragraph [0033] (Family: none)	1-7
A	JP 2015-114075 A (ORION MACHINERY CO., LTD.) 22 June 2015, paragraphs [0035]-[0036] (Family: none)	1-7
<input type="checkbox"/> Further documents are listed in the continuation of Box C. <input type="checkbox"/> See patent family annex.		
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Date of the actual completion of the international search 02 April 2019 (02.04.2019)		Date of mailing of the international search report 16 April 2019 (16.04.2019)
Name and mailing address of the ISA/ Japan Patent Office 3-4-3, Kasumigaseki, Chiyoda-ku, Tokyo 100-8915, Japan		Authorized officer Telephone No.