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(54) **AIR CONDITIONING SYSTEM AND METHOD FOR CONTROLLING AIR CONDITIONING SYSTEM**

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See application file for complete search history.

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(57) **ABSTRACT**

An air conditioning system and a method for controlling an air conditioning system are provided. The air conditioning system determines loads for each indoor unit of a plurality of indoor units considering capacities of the plurality of indoor units, and a length of an indoor unit pipe connected from a pump to each indoor unit, and maps the plurality of indoor units and a plurality of pumps based on the determined loads.

11 Claims, 12 Drawing Sheets

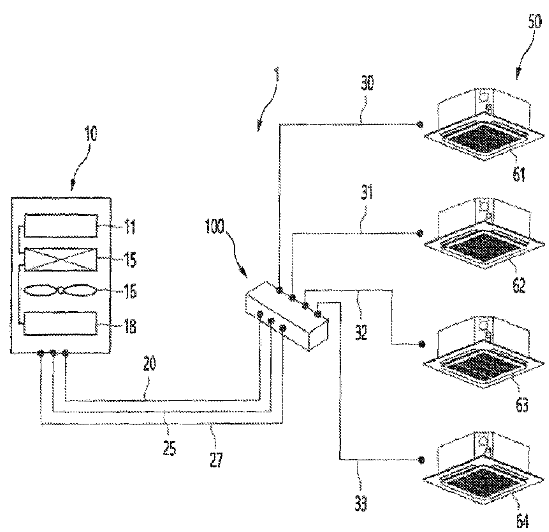

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Fig. 1

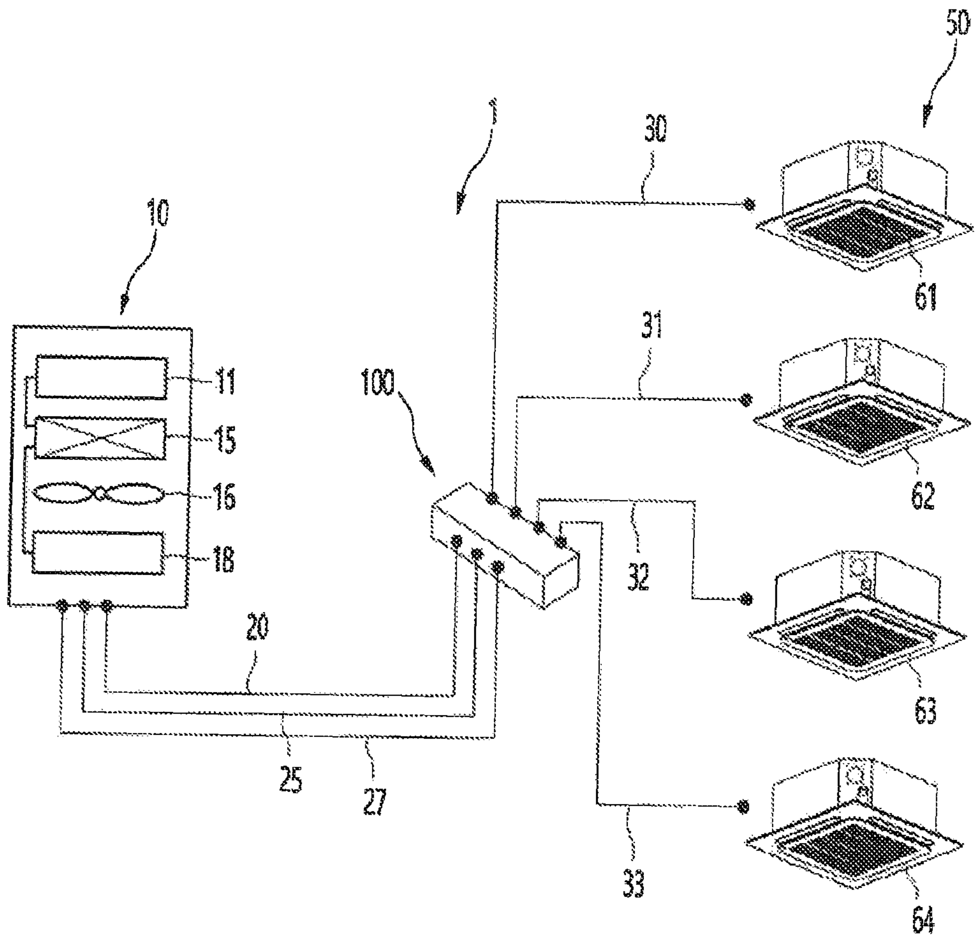


Fig. 2

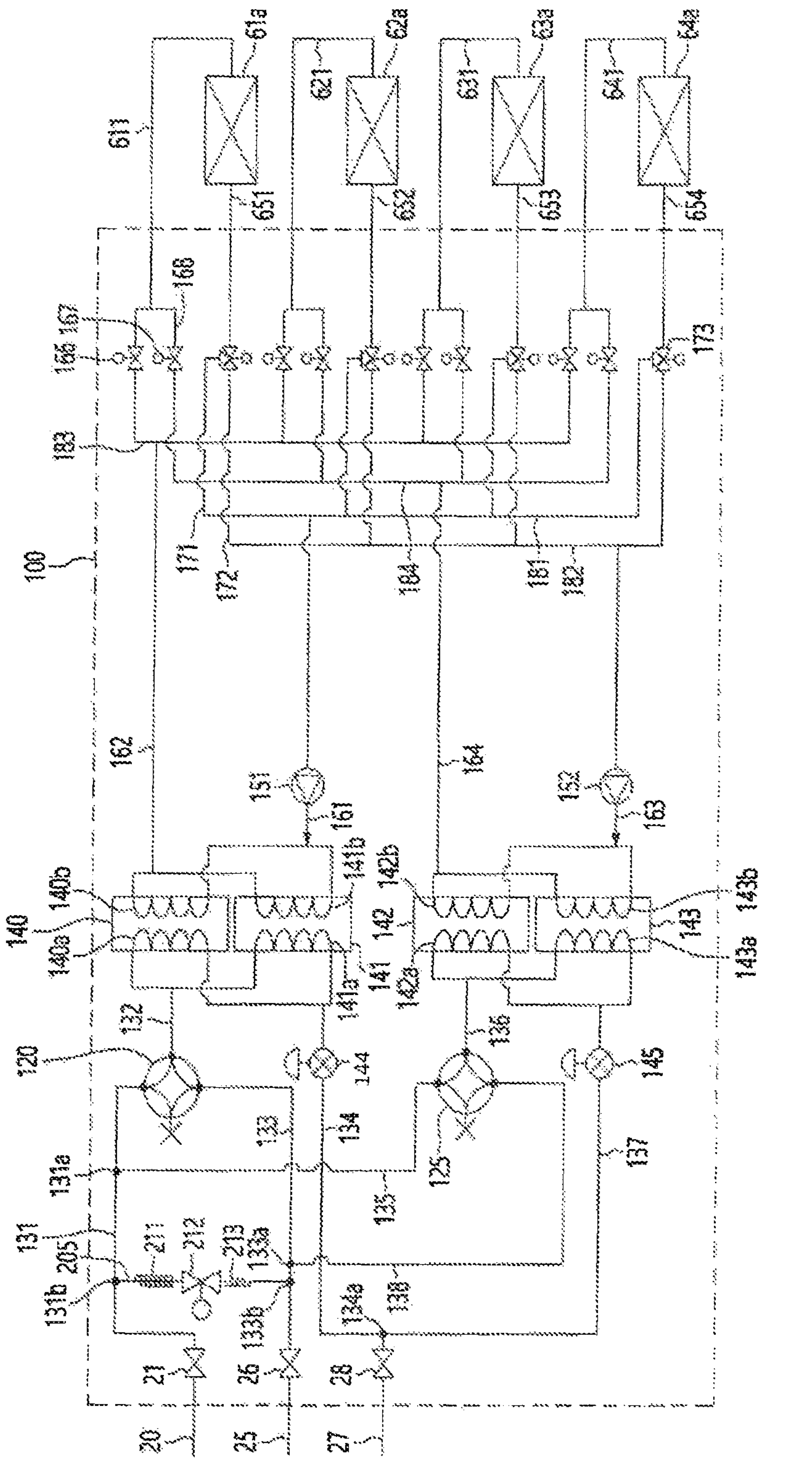

61a
62a
63a
64a
611
621
631
641
651
652
653
654
166
167
168
173
183
100
171
172
184
181
182
162
151
161
164
152
163
140
140a
140b
141
141a
141b
142
142a
142b
143
143a
143b
120
132
144
136
145
131a
133
134
125
135
137
131
205
211
212
213
133a
131b
133b
138
134a
21
26
28
20
25
27

Fig. 3

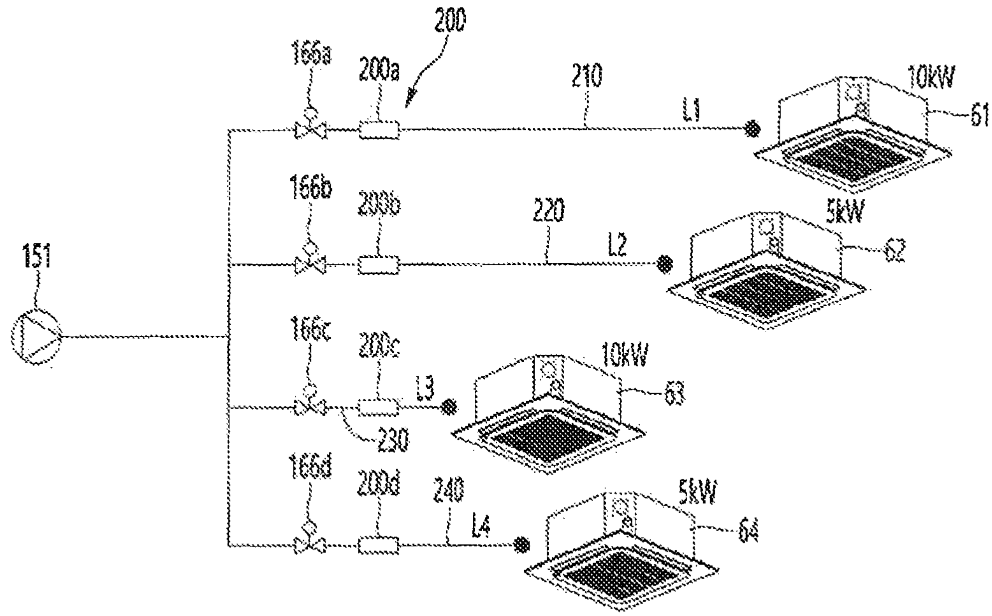

200
166a
200a
210
10kW
L1
61
166b
200b
220
5kW
L2
62
151
166c
200c
10kW
L3
63
230
166d
200d
240
5kW
L4
64

Fig. 4A

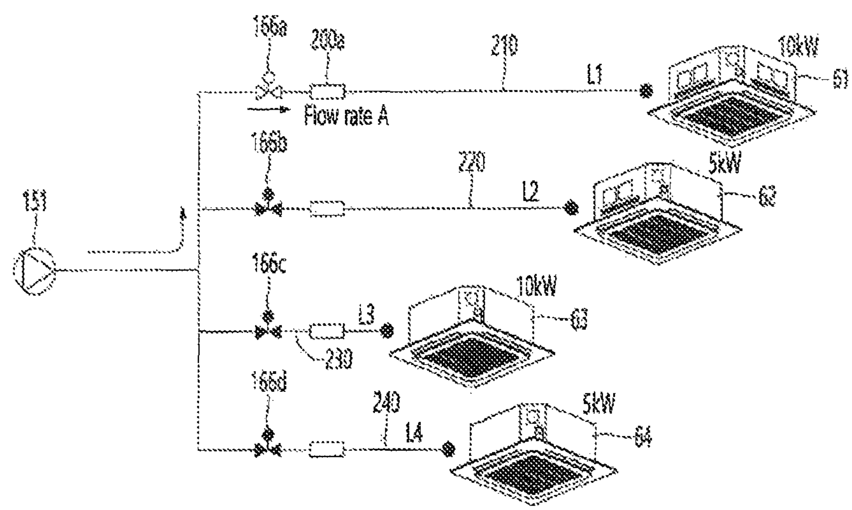

166a
200a
210
10kW
L1
61
Flow rate A
166b
220
5kW
L2
62
151
166c
10kW
L3
63
230
166d
240
5kW
L4
64

Fig. 4B

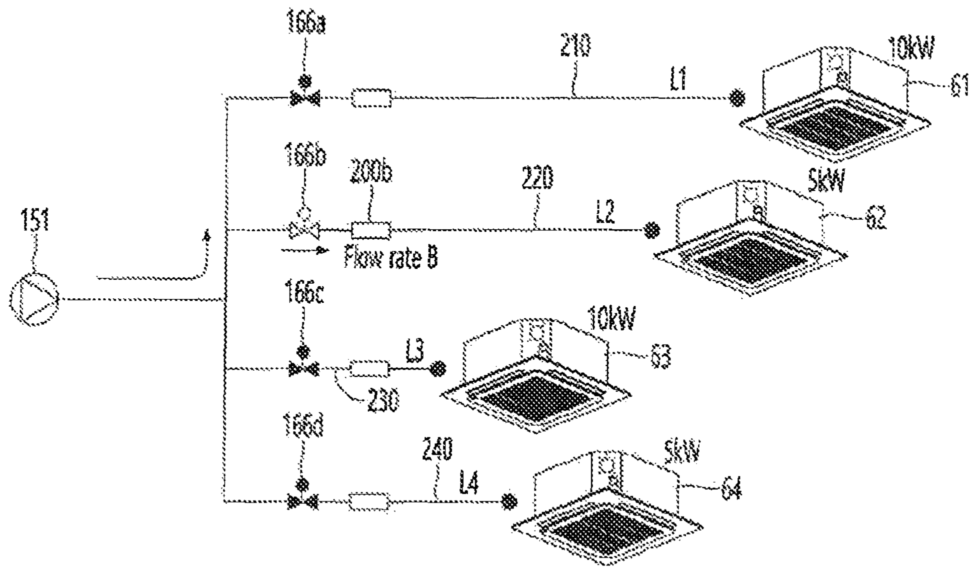

166a
210
L1
10kW
61
166b
200b
220
L2
5kW
62
151
Flow rate B
166c
10kW
L3
63
230
166d
240
L4
5kW
64

Fig. 4C

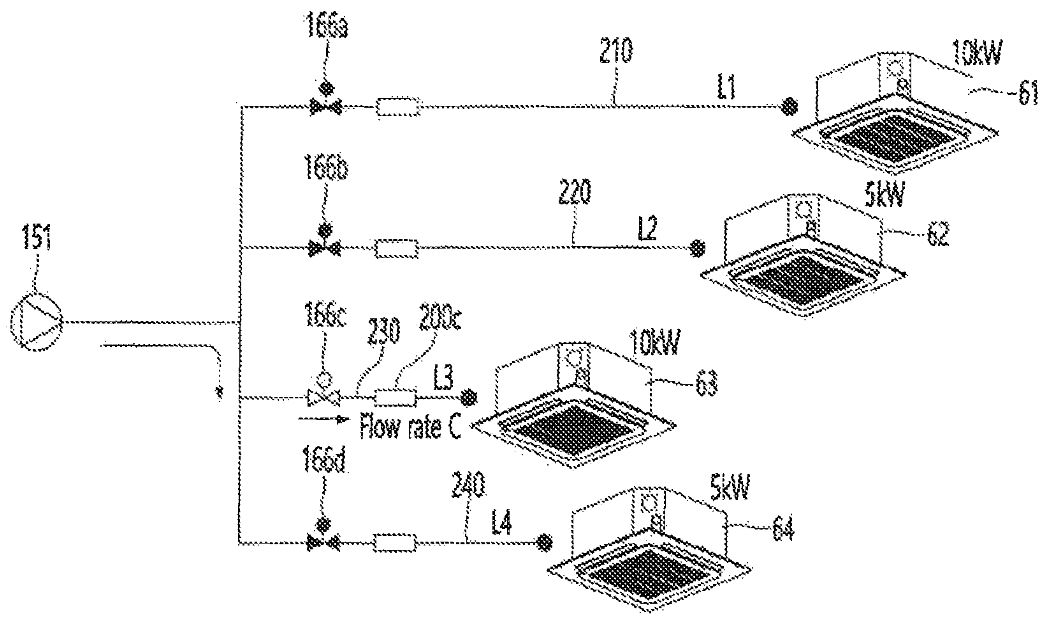

166a
210
L1
10kW
61
166b
220
L2
5kW
62
151
166c
230
200c
L3
10kW
63
Flow rate C
166d
240
L4
5kW
64

Fig. 4D

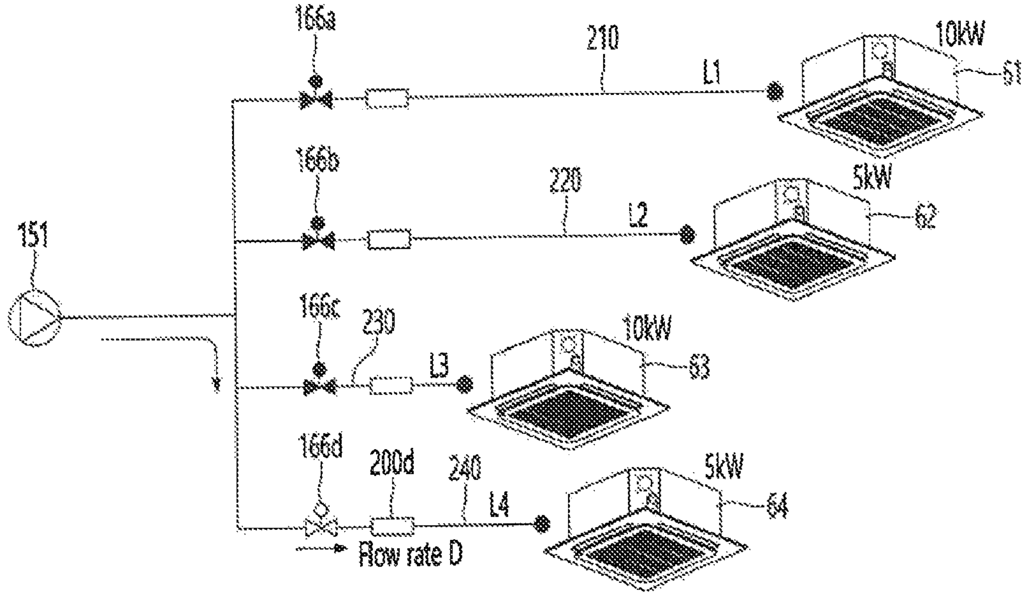

166a
210
10kW
L1
61
166b
220
5kW
L2
62
151
166c
230
10kW
L3
63
166d
200d
240
5kW
L4
64
Flow rate D

Fig. 5

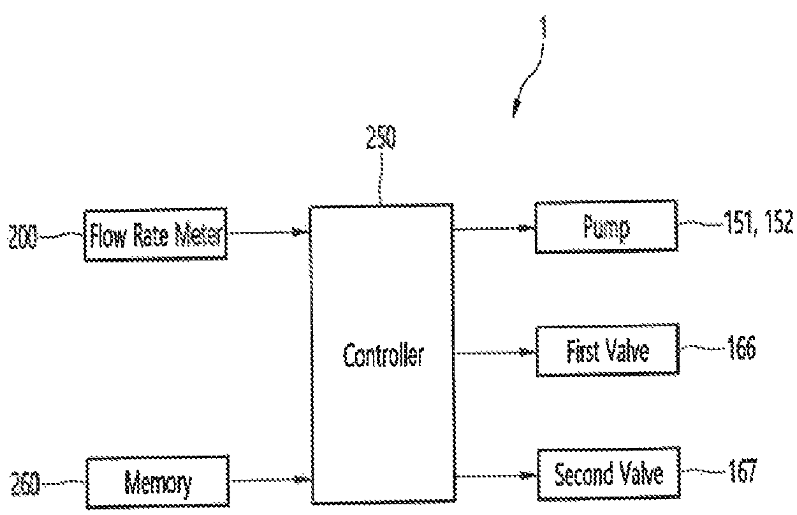

1
250
200
Flow Rate Meter
Controller
Pump
151, 152
First Valve
166
260
Memory
Second Valve
167

Fig. 6

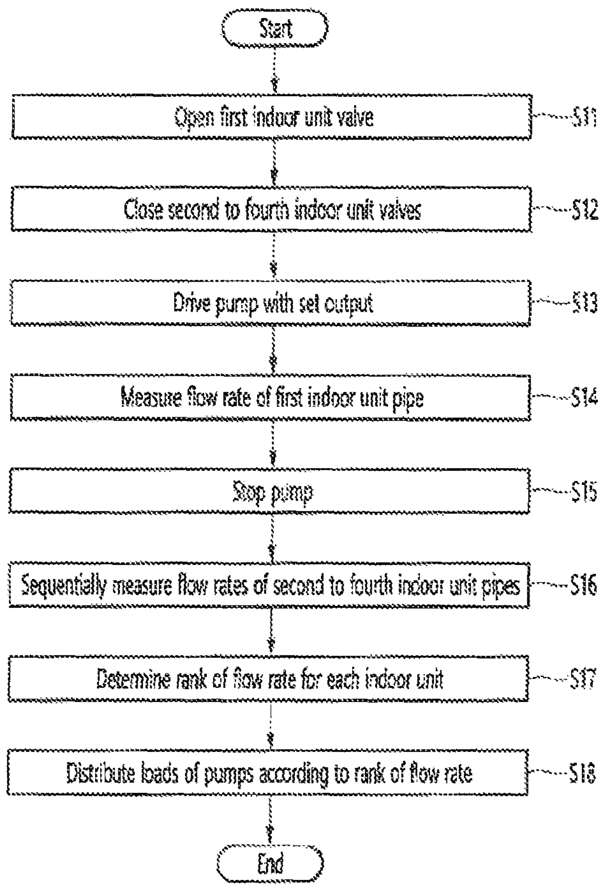

Start
Open first indoor unit valve
S11
Close second to fourth indoor unit valves
S12
Drive pump with set output
S13
Measure flow rate of first indoor unit pipe
S14
Stop pump
S15
Sequentially measure flow rates of second to fourth indoor unit pipes
S16
Determine rank of flow rate for each indoor unit
S17
Distribute loads of pumps according to rank of flow rate
S18
End

Fig. 7

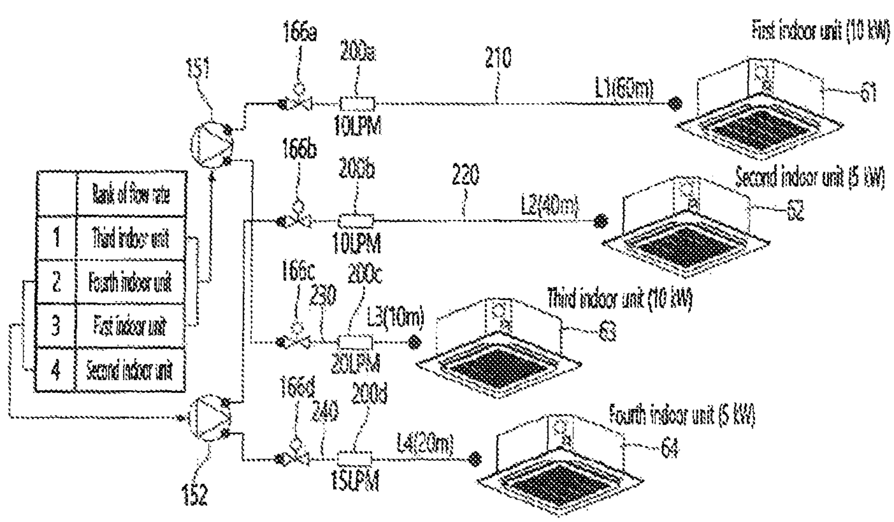
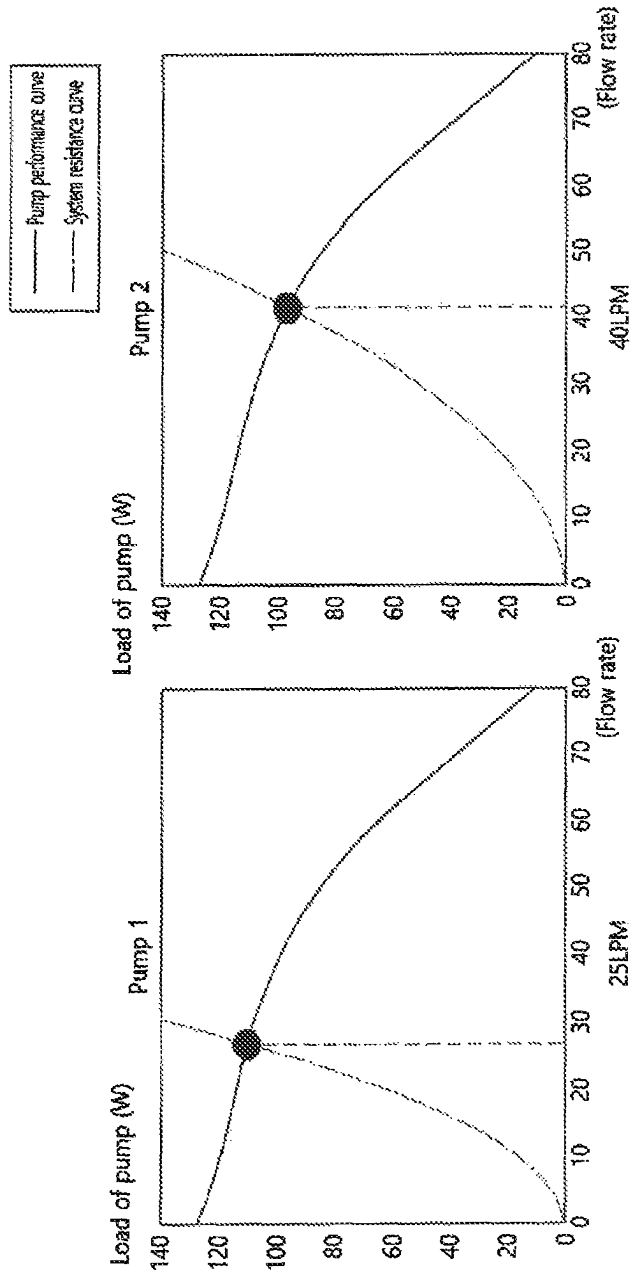

First indoor unit (10 kW)
61
Second indoor unit (5 kW)
62
Third indoor unit (10 kW)
63
Fourth indoor unit (5 kW)
64
151
152
166a
166b
166c
166d
200a
200b
200c
200d
210
220
230
240
L1(60m)
L2(40m)
L3(10m)
L4(20m)
10LPM
10LPM
20LPM
15LPM
Rank of flow rate
1 Third indoor unit
2 Fourth indoor unit
3 First indoor unit
4 Second indoor unit

Fig. 8A



Pump performance curve
System resistance curve
Pump 1
Pump 2
Load of pump (W)
Load of pump (W)
140
120
100
80
60
40
20
0
0
10
20
30
40
50
60
70
80
(Flow rate)
25LPM
40LPM

Fig. 8B

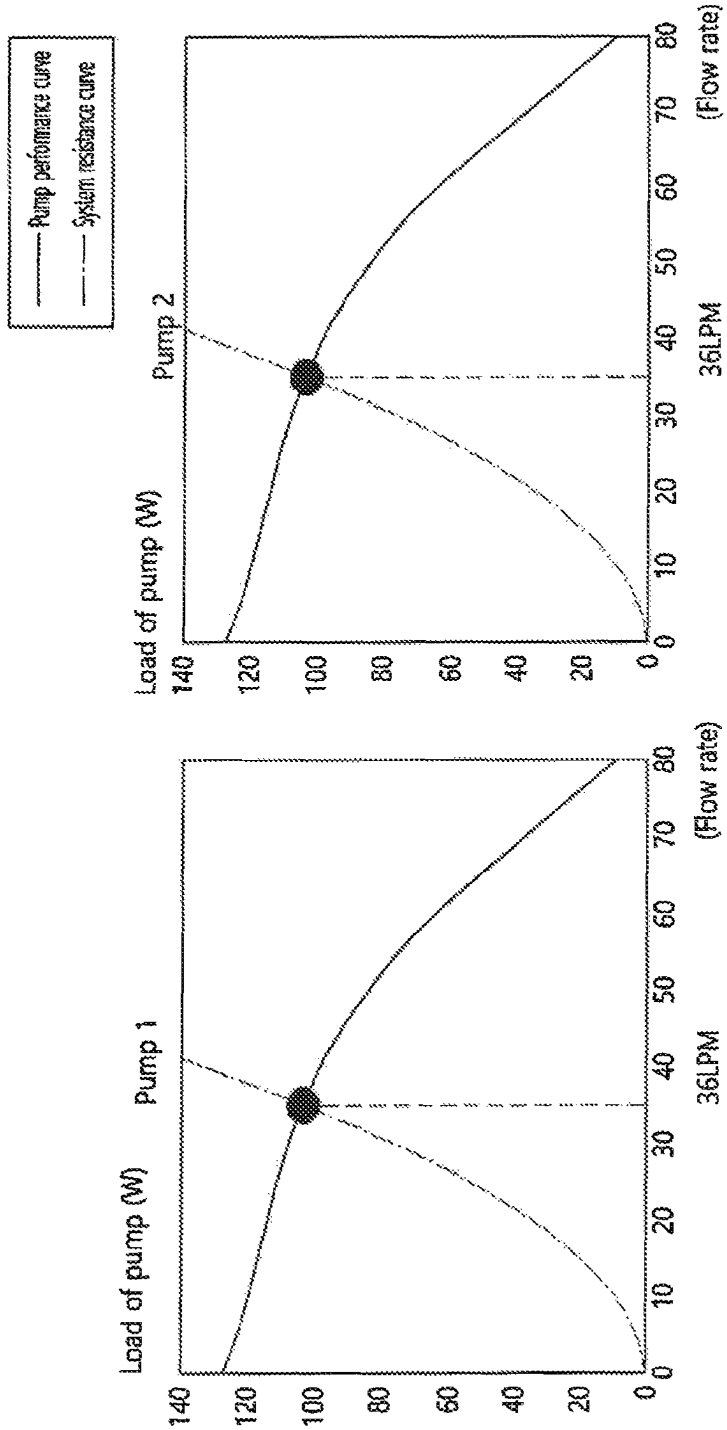

Pump performance curve
System resistance curve
Pump 1
Pump 2
Load of pump (W)
Load of pump (W)
140
120
100
80
60
40
20
0
0
10
20
30
40
50
60
70
80
36LPM
36LPM
(Flow rate)
(Flow rate)

Fig. 9

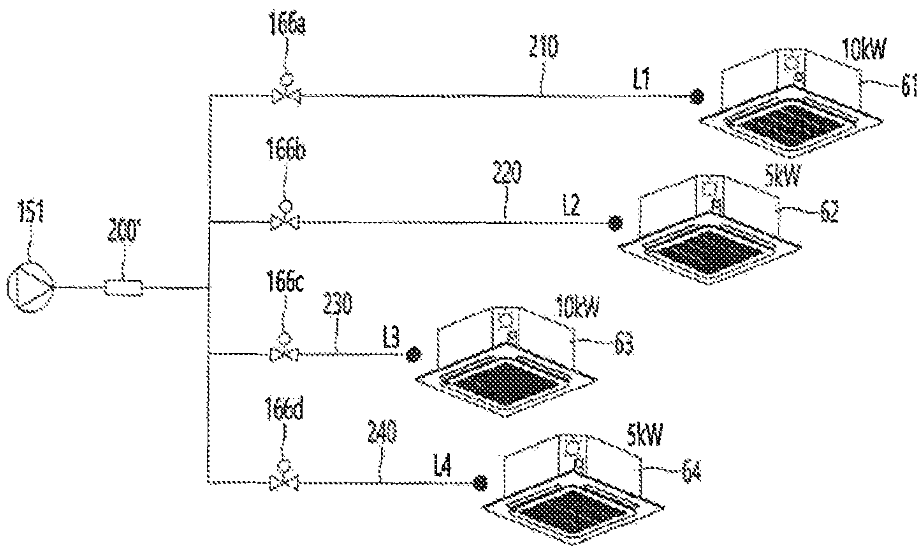

166a
210
L1
10kW
61
166b
220
L2
5kW
62
151
200'
166c
230
L3
10kW
63
166d
240
L4
5kW
64

Fig. 10

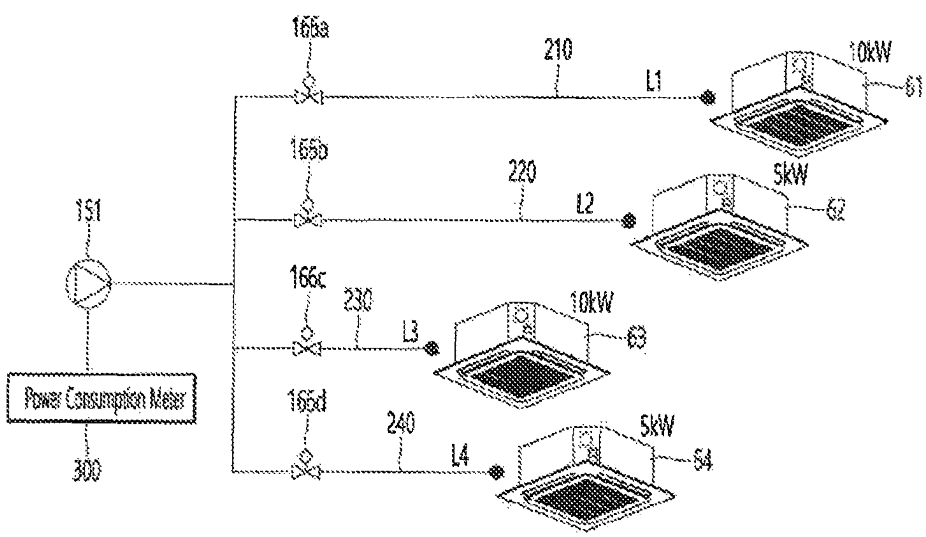

165a
210
L1
10kW
61
165b
220
L2
5kW
62
151
166c
230
L3
10kW
63
Power Consumption Meter
165d
240
L4
5kW
64
300

Fig. 11A

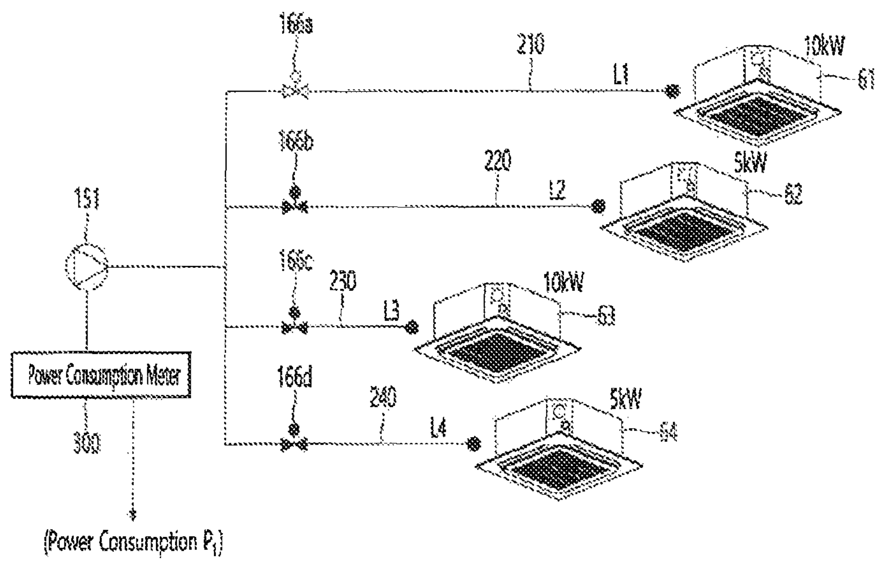


Fig. 11B

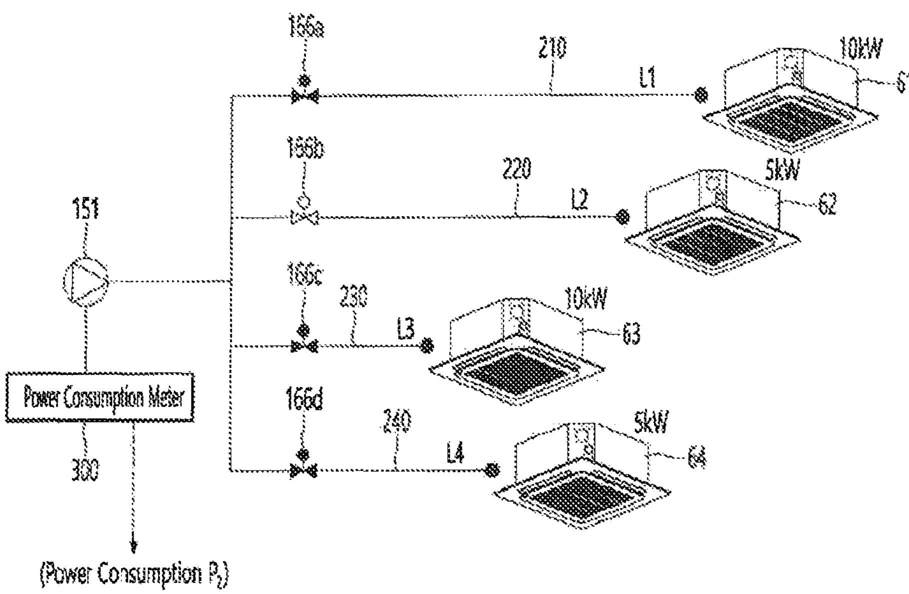


Fig. 11C

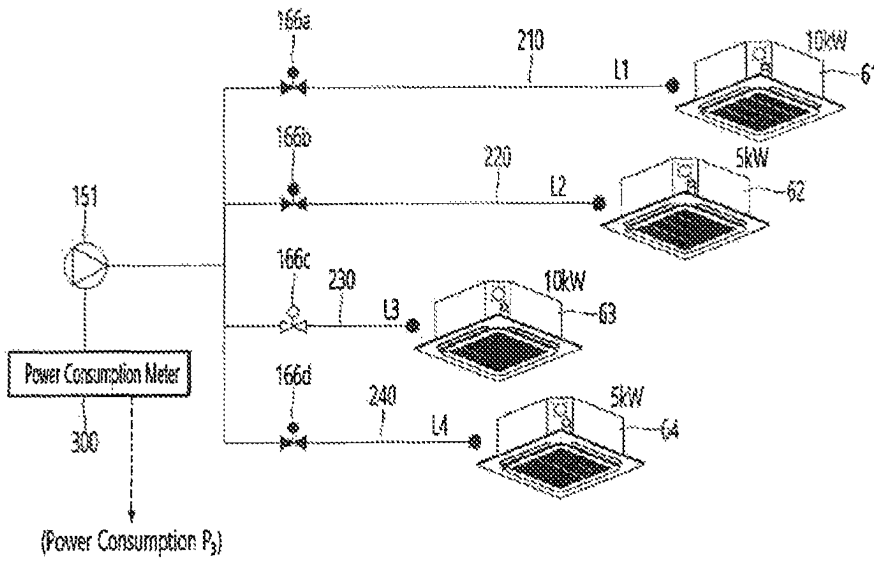


Fig. 11D

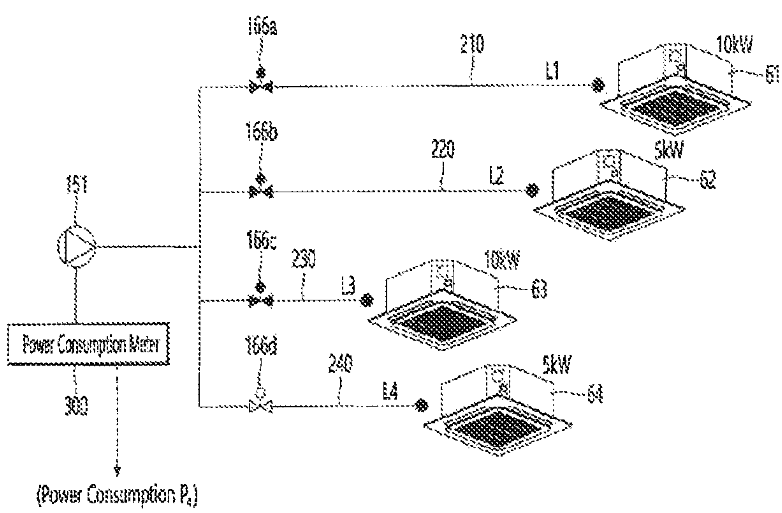


Fig. 12

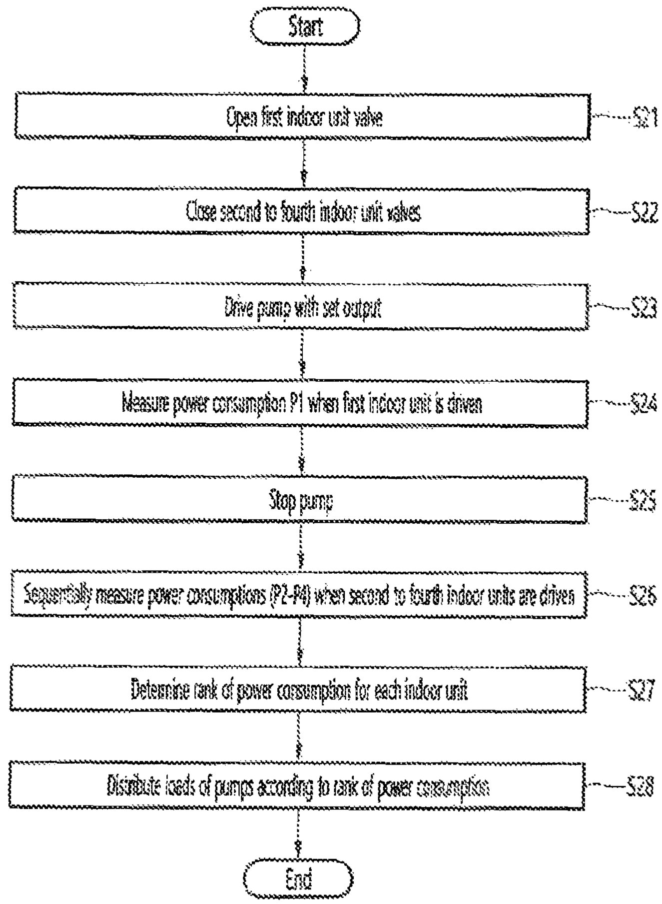
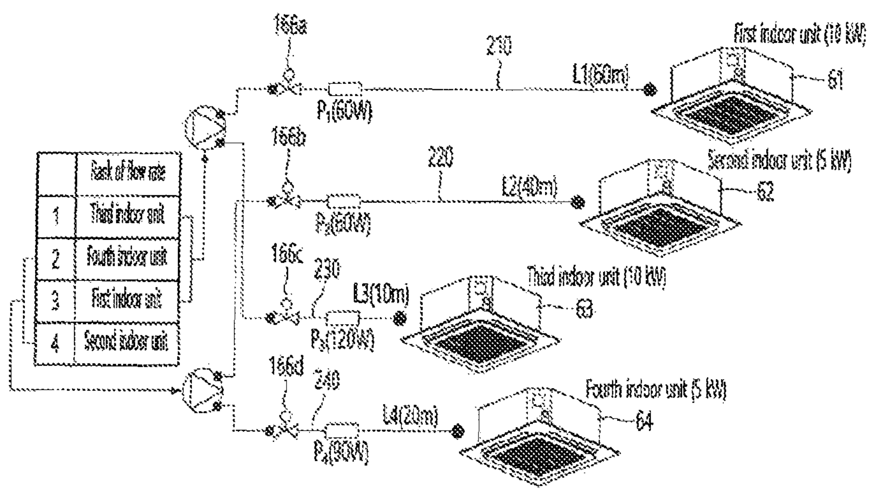

Start
Open first indoor unit valve
S21
Close second to fourth indoor unit valves
S22
Drive pump with set output
S23
Measure power consumption P1 when first indoor unit is driven
S24
Stop pump
S25
Sequentially measure power consumptions (P2-P4) when second to fourth indoor units are driven
S26
Determine rank of power consumption for each indoor unit
S27
Distribute loads of pumps according to rank of power consumption
S28
End

Fig. 13


166a
210
L1(60m)
First indoor unit (10 kW)
61
P1(60W)
166b
220
L2(40m)
Second indoor unit (5 kW)
62
P2(60W)
Rank of flow rate
1 Third indoor unit
2 Fourth indoor unit
3 First indoor unit
4 Second indoor unit
166c
230
L3(10m)
Third indoor unit (10 kW)
63
P3(120W)
166d
240
L4(20m)
Fourth indoor unit (5 kW)
64
P4(90W)

AIR CONDITIONING SYSTEM AND METHOD FOR CONTROLLING AIR CONDITIONING SYSTEM

CROSS-REFERENCE TO RELATED PATENT APPLICATIONS

This application is a U.S. National Stage Application under 35 U.S.C. § 371 of PCT Application No. PCT/KR2020/011420, filed Aug. 26, 2020, which claims priority to Korean Patent Application No. 10-2020-0010248, filed Jan. 29, 2020, whose entire disclosures are hereby incorporated by reference.

TECHNICAL FIELD

The present disclosure relates to an air conditioning system and a method for controlling the same.

BACKGROUND ART

An air conditioning apparatus is an apparatus for maintaining air in a predetermined space in the most suitable state according to the usage and purpose. Generally, the air conditioning apparatus includes a compressor, a condenser, an expansion device, and an evaporator. A refrigeration cycle that performs compression, condensation, expansion, and evaporation processes of a refrigerant is driven to cool or heat the predetermined space.

When the air conditioning apparatus performs a cooling operation, an outdoor heat exchanger provided in an outdoor unit functions as a condenser, and an indoor heat exchanger provided in an indoor unit functions as an evaporator. Meanwhile, when the air conditioning apparatus performs a heating operation, the indoor heat exchanger functions as a condenser, and the outdoor heat exchanger functions as an evaporator.

Recently, there has been a tendency to limit the type of refrigerant used in the air conditioning apparatus and reduce the amount of refrigerant used in accordance with the environmental regulation policy.

In order to reduce the amount of refrigerant used, a technique for performing cooling or heating by performing heat exchange between a refrigerant and a predetermined fluid has been proposed. For example, the predetermined fluid may include water.

US Patent Publication No. 2016-0245561 A1 (published date: Aug. 25, 2016, entitled "Refrigeration Cycle Mechanism) as the prior art document discloses an air conditioning apparatus that performs cooling or heating through heat exchange between a refrigerant and water.

Specifically, the air conditioning apparatus disclosed in the prior art document determines the capacity of a plurality of indoor units connected to a distributor and distributes loads to a plurality of pumps provided in the distributor, based on the determined capacity.

However, in the case of the above prior art document, the loads are distributed to the pumps considering only the capacity of the plurality of indoor units, and installation conditions for each indoor unit that may affect the loads of the pumps, for example, lengths of indoor unit pipes or pipe accessories, may not considered. Therefore, the loads may not be evenly distributed to the pumps.

DISCLOSURE OF INVENTION

Technical Problem

The present disclosure has been made in an effort to solve the above problems, and an object of the present disclosure is to provide an air conditioning system that is provided with a plurality of pumps to forcibly circulate water to a plurality of indoor units, wherein the load for each pump is evenly distributed considering installation conditions of the plurality of indoor units, thereby securing the load capability of the system and reducing the power consumption.

In addition, an object of the present disclosure is to provide an air conditioning system that is provided with a measurement device for measuring the capacity of circulating water for each indoor unit in order to evenly distribute the load of the pump, and determines the loads of the indoor units.

In another example, an object of the present disclosure is to provide an air conditioning system that is provided with a measurement device for measuring the power consumption for each indoor unit in order to evenly distribute the load of the pump, and determines the loads of the indoor units.

Furthermore, an object of the present disclosure is to provide an air conditioning system capable of determining ranks of indoor units by using values measured by the measurement device and mapping a plurality of pumps and a plurality of indoor units by using the determined ranks of the indoor units.

Solution to Problem

An air conditioning system according to an embodiment of the present disclosure may determine loads for each indoor unit considering the capacities of indoor units, length of an indoor unit pipe connected from a pump to the indoor unit, and the like, and may map a plurality of indoor units and a plurality of pumps based on the determined loads.

For example, a measurement device is provided to measure a flow rate of water circuiting the indoor unit when a pump is connected to a plurality of indoor units one by one and the pump is operated with a set output in order to determine loads for each indoor unit.

As another example, a measurement device is provided to measure power consumption of a pump when a pump is connected to a plurality of indoor units one by one and the pump is operated with a set output in order to determine loads for each indoor unit.

Based on the determined loads for each indoor unit, an indoor unit having a largest load and an indoor unit having a smallest load are mapped to a first pump, and indoor units having a middle load are mapped to a second pump, thereby evenly distributing the loads to the first and second pumps.

As a result, the capacity of water circulating the first pump and the capacity of water circulating the second pump are formed similarly. Therefore, the operation efficiency of the system is improved and the malfunction of the pump is prevented, thereby securing the durability of the system.

According to one aspect of the present disclosure, an air conditioning system includes an outdoor unit through which a refrigerant circulates, the outdoor unit including a compressor and an outdoor heat exchanger, a plurality of indoor units to which water is supplied, a heat exchanger configured to perform heat exchange between the refrigerant and the water, an indoor unit pipe connecting the heat exchanger to the indoor unit, the indoor unit pipe being configured to guide the circulation of the water in the heat exchanger and the indoor unit, a plurality of pumps installed in the indoor unit pipe to forcibly circulate the water, and an indoor unit load measurement device configured to, when the plurality of indoor units are mapped to the plurality of pumps, measure loads of the plurality of indoor units based on capacities of the plurality of indoor units and length of the indoor unit pipe.

The indoor unit load measurement device may be installed in the indoor unit pipe and may include a flow rate meter configured to measure a flow rate of water circulating the pump and the indoor unit.

The air conditioning system may further include a controller configured to determine the load of the indoor unit based on the flow rate measured by the flow rate meter.

The controller may be configured to determine ranks of flow rates measured for the plurality of indoor units and determine mapping of the plurality of pumps and the plurality of indoor units according to the determined ranks.

The controller may be configured to map, to a first pump, two indoor units corresponding to a highest rank and a lowest rank among the measured ranks of the flow rates, and map, to a second pump, two different indoor units corresponding to a middle rank among the measured ranks of the flow rates.

The flow rate meter may be provided with a plurality of flow rate meters, and the plurality of flow rate meters may be respectively installed in a plurality of indoor unit pipes connected to the plurality of indoor units.

The indoor unit load measurement device may include a power consumption meter electrically connected to the pump and configured to measure power consumption output by the pump.

The air conditioning system may further include a controller configured to determine the load of the indoor unit based on the power consumption measured by the power consumption meter, and the controller may be configured to determine ranks of power consumptions measured for the plurality of indoor units and determine mapping of the plurality of pumps and the plurality of indoor units according to the determined ranks.

The controller may be configured to map, to a first pump, two indoor units corresponding to a highest rank and a lowest rank among the measured ranks of the power consumptions, and map, to a second pump, two different indoor units corresponding to a middle rank among the measured ranks of the power consumptions.

The indoor unit pipe may be provided with a plurality of indoor unit pipes corresponding to the plurality of indoor units, and each of the plurality of indoor unit pipes may be provided with a valve configured to selectively allow supply of water to the plurality of indoor units.

According to another aspect of the present disclosure, a method for controlling an air conditioning system including an outdoor unit through which a refrigerant circulates, the outdoor unit including a compressor and an outdoor heat exchanger, a plurality of indoor units to which water is supplied, a heat exchanger configured to perform heat exchange between the refrigerant and the water, and a plurality of pumps configured to forcibly supply the water to the plurality of indoor units includes sequentially connecting one of the plurality of pumps to the plurality of indoor units and driving the pump.

The method may include determining loads of a plurality of indoor units measured when the pump is driven, and determining ranks for the determined loads of the plurality of indoor units, and mapping the plurality of indoor units and the plurality of pumps based on the ranks.

The determining of the loads of the plurality of indoor units may include measuring the loads of the plurality of indoor units by using an indoor unit load measurement device.

The indoor unit load measurement device may include a flow rate meter configured to measure an amount of water circulating the pump and the indoor unit, or a power consumption meter configured to measure power consumption of the pump.

The mapping of the plurality of indoor units and the plurality of pumps based on the ranks may include mapping, to the first pump, two indoor units corresponding to a highest rank and a lowest rank among the ranks of the loads of the plurality of indoor units, and mapping, to the second pump, two different indoor units corresponding to a middle rank among the ranks of the loads of the plurality of indoor units.

The plurality of indoor units may include first to fourth indoor units, and the plurality of pumps include first and second pumps, two indoor units corresponding to first and fourth ranks among the determined ranks may be mapped to the first pump, and two indoor units corresponding to second and third ranks may be mapped to the second pump.

According to another aspect of the present disclosure, an air conditioning system includes an outdoor unit through which a refrigerant circulates, a plurality of indoor units to which water is supplied, a heat exchanger configured to perform heat exchange between the refrigerant and the water, an indoor unit pipe connecting the heat exchanger to the indoor unit, a plurality of pumps installed in the indoor unit pipe to forcibly circulate the water, and an indoor unit load measurement device configured to measure loads of the plurality of indoor units when the plurality of indoor units are mapped to the plurality of pumps.

The indoor unit load measurement device may include a flow rate meter configured to measure a flow rate of water circulating the pump and the indoor unit, or a power consumption meter configured to measure power consumption output by the pump.

The air conditioning system may further include a controller configured to determine ranks of the measured loads for the plurality of indoor units, and the controller may be configured to determine mapping of the plurality of pumps and the plurality of indoor units according to the determined ranks.

The controller may be configured to map, to a first pump, two indoor units corresponding to a highest rank and a lowest rank among the measured ranks of the loads, and map, to a second pump, two different indoor units corresponding to a middle rank among the measured ranks of the loads.

Advantageous Effects of Invention

According to the air conditioning system according to the embodiment of the present disclosure has the following effects.

First, the load per pump may be evenly distributed considering installation conditions of a plurality of indoor units, and thus, it is possible to secure the load capacity of the system and reduce power consumption.

Second, as an example, a measurement device that measures the capacity of circulating water for each indoor unit is provided to determine loads of indoor units. The loads of the indoor units are determined considering not only the capacity of the indoor unit but also the length of the indoor unit pipe and the installation situation of the pipe accessories, thereby evenly distributing the loads of the pumps.

As another example, a measuring device that measures power consumption for each indoor unit is provided to measure loads of indoor units, thereby evenly distributing loads of pumps.

Third, the ranks of the indoor units are determined by using the values measured by the measurement device, and a plurality of pumps and a plurality of indoor units may mapped by using the determined ranks of the indoor units, thereby evenly distributing the loads applied to the pumps.

BRIEF DESCRIPTION OF DRAWINGS

FIG. **1** is a schematic diagram illustrating an air conditioning apparatus according to an embodiment of the present disclosure.

FIG. **2** is a cycle diagram illustrating the configuration of the air conditioning apparatus according to an embodiment of the present disclosure.

FIG. **3** is a schematic diagram illustrating a connection configuration between a first pump and a plurality of indoor units according to a first embodiment of the present disclosure.

FIGS. **4**A to **4**D are schematic diagrams illustrating a state in which the first pump and the plurality of indoor units according to the first embodiment of the present disclosure are sequentially connected one by one to measure a flow rate of an indoor unit pipe.

FIG. **5** is a block diagram illustrating a configuration of an air conditioning system according to the first embodiment of the present disclosure.

FIG. **6** is a flowchart illustrating a method for controlling an air conditioning system according to the first embodiment of the present disclosure.

FIG. **7** is a schematic diagram illustrating a result of mapping a plurality of pumps and a plurality of indoor units according to the first embodiment of the present disclosure.

FIG. **8**A is a graph showing a result of distributing the load of the pump considering only the capacity of the indoor unit, and FIG. **8**B is a graph showing a result of distributing the load of the pump considering the capacity of the indoor unit and the length of the indoor unit pipe according to an embodiment of the present disclosure.

FIG. **9** is a schematic diagram illustrating a connection configuration between a first pump and a plurality of indoor units according to a second embodiment of the present disclosure.

FIG. **10** is a schematic diagram illustrating a connection configuration between a first pump and a plurality of indoor units according to a third embodiment of the present disclosure.

FIGS. **11**A to **11**D are schematic diagrams illustrating a state in which the first pump and the plurality of indoor units according to the third embodiment of the present disclosure are sequentially connected one by one to measure a flow rate of an indoor unit pipe.

FIG. **12** is a flowchart illustrating a method for controlling an air conditioning system according to the third embodiment of the present disclosure.

FIG. **13** is a schematic diagram illustrating a result of mapping a plurality of pumps and a plurality of indoor units according to the third embodiment of the present disclosure.

MODE FOR THE INVENTION

Hereinafter, embodiments of the present disclosure will be described in detail with reference to the drawings. It should be noted that, in adding reference numerals to the components of each drawing, the same components are denoted by the same reference numerals even though they are shown in different drawings. In describing the present disclosure, when the detailed description of the relevant functions or configurations is determined to unnecessarily obscure the gist of the disclosure, the detailed description may be omitted.

In describing the components of the embodiments of the present disclosure, the terms such as first, second, A, B, (a), and (b) may be used. These terms are only used for distinguishing a component from another, and the nature, order, or sequence of the components is not limited by these terms. When a component is described as being "connected" or "coupled" to another component, it should be understood that the component may be directly connected or coupled to the other component, but another component may be "connected" or "coupled" between the components.

FIG. **1** is a schematic diagram illustrating an air conditioning apparatus according to an embodiment of the present disclosure, and FIG. **2** is a cycle diagram illustrating the configuration of the air conditioning apparatus according to an embodiment of the present disclosure.

Referring to FIGS. **1** and **2**, the air conditioning apparatus **1** according to an embodiment of the present disclosure may include an outdoor unit **10**, an indoor unit **50**, and a heat exchange device **100** connected to the outdoor unit **10** and the indoor unit **50**.

The outdoor unit **10** and the heat exchange device **100** may be fluidly connected by a first fluid. In one example, the first fluid may include a refrigerant.

The refrigerant may flow through the outdoor unit **10** and a refrigerant-side passage of a heat exchanger provided in the heat exchange device **100**.

The outdoor unit **10** may include a compressor **11** and an outdoor heat exchanger **15**.

An outdoor fan **16** is provided on one side of the outdoor heat exchanger **15** to blow outside air toward the outdoor heat exchanger **15**, and the outdoor fan **16** may be driven to perform heat exchange between the outside air and the refrigerant of the outdoor heat exchanger **15**.

The outdoor unit **10** may further include an electronic expansion valve (EEV) **18**.

The air conditioning apparatus **1** may further include connecting pipes **20**, **25**, and **27** connecting the outdoor unit **10** to the heat exchange device **100**.

The connecting pipes **20**, **25**, and **27** may include a first outdoor unit connecting pipe **20** as a gas pipe (high pressure gas pipe) through which a high pressure gas refrigerant flows, a second outdoor unit connecting pipe **25** as a gas pipe (low pressure gas pipe) through which a low pressure gas refrigerant flows, and a third outdoor unit connecting pipe **27** as a liquid pipe through which a liquid refrigerant flows.

That is, the outdoor unit **10** and the heat exchange device **100** have a "three-pipe connection structure", and the three connecting pipes **20**, **25**, and **27** may cause the refrigerant to circulate through the outdoor unit **10** and the heat exchange device **100**.

The heat exchange device **100** and the indoor unit **50** may be fluidly connected by a second fluid. In one example, the second fluid may include water.

The water may flow through the indoor unit **50** and a water-side passage of a heat exchanger provided in the heat exchange device **100**.

The heat exchange device **100** may include a plurality of heat exchangers **140**, **141**, **142**, and **143**. The heat exchanger may include, for example, a plate heat exchanger.

The indoor unit **50** may include a plurality of indoor units **61**, **62**, **63**, and **64**.

In the present embodiment, it is noted that there is no limitation to the number of indoor units **61**, **62**, **63**, and **64**.

In FIG. **1**, for example, four indoor units **61**, **62**, **63**, and **64** are illustrated as being connected to the heat exchange device **100**.

The plurality of indoor units **61**, **62**, **63**, and **64** may include a first indoor unit **61**, a second indoor unit **62**, a third indoor unit **63**, and a fourth indoor unit **64**.

The air conditioning apparatus **1** may further include pipes **30**, **31**, **32**, and **33** connecting the heat exchange device **100** to the indoor unit **50**. The pipes **30**, **31**, **32**, and **33** may be provided with water pipes through which water flows.

The pipes **30**, **31**, **32**, and **33** may include a first indoor unit connecting pipe **30**, a second indoor unit connecting pipe **31**, a third indoor unit connecting pipe **32**, and a fourth indoor unit connecting pipe connecting the heat exchange device **100** to the indoor units **61**, **62**, **63**, and **64**.

Water may circulate through the heat exchange device **100** and the indoor unit **50** through the indoor unit connecting pipes **30**, **31**, **32**, and **33**. When the number of indoor units increases, the number of pipes connecting the heat exchange device **100** to the indoor units increases.

With this configuration, the refrigerant circulating through the outdoor unit **10** and the heat exchange device **100** and the water circulating through the heat exchange device **100** and the indoor unit **50** exchange heat through the heat exchangers **140**, **141**, **142**, and **143** provided in the heat exchange device **100**.

The water cooled or heated through the heat exchange may exchange heat with the indoor heat exchangers **61***a*, **62***a*, **63***a*, and **64***a* provided in the indoor unit **50** to cool or heat the indoor space.

The plurality of heat exchangers **140**, **141**, **142**, and **143** may be provided in the same number as the number of the plurality of indoor units **61**, **62**, **63**, and **64**. Alternatively, two or more indoor units may be connected to one heat exchanger.

Hereinafter, the heat exchange device **100** will be described in more detail with reference to the accompanying drawings.

The heat exchange device **100** may include the first to fourth heat exchangers **140**, **141**, **142**, and **143** fluidly connected to the indoor units **61**, **62**, **63**, and **64**, respectively.

The first to fourth heat exchangers **140**, **141**, **142**, and **143** may have the same structure.

The heat exchangers **140**, **141**, **142**, and **143** may each include, for example, a plate heat exchanger, and may be configured such that the water and the refrigerant passage are alternately stacked.

The heat exchangers **140**, **141**, **142**, and **143** may include refrigerant passages **140***a*, **141***a*, **142***a*, and **143***a* and water passages **140***b*, **141***b*, **142***b*, and **143***b*, respectively.

The refrigerant passage **140***a*, **141***a*, **142***a*, and **143***a* are fluidly connected to the outdoor unit **10**. The refrigerant discharged from the outdoor unit **10** may be introduced into the refrigerant passages **140***a*, **141***a*, **142***a*, and **143***a*, or the refrigerant having passed through the refrigerant passages **140***a*, **141***a*, **142***a*, and **143***a* may be introduced into the outdoor unit **10**.

The water passages **140***b*, **141***b*, **142***b*, and **143***b* are connected to the indoor units **61**, **62**, **63**, and **64**, respectively. The water discharged from the indoor units **61**, **62**, **63**, and **64** may be introduced into the water passages **140***b*, **141***b*, **142***b*, and **143***b*, and the water having passed through the water passages **140***b*, **141***b*, **142***b*, and **143***b* may be introduced into the indoor units **61**, **62**, **63**, and **64**.

The heat exchange device **100** may include a first connecting pipe **131** connected to the first outdoor unit connecting pipe **20** through a first service valve **21**. The first connecting pipe **131** may extend into the heat exchange device **100** and may be connected to a first port of a first valve device **120**.

The heat exchange device **100** may include a third connecting pipe **133** connected to the second outdoor unit connecting pipe **25** through a second service valve **26**. The third connecting pipe **133** may extend into the heat exchange device **100** and may be connected to a third port of the first valve device **120**.

The heat exchange device **100** may include a fourth connecting pipe **134** connected to the third outdoor unit connecting pipe **27** through a third service valve **28**. The fourth connecting pipe **134** may extend into the heat exchange device **100** and may be connected to the first heat exchanger **140** and the second heat exchanger **141**.

The heat exchange device **100** may include a seventh connecting pipe **137** connected to the third outdoor unit connecting pipe **27** through the third service valve **28**. The seventh connecting pipe **137** may extend into the heat exchange device **100** and may be connected to the third heat exchanger **142** and the fourth heat exchanger **143**.

The seventh connecting pipe **137** may extend from a third branch portion **134***a* of the fourth connecting pipe **134** and may be connected to the third heat exchanger **142** and the fourth heat exchanger **143**. That is, the fourth connecting pipe **134** and the seventh connecting pipe **137** may be pipes branched from pipes extending from the third service valve **28**.

The first to third outdoor unit connecting pipes **20**, **25** and **27** may be connected to the heat exchange device **100** through the first to third service valves **21**, **26**, and **28**, such that the outdoor unit **10** and the heat exchange device **100** form the "three-pipe connection".

The first heat exchanger **140** may include the first refrigerant passage **140***a* and the first water passage **140***b*. One side of the first refrigerant passage **140***a* may be connected to the second connecting pipe **132**. The second connecting pipe **132** may extend from the second port of the first valve device **120** and may be connected to the first heat exchanger **140** and the second heat exchanger **141**.

The other side of the first refrigerant passage **140***a* may be connected to the fourth connecting pipe **134**. The fourth connecting pipe **134** may extend from the third service valve **28** and may be connected to the first heat exchanger **140** and the second heat exchanger **141**. That is, both sides of the first refrigerant passage **140***a* may be connected to the second connecting pipe **132** and the fourth connecting pipe **134**.

The second heat exchanger **141** may include the second refrigerant passage **141***a* and the second water passage **141***b*. One side of the second refrigerant passage **141***a* may be connected to the second connecting pipe **132**. The second connecting pipe **132** may be branched and connected to the first heat exchanger **140** and the second heat exchanger **141**.

The other side of the second refrigerant passage **141***a* may be connected to the fourth connecting pipe **134**. Both sides of the second refrigerant passage **141***a* may be connected to the second connecting pipe **132** and the fourth connecting pipe **134**. The fourth connecting pipe **134** may be branched and connected to the first heat exchanger **140** and the second heat exchanger **141**.

The refrigerant discharged from the outdoor unit **10** may be introduced into the first refrigerant passage **140***a* and the second refrigerant passage **141***a* through the first connecting pipe **131** and the first valve device **120**, and the refrigerant having passed through the first refrigerant passage **140***a* and the second refrigerant passage **141***a* may be introduced into the outdoor unit **10** through the fourth connecting pipe **134**.

The third heat exchanger **142** may include the third refrigerant passage **142***a* and the third water passage **142***b*. One side of the third refrigerant passage **142***a* may be connected to the sixth connecting pipe **136**. The sixth connecting pipe **136** may extend from the second port of the second valve device **125** and be connected to the third heat exchanger **142** and the fourth heat exchanger **143**.

The other side of the third refrigerant passage **142***a* may be connected to the seventh connecting pipe **137**. The seventh connecting pipe **137** may extend from the third service valve **28** and may be connected to the third heat exchanger **142** and the fourth heat exchanger **143**. That is, both sides of the third refrigerant passage **142***a* may be connected to the sixth connecting pipe **136** and the seventh connecting pipe **137**.

The fourth heat exchanger **143** may include the fourth refrigerant passage **143***a* and the fourth water passage **143***b*. One side of the fourth refrigerant passage **143***a* may be connected to the sixth connecting pipe **136**. The sixth connecting pipe **136** may be branched and connected to the third heat exchanger **142** and the fourth heat exchanger **143**.

The other side of the fourth refrigerant passage **143***a* may be connected to the seventh connecting pipe **137**. Both sides of the fourth refrigerant passage **143***a* may be connected to the sixth connecting pipe **136** and the seventh connecting pipe **137**. The seventh connecting pipe **137** may be branched and connected to the third heat exchanger **142** and the fourth heat exchanger **143**.

The refrigerant discharged from the outdoor unit **10** may be introduced into the third refrigerant passage **142***a* and the fourth refrigerant passage **143***a* through the first connecting pipe **131** and the second valve device **125**, and the refrigerant having passed through the third refrigerant passage **142***a* and the fourth refrigerant passage **143***a* may be introduced into the outdoor unit **10** through the seventh connecting pipe **137**.

A first branch portion **131***a* may be formed in the first connecting pipe **131**.

The heat exchange device **100** may further include a fifth connecting pipe **135** connected to the first branch portion **131***a* and extending to the second valve device **125**. The fifth connecting pipe **135** may be connected to a first port of the second valve device **125**.

A second branch portion **133***a* may be formed in the third connecting pipe **133**.

The heat exchange device **100** may further include an eighth connecting pipe **138** connected to the second branch portion **133***a* and extending to the second valve device **125**. The eighth connecting pipe **138** may be connected to a third port of the second valve device **125**.

The heat exchange device **100** may include a first valve device **120** and a second valve device **125** that control the flow direction of the refrigerant. The first valve device **120** and the second valve device **125** may be provided with four-way valves or three-way valves. Hereinafter, a case in which the first valve device **120** and the second valve device **125** are provided with four-way valves will be described.

The first valve device **120** may include a first port to which the first connecting pipe **131** is connected, a second port to which the second connecting pipe **132** is connected, and a third port to which the third connecting pipe **133** is connected. A fourth port of the first valve device **120** may be closed.

The second valve device **125** may include a first port to which the fifth connecting pipe **135** is connected, a second port to which the sixth connecting pipe **136** is connected, and a third port to which the eighth connecting pipe **138** is connected. A fourth port of the second valve device **125** may be closed.

The heat exchange device **100** may further include expansion valves **144** and **145** for depressurizing the refrigerant. The expansion valves **144** and **145** may include an electronic expansion valve (EEV).

The expansion valves **144** and **145** may decrease the pressure of the refrigerant passing through the expansion valves **144** and **145** through opening control. For example, when the electronic expansion valves **144** and **145** are fully opened (full-open state), the refrigerant can pass without depressurization, and when the opening degree of the expansion valves **140** and **145** decreases, the refrigerant may be depressurized. The degree of depressurization of the refrigerant increases as the opening degree decreases.

In detail, the expansion valves **144** and **145** may include a first expansion valve **144** installed in the fourth connecting pipe **134**. The first expansion valve **144** may be installed at one point of the fourth connecting pipe **134** between the third service valve **38** and the first refrigerant passage **140***a* or the second refrigerant passage **141***a*.

The expansion valves **144** and **145** may further include a second expansion valve **145** installed in the seventh connecting pipe **137**.

The heat exchange device **100** may further include a bypass pipe **205** connecting the first connecting pipe **131** to the third connecting pipe **133**.

The bypass pipe **205** may be understood as a pipe for preventing liquid refrigerant from being accumulated in a high pressure gas pipe during a cooling operation. One end of the bypass pipe **205** may be connected to a first bypass branch portion **131***b* of the first connecting pipe **131**, and the other end of the bypass pipe **205** may be connected to a second bypass branch portion **133***b* of the third connecting pipe **133**.

Based on the first connecting pipe **131**, the first branch portion **131***a* may be formed at one point between the first bypass branch portion **131***b* and the first port of the first valve device **120**.

Based on the first connecting pipe **131**, the first bypass branch portion **131***b* may be formed at one point between the first service valve **21** and the first branch portion **131***a*.

Based on the third connecting pipe **133**, the second branch portion **133***a* may be formed at one point between the second bypass branch portion **133***b* and the third port of the first valve device **120**.

Based on the third connecting pipe **133**, the second bypass branch portion **133***b* may be formed at one point between the second service valve **26** and the second branch portion **133***a*.

The bypass pipe **205** may be provided with a bypass valve **212** that controls opening and closing of the pipe. For example, the bypass valve **212** may include a two-way valve or a solenoid valve having a relatively low pressure loss.

The bypass pipe **205** may be provided with a strainer **211** for filtering wastes in the refrigerant flowing through the pipe. In one example, the strainer **211** may be made of a metal mesh. The strainer **211** may be disposed at one point between the bypass valve **212** and the first bypass branch portion **131***b*.

The bypass pipe **205** may further include an expansion device **213** for depressurizing the refrigerant flowing through the pipe. In one example, the expansion device **213** may be configured as a capillary tube using a capillary phenomenon.

The expansion device **213** may be disposed at one point between the bypass valve **212** and the second bypass branch portion **133**b. Therefore, the pressure of the refrigerant passing through the expansion device **213** may drop.

The heat exchange device **100** may further include a heat exchanger inlet pipe and a heat exchanger outlet pipe connected to the water passages **140**b, **141**b, **142**b, and **143**b of the heat exchangers **140**, **141**, **142**, and **143**.

A first heat exchanger inlet pipe of the first heat exchanger **140** and a second heat exchanger inlet pipe of the second heat exchanger **141** may be branched from a first common inlet pipe **161**. A first pump **151** may be provided in the first common inlet pipe **161**.

A third heat exchanger inlet pipe of the third heat exchanger **142** and a fourth heat exchanger inlet pipe of the fourth heat exchanger **143** may be branched from a second common inlet pipe **163**. A second pump **152** may be provided in the second common inlet pipe **163**.

A first heat exchanger outlet pipe of the first heat exchanger **140** and a second heat exchanger outlet pipe of the second heat exchanger **141** may be branched from a first common outlet pipe **162**.

A third heat exchanger outlet pipe of the third heat exchanger **142** and a fourth heat exchanger outlet pipe of the fourth heat exchanger **143** may be branched from a second common outlet pipe **164**.

A first joint pipe **181** may be connected to the first common inlet pipe **161**. A second joint pipe **182** may be connected to the second common inlet pipe **163**.

A third joint pipe **183** may be connected to the first common outlet pipe **162**. A fourth joint pipe **184** may be connected to the second common outlet pipe **164**.

A first water discharge pipe **171** through which water discharged from the indoor heat exchangers **61**a, **62**a, **63**a, and **64**a flows may be connected to the first joint pipe **181**. The first water discharge pipe **171** may be branched to four pipes from the first joint pipe **181** in correspondence to the first to fourth indoor units and may be connected to the first to fourth indoor units.

A second water discharge pipe **172** through which water discharged from the indoor heat exchangers **61**a, **62**a, **63**a, and **64**a flows may be connected to the second joint pipe **182**. The second water discharge pipe **172** may be branched to four pipes from the second joint pipe **182** in correspondence to the first to fourth indoor units and may be connected to the first to fourth indoor units.

The first water discharge pipe **171** and the second water discharge pipe **172** may be disposed in parallel and may be connected to common water outlet pipes **651**, **652**, **653**, and **654** communicating with the indoor heat exchangers **61**a, **62**a, **63**a, and **64**a.

The first water discharge pipe **171**, the second water discharge pipe **172**, and the common water outlet pipe **651**, **652**, **653**, and **654** may be connected by, for example, a three-way valve **173**.

Therefore, due to the three-way valve **173**, the water of the common water outlet pipes **651**, **652**, **653**, and **654** can flow through one of the first water discharge pipe **171** and the second water discharge pipe **172**.

The common water outlet pipes **651**, **652**, **653**, and **654** may be connected to the discharge pipes of the indoor heat exchangers **61**a, **62**a, **63**a, and **64**a.

The third joint pipe **183** may be branched into a plurality of pipes corresponding to the first to fourth indoor units, and water to be introduced into the indoor heat exchangers **61**a, **62**a, **63**a, and **64**a may flow therethrough. The third joint pipe **183** may be referred to as a "first indoor unit pipe".

The third joint pipe **184** may be branched into a plurality of pipes corresponding to the first to fourth indoor units, and water to be introduced into the indoor heat exchangers **61**a, **62**a, **63**a, and **64**a may flow therethrough. The fourth joint pipe **184** may be referred to as a "second indoor unit pipe".

The plurality of third joint pipes **183** and the plurality of fourth joint pipes **184** may be disposed in parallel and may be connected to common water inlet pipes **611**, **621**, **631**, and **641** communicating with the indoor heat exchangers **61**a, **62**a, **63**a, and **64**a.

A first valve **166** may be provided in the third joint pipe **183**, and a second valve **167** may be provided in the fourth joint pipe **184**. For example, the first valve **166** and the second valve **167** may be configured as a solenoid valve capable of on/off control.

When the first pump **151** is driven, if the first valve **166** is opened, water discharged from the first pump **151** may be branched through the plurality of third joint pipes **183** and flow into the indoor units (first to fourth indoor units). The first valve **166** may be referred to as a "first indoor unit valve".

When the second pump **152** is driven, if the second valve **167** is opened, water discharged from the second pump **152** may be branched through the plurality of fourth joint pipes **184** and flow into the indoor units (first to fourth indoor units). The second valve **167** may be referred to as a "second indoor unit valve".

For convenience of description, the first heat exchanger **140** and the second heat exchanger **141** may be referred to as a "first-side heat exchanger". In addition, the third heat exchanger **142** and the fourth heat exchanger **143** may be referred to as a "second-side heat exchanger".

FIG. **3** is a schematic diagram illustrating a connection configuration between a first pump and a plurality of indoor units, according to a first embodiment of the present disclosure.

Referring to FIG. **3**, when an air conditioning system **1** according to an embodiment of the present disclosure is installed and then performs a test drive, a first pump **151** may be driven so as to determine loads of a plurality of indoor units, and the amount of water flowing through the first pump **151** and the indoor units may be determined. Instead of the first pump **151**, a second pump **152** may be driven and the amount of water flowing through the second pump **152** and the indoor units may be determined.

FIG. **3** is a diagram schematically illustrating the connection structure of the first pump **151** and the first to fourth indoor units **61**, **62**, **63**, and **64**. The first pump **151** may be connected to the first to fourth indoor units **61**, **62**, **63**, and **64** through an indoor unit pipe. For convenience of explanation, the indoor unit pipe is a pipe extending from a heat exchange device **100** to first to fourth indoor unit pipes, and may be understood as a pipe in which a first common inlet pipe **161**, a first common outlet pipe **162**, and a third joint pipe **183** are combined.

The indoor unit pipe **183** includes a first indoor unit pipe **210** connected to the first indoor unit **61**, a second indoor unit pipe **220** connected to the second indoor unit **62**, a third indoor unit pipe **230** connected to the third indoor unit **63**, and a fourth indoor unit pipe **240** connected to the fourth indoor unit **64**.

The length of the first indoor unit pipe **210** may be a first length L**1**, the length of the second indoor unit pipe **220** may be a second length L**2**, the length of the third indoor unit pipe **230** may be a third length L**3**, and the length of the fourth indoor unit pipe **240** may be a fourth length L**4**.

For example, the first length L**1** may be 60 m, the second length L**2** may be 40 m, the third length L**3** may be 10 m, and the fourth length L**4** may be 20 m.

The first to fourth indoor units **61**, **62**, **63**, and **64** may have different capacities. For example, the capacity of the first indoor unit **61** may be 10 kw, the capacity of the second indoor unit **62** may be 5 kw, the capacity of the third indoor unit **63** may be 10 kw, and the capacity of the fourth indoor unit **64** may be 5 kw

The first valve **166** described above is installed in the indoor unit pipe **183**. In detail, the first valve **166** includes a first indoor unit valve **166***a* installed in the first indoor unit pipe **210**, a second indoor unit valve **166***b* installed in the second indoor unit pipe **220**, a third indoor unit valve **166***c* installed in the third indoor unit pipe **230**, and a fourth indoor unit valve **166***d* installed in the fourth indoor unit pipe **240**.

A flow rate meter **200** may be installed in the first to fourth indoor unit pipes **210**, **220**, **230**, and **240**. In detail, the flow rate meter **200** may include first to fourth flow rate meters **200***a*, **200***b*, **200***c*, and **200***d*. The first to fourth flow rate meters **200***a*, **200***b*, **200***c*, and **200***d* may measure the amount of water flowing to the first to fourth indoor units **61**, **62**, **63** and **64**, respectively.

Under these installation conditions, the first pump **151** and the first to fourth indoor units **61**, **62**, **63**, and **64** are sequentially connected one by one, and the first pump **151** may be driven to determine the amount of water measured by the flow rate meter. In this case, the amount of water may be understood as a result of reflecting installation conditions such as the capacity of the indoor unit, the length of the indoor unit pipe, and accessories of the indoor unit pipe. Hereinafter, such a measurement method will be described in detail with reference to the drawings.

FIGS. **4***a* to **4***d* are schematic diagrams illustrating a state in which the first pump and the plurality of indoor units according to the first embodiment of the present disclosure are sequentially connected one by one to measure the flow rate of the indoor unit pipe, FIG. **5** is a block diagram illustrating a configuration of an air conditioning system according to the first embodiment of the present disclosure, and FIG. **6** is a flowchart illustrating a method for controlling an air conditioning system according to the first embodiment of the present disclosure.

A method for determining the load of the indoor unit according to the first embodiment of the present disclosure will be described with reference to FIGS. **4**A to **4**D and FIGS. **5** and **6** together.

First, as illustrated in FIG. **4***a*, a controller **250** opens the first indoor unit valve **166***a* and closes the second to fourth indoor unit valves **166***b*, **166***c*, and **166***d* (S**11**, S**12**).

The first pump **151** is driven with a set output. For example, the set output may be the maximum output of the first pump **151** (S**13**).

When the first pump **151** is driven, water discharged from the first pump **151** flows through the first indoor unit pipe **210**, and the flow through the second to fourth indoor unit pipes **220**, **230**, and **240** may be limited.

The water passes through the first flow rate meter **200***a*, and in this process, the amount of water flowing through the first indoor unit pipe **210** may be measured (S**14**).

Such measurement may be made for a set time, and after that, the controller **250** stops driving the first pump **151**. The measured amount of water is stored in a memory **260**, and this may be determined as the load of the first indoor unit **61** (S**15**).

In this way, the loads of the second to fourth indoor units **62**, **63** and **64** may be sequentially determined.

That is, in order to determine the load of the second indoor unit **62**, as illustrated in FIG. **4***b*, the controller **250** opens the second indoor unit valve **166***b* and closes the first, third, and fourth indoor unit valves **166***a*, **166***c*, and **166***d*.

When the first pump **151** is driven with a set output, water discharged from the first pump **151** flows through the second indoor unit pipe **220**, and the flow through the first, third, and fourth indoor unit pipes **210**, **230**, and **240** may be limited.

The water passes through the second flow rate meter **200***b*, and in this process, the amount of water flowing through the second indoor unit pipe **220** may be measured. The measured amount of water is stored in the memory **260**, and this may be determined as the load of the second indoor unit **62**.

Similarly, in order to determine the load of the third indoor unit **63**, as illustrated in FIG. **4***c*, the controller **250** opens the third indoor unit valve **166***c* and closes the first, second, and fourth indoor unit valves **166***a*, **166***b*, and **166***d*.

When the first pump **151** is driven with a set output, water discharged from the first pump **151** flows through the third indoor unit pipe **230**, and the flow through the first, second, and fourth indoor unit pipes **210**, **220**, and **240** may be limited.

The water passes through the third flow rate meter **200***c*, and in this process, the amount of water flowing through the third indoor unit pipe **230** may be measured. The measured amount of water is stored in the memory **260**, and this may be determined as the load of the third indoor unit **63**.

Finally, in order to determine the load of the fourth indoor unit **64**, as illustrated in FIG. **4***d*, the controller **250** opens the fourth indoor unit valve **166***d* and closes the first, second, and third indoor unit valves **166***a*, **166***b*, and **166***c*.

When the first pump **151** is driven with a set output, water discharged from the first pump **151** flows through the fourth indoor unit pipe **240**, and the flow through the first, second, and third indoor unit pipes **210**, **220**, and **230** may be limited.

The water passes through the fourth flow rate meter **200***d*, and in this process, the amount of water flowing through the fourth indoor unit pipe **240** may be measured. The measured amount of water is stored in the memory **260**, and this may be determined as the load of the fourth indoor unit **64**.

For example, the measured amount of water may change little by little over time, and the maximum value among the measured values may be determined as the amount of water (S**16**).

In the above-described method, the amount of water flowing through the first to fourth indoor units is measured, and the rank of the flow rate for each indoor unit is determined. The rank of the flow rate may correspond to the load rank for each indoor unit. According to the rank of the flow rate, mapping information of the first and second pumps **151** and **152** and the first to fourth indoor units **61**, **62**, **63** and **64** is determined, and the loads of the first and second pumps are equally distributed (S**17**, S**18**).

FIG. **6** illustrates the mapping result of the first and second pumps **151** and **152** with respect to the first to fourth indoor units **61**, **62**, **63**, and **64**. Details will be described in detail with reference to FIG. **7**.

FIG. **7** is a schematic diagram illustrating a result of mapping a plurality of pumps and a plurality of indoor units according to the first embodiment of the present disclosure.

Referring to FIG. **7**, after the pump for each indoor unit is operated, the water flow rate of each indoor unit pipe may be measured through the flow rate meter. It may be determined that as the flow rate of water flowing through the indoor unit pipe increases, the load of the indoor unit is small, and as the flow rate of water decreases, the load of the indoor unit is large.

As a result of the measuring, for example, the flow rate of water flowing through the first indoor unit pipe **210** may be 10 LPM (Liters Per Minute), the flow rate of water flowing through the second indoor unit pipe **220** may be 10 LPM, the flow rate of water flowing through the third indoor unit pipe **230** may be 20 LPM, and the flow rate of water flowing through the fourth indoor unit pipe **240** may be 15 LPM.

Therefore, the water flow rate of the third indoor unit **63** may be rank 1, the water flow rate of the fourth indoor unit **64** may be rank 2, the water flow rate of the first indoor unit **61** may be rank 3, and the water flow rate of the second indoor unit **62** may be rank 4.

Based on the rank of the flow rate, ranks 1 and 3 may be mapped to one of the first and second pumps **151** and **152**, and ranks 2 and 4 may be mapped to the other of the first and second pumps **151** and **152**).

For example, as illustrated in FIG. **7**, the third indoor unit **63** of rank 1 and the first indoor unit **61** of rank 3 may be connected to the first pump **151**, and the fourth indoor unit **64** of rank 2 and the second indoor unit **62** of rank 4 may be connected to the second pump **152**.

As a result, among the four first valves **166** connected to the first pump **151**, the first and third indoor unit valves **166***a* and **166***c* may be opened and the second and fourth indoor unit valves **166***b* and **166***d* may be closed. On the other hand, among the four second valves **167** connected to the second pump **152**, the valves connected to the second and fourth indoor units **62** and **64** may be opened and the valves connected to the first and third indoor units **61** and **63** may be closed.

As such, since the first and second pumps **151** and **152** may be mapped to the first to fourth indoor units **61**, **62**, **63** and **64** according to the load of the indoor unit, the equal load may be distributed to the pumps.

The air conditioning system **1** may be operated according to the mapping result of the first and second pumps **151** and **152** and the first to fourth indoor units **61**, **62**, **63** and **64**.

FIG. **8**A is a graph showing a result of distributing the load of the pump considering only the capacity of the indoor unit, and FIG. **8**B is a graph showing a result of distributing the load of the pump considering the capacity of the indoor unit and the length of the indoor pipe according to an embodiment of the present disclosure.

In the graphs of FIGS. **8**A and **8**B, the horizontal axis represents the flow rate of the pump, and the vertical axis represents the load of the pump. In the graphs, the solid line represents the pump performance curve and the dotted line represents the system resistance curve. When the slope of the system resistance curve is large, it means that the pump load is large.

The flow rate of the pump may be formed at a point where the pump performance curve and the system resistance curve meet.

Referring to FIG. **8**A, when the plurality of pumps are mapped to the plurality of indoor units considering only the capacity of the indoor unit, the slope of the system resistance curve of the first pump (pump **1**) is formed relatively large, and the slope of the system resistance curve of the second pump (pump **2**) is formed relatively small.

Therefore, the flow rate of the first pump is measured as 25 LPM, and the flow rate of the second pump is measured as 40 LPM. That is, in the case of FIG. **8**A, it can be seen that the indoor unit is allocated such that the load is biased to the first pump and the flow rate decreases.

On the other hand, referring to FIG. **8***b*, when the plurality of pumps are mapped to the plurality of indoor units, based on a result of measuring the flow rate of the indoor unit pipe considering not only the capacity of the indoor unit but also the installation conditions such as the length of the indoor unit pipe and the pipe accessories, the slope of the system resistance curve of the first and second pumps is formed almost similarly.

Therefore, since both the flow rates of the first pump and the second pump are measured as 36 LPM, it can be seen that the loads of the indoor units are equally distributed to the first and second pumps. In addition, it can be seen that the sum (72 LPM) of the flow rates of the first and second pumps is larger than the sum (65 LPM) of the flow rates of the first and second pumps in FIG. **7**A. This indicates that the performance of the system is improved.

FIG. **9** is a schematic diagram illustrating a connection configuration between a first pump and a plurality of indoor units, according to a second embodiment of the present disclosure.

Referring to FIG. **9**, the air conditioning system according to the second embodiment of the present disclosure may be configured to measure the flow rate of the indoor unit by using a single flow rate meter **200'**.

The single flow rate meter **200'** may be installed at an inlet side or an outlet side of the first pump **151**. As described above with reference to FIGS. **4**A to **4**D, when water is circulated by sequentially opening the first to fourth indoor units **61**, **62**, **63**, and **64**, the amount of water flowing into the first pump **151** or discharged from the first pump **151** may be measured through the flow rate meter **200'**.

In this way, since the single flow rate meter is installed to measure the flow rate of the indoor unit, the cost consumed when the system performs the test drive may be reduced. The description of the air conditioning system according to the first embodiment may be applied to the other description of the air conditioning system according to the present embodiment.

FIG. **10** is a schematic diagram illustrating a connection configuration between a first pump and a plurality of indoor units according to a third embodiment of the present disclosure.

Referring to FIG. **10**, when an air conditioning system **1** according to a third embodiment of the present disclosure is installed and then performs a test drive, a first pump **151** may be driven so as to determine loads of a plurality of indoor units, and may determine the amount of water flowing through the first pump **151** and the indoor units.

FIG. **10** is a diagram schematically illustrating the connection structure of the first pump **151** and first to fourth indoor units **61**, **62**, **63**, and **64**. A first pump **151** may be connected to first to fourth indoor units **61**, **62**, **63**, and **64** through first to fourth indoor unit pipes **210**, **220**, **230**, and **240**. First to fourth indoor unit valves **166***a*, **166***b*, **166***c*, and **166***d* may be installed in the first to fourth indoor unit pipes **210**, **220**, **230**, and **240**, respectively.

The description of the first embodiment is applied to the description of the first to fourth indoor units **61**, **62**, **63**, and **64**, the first to fourth indoor unit pipes **210**, **220**, **230**, and **240**, and the first to fourth indoor unit valves **166***a*, **166***b*, **166***c*, and **166***d*.

A power consumption meter **300** capable of measuring power consumed when the first pump **151** is driven may be electrically connected to the first pump **151**.

Under these installation conditions, when the first pump **151** and the first to fourth indoor units **61**, **62**, **63** and **64** are sequentially connected one by one and the first pump **151** is driven, the power consumption of the first pump **151** may be measured.

In this case, the measured power consumption may correspond to the flow rate described in the first embodiment and may be understood as a result of reflecting installation conditions such as the capacity of the indoor unit, the length of the indoor unit pipe, and accessories of the indoor unit pipe. Hereinafter, such a measurement method will be described in detail with reference to the drawings.

FIGS. **11**A to **11**D are schematic diagrams illustrating a state in which the first pump and the plurality of indoor units according to the third embodiment of the present disclosure are sequentially connected one by one to measure a flow rate of an indoor unit pipe, and FIG. **12** is a flowchart illustrating a method for controlling an air conditioning system according to the third embodiment of the present disclosure.

A method for determining the load of the indoor unit according to the third embodiment of the present disclosure will be described with reference to FIGS. **11***a* to **11***d* and **12** together.

First, as illustrated in FIG. **11**A, a controller **250** opens a first indoor unit valve **166***a* and closes second to fourth indoor unit valves **166***b*, **166***c*, and **166***d* (S**21**, S**22**).

A first pump **151** is driven with a set output. For example, the set output may be the maximum output of the first pump **151** (S**23**).

When the first pump **151** is driven, water discharged from the first pump **151** flows through the first indoor unit pipe **210**, and the flow through the second to fourth indoor unit pipes **220**, **230**, and **240** may be limited.

While water flows through the first indoor unit pipe **210**, power consumption of the first pump **151** may be measured. The measured power consumption may constitute first power consumption P**1** corresponding to the first indoor unit **61** (S**24**).

Such measurement may be made for a set time, and then the controller **250** may stop driving the first pump **151**. The measured power consumption is stored in a memory **260**, and this may be determined as the load of the first indoor unit **61** (S**25**).

In this way, the loads of the second to fourth indoor units **62**, **63** and **64** may be sequentially determined.

That is, in order to determine the load of the second indoor unit **62**, as illustrated in FIG. **11**B, the controller **250** opens the second indoor unit valve **166***b* and closes the first, third, and fourth indoor unit valves **166***a*, **166***c*, and **166***d*.

When the first pump **151** is driven with a set output, water discharged from the first pump **151** flows through the second indoor unit pipe **220**, and the flow through the first, third, and fourth indoor unit pipes **210**, **230**, and **240** may be limited.

In this process, second power consumption P**2** of the first pump **151** may be measured. The measured power consumption is stored in the memory **260**, and this may be determined as the load of the second indoor unit **62**.

Similarly, in order to determine the load of the third indoor unit **63**, as illustrated in FIG. **11**C, the controller **250** opens the third indoor unit valve **166***c* and closes the first, second, and fourth indoor unit valves **166***a*, **166***b*, and **166***d*.

When the first pump **151** is driven with a set output, water discharged from the first pump **151** flows through the third indoor unit pipe **230**, and the flow through the first, second, and fourth indoor unit pipes **210**, **220**, and **240** may be limited.

In this process, third power consumption P**3** of the first pump **151** may be measured. The measured power consumption is stored in the memory **260**, and this may be determined as the load of the third indoor unit **63**.

Finally, in order to determine the load of the fourth indoor unit **64**, as illustrated in FIG. **11**D, the controller **250** opens the fourth indoor unit valve **166***d* and closes the first, second, and third indoor unit valves **166***a*, **166***b*, and **166***c*.

When the first pump **151** is driven with a set output, water discharged from the first pump **151** flows through the fourth indoor unit pipe **240**, and the flow through the first, second, and third indoor unit pipes **210**, **220**, and **230** may be limited.

In this process, fourth power consumption P**4** of the first pump **151** may be measured. The measured power consumption is stored in the memory **260**, and this may be determined as the load of the fourth indoor unit **64**.

For example, the measured power consumption may change little by little over time, and the maximum value among the measured values may be determined as the power consumption (S**26**).

In the above-described method, the power consumption of the first to fourth indoor units is measured, and the rank of the power consumption for each indoor unit is determined. The rank of the power consumption may correspond to the load rank for each indoor unit. According to the rank of the power consumption, mapping information of the first and second pumps **151** and **152** and the first to fourth indoor units **61**, **62**, **63** and **64** is determined, and the loads of the first and second pumps are equally distributed (S**27**, S**28**).

FIG. **13** illustrates the mapping result of the first and second pumps **151** and **152** with respect to the first to fourth indoor units **61**, **62**, **63**, and **64**. Details will be described in detail with reference to FIG. **13**.

FIG. **13** is a schematic diagram illustrating a result of mapping a plurality of pumps and a plurality of indoor units according to the third embodiment of the present disclosure.

Referring to FIG. **13**, power consumption of the first pump **151** may be measured through the power consumption meter **300** after the pump is operated for each indoor unit. It may be determined that as the measured power consumption increases, the load of the indoor unit is small, and as the measured power consumption decreases, the load of the indoor unit is large.

As a result of the measuring, for example, the first power consumption P**1** may be 60 W, the second power consumption P**2** may be 60 W, the third power consumption P**3** may be 120 W, and the fourth power consumption P**4** may be 90 W. Therefore, the rank of the power consumption rate of the third indoor unit **63** may be first, the rank of the power consumption of the fourth indoor unit **64** may be second, the rank of the power consumption of the first indoor unit **61** may be third, and the rank of the power consumption of the second indoor unit **62** may be fourth.

Based on the rank of the power consumption, ranks 1 and 3 may be mapped to one of the first and second pumps **151** and **152**, and ranks 2 and 4 may be mapped to the other of the first and second pumps **151** and **152**).

For example, as illustrated in FIG. **13**, the third indoor unit **63** of rank 1 and the first indoor unit **61** of rank 3 may be connected to the first pump **151**, and the fourth indoor unit **64** of rank 2 and the second indoor unit **62** of rank 4 may be connected to the second pump **152**.

As a result, among the four first valves **166** connected to the first pump **151**, the controller **250** may open the first and third indoor unit valves **166***a* and **166***c* and may close the second and fourth indoor unit valves **166***b* and **166***d*. On the other hand, among the four second valves **167** connected to the second pump **152**, the controller **250** may open the valves connected to the second and fourth indoor units **62** and **64** and may close the valves connected to the first and third indoor units **61** and **63**.

As such, since the first and second pumps **151** and **152** may be mapped to the first to fourth indoor units **61**, **62**, **63** and **64** according to the load of the indoor unit, the equal load may be distributed to the pumps.

The air conditioning system **1** may be operated according to the mapping result of the first and second pumps **151** and **152** and the first to fourth indoor units **61**, **62**, **63** and **64**.

The "flow rate meter" described in the first and second embodiments and the "power consumption meter" described in the third embodiment are devices for measuring the load of the indoor unit, and may be collectively referred to as "indoor load measurement device".

INDUSTRIAL APPLICABILITY

The present disclosure relates to an air conditioning system and a method for controlling the same. The load per pump may be evenly distributed considering installation conditions of a plurality of indoor units, and thus, it is possible to secure the load capacity of the system and reduce power consumption. Therefore, the present disclosure is remarkably industrially applicable.

The invention claimed is:

1. An air conditioning system, comprising:

an outdoor unit through which a refrigerant circulates, the outdoor unit including a compressor and an outdoor heat exchanger;

a plurality of indoor units to which a fluid is supplied;

a heat exchanger configured to perform heat exchange between the refrigerant and the fluid;

at least one indoor unit pipe that connects the heat exchanger to the plurality of indoor units, the at least one indoor unit pipe being configured to guide circulation of the fluid in the heat exchanger and the plurality of indoor units;

a plurality of pumps installed in the at least one indoor unit pipe to forcibly circulate the fluid, the plurality of pumps including a first pump and a second pump;

at least one flow rate meter configured to measure loads of the plurality of indoor units based on capacities of the plurality of indoor units and a length of the at least one indoor unit pipe when the plurality of indoor units is mapped to the plurality of pumps, the at least one flow rate meter being installed in the at least one indoor unit pipe and configured to measure a flow rate of the fluid circulating in the plurality of pumps and the plurality of indoor units; and

a controller configured to determine the loads of the plurality of indoor units based on the flow rate measured by the at least one flow rate meter, wherein the controller is configured to:

determine ranks of the plurality of indoor units based on flow rates measured for the plurality of indoor units;

map, to the first pump of the plurality of pumps, at least one first indoor unit having a first rank among the plurality of indoor units; and

map, to the second pump of the plurality of pumps, at least one second indoor unit having a second rank among the plurality of indoor units.

2. The air conditioning system according to claim **1**, wherein the controller is configured to:

map, to the first pump of the plurality of pumps, two first indoor units having a highest rank and a lowest rank among the plurality of indoor units; and

map, to the second pump of the plurality of pumps, two second indoor units having a middle rank among the plurality of indoor units.

3. The air conditioning system according to claim **1**, wherein the at least one flow rate meter includes a plurality of flow rate meters, wherein the at least one indoor unit pipe comprises a plurality of indoor unit pipes, and wherein the plurality of flow rate meters is installed in the plurality of indoor unit pipes connected to the plurality of indoor units.

4. The air conditioning system according to claim **1**, wherein the at least one indoor unit pipe comprises a plurality of indoor unit pipes corresponding to the plurality of indoor units, and wherein each of the plurality of indoor unit pipes is provided with a valve configured to selectively allow supply of fluid to the plurality of indoor units.

5. The air conditioning system according to claim **1**, wherein the fluid comprises water.

6. A method for controlling an air conditioning system including an outdoor unit through which a refrigerant circulates, the outdoor unit including a compressor and an outdoor heat exchanger, a plurality of indoor units to which fluid is supplied, a heat exchanger configured to perform heat exchange between the refrigerant and the fluid, and a plurality of pumps configured to forcibly supply the fluid to the plurality of indoor units, the method comprising:

sequentially connecting the plurality of pumps to the plurality of indoor units and driving the connected pump;

determining loads of a plurality of indoor units measured while each pump is driven, using:

at least one flow rate meter configured to measure an amount of fluid circulating through the plurality of pumps and the plurality of indoor units, or at least one power consumption meter configured to measure power consumption of the plurality of pumps; and

determining ranks for the determined loads of the plurality of indoor units based on the amount of fluid for the plurality of indoor units or the power consumption of the plurality of pumps, and mapping the plurality of indoor units and the plurality of pumps based on the ranks, the mapping comprising:

mapping, to a first pump of the plurality of pumps, at least one first indoor unit having a first rank among the plurality of indoor units, and mapping, to a second pump of the plurality of pumps, at least one second indoor unit having a second rank among the plurality of indoor units.

7. The method according to claim **6**, wherein the mapping of the plurality of indoor units and the plurality of pumps based on the determined ranks comprises:

mapping, to the first pump of the plurality of pumps, two indoor units having a highest rank and a lowest rank among the ranks of the loads of the plurality of indoor units; and

mapping, to the second pump of the plurality of pumps, two different indoor units having a middle rank among the ranks of the loads of the plurality of indoor units.

8. The method according to claim **6**, wherein the plurality of indoor units include first to fourth indoor units, and the plurality of pumps include the first and second pumps, and wherein two indoor units corresponding to first and fourth ranks among the determined ranks are mapped to the first pump, and two indoor units corresponding to second and third ranks are mapped to the second pump.

9. An air conditioning system, comprising:

an outdoor unit through which a refrigerant circulates;

a plurality of indoor units to which a fluid is supplied;

a heat exchanger configured to perform heat exchange between the refrigerant and the fluid;

at least one indoor unit pipe that connects the heat exchanger to the plurality of indoor units;

a plurality of pumps installed in the at least one indoor unit pipe to forcibly circulate the fluid;

at least one power consumption meter configured to measure loads of the plurality of indoor units when the plurality of indoor units is mapped to the plurality of pumps, the at least one power consumption meter being configured to measure power consumption output by the plurality of pumps; and

a controller configured to determine the loads of the plurality of indoor units based on the power consumption output measured by the at least one power consumption meter, wherein the controller is configured to:

determine ranks of the plurality of indoor units based on power consumption outputs measured for the plurality of pumps;

map, to a first pump of the plurality of pumps, at least one first indoor unit having a first rank among the plurality of indoor units; and

map, to a second pump of the plurality of pumps, at least one second indoor unit having a second rank among the plurality of indoor units.

10. The air conditioning system according to claim 9, wherein the controller is further configured to:

map, to the first pump of the plurality of pumps, two indoor units having a highest rank and a lowest rank among the plurality of indoor units; and

map, to the second pump of the plurality of pumps, two different indoor units corresponding to a middle rank among the plurality of indoor units.

11. The air conditioning system according to claim 9, wherein the at least one indoor unit pipe comprises a plurality of indoor unit pipes corresponding to the plurality of indoor units, and wherein each of the plurality of indoor unit pipes is provided with a valve configured to selectively allow supply of fluid to the plurality of indoor units.

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