(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 3 859 238 A1**

(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 153(4) EPC

(43) Date of publication:
04.08.2021 Bulletin 2021/31

(21) Application number: **18935979.7**

(22) Date of filing: **26.09.2018**

(51) Int Cl.:
F25B 29/00 *(2006.01)* ***F25B 41/04*** *(2006.01)*

(86) International application number:
PCT/JP2018/035793

(87) International publication number:
WO 2020/065791 (02.04.2020 Gazette 2020/14)

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
KH MA MD TN

(71) Applicant: **Hitachi-Johnson Controls Air Conditioning, Inc.**
Tokyo 105-0022 (JP)

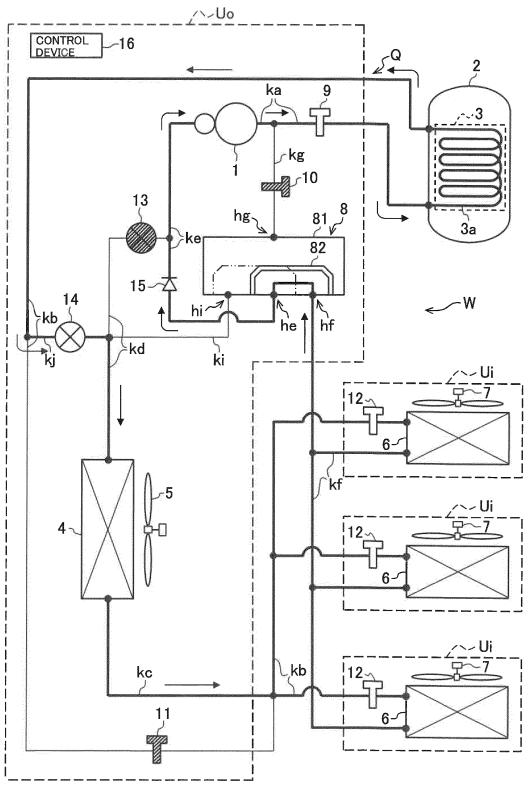
(72) Inventors:
- **TAKAHASHI, Norio**
  Tokyo 105-0022 (JP)
- **MURAWAKA, Masatoshi**
  Tokyo 105-0022 (JP)

(74) Representative: **MERH-IP Matias Erny Reichl Hoffmann**
Patentanwälte PartG mbB
Paul-Heyse-Strasse 29
80336 München (DE)

(54) AIR CONDITIONING AND HOT WATER SUPPLY DEVICE

(57) Provided is an air-conditioning hot-water-supply device configured so that hot-water supply operation and the like can be properly performed. The air-conditioning hot-water-supply device (W) includes a refrigerant circuit Q in which refrigerant circulates sequentially through a compressor (1), a hot-water-supply heat exchanger (3), an expansion valve (11), and an outdoor heat exchanger (4). Further, the air-conditioning hot-water-supply device (W) includes a check valve (15) provided at a pipe (ke) connecting a low-pressure-side connection port (he) of a four-way valve (8) and a suction side of the compressor (1). An expansion valve (10) blocks between a high-pressure-side connection port (hg) of the four-way valve (8) and a discharge side of the compressor (1). The check valve (15) allows a refrigerant flow from the four-way valve (8) to the suction side of the compressor (1) through the pipe (ke) and inhibits a flow in an opposite direction.

FIG. 5



EP 3 859 238 A1

Description

TECHNICAL FIELD

[0001] The present invention relates to an air-conditioning hot-water-supply device.

BACKGROUND ART

[0002] Regarding an air-conditioning hot-water-supply device configured to perform air-conditioning and hot-water supply, e.g., a technique described in Patent Literature 1 has been known. That is, Patent Literature 1 describes that in air-cooling air-conditioning operation for utilizing exhaust heat caused in an indoor heat exchanger for hot-water supply in a hot-water-supply heat exchanger, control is made such that the total condensation capacity of a first condensation capacity of an outdoor heat exchanger and a second condensation capacity of the hot-water-supply heat exchanger reaches a predetermined value.

CITATION LIST

PATENT LITERATURE

[0003] PATENT LITERATURE 1: JP-A-2013-213612

SUMMARY OF THE INVENTION

PROBLEMS TO BE SOLVED BY THE INVENTION

[0004] However, in the technique described in Patent Literature 1, the outdoor heat exchanger constantly functions as a condenser, and for this reason, it is configured such that only hot-water supply operation cannot be independently performed without the air-conditioning operation. Moreover, in the technique described in Patent Literature 1, e.g., suppression in refrigerant outflow through a four-way valve in the hot-water supply operation is not taken into consideration.

[0005] For this reason, the present invention is intended to provide an air-conditioning hot-water-supply device configured so that hot-water supply operation and the like can be properly performed.

SOLUTIONS TO THE PROBLEMS

[0006] For solving the above-described problems, the air-conditioning hot-water-supply device according to the present invention includes a refrigerant circuit in which refrigerant circulates sequentially through a compressor, a hot-water-supply heat exchanger, a first expansion valve, and an outdoor heat exchanger. Moreover, the air-conditioning hot-water-supply device includes a four-way valve having a main body and a valve body provided inside the main body and configured to switch a refrigerant flow path in the refrigerant circuit, and a check valve provided at a first pipe connecting a low-pressure-side connection port of the four-way valve and a suction side of the compressor. A first opening/closing section blocks between a high-pressure-side connection port of the four-way valve and a discharge side of the compressor. The check valve allows a refrigerant flow from the four-way valve to the suction side of the compressor through the first pipe, and inhibits a flow in an opposite direction.

EFFECTS OF THE INVENTION

[0007] According to the present invention, the air-conditioning hot-water-supply device configured so that the hot-water supply operation and the like can be properly performed can be provided.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008]

Fig. 1 is a configuration diagram including a refrigerant circuit of an air-conditioning hot-water-supply device according to an embodiment of the present invention;

Fig. 2A is a sectional view of a four-way valve included in the air-conditioning hot-water-supply device according to the embodiment of the present invention;

Fig. 2B is a sectional view illustrating another state of the four-way valve included in the air-conditioning hot-water-supply device according to the embodiment of the present invention;

Fig. 3 is a functional block diagram including a control device of the air-conditioning hot-water-supply device according to the embodiment of the present invention;

Fig. 4 is a diagram for describing the state of each valve and a refrigerant flow in independent air-cooling operation of the air-conditioning hot-water-supply device according to the embodiment of the present invention;

Fig. 5 is a diagram for describing the state of each valve and a refrigerant flow in air-cooling hot-water-supply operation of the air-conditioning hot-water-supply device according to the embodiment of the present invention;

Fig. 6 is a diagram for describing the state of each valve and a refrigerant flow in first independent hot-water supply operation of the air-conditioning hot-water-supply device according to the embodiment of the present invention;

Fig. 7 is a diagram for describing the state of each valve and a refrigerant flow in air-heating hot-water-supply operation of the air-conditioning hot-water-supply device according to the embodiment of the present invention;

Fig. 8 is a diagram for describing the state of each valve and a refrigerant flow in second independent

hot-water supply operation of the air-conditioning hot-water-supply device according to the embodiment of the present invention; and

Fig. 9 is a diagram for describing the state of each valve and a refrigerant flow in second defrosting operation of the air-conditioning hot-water-supply device according to the embodiment of the present invention.

DESCRIPTION OF EMBODIMENTS

<<First Embodiment>>

<Configuration of Air-conditioning Hot-Water-Supply Device>

[0009] Fig. 1 is a configuration diagram including a refrigerant circuit Q of an air-conditioning hot-water-supply device W according to an embodiment.

[0010] The air-conditioning hot-water-supply device W is a device configured to perform air-conditioning and hot-water supply. Fig. 1 illustrates, as one example, a multi-type air-conditioning hot-water-supply device W including three indoor units Ui.

[0011] As illustrated in Fig. 1, the air-conditioning hot-water-supply device W includes a compressor 1, a hot-water storage tank 2, a hot-water-supply heat exchanger 3, an outdoor heat exchanger 4, an outdoor fan 5, indoor heat exchangers 6, and indoor fans 7. Moreover, in addition to the above-described configurations, the air-conditioning hot-water-supply device W includes a four-way valve 8, expansion valves 9 to 12, electromagnetic valves 13, 14, a check valve 15, and a control device 16.

[0012] The compressor 1 is equipment configured to compress low-temperature low-pressure gas refrigerant to discharge high-temperature high-pressure gas refrigerant. For example, a scroll compressor or a rotary compressor is used as the compressor 1, but the present invention is not limited to such a compressor.

[0013] The hot-water storage tank 2 is a shell-shaped member configured to store hot water. Note that although not shown in Fig. 1, a water supply pipe (not shown) for supplying water from a water supply source (not shown) to the hot-water storage tank 2 is connected to a lower portion of the hot-water storage tank 2. Moreover, a hot-water supply pipe (not shown) for taking out high-temperature water stored in the hot-water storage tank 2 is connected to an upper portion of the hot-water storage tank 2. Further, the high-temperature water flowing in the above-described hot-water supply pipe and the water supplied from the water supply pipe are mixed in a predetermined ratio, and the mixed hot water is supplied to a hot-water supply terminal (not shown).

[0014] The hot-water-supply heat exchanger 3 is a heat exchanger configured to perform heat exchange between refrigerant flowing through a heat transfer pipe 3a of the heat exchanger and hot water stored in the hot-water storage tank 2. Note that Fig. 1 illustrates an example where the hot-water-supply heat exchanger 3 is arranged inside the hot-water storage tank 2, but the present invention is not limited to such an example. That is, the hot-water-supply heat exchanger 3 may be arranged outside the hot-water storage tank 2 such that heat exchange is performed between hot water pumped from the hot-water storage tank 2 by a pump (not shown) and refrigerant flowing in the heat transfer pipe 3a.

[0015] As illustrated in Fig. 1, one end p3 of the heat transfer pipe 3a of the hot-water-supply heat exchanger 3 is connected to a discharge side of the compressor 1 through a pipe ka. Moreover, the other end q3 of the heat transfer pipe 3a is connected to one ends p6 of the indoor heat exchangers 6 through a pipe kb (a third pipe). That is, the pipe kb is branched into three pipes, and end portions thereof are connected to three indoor heat exchangers 6 in one-to-one correspondence.

[0016] The outdoor heat exchanger 4 is a heat exchanger configured to perform heat exchange between refrigerant flowing in a heat transfer pipe (not shown) of the heat exchanger and external air sent from the outdoor fan 5. One end p4 of the outdoor heat exchanger 4 is connected to one ends p6 of the indoor heat exchangers 6 sequentially through a pipe kc and the pipe kb (part thereof). The other end q4 of the outdoor heat exchanger 4 is connected to another pipe ke (a first pipe) through a pipe kd (a second pipe). The pipe ke is a pipe for connecting a suction side of the compressor 1 and the four-way valve 8.

[0017] The outdoor fan 5 is a fan configured to send external air to the outdoor heat exchanger 4, and is arranged in the vicinity of the outdoor heat exchanger 4.

[0018] The indoor heat exchanger 6 is a heat exchanger configured to perform heat exchange between refrigerant flowing in a heat transfer pipe (not shown) of the heat exchanger and indoor air (air in an air-conditioning target space) sent from the indoor fan 7. As described above, one ends p6 of three indoor heat exchangers 6 are connected to the pipe kb. The other ends q6 of three indoor heat exchangers 6 are connected to the four-way valve 8 through a pipe kf. That is, the pipe kf is branched into three pipes, and end portions thereof are connected to three indoor heat exchangers 6 in one-to-one correspondence.

[0019] The indoor fan 7 is a fan configured to send indoor air to the indoor heat exchanger 6, and is arranged in the vicinity of the indoor heat exchanger 6.

[0020] The four-way valve 8 is a valve configured to switch a refrigerant flow path in the refrigerant circuit Q according to an operation mode. A configuration of the four-way valve 8 will be described with reference to Figs. 2A and 2B.

[0021] Fig. 2A is a sectional view of the four-way valve 8 included in the air-conditioning hot-water-supply device.

[0022] As illustrated in Fig. 2A, the four-way valve 8 includes a main body 81, a valve body 82, a seat 83, a coupling plate 84, and pistons 85, 86.

[0023] The main body 81 is a cylinder configured such that the pistons 85, 86 move therein, and the outer shape thereof is a cylindrical shape. A high-pressure-side connection port hg is provided at an upper portion of the main body 81. The high-pressure-side connection port hg is a hole for connecting the discharge side of the compressor 1 (see Fig. 1) and the four-way valve 8. One end of a pipe kg is connected to the high-pressure-side connection port hg.

[0024] As illustrated in Fig. 2A, the seat 83 is placed on the opposite side (a lower side) of the high-pressure-side connection port hg in the main body 81 of the four-way valve 8. The seat 83 is a fixed member as a partner when the valve body 82 moves while sliding. An outdoor-side connection port hi, a low-pressure-side connection port he, and an indoor-side connection port hf are arranged next to each other at the seat 83 and the main body 81.

[0025] The outdoor-side connection port hi is a hole for connecting the outdoor heat exchanger 4 (see Fig. 1) and the four-way valve 8. One end of a pipe ki is connected to the outdoor-side connection port hi. Note that the other end (a connection spot m1 in Fig. 1) of the pipe ki is connected to the pipe kd on an upstream side (a side close to the outdoor heat exchanger 4) of the electromagnetic valve 13.

[0026] The low-pressure-side connection port he is a hole for connecting the suction side of the compressor 1 (see Fig. 1) and the four-way valve 8 through the check valve 15 and the like (see Fig. 1). One end of the pipe ke is connected to the low-pressure-side connection port he. Note that the other end of the pipe ke is connected to the suction side of the compressor 1.

[0027] The indoor-side connection port hf is a hole for connecting another-end-q6 side of the indoor heat exchangers 6 (see Fig. 1) and the four-way valve 8. The indoor-side connection port hf is connected to the hot-water-supply heat exchanger 3 sequentially through the pipe kf, the indoor heat exchangers 6, and the pipe kb (the third pipe).

[0028] The valve body 82 is configured to switch the flow path of the four-way valve 8 by movement of the valve body 82, and is provided inside the main body 81. As illustrated in Fig. 2A, the valve body 82 includes a curved portion 82a and a flange 82b. The curved portion 82a is curved in an inverted U-shape raised upwardly as viewed in a longitudinal section. The flange 82b is molded integrally with the curved portion 82a, and extends outward in a lateral direction from a peripheral edge of the curved portion 82a. Moreover, in the process of moving the valve body 82 in the lateral direction, the flange 82b slides on the seat 83.

[0029] The coupling plate 84 is a plate for coupling the valve body 82 and the pistons 85, 86. The coupling plate 84 is fixed to the valve body 82, and both of right and left ends thereof are fixed to the pistons 85, 86. A hole hx (a state of Fig. 2A) for connecting the outdoor-side connection port hi to an upper space of the valve body 82 and a hole hy (a state of Fig. 2B) for connecting the indoor-side connection port hf to the upper space of the valve body 82 are provided at the coupling plate 84.

[0030] The pistons 85, 86 are for moving the valve body 82 and the coupling plate 84 in a right-left direction.

[0031] For example, when at least air-cooling operation is performed, the valve body 82 is arranged at a "first position" illustrated in Fig. 2A. Thus, the high-pressure-side connection port hg and the outdoor-side connection port hi are connected to each other through the upper space of the valve body 82. Moreover, the indoor-side connection port hf and the low-pressure-side connection port he are connected to each other through a lower space of the valve body 82. Such a state of the four-way valve 8 will be hereinafter referred to as a "first state."

[0032] Fig. 2B is a sectional view illustrating another state of the four-way valve 8 included in the air-conditioning hot-water-supply device.

[0033] For example, when at least air-heating operation is performed, the valve body 82 is arranged at a "second position" illustrated in Fig. 2B. As a result, the high-pressure-side connection port hg and the indoor-side connection port hf are connected to each other through the upper space of the valve body 82. Moreover, the outdoor-side connection port hi and the low-pressure-side connection port he are connected to each other through the lower space of the valve body 82. Such a state of the four-way valve 8 will be hereinafter referred to as a "second state." Note that the configuration of the four-way valve 8 illustrated in Figs. 2A and 2B is one example, and the present invention is not limited to such a configuration.

[0034] Returning to Fig. 1, description will be continued. Note that Fig. 1 schematically illustrates the main body 81 and the valve body 82 of the four-way valve 8, and does not show other configurations of the four-way valve 8.

[0035] The expansion valve 9 illustrated in Fig. 1 is a valve to be opened upon hot-water supply operation, and is provided at the pipe ka.

[0036] Another expansion valve 10 (a first opening/closing section) is a valve to be opened when high-pressure refrigerant discharged from the compressor 1 is guided to the four-way valve 8, and is provided at the pipe kg. Note that one end of the pipe kg is connected to the high-pressure-side connection port hg. Moreover, the other end of the pipe kg is connected to the pipe ka on the upstream side of the expansion valve 9.

[0037] The expansion valve 11 (a first expansion valve) is a valve configured to depressurize refrigerant during the hot-water supply operation, and is provided at the pipe kb. More specifically, the expansion valve 11 is provided on the upstream side (a side close to the hot-water-supply heat exchanger 3) with respect to a branching point m2 of the pipe kb.

[0038] The expansion valve 12 (a second expansion valve) is a valve configured to depressurize refrigerant when the air-cooling operation or the air-heating opera-

tion is performed. The expansion valve 12 is provided in the vicinity of one end p6 of the indoor heat exchanger 6 at the pipe kb (the third pipe).

[0039] The electromagnetic valve 13 (a second opening/closing section) illustrated in Fig. 1 is a valve to be opened when the outdoor heat exchanger 4 functions as an evaporator and refrigerant evaporated in the outdoor heat exchanger 4 returns to the suction side of the compressor 1, and is provided at the pipe kd (the second pipe). Note that the electromagnetic valve 13 is a two-way valve switchable between two open and closed states (the same also applies to the electromagnetic valve 14).

[0040] Moreover, a pipe kj (a fourth pipe) illustrated in Fig. 1 is provided. One end of the pipe kj is connected to an outdoor-heat-exchanger-4 side with respect to the electromagnetic valve 13 at the pipe kd, and the other end of the pipe kj is connected to a hot-water-supply-heat-exchanger-3 side with respect to the expansion valve 11 at the pipe kb.

[0041] The electromagnetic valve 14 (a third opening/closing section) is a valve to be opened when refrigerant condensed in the hot-water-supply heat exchanger 3 is guided to the outdoor heat exchanger 4, and is provided at the pipe kj.

[0042] The check valve 15 is a valve allowing a refrigerant flow from the four-way valve 8 to the suction side of the compressor 1 through the pipe ke (the first pipe) and inhibiting a flow in an opposite direction. The check valve 15 is provided at the pipe ke connecting the low-pressure-side connection port he of the four-way valve 8 and the suction side of the compressor 1. Moreover, at the pipe ke, a downstream side of the check valve 15 and the outdoor heat exchanger 4 are connected to each other through the pipe kd.

[0043] The control device 16 illustrated in Fig. 1 is a device configured to control each type of equipment of the air-conditioning hot-water-supply device W. Although not shown in the figure, the control device 16 includes electronic circuits such as a central processing unit (CPU), a read only memory (ROM), a random access memory (RAM), and various interfaces. Moreover, a program stored in the ROM is read and loaded in the RAM, and the CPU executes various types of processing. The control device 16 controls not only the outdoor fan 5 and the indoor fans 7 but also each valve such as the four-way valve 8 based on detection values of not-shown various sensors and a signal from a remote controller.

[0044] Note that in the example illustrated in Fig. 1, the compressor 1, the outdoor heat exchanger 4, the outdoor fan 5, the four-way valve 8, the expansion valves 9 to 11, the electromagnetic valves 13, 14, the check valve 15, the control device 16 and the like are provided in an outdoor unit Uo. On the other hand, the indoor heat exchanger 6 and the indoor fan 7 are provided in the indoor unit Ui.

[0045] Fig. 3 is a functional block diagram including the control device 16 of the air-conditioning hot-water-supply device.

[0046] As illustrated in Fig. 3, the control device 16 includes a compressor control section 16a, a fan control section 16b, and a valve control section 16c.

[0047] The compressor control section 16a controls the compressor 1 based on the detection valve ("SENSOR INPUT" illustrated in Fig. 3) of each sensor and the signal ("REMOTE CONTROLLER INPUT" illustrated in Fig. 3) from the remote controller.

[0048] The fan control section 16b controls the outdoor fan 5 and the indoor fans 7 based on, e.g., the detection value of each sensor.

[0049] The valve control section 16c controls the four-way valve 8, the expansion valves 9 to 12, and the electromagnetic valve 13 based on, e.g., the detection value of each sensor.

[0050] Note that Fig. 3 illustrates an example where the control device 16 provided in the outdoor unit Uo (see Fig. 1) controls each type of equipment, but the present invention is not limited to such an example. That is, different control devices (not shown) may be each provided at three indoor units Ui (see Fig. 1), and predetermined communication with the control device 16 of the outdoor unit Uo may be performed.

[0051] Next, each operation mode of the air-conditioning hot-water-supply device W will be described.

<Independent Air-Cooling Operation>

[0052] Fig. 4 is a diagram for describing the state of each valve and a refrigerant flow in independent air-cooling operation.

[0053] Note that the "independent air-cooling operation" is an operation mode for independently performing the air-cooling operation without a refrigerant flow in the hot-water-supply heat exchanger 3. Fig. 4 illustrates the expansion valves 9, 11 and the electromagnetic valves 13, 14 in the closed state by hatching (shading), and illustrates the expansion valve 10 in an open state and the expansion valves 12 targeted for opening degree adjustment by the color of white (the same also applies to Figs. 5 to 8). Further, Fig. 4 illustrates, by a thick line, the flow path in which refrigerant circulates.

[0054] When the independent air-cooling operation is performed, the control device 16 brings the four-way valve 8 into the "first state" (see Fig. 2A) as illustrated in Fig. 4. Further, the control device 16 closes the expansion valves 9, 11 and the electromagnetic valves 13, 14, and on the other hand, opens (substantially fully opens) the expansion valve 10 and adjusts the degrees of opening of three expansion valves 12 as necessary.

[0055] Accordingly, no refrigerant flows in the hot-water-supply heat exchanger 3. Moreover, the outdoor heat exchanger 4 functions as a condenser, and the indoor heat exchangers 6 function as evaporators. Then, refrigerant discharged from the compressor 1 returns to the suction side of the compressor 1 sequentially through the four-way valve 8, the outdoor heat exchanger 4 (the condenser), the expansion valves 12, the indoor heat

exchangers 6 (the evaporators), the four-way valve 8, and the check valve 15. As a result, air in the air-conditioning target space (not shown) in which the indoor unit Ui is provided is cooled.

<Air-Cooling Hot-Water-Supply Operation>

[0056] Fig. 5 is a diagram for describing the state of each valve and a refrigerant flow in air-cooling hot-water-supply operation.

[0057] Note that the "air-cooling hot-water-supply operation" is an operation mode for performing the air-cooling operation while causing refrigerant to flow in the hot-water-supply heat exchanger 3 to perform hot-water boiling or additional hot-water boiling.

[0058] When the air-cooling hot-water-supply operation is performed, the control device 16 maintains the four-way valve 8 in the "first state" (see Fig. 2A) as illustrated in Fig. 5. Further, the control device 16 closes the expansion valves 10, 11 and the electromagnetic valve 13, and on the other hand, opens the expansion valve 9 and the electromagnetic valve 14 and adjusts the degrees of opening of the expansion valves 12 as necessary.

[0059] Accordingly, the hot-water-supply heat exchanger 3 and the outdoor heat exchanger 4 function as the condensers, and on the other hand, the indoor heat exchangers 6 serve as the evaporators. Then, refrigerant discharged from the compressor 1 returns to the suction side of the compressor 1 sequentially through the four-way valve 8, the expansion valve 9, the hot-water-supply heat exchanger 3 (the condenser), the electromagnetic valve 14, the outdoor heat exchanger 4 (the condenser), the expansion valves 12, the indoor heat exchangers 6 (the evaporators), the four-way valve 8, and the check valve 15. Accordingly, part of heat of the refrigerant discharged from the compressor 1 can be used for hot-water supply, and the remaining heat can be used for air-cooling.

[0060] Note that during the air-cooling hot-water-supply operation, in a case where the temperature of hot water stored in the hot-water storage tank 2 reaches equal to or higher than a predetermined value, the control device 16 maintains the four-way valve 8 in the "first state" (see Fig. 2A) while switching the operation to the independent air-cooling operation (see Fig. 4).

<First Independent Hot-Water Supply Operation>

[0061] Fig. 6 is a diagram for describing the state of each valve and a refrigerant flow in first independent hot-water supply operation.

[0062] Note that the "first independent hot-water supply operation" is an operation mode for bringing the four-way valve 8 into the "first state" (see Fig. 2A) to independently perform hot-water boiling or additional hot-water boiling without performing air-conditioning operation.

[0063] When the first independent hot-water supply operation is performed, the control device 16 brings the four-way valve 8 into the "first state" (see Fig. 2A) as illustrated in Fig. 6. For example, in a case where the independent air-cooling operation (see Fig. 4) is switched to the first independent hot-water supply operation or a case where the air-cooling hot-water-supply operation (see Fig. 5) is switched to the first independent hot-water supply operation, the control device 16 maintains the four-way valve 8 in the "first state."

[0064] Accordingly, even when the operation mode is switched during the summertime, it is enough to maintain the four-way valve 8 in the "first state," and therefore, it is not necessary to temporarily stop a refrigeration cycle (i.e., stop the compressor 1). Thus, the operation mode can be quickly switched during the summertime, and therefore, user's comfortability can be enhanced.

[0065] When the first independent hot-water supply operation is performed, the control device 16 closes the expansion valves 10, 12 and the electromagnetic valve 14, and on the other hand, opens the electromagnetic valve 13 and adjusts the degree of opening of the expansion valve 11 as necessary. Accordingly, the hot-water-supply heat exchanger 3 functions as the condenser, and on the other hand, the outdoor heat exchanger 4 serves as the evaporator. That is, refrigerant discharged from the compressor 1 circulates, in the refrigerant circuit Q, sequentially through the hot-water-supply heat exchanger 3 (the condenser), the expansion valve 11 (the first expansion valve), the outdoor heat exchanger 4 (the evaporator), and the electromagnetic valve 13.

[0066] Moreover, during the first independent hot-water supply operation, the four-way valve 8 is in the "first state." Thus, the indoor heat exchangers 6 are connected to the pipe ke (the first pipe) sequentially through the pipe kf and the indoor-side connection port hf and the low-pressure-side connection port he of the four-way valve 8. In other words, the valve body 82 of the four-way valve 8 is present at the "first position" at which the other-end-q6 side of the indoor heat exchangers 6 for which the refrigerant flow is blocked on a one-end-p6 side and the pipe ke (the first pipe) are connected to each other.

[0067] Further, during the first independent hot-water supply operation, the expansion valve 10 is in a closed state. That is, the expansion valve 10 (the first opening/closing section) blocks between the high-pressure-side connection port hg of the four-way valve 8 and the discharge side of the compressor 1. Thus, in the four-way valve 8, almost no high-pressure refrigerant flows into the upper space of the valve body 82.

[0068] In such first independent hot-water supply operation, the pressure of pressing the valve body 82 from above against the seat 83 (see Fig. 2A) of the four-way valve 8 is weakened. Note that in the summertime in which the first independent hot-water supply operation is often performed, the temperature of external air is higher than the temperature of air in the air-conditioning target space cooled by air-cooling in many cases. Moreover, in the main body 81 of the four-way valve 8, the upper (out-

er) space of the valve body 82 is connected to the outdoor heat exchanger 4 through, e.g., the outdoor-side connection port hi. On the other hand, the lower (inner) space of the valve body 82 is connected to the indoor heat exchangers 6 through, e.g., the indoor-side connection port hf. Thus, the temperature and the pressure tend to be higher on the upper side than on the lower side of the valve body 82.

[0069] As a result, the valve body 82 is pressed from above against the seat 83 (see Fig. 2A) of the four-way valve 8, and therefore, there is almost no clearance between the seat 83 and the valve body 82. Thus, almost no refrigerant flowing from the outdoor heat exchanger 4 through the pipe kd flows out to the indoor heat exchangers 6 sequentially through the pipe ki, the four-way valve 8, and the pipe kf.

[0070] On the other hand, the upstream side of the pipe ke is connected to the indoor heat exchangers 6 sequentially through the low-pressure-side connection port he, the indoor-side connection port hf, and the pipe kf. If no check valve 15 is provided at the pipe ke, gas refrigerant evaporated in the outdoor heat exchanger 4 might flow into the indoor heat exchangers 6 sequentially through the pipe kd, the pipe ke (part thereof), the low-pressure-side connection port he, the indoor-side connection port hf, and the pipe kf. As a result, much refrigerant is uselessly stored in the indoor heat exchangers 6, and for this reason, there is a probability that the efficiency of the refrigeration cycle is degraded.

[0071] On the other hand, in the present embodiment, the check valve 15 is provided at the pipe ke connecting the low-pressure-side connection port he of the four-way valve 8 and the suction side of the compressor 1. This can suppress, even in the case of performing the first independent hot-water supply operation, gas refrigerant evaporated in the outdoor heat exchanger 4 from flowing out to the indoor heat exchangers 6 through the four-way valve 8, and therefore, the efficiency of the refrigeration cycle can be enhanced.

[0072] Moreover, in the present embodiment, switching from one of a state (the first independent hot-water supply operation: see Fig. 6) in which refrigerant circulates sequentially through the compressor 1, the hot-water-supply heat exchanger 3, the expansion valve 11 (the first expansion valve), and the outdoor heat exchanger 4 or another state (the independent air-cooling operation or the air-cooling hot-water-supply operation: see Figs. 4 and 5) in which the outdoor heat exchanger 4 functions as the condenser and the indoor heat exchangers 6 function as the evaporators to the other one of these states can be made. Further, when switching from one state to the other state is made, the position of the valve body 82 of the four-way valve 8 is maintained at the "first position" (see Fig. 2A). Thus, as described above, the operation mode can be quickly switched, and the user's comfortability can be enhanced.

[0073] In addition, during the first independent hot-water supply operation, the electromagnetic valve 13 (the second opening/closing section) is opened. Thus, the outdoor heat exchanger 4 and the suction side of the compressor 1 are connected to each other sequentially through the pipe kd and the pipe ke (part thereof). Consequently, refrigerant evaporated in the outdoor heat exchanger 4 can return to the suction side of the compressor 1.

[0074] Moreover, during the first independent hot-water supply operation, the expansion valves 12 (the second expansion valves) and the electromagnetic valve 14 (the third opening/closing section) are all closed. Thus, the outdoor heat exchanger 4 can function as the evaporator while the refrigerant flow to the indoor heat exchangers 6 is blocked.

<Independent Air-Heating Operation>

[0075] Next, although not shown in the figure, "independent air-heating operation" for independently performing the air-heating operation without a refrigerant flow in the hot-water-supply heat exchanger 3 will be briefly described.

[0076] When the independent air-heating operation is performed, the control device 16 brings the four-way valve 8 into the "second state" (see Fig. 2B) and closes the expansion valves 9, 11 and the electromagnetic valve 14, and on the other hand, opens the expansion valve 10 and the electromagnetic valve 13 and adjusts the degrees of opening of the expansion valves 12 as necessary. Accordingly, the indoor heat exchangers 6 function as the condensers, and the outdoor heat exchanger 4 functions as the evaporator. Thus, air in the air-conditioning target space (not shown) is heated.

<Air-Heating Hot-Water-Supply Operation>

[0077] Fig. 7 is a diagram for describing the state of each valve and a refrigerant flow in air-heating hot-water-supply operation.

[0078] Note that the "air-heating hot-water-supply operation" is an operation mode for performing the air-heating operation while causing refrigerant to flow in the hot-water-supply heat exchanger 3 to perform hot-water boiling or additional hot-water boiling.

[0079] When the air-heating hot-water-supply operation is performed, the control device 16 brings the four-way valve 8 into the "second state" (see Fig. 2B) as illustrated in Fig. 7. Further, the control device 16 closes the electromagnetic valve 14, opens the expansion valves 9, 10 and the electromagnetic valve 13, and adjusts the degrees of opening of the expansion valves 11, 12 as necessary.

[0080] Accordingly, the hot-water-supply heat exchanger 3 and the indoor heat exchangers 6 function as the condensers, and the outdoor heat exchanger 4 functions as the evaporator. Then, refrigerant discharged from the compressor 1 is guided to the hot-water-supply heat exchanger 3 through the expansion valve 9, and is

also guided to the four-way valve 8 through another expansion valve 10. The refrigerant guided from the compressor 1 to the hot-water-supply heat exchanger 3 (the condenser) is guided to the pipe kc through the expansion valve 11 while the refrigerant guided from the compressor 1 to the four-way valve 8 is guided to the pipe kc sequentially through the indoor heat exchangers 6 (the condensers) and the expansion valves 12.

[0081] Part of the refrigerant evaporated in the outdoor heat exchanger 4 (the evaporator) after having joined together at the pipe kc returns to the suction side of the compressor 1 through the electromagnetic valve 13. Meanwhile, the remaining refrigerant evaporated in the outdoor heat exchanger 4 (the evaporator) returns to the suction side of the compressor 1 sequentially through the four-way valve 8 and the check valve 15. Thus, part of heat of the refrigerant discharged from the compressor 1 can be used for hot-water supply, and the remaining heat can be used for air-heating.

<Second Independent Hot-Water Supply Operation>

[0082] Fig. 8 is a diagram for describing the state of each valve and a refrigerant flow in second independent hot-water supply operation.

[0083] Note that the "second independent hot-water supply operation" is an operation mode for bringing the four-way valve 8 into the "second state" (see Fig. 2B) to independently perform hot-water boiling or additional hot-water boiling without performing the air-conditioning operation.

[0084] When the second independent hot-water supply operation is performed, the control device 16 brings the four-way valve 8 into the "second state" (see Fig. 2B) as illustrated in Fig. 8. For example, in a case where the independent air-heating operation is switched to the second independent hot-water supply operation or a case where the air-heating hot-water-supply operation (see Fig. 7) is switched to the second independent hot-water supply operation, the control device 16 maintains the four-way valve 8 in the "second state."

[0085] Accordingly, even when the operation mode is switched during the wintertime, the four-way valve 8 can be maintained in the "second state," and therefore, it is not necessary to temporarily stop the refrigeration cycle (i.e., stop the compressor 1). Thus, the operation mode can be quickly switched during the wintertime, and therefore, the user's comfortability can be enhanced.

[0086] When the second independent hot-water supply operation is performed, the control device 16 closes the expansion valves 10, 12 and the electromagnetic valve 14, and on the other hand, opens the expansion valve 9 and the electromagnetic valve 13 and adjusts the degree of opening of the expansion valve 11 as necessary. Accordingly, the hot-water-supply heat exchanger 3 functions as the condenser, and on the other hand, the outdoor heat exchanger 4 functions as the evaporator. Refrigerant discharged from the compressor 1 circulates, in the refrigerant circuit Q, sequentially through the hot-water-supply heat exchanger 3 (the condenser), the expansion valve 11 (the first expansion valve), the outdoor heat exchanger 4 (the evaporator), and the electromagnetic valve 13. Note that part of the refrigerant evaporated in the outdoor heat exchanger 4 returns to the suction side of the compressor 1 sequentially through the four-way valve 8 and the check valve 15.

[0087] Moreover, during the second independent hot-water supply operation, the four-way valve 8 is in the "second state." Thus, the outdoor heat exchanger 4 is connected to the pipe ke (the first pipe) sequentially through the pipe kd (part thereof) and the outdoor-side connection port hi and the low-pressure-side connection port he of the four-way valve 8. In other words, the valve body 82 of the four-way valve 8 is at the "second position" at which the outdoor heat exchanger 4 and the pipe ke (the first pipe) are connected to each other.

[0088] Further, during the second independent hot-water supply operation, the expansion valve 10 is in the closed state. That is, the expansion valve 10 (the first opening/closing section) blocks between the high-pressure-side connection port hg of the four-way valve 8 and the discharge side of the compressor 1. Thus, in the four-way valve 8, almost no high-pressure refrigerant flows into the upper space of the valve body 82.

[0089] In such second independent hot-water supply operation, the pressure of pressing the valve body 82 against the seat 83 (see Fig. 2B) is weakened. Note that in the wintertime in which the second independent hot-water supply operation is often performed, the temperature of external air is lower than the temperature of air in the air-conditioning target space heated by air-heating in many cases. Moreover, in the main body 81 of the four-way valve 8, the upper (outer) space of the valve body 82 is connected to the indoor heat exchangers 6 through, e.g., the indoor-side connection port hf. On the other hand, the lower (inner) space of the valve body 82 is connected to the outdoor heat exchanger 4 through, e.g., the outdoor-side connection port hi. Thus, the temperature and the pressure tend to be higher on the upper side than on the lower side of the valve body 82. As a result, the valve body 82 is pressed from above against the seat 83 (see Fig. 2B) of the four-way valve 8, and therefore, there is almost no clearance between the seat 83 and the valve body 82.

[0090] In addition, the check valve 15 is placed to allow the refrigerant flow from the four-way valve 8 to the suction side of the compressor 1 through the pipe ke and inhibit the flow in the opposite direction. Thus, there is no probability that the flow of refrigerant toward the suction side of the compressor 1 sequentially through the pipe kd (part thereof), the pipe ki, the outdoor-side connection port hi, the low-pressure-side connection port he, and the pipe ke is blocked by the check valve 15.

[0091] Moreover, in the present embodiment, switching from one of a state (the second independent hot-water supply operation: see Fig. 8) in which refrigerant

circulates sequentially through the compressor 1, the hot-water-supply heat exchanger 3, the expansion valve 11 (the first expansion valve), and the outdoor heat exchanger 4 or another state (the independent air-heating operation or the air-heating hot-water-supply operation: see Fig. 7) in which the indoor heat exchangers 6 function as the condensers and the outdoor heat exchanger 4 functions as the evaporator to the other one of these states can be made. Further, when switching from one state to the other state is made, the position of the valve body 82 of the four-way valve 8 is maintained at the "second position" (see Fig. 2B). Thus, as described above, the operation mode can be quickly switched, and the user's comfortability can be enhanced.

[0092] Further, during the second independent hot-water supply operation, the electromagnetic valve 13 (the second opening/closing section) is opened. Thus, refrigerant evaporated in the outdoor heat exchanger 4 can return to the suction side of the compressor 1 through the electromagnetic valve 13.

[0093] In addition, during the second independent hot-water supply operation, the expansion valves 12 (the second expansion valves) and the electromagnetic valve 14 (the third opening/closing section) are all closed. Thus, the outdoor heat exchanger 4 can function as the evaporator while the refrigerant flow to the indoor heat exchangers 6 is blocked.

[0094] Moreover, when at least the air-cooling operation (the independent air-cooling operation, freezing hot-water-supply operation: see Figs. 4 and 5) is performed, the valve body 82 is arranged at the "first position" illustrated in Fig. 2A in the four-way valve 8. On the other hand, when at least the air-heating operation (the independent air-heating operation, the air-heating hot-water-supply operation: see Fig. 7) is performed, the valve body 82 is arranged at the "second position" illustrated in Fig. 2B.

[0095] Further, the position of the valve body 82 of the four-way valve 8 during the independent hot-water supply operation is different between the case of performing at least the air-cooling operation before the start of the independent hot-water supply operation (i.e., as the operation mode right before the start of the independent hot-water supply operation) and the case of performing at least the air-heating operation before the start of the independent hot-water supply operation.

[0096] For example, at least the air-cooling operation (see Figs. 4 and 5) is performed before the start of the first independent hot-water supply operation (see Fig. 6) in a case where the valve body 82 of the four-way valve 8 is at the "first position" (see Fig. 2A). On the other hand, at least the air-heating operation (see Fig. 7) is performed before the start of the second independent hot-water supply operation (see Fig. 8) in a case where the valve body 82 of the four-way valve 8 is at the "second position" (see Fig. 2B). Thus, the valve body 82 of the four-way valve 8 can be maintained at the "first position" during the summertime, and on the other hand, can be maintained at the "second position" during the wintertime. Consequently, in any of the summertime and the wintertime, the operation mode of the air-conditioning hot-water-supply device W can be quickly switched without changing the state of the four-way valve 8.

<<Defrosting Operation>>

[0097] In a case where a great amount of frost adheres to the outdoor heat exchanger 4 functioning as the evaporator, degradation of a heat exchange efficiency is preferably suppressed in such a manner that the frost is melted by the flow of high-temperature refrigerant in the heat transfer pipe (not shown) of the outdoor heat exchanger 4. First defrosting operation and second defrosting operation will be sequentially described below as such defrosting operation.

<First Defrosting Operation>

[0098] The first defrosting operation is an operation mode for melting frost on the outdoor heat exchanger 4 by means of heat of hot water in the hot-water storage tank 2. Note that the open/closed state of each valve in the first defrosting operation is similar to that in the air-heating hot-water-supply operation (see Fig. 7), except for the degrees of opening of the expansion valves 9 to 12. Thus, the first defrosting operation will be described with reference to Fig. 7. Note that at the start of the first defrosting operation, the temperature of hot water stored in the hot-water storage tank 2 is relatively high.

[0099] When the first defrosting operation is performed, the control device 16 brings the four-way valve 8 into the "second state" (see Fig. 2B) as illustrated in Fig. 7. Further, the control device 16 closes the electromagnetic valve 14, and on the other hand, opens the electromagnetic valve 13 and adjusts the degrees of opening of the expansion valves 9 to 12 as necessary. Note that the degree of opening of the expansion valve 11 is substantially fully open.

[0100] For example, when the air-heating operation transitions to the first defrosting operation, the control device 16 controls each valve including the four-way valve 8 as described above, and brings the expansion valve 11 in the closed state during the air-heating operation into a substantially fully-open state. Accordingly, high-temperature refrigerant present in the hot-water-supply heat exchanger 3 flows into the outdoor heat exchanger 4 sequentially through the pipe kb (part thereof) and the pipe kc. Thus, frost adhering to the outdoor heat exchanger 4 is melted.

[0101] That is, during the defrosting operation for defrosting the outdoor heat exchanger 4, the valve body 82 of the four-way valve 8 is at the "second position" (see Fig. 2B), and refrigerant circulates sequentially through the compressor 1, the hot-water-supply heat exchanger 3, the expansion valve 11 (the first expansion valve), and the outdoor heat exchanger 4.

[0102] Further, refrigerant circulates sequentially through the compressor 1, the expansion valve 10 (the first opening/closing section) in the open state, the four-way valve 8, the indoor heat exchangers 6, the expansion valves 12 (the second expansion valves), and the outdoor heat exchanger 4. Accordingly, the air-heating operation can be continued while defrosting of the outdoor heat exchanger 4 is performed. Note that a state in which the degree of opening of the expansion valve 10 is adjusted to a predetermined degree is also included in the above-described "open state."

[0103] In addition, it is not necessary to move the valve body 82 of the four-way valve 8 upon transition from one of the air-heating operation or the first defrosting operation to the other one of the air-heating operation or the first defrosting operation, and therefore, the operation mode can be quickly switched. Thus, the user's comfortability can be enhanced.

<Second Defrosting Operation>

[0104] Fig. 9 is a diagram for describing the state of each valve and a refrigerant flow in the second defrosting operation.

[0105] Note that the "second defrosting operation" is an operation mode for causing the outdoor heat exchanger 4 to function as the condenser to perform defrosting and defrosting the outdoor heat exchanger 4 by means of heat of hot water of the hot-water storage tank 2. Note that at the start of the second defrosting operation, the temperature of hot water stored in the hot-water storage tank 2 is relatively high.

[0106] When the second defrosting operation is performed, the control device 16 brings the four-way valve 8 into the "first state" (see Fig. 2A) as illustrated in Fig. 9. Further, the control device 16 closes the expansion valve 11 and the electromagnetic valve 13, and on the other hand, opens the electromagnetic valve 14 and adjusts the degrees of opening of the expansion valves 9, 10, 12 as necessary.

[0107] For example, when the air-heating operation transitions to the second defrosting operation, if the electromagnetic valve 14 in the closed state during the air-heating operation is opened, high-temperature refrigerant present in the hot-water-supply heat exchanger 3 flows into the outdoor heat exchanger 4 sequentially through the pipe kb (part thereof), the pipe kj, and the pipe kd (part thereof). Thus, frost adhering to the outdoor heat exchanger 4 is melted.

[0108] That is, during the defrosting operation for defrosting the outdoor heat exchanger 4, refrigerant flowing sequentially through the compressor 1 and the hot-water-supply heat exchanger 3 flows around the expansion valve 11 (the first expansion valve), and further circulates sequentially through the outdoor heat exchanger 4, the expansion valves 12 (the second expansion valves), the indoor heat exchangers 6, the four-way valve 8, and the check valve 15. In this case, the valve body 82 of the four-way valve 8 is at the "first position" at which the other-end-q6 side of the indoor heat exchangers 6 and the pipe ke (the first pipe) are connected to each other. Thus, the outdoor heat exchanger 4 functions as the condenser.

[0109] As a result, frost on the outdoor heat exchanger 4 is quickly melted in combination with high-temperature refrigerant guided from the hot-water-supply heat exchanger 3 to the outdoor heat exchanger 4. Thus, in the second defrosting operation, defrosting of the outdoor heat exchanger 4 can be performed in shorter time than that in the first defrosting operation.

[0110] Note that the defrosting operation for the outdoor heat exchanger 4 is not limited to the above-described control. For example, defrosting of the outdoor heat exchanger 4 may be performed in such a manner that the flow of refrigerant to the hot-water-supply heat exchanger 3 is blocked by the expansion valve 9 to cause the outdoor heat exchanger 4 to function as the condenser and cause the indoor heat exchangers 6 to function as the evaporators.

<Advantageous Effects>

[0111] According to the present embodiment, the check valve 15 allows the flow of refrigerant from the four-way valve 8 toward the suction side of the compressor 1 through the pipe ke, and inhibits the flow in the opposite direction. This can suppress gas refrigerant evaporated in the outdoor heat exchanger 4 from flowing out to the indoor heat exchangers 6 through the four-way valve 8 when the first independent hot-water supply operation (see Fig. 6) or the second independent hot-water supply operation (see Fig. 8) is performed. Thus, the efficiency of the refrigeration cycle can be enhanced.

[0112] Moreover, when a state (see Figs. 4 and 5) in which at least the air-cooling operation is performed is switched to the first independent hot-water supply operation (see Fig. 6), the four-way valve 8 is maintained in the "first state" (see Fig. 2A). On the other hand, when a state (see Fig. 7) in which at least the air-heating operation is performed is switched to the second independent hot-water supply operation (see Fig. 8), the four-way valve 8 is maintained in the "second state" (see Fig. 2B). Thus, the operation mode can be quickly switched, and therefore, the user's comfortability can be enhanced.

<<Variations>>

[0113] The air-conditioning hot-water-supply device W according to the present invention has been described above in the embodiment, but the present invention is not limited to such description and various changes can be made.

[0114] For example, in the embodiment (see Fig. 1), the configuration in which the expansion valve 9 is provided at the pipe ka and the expansion valve 10 (the first opening/closing section) is provided at another pipe kg has been described. However, the expansion valves 9,

10 are not necessarily provided as independent valves. That is, instead of the expansion valves 9, 10, a three-way valve (the first opening/closing section) may be provided at a connection spot between the pipes ka, kg, or a four-way valve (the first opening/closing section) may be provided. Even with this configuration, advantageous effects similar to those of the embodiment are provided.

[0115] Moreover, an electromagnetic valve (not shown) may be provided instead of the expansion valve 9 described in the embodiment (see Fig. 1), and an electromagnetic valve (the first opening/closing section: not shown) may be provided instead of another expansion valve 10. Note that an open/closed state of each of the above-described electromagnetic valves in each operation mode is similar to the open/closed state of the expansion valves 9, 10.

[0116] Further, in the embodiment (see Fig. 1), the configuration in which the check valve 15 is provided at the pipe ke has been described, but the present invention is not limited to such a configuration. For example, instead of the check valve 15, an expansion valve (not shown) may be provided at the pipe ke. Moreover, when the first independent hot-water supply operation (see Fig. 6) or the second independent hot-water supply operation (see Fig. 8) is performed, the control device 16 may close the above-described expansion valve (not shown). Even this configuration can suppress gas refrigerant evaporated in the outdoor heat exchanger 4 from flowing out to the indoor heat exchangers 6 through the four-way valve 8.

[0117] In addition, the configuration of the air-conditioning hot-water-supply device W described in the embodiment is one example, and the present invention is not limited to such a configuration. For example, the electromagnetic valve 13 or the like may be omitted as necessary. That is, the air-conditioning hot-water-supply device W including the refrigerant circuit Q having the flow path (see Figs. 6 and 8) for refrigerant circulation sequentially through the compressor 1, the hot-water-supply heat exchanger 3, the expansion valve 11 (the first expansion valve), and the outdoor heat exchanger 4 further includes the following configuration. That is, the air-conditioning hot-water-supply device W includes the four-way valve 8 having the main body 81 and the valve body 82 provided inside the main body 81 and configured to switch the refrigerant flow path in the refrigerant circuit Q and the check valve 15 provided at the pipe ke (the first pipe) connecting the low-pressure-side connection port he of the four-way valve 8 and the suction side of the compressor 1. Moreover, the expansion valve 10 (the first opening/closing section) blocks between the high-pressure-side connection port hg of the four-way valve 8 and the discharge side of the compressor 1, and the check valve 15 allows the refrigerant flow from the four-way valve 8 to the suction side of the compressor 1 through the pipe ke (the first pipe) and inhibits the flow in the opposite direction. Thus, the independent hot-water supply operation in the air-conditioning hot-water-supply device W can be properly performed.

[0118] Moreover, in the embodiment, the processing of maintaining the valve body 82 of the four-way valve 8 at the "first position" (see Fig. 2A) by the control device 16 in the case of the performing the independent hot-water supply operation after at least the air-cooling operation has been performed has been described, but the present invention is not limited to such processing.

[0119] That is, in the case of performing the independent hot-water supply operation for heating hot water by the hot-water-supply heat exchanger 3, when the temperature of the indoor heat exchanger 6 is lower than that of the outdoor heat exchanger 4 or the temperature of the air-conditioning target space of the indoor heat exchanger 6 is lower than that of external air, the control device 16 may perform the following processing. That is, in a state in which the valve body 82 of the four-way valve 8 is at the "first position" (see Fig. 2A), the control device 16 may cause refrigerant to circulate sequentially through the compressor 1, the hot-water-supply heat exchanger 3, the expansion valve 11 (the first expansion valve), and the outdoor heat exchanger 4 as illustrated in Fig. 6.

[0120] Suppose that a temperature sensor (not shown) is placed at each of the outdoor heat exchanger 4 and the indoor heat exchangers 6 and an indoor temperature sensor (not shown) configured to detect the temperature of the air-conditioning target space and an outdoor temperature sensor (not shown) configured to detect the external air temperature are placed.

[0121] As described above, when the temperature of the indoor heat exchanger 6 is lower than that of the outdoor heat exchanger 4, the control device 16 brings the valve body 82 of the four-way valve 8 into the "first position," and in this manner, the pressure tends to be higher on the upper side (the outside) than on the lower side (the inside) of the valve body 82. Thus, it is less likely to cause a clearance between the valve body 82 and the seat 83 (see Fig. 2A), and therefore, outflow of refrigerant from the outdoor heat exchanger 4 to indoor heat exchanger 8 through the four-way valve 8 can be suppressed.

[0122] Moreover, in a case where the multiple indoor heat exchangers 6 are connected in parallel with the outdoor heat exchanger 4 and the independent hot-water supply operation for heating hot water by the hot-water-supply heat exchanger 3 is performed, the control device 16 preferably performs the following processing. That is, when there is at least one of the multiple indoor heat exchangers 6 having a lower temperature than that of the outdoor heat exchanger 4 or when there is at least one of the air-conditioning target spaces of the multiple indoor heat exchangers 6 having a lower temperature than that of external air, the control device 16 causes refrigerant to circulate sequentially through the compressor 1, the hot-water-supply heat exchanger 3, the expansion valve 11 (the first expansion valve), and the outdoor heat exchanger 4 in a state in which the valve body 82 of the four-way valve 8 is at the "first position" (see Fig. 2A). Thus, the pressure tends to be higher on the upper

side than on the lower side of the valve body 82, and it is less likely to cause the clearance between the valve body 82 and the seat 83 (see Fig. 2A).

[0123] Further, in the case of performing the independent hot-water supply operation for heating hot water by the hot-water-supply heat exchanger 3, when a difference between the temperature of the indoor heat exchanger 6 and the temperature of the outdoor heat exchanger 4 is within a predetermined range and the valve body 82 of the four-way valve 8 is at the "first position" (see Fig. 2A) before the start of the independent hot-water supply operation (i.e., in a case where at least the air-cooling operation is performed right before the independent hot-water supply operation), the control device 16 preferably performs the following processing. That is, the control device 16 maintains the valve body 82 at the "first position," and causes refrigerant to circulate sequentially through the compressor 1, the hot-water-supply heat exchanger 3, the expansion valve 11 (the first expansion valve), and the outdoor heat exchanger 4. Thus, switching to the independent hot-water supply operation can be quickly made without movement of the valve body 82 of the indoor heat exchanger 8.

[0124] In addition, in the case of performing the independent hot-water supply operation for heating hot water by the hot-water-supply heat exchanger 3, when the temperature of the indoor heat exchanger 6 is higher than that of the outdoor heat exchanger 4 or when the temperature of the air-conditioning target space of the indoor heat exchanger 6 is higher than that of external air, the control device 16 preferably performs the following processing. That is, in a state in which the valve body 82 of the four-way valve 8 is at the "second position" (see Fig. 2B), the control device 16 causes, as illustrated in Fig. 8, refrigerant to circulate sequentially through the compressor 1, the hot-water-supply heat exchanger 3, the expansion valve 11 (the first expansion valve), and the outdoor heat exchanger 4.

[0125] As described above, when the temperature of the indoor heat exchanger 6 is higher than that of the outdoor heat exchanger 4, the control device 16 brings the valve body 82 of the four-way valve 8 into the "second position," and therefore, the pressure tends to be higher on the upper side than on the lower side of the valve body 82. Thus, it is less likely to cause the clearance between the valve body 82 and the seat 83 (see Fig. 2B), and therefore, outflow of refrigerant from the outdoor heat exchanger 4 to the four-way valve 8 through the four-way valve 8 can be suppressed.

[0126] Moreover, in a case where the multiple indoor heat exchangers 6 are connected in parallel with the outdoor heat exchanger 4 and the independent hot-water supply operation for heating hot water by the hot-water-supply heat exchanger 3 is performed, the control device 16 preferably performs the following processing. That is, when all of the temperatures of the multiple indoor heat exchangers 6 are higher than that of the outdoor heat exchanger 4 or when all of the temperatures of the air-conditioning target spaces of the multiple indoor heat exchangers 6 are higher than that of external air, the control device 16 causes refrigerant to circulate sequentially through the compressor 1, the hot-water-supply heat exchanger 3, the expansion valve 11 (the first expansion valve), and the outdoor heat exchanger 4 in a state in which the valve body 82 of the four-way valve 8 is at the "second position" (see Fig. 2B). Thus, the pressure tends to be higher on the upper side than on the lower side of the valve body 82, and it is less likely to cause the clearance between the valve body 82 and the seat 83 (see Fig. 2B).

[0127] Further, in the case of performing the independent hot-water supply operation for heating hot water by the hot-water-supply heat exchanger 3, when the difference between the temperature of the indoor heat exchanger 6 and the temperature of the outdoor heat exchanger 4 is within the predetermined range and the valve body 82 of the four-way valve 8 is at the "second position" (see Fig. 2B) before the start of the independent hot-water supply operation (i.e., in a case where at least the air-heating operation is performed right before the independent hot-water supply operation), the control device 16 preferably performs the following processing. That is, the control device 16 maintains the valve body 82 at the "second position," and causes refrigerant to circulate sequentially through the compressor 1, the hot-water-supply heat exchanger 3, the expansion valve 11 (the first expansion valve), and the outdoor heat exchanger 4. Thus, switching to the independent hot-water supply operation can be quickly made without movement of the valve body 82 of the four-way valve 8.

[0128] In addition, in the case of performing the independent hot-water supply operation, the valve body 82 of the four-way valve 8 may be arranged at the "first position" (see Fig. 2A) regardless of the previous operation mode. In this case, in, e.g., the wintertime in which the temperature of external air tends to be lower than the temperature of the air-conditioning target space, the pressure of the lower side (the inside) of the valve body 82 of the four-way valve 8 might be slightly higher than that of the upper side (the outside) of the valve body 82. In this case, there is a probability that the clearance is caused between the valve body 82 and the seat 83 (see Fig. 2A) and gas refrigerant evaporated in the outdoor heat exchanger 4 flows out to the indoor heat exchangers 6 through the above-described clearance. However, in the wintertime in which the indoor heat exchanger 6 often functions as the condenser, the indoor heat exchanger 6 is filled with gas refrigerant. Thus, even if gas refrigerant leaks to a certain extent to the indoor heat exchangers 6 through the clearance caused at the four-way valve 8, the refrigerant pressure reaches a balanced state (a pressure equalization state), and refrigerant leakage is promptly stopped. This causes no particular problem.

[0129] Moreover, in the embodiment (see Fig. 1), the multi-type air-conditioning hot-water-supply device W provided with three indoor units Ui has been described,

but the present invention is not limited to such an air-conditioning hot-water-supply device. For example, the embodiment can be applied to various types of air-conditioners in addition to an air-conditioner (not shown) provided with one indoor unit and one outdoor unit.

[0130] Further, the embodiment has been described in detail for the sake of simplicity in description of the present invention, and the present invention is not limited to one including all configurations described above. In addition, addition/omission/replacement of other configurations can be made to some of the configurations of the embodiment.

[0131] Moreover, the above-described mechanisms and configurations are considered as necessary for description, and are not all mechanisms and configurations necessary for a product.

LIST OF REFERENCE NUMERALS

[0132]

1	compressor
2	hot-water storage tank
3	hot-water-supply heat exchanger
4	outdoor heat exchanger
5	outdoor fan
6	indoor heat exchanger
7	indoor fan
8	four-way valve
81	main body
82	valve body
9	expansion valve
10	expansion valve (first opening/closing section)
11	expansion valve (first expansion valve)
12	expansion valve (second expansion valve)
13	electromagnetic valve (second opening/closing section)
14	electromagnetic valve (third opening/closing section)
15	check valve
16	control device
he	low-pressure-side connection port
hf	indoor-side connection port
hg	high-pressure-side connection port
hi	outdoor-side connection port
kb	pipe (third pipe)
kd	pipe (second pipe)
ke	pipe (first pipe)
kj	pipe (fourth pipe)
Ui	indoor unit
Uo	outdoor unit
W	air-conditioning hot-water-supply device

Claims

1. An air-conditioning hot-water-supply device including a refrigerant circuit in which refrigerant circulates sequentially through a compressor, a hot-water-supply heat exchanger, a first expansion valve, and an outdoor heat exchanger, comprising:

a four-way valve including a main body and a valve body provided inside the main body and configured to switch a refrigerant flow path in the refrigerant circuit; and
a check valve provided at a first pipe connecting a low-pressure-side connection port of the four-way valve and a suction side of the compressor,
wherein a first opening/closing section blocks between a high-pressure-side connection port of the four-way valve and a discharge side of the compressor, and
the check valve allows a refrigerant flow from the four-way valve to the suction side of the compressor through the first pipe and inhibits a flow in an opposite direction.

2. The air-conditioning hot-water-supply device according to claim 1, wherein
a downstream side of the check valve at the first pipe and the outdoor heat exchanger are connected to each other through a second pipe, and
the valve body of the four-way valve is at a first position at which another end side of an indoor heat exchanger for which a refrigerant flow is blocked on one end side and the first pipe are connected to each other.

3. The air-conditioning hot-water-supply device according to claim 2, wherein
switching from one of a state in which refrigerant circulates sequentially through the compressor, the hot-water-supply heat exchanger, the first expansion valve, and the outdoor heat exchanger or another state in which the outdoor heat exchanger functions as a condenser and the indoor heat exchanger functions as an evaporator to the other one of the state or the another state is allowed, and
when switching from one state to the other state is made, a position of the valve body of the four-way valve is maintained at the first position.

4. The air-conditioning hot-water-supply device according to claim 2, wherein
a position of the valve body during independent hot-water supply operation for causing refrigerant to circulate sequentially through the compressor, the hot-water-supply heat exchanger, the first expansion valve, and the outdoor heat exchanger is different between a case of performing at least air-cooling operation before a start of the independent hot-water supply operation and a case of performing at least air-heating operation before the start of the independent hot-water supply operation, and
at least the air-cooling operation is performed before

the start of the independent hot-water supply operation in a case where the valve body is at the first position.

5. The air-conditioning hot-water-supply device according to claim 2, further comprising:

a second opening/closing section provided at the second pipe,
wherein the second opening/closing section is opened.

6. The air-conditioning hot-water-supply device according to claim 5, wherein
an indoor-side connection port of the four-way valve is connected to the hot-water-supply heat exchanger sequentially through the indoor heat exchanger and a third pipe,
a fourth pipe of which one end is connected to an outdoor heat exchanger side of the second opening/closing section at the second pipe and of which other end is connected to the third pipe is further provided,
a second expansion valve is further provided in a vicinity of the indoor heat exchanger at the third pipe,
a third opening/closing section is further provided at the fourth pipe, and
the second expansion valve and the third opening/closing section are both closed.

7. The air-conditioning hot-water-supply device according to claim 2, wherein
in a case of performing independent hot-water supply operation for heating hot water by the hot-water-supply heat exchanger,
when a temperature of the indoor heat exchanger is lower than that of the outdoor heat exchanger or a temperature of an air-conditioning target space of the indoor heat exchanger is lower than that of external air,
refrigerant circulates sequentially through the compressor, the hot-water-supply heat exchanger, the first expansion valve, and the outdoor heat exchanger in a state in which the valve body of the four-way valve is at the first position.

8. The air-conditioning hot-water-supply device according to claim 2, wherein
in a case where multiple indoor heat exchangers are connected in parallel with the outdoor heat exchanger and independent hot-water supply operation for heating hot water by the hot-water-supply heat exchanger is performed,
when there is at least one of the multiple indoor heat exchangers having a lower temperature than that of the outdoor heat exchanger or there is at least one of air-conditioning target spaces of the multiple indoor heat exchangers having a lower temperature than that of external air,
refrigerant circulates sequentially through the compressor, the hot-water-supply heat exchanger, the first expansion valve, and the outdoor heat exchanger in a state in which the valve body of the four-way valve is at the first position.

9. The air-conditioning hot-water-supply device according to claim 2, wherein
in a case of performing independent hot-water supply operation for heating hot water by the hot-water-supply heat exchanger, when a difference between a temperature of the indoor heat exchanger and a temperature of the outdoor heat exchanger is within a predetermined range and the valve body of the four-way valve is at the first position before a start of the independent hot-water supply operation, the valve body is maintained at the first position, and refrigerant circulates sequentially through the compressor, the hot-water-supply heat exchanger, the first expansion valve, and the outdoor heat exchanger.

10. The air-conditioning hot-water-supply device according to claim 1, wherein
the valve body of the four-way valve is at a second position at which the outdoor heat exchanger and the first pipe are connected to each other.

11. The air-conditioning hot-water-supply device according to claim 10, wherein
switching from one of a state in which refrigerant circulates sequentially through the compressor, the hot-water-supply heat exchanger, the first expansion valve, and the outdoor heat exchanger or another state in which an indoor heat exchanger functions as a condenser and the outdoor heat exchanger functions as an evaporator to the other one of the state or the another state is allowed, and
when switching from one state to the other state is made, a position of the valve body of the four-way valve is maintained at the second position.

12. The air-conditioning hot-water-supply device according to claim 10, wherein
a position of the valve body during independent hot-water supply operation for causing refrigerant to circulate sequentially through the compressor, the hot-water-supply heat exchanger, the first expansion valve, and the outdoor heat exchanger is different between a case of performing at least air-cooling operation before a start of the independent hot-water supply operation and a case of performing at least air-heating operation before the start of the independent hot-water supply operation, and
at least the air-heating operation is performed before the start of the independent hot-water supply operation in a case where the valve body is at the second

position.

13. The air-conditioning hot-water-supply device according to claim 10, further comprising:

a second pipe connecting a downstream side of the check valve at the first pipe and the outdoor heat exchanger; and
a second opening/closing section provided at the second pipe,
wherein the second opening/closing section is opened.

14. The air-conditioning hot-water-supply device according to claim 13, wherein
an indoor-side connection port of the four-way valve is connected to the hot-water-supply heat exchanger sequentially through an indoor heat exchanger and a third pipe,
a fourth pipe of which one end is connected to an outdoor heat exchanger side of the second opening/closing section at the second pipe and of which other end is connected to the third pipe is further provided,
a second expansion valve is further provided in a vicinity of the indoor heat exchanger at the third pipe,
a third opening/closing section is further provided at the fourth pipe, and
the second expansion valve and the third opening/closing section are both closed.

15. The air-conditioning hot-water-supply device according to claim 10, wherein
during defrosting operation for defrosting the outdoor heat exchanger, the valve body of the four-way valve is at the second position, refrigerant circulates sequentially through the compressor, the hot-water-supply heat exchanger, the first expansion valve, and the outdoor heat exchanger, and refrigerant circulates sequentially through the compressor, the first opening/closing section in an open state, the four-way valve, an indoor heat exchanger, a second expansion valve, and the outdoor heat exchanger.

16. The air-conditioning hot-water-supply device according to claim 10, further comprising:

a second expansion valve provided in a vicinity of one end of an indoor heat exchanger,
wherein during defrosting operation for defrosting the outdoor heat exchanger, refrigerant flowing sequentially through the compressor and the hot-water-supply heat exchanger flows around the first expansion valve, and further circulates sequentially through the outdoor heat exchanger, the second expansion valve, the indoor heat exchanger, the four-way valve, and the check valve, and
the valve body of the four-way valve is at a first position at which the other end side of the indoor heat exchanger and the first pipe are connected to each other.

17. The air-conditioning hot-water-supply device according to claim 10, wherein
in a case of performing independent hot-water supply operation for heating hot water by the hot-water-supply heat exchanger,
when a temperature of an indoor heat exchanger is higher than that of the outdoor heat exchanger or a temperature of an air-conditioning target space of the indoor heat exchanger is higher than that of external air,
refrigerant circulates sequentially through the compressor, the hot-water-supply heat exchanger, the first expansion valve, and the outdoor heat exchanger in a state in which the valve body of the four-way valve is at the second position.

18. The air-conditioning hot-water-supply device according to claim 10, wherein
in a case where multiple indoor heat exchangers are connected in parallel with the outdoor heat exchanger and independent hot-water supply operation for heating hot water by the hot-water-supply heat exchanger is performed,
when all of temperatures of the multiple indoor heat exchangers are higher than that of the outdoor heat exchanger or all of temperatures of air-conditioning target spaces of the multiple indoor heat exchangers are higher than that of the external air,
refrigerant circulates sequentially through the compressor, the hot-water-supply heat exchanger, the first expansion valve, and the outdoor heat exchanger in a state in which the valve body of the four-way valve is at the second position.

19. The air-conditioning hot-water-supply device according to claim 10, wherein
in a case of performing independent hot-water supply operation for heating hot water by the hot-water-supply heat exchanger, when a difference between a temperature of an indoor heat exchanger and a temperature of the outdoor heat exchanger is within a predetermined range and the valve body of the four-way valve is at the second position before a start of the independent hot-water supply operation, the valve body is maintained at the second position, and refrigerant circulates sequentially through the compressor, the hot-water-supply heat exchanger, the first expansion valve, and the outdoor heat exchanger.

FIG. 1

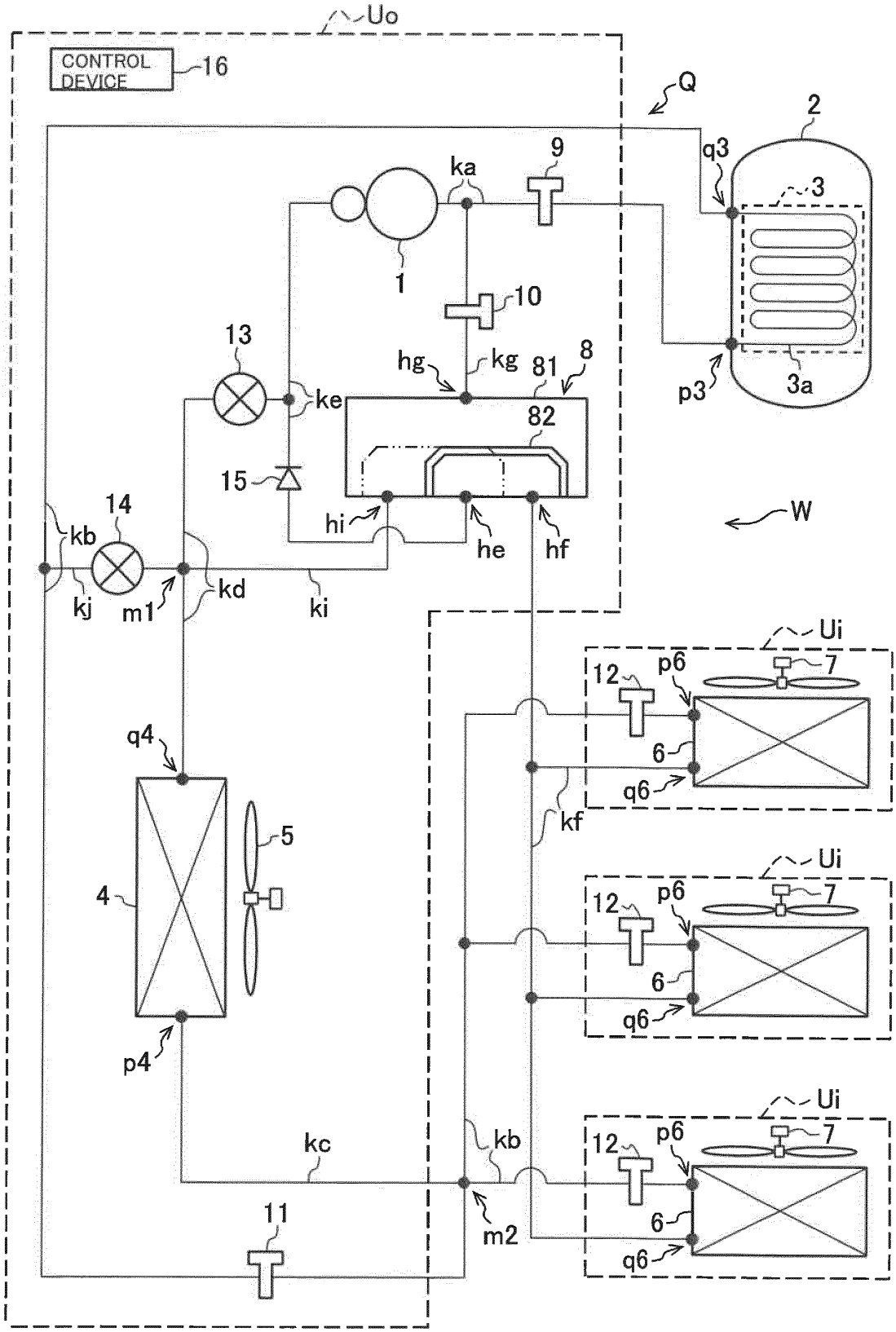

Uo
CONTROL DEVICE
16
Q
2
q3
3
9
ka
1
10
13
hg
kg
81
8
ke
82
p3
3a
15
14
kb
hi
he
hf
W
kj
m1
kd
ki
Ui
12
p6
7
6
q6
kf
q4
5
4
p4
kc
kb
11
m2

FIG. 2A

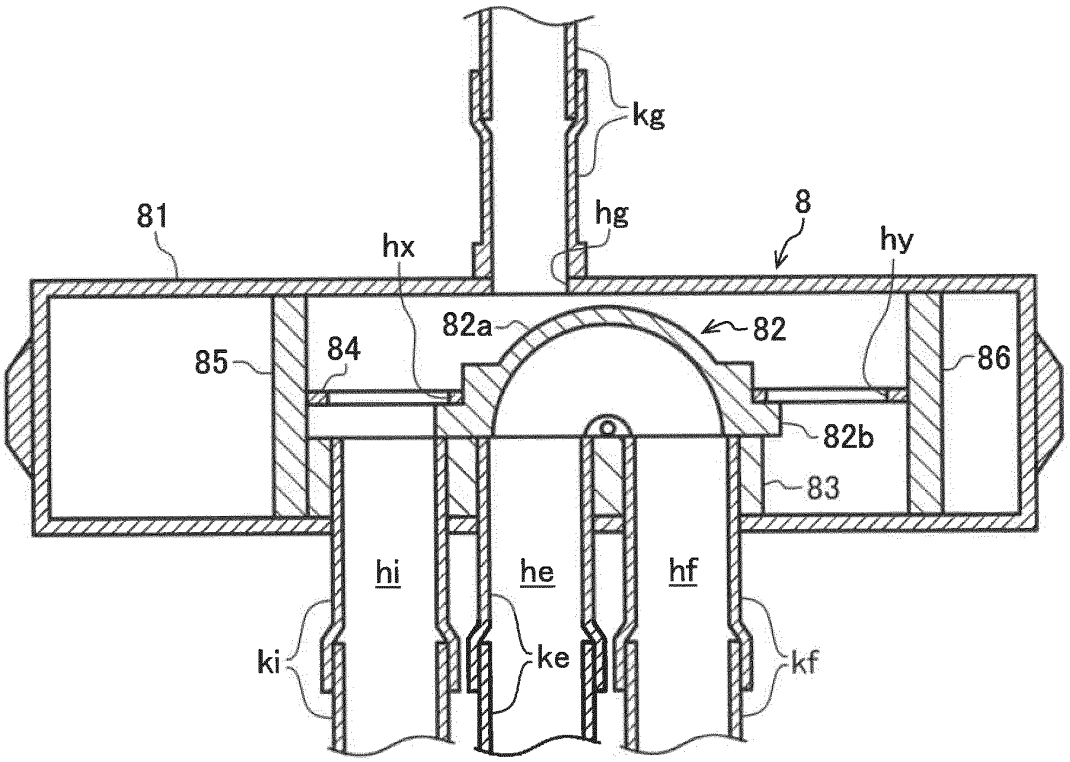

kg
81
hg
8
hx
hy
82a
82
85
84
86
82b
83
hi
he
hf
ki
ke
kf

FIG. 2B

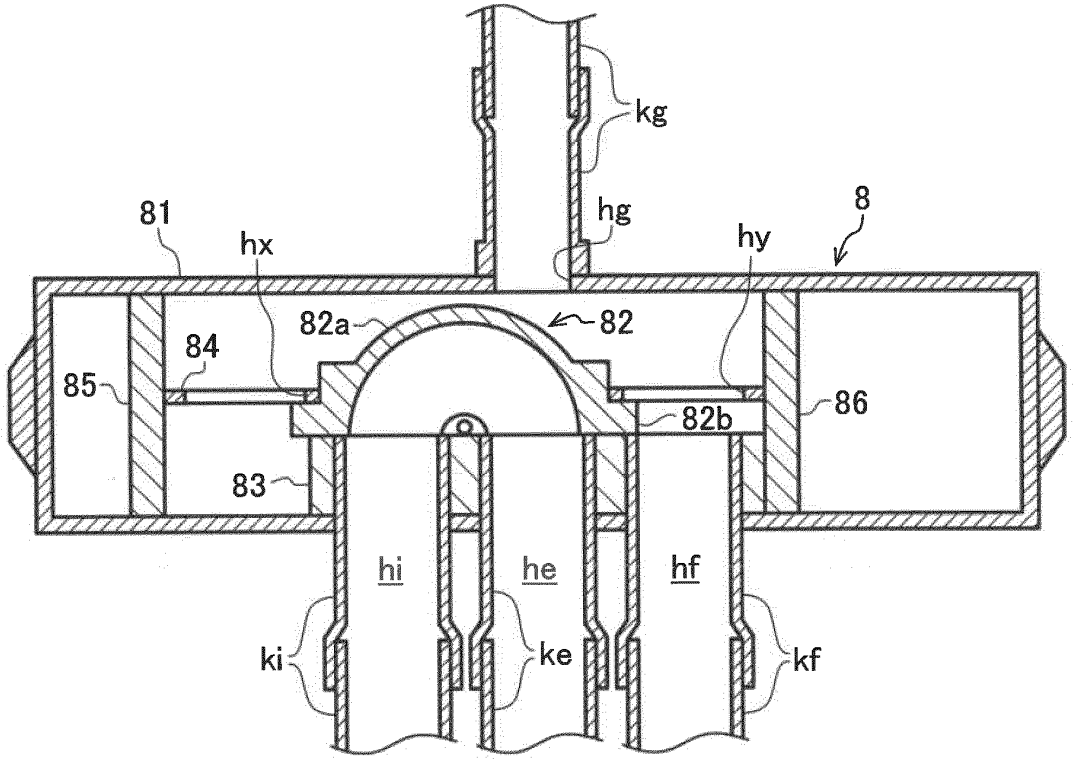

kg
81
hg
8
hx
hy
82a
82
84
85
86
82b
83
hi
he
hf
ki
ke
kf

FIG. 3

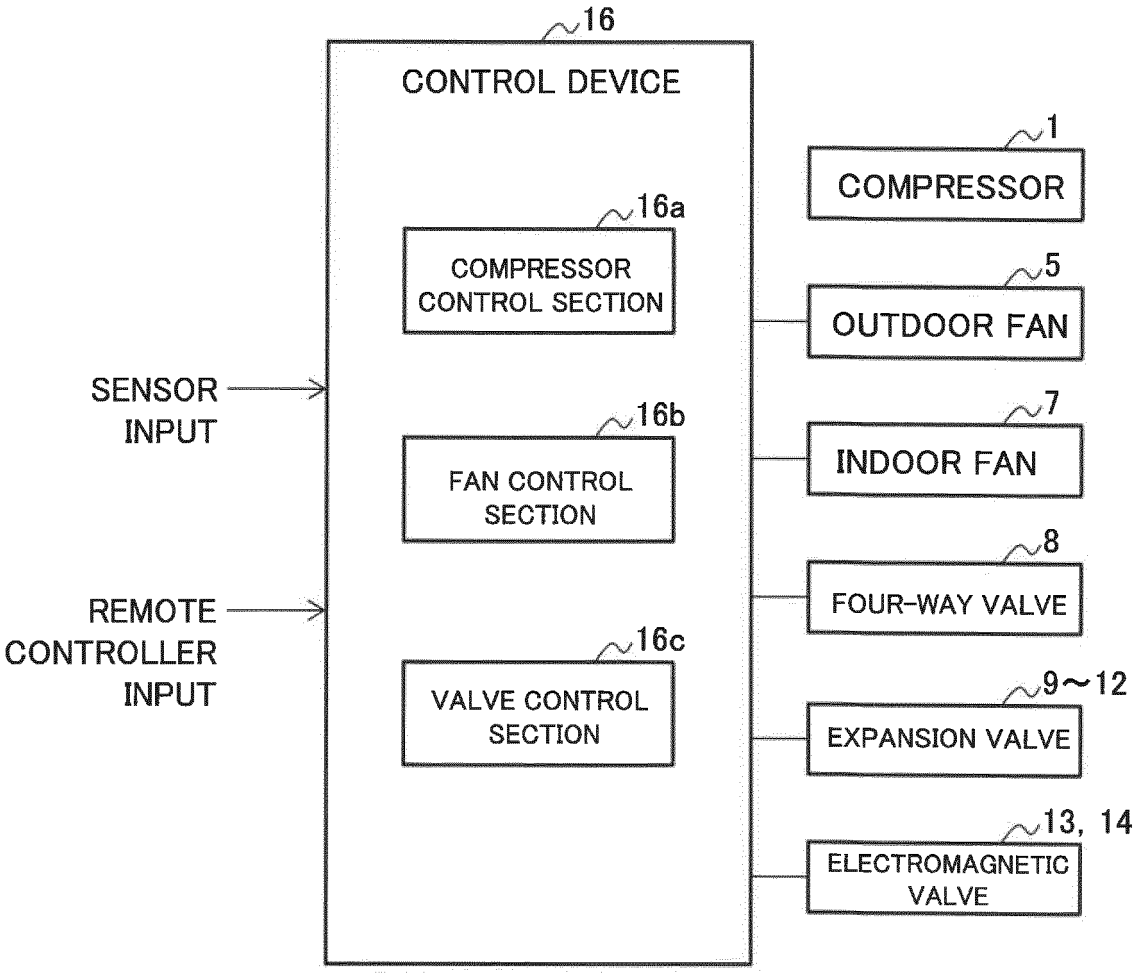

16
CONTROL DEVICE
16a
COMPRESSOR CONTROL SECTION
16b
FAN CONTROL SECTION
16c
VALVE CONTROL SECTION
SENSOR INPUT
REMOTE CONTROLLER INPUT
1
COMPRESSOR
5
OUTDOOR FAN
7
INDOOR FAN
8
FOUR-WAY VALVE
9～12
EXPANSION VALVE
13, 14
ELECTROMAGNETIC VALVE

FIG. 4

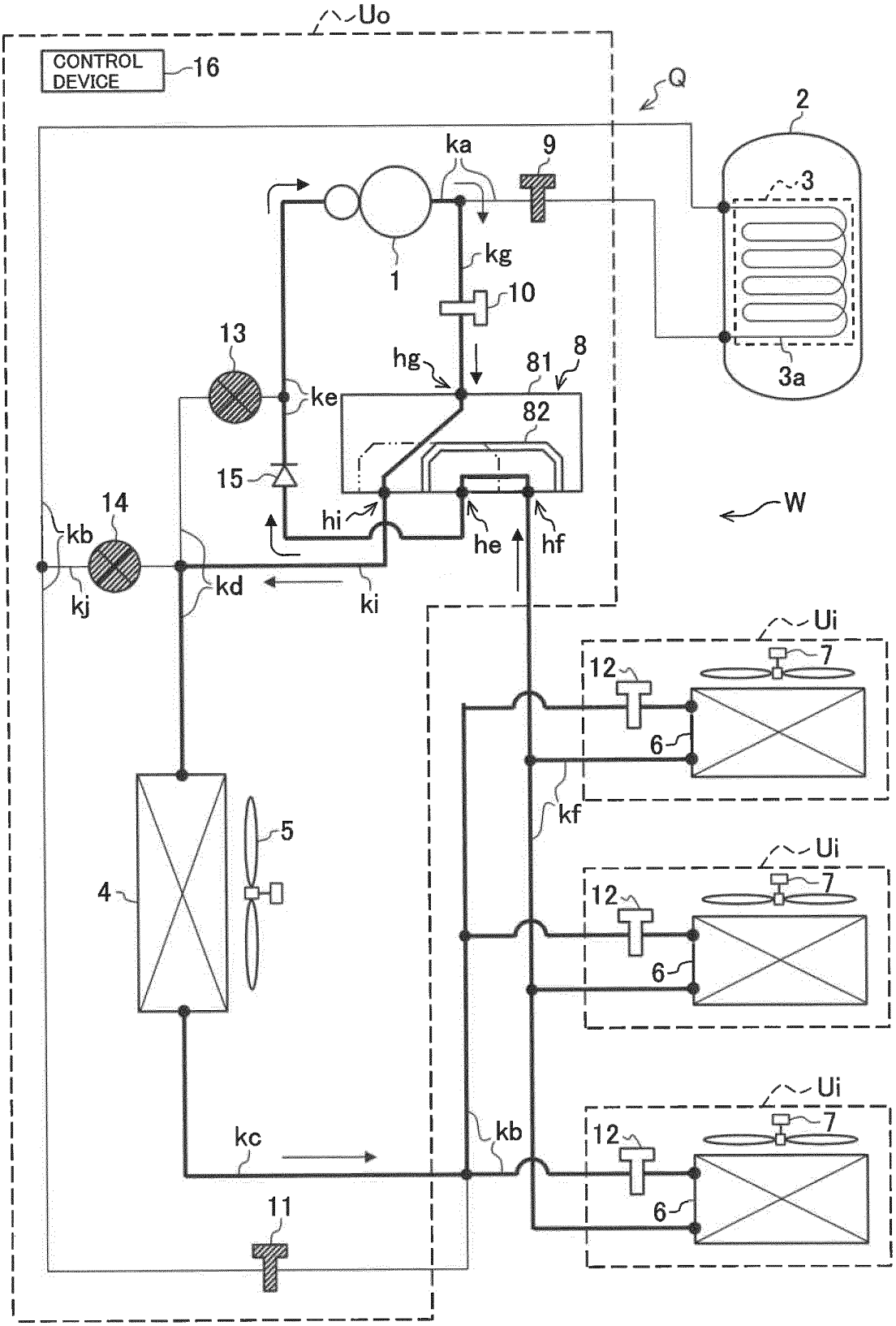

Uo
CONTROL DEVICE
16
Q
2
3
3a
ka
9
1
kg
10
13
hg
81
8
ke
82
15
14
kb
hi
he
hf
W
kj
kd
ki
Ui
7
12
6
kf
5
4
kc
kb
11

FIG. 5

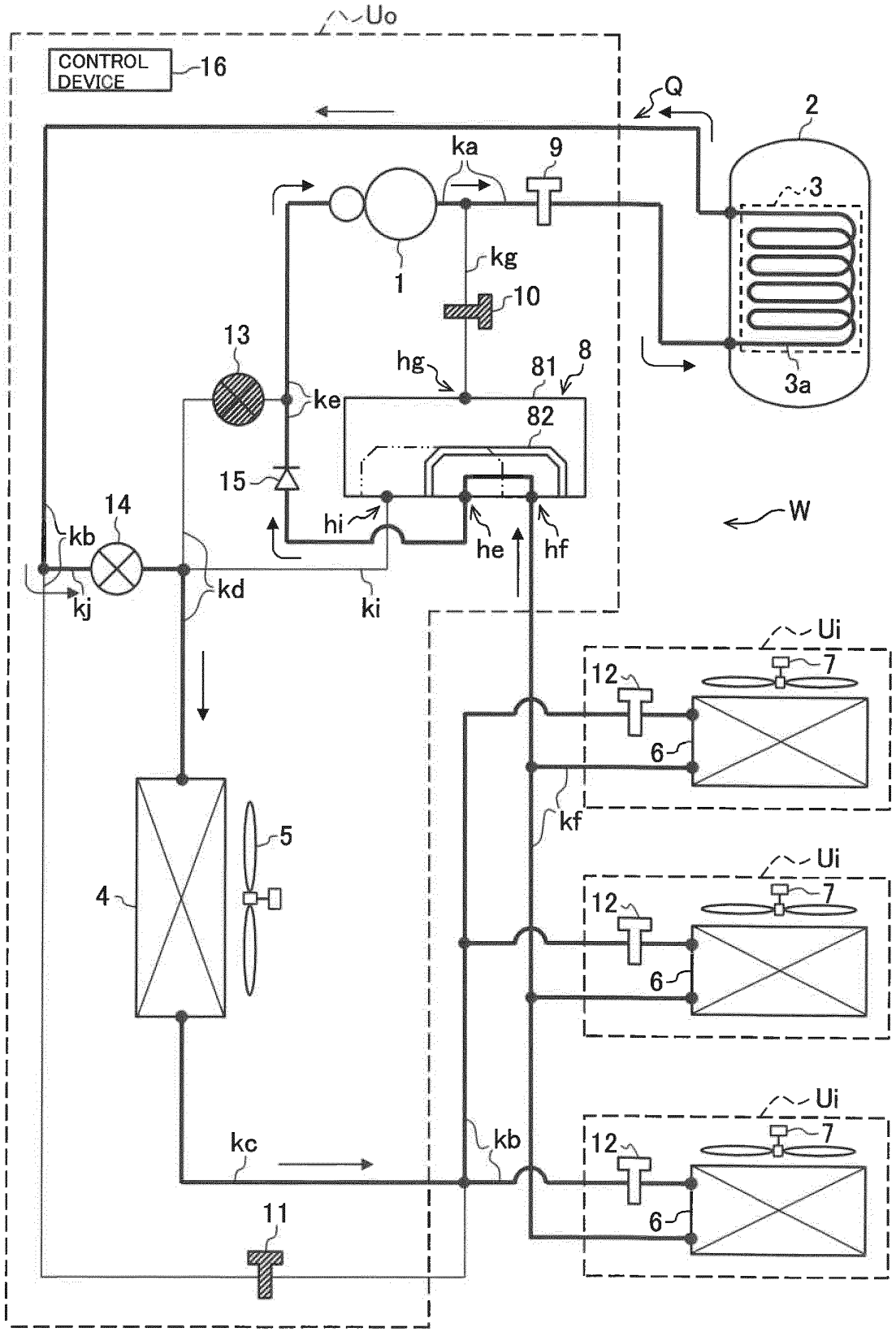

Uo
CONTROL DEVICE
16
Q
2
ka
9
3
1
kg
10
13
hg
81
8
ke
82
3a
15
14
kb
hi
he
hf
W
kj
kd
ki
Ui
12
7
6
kf
5
4
kc
kb
11

FIG. 6

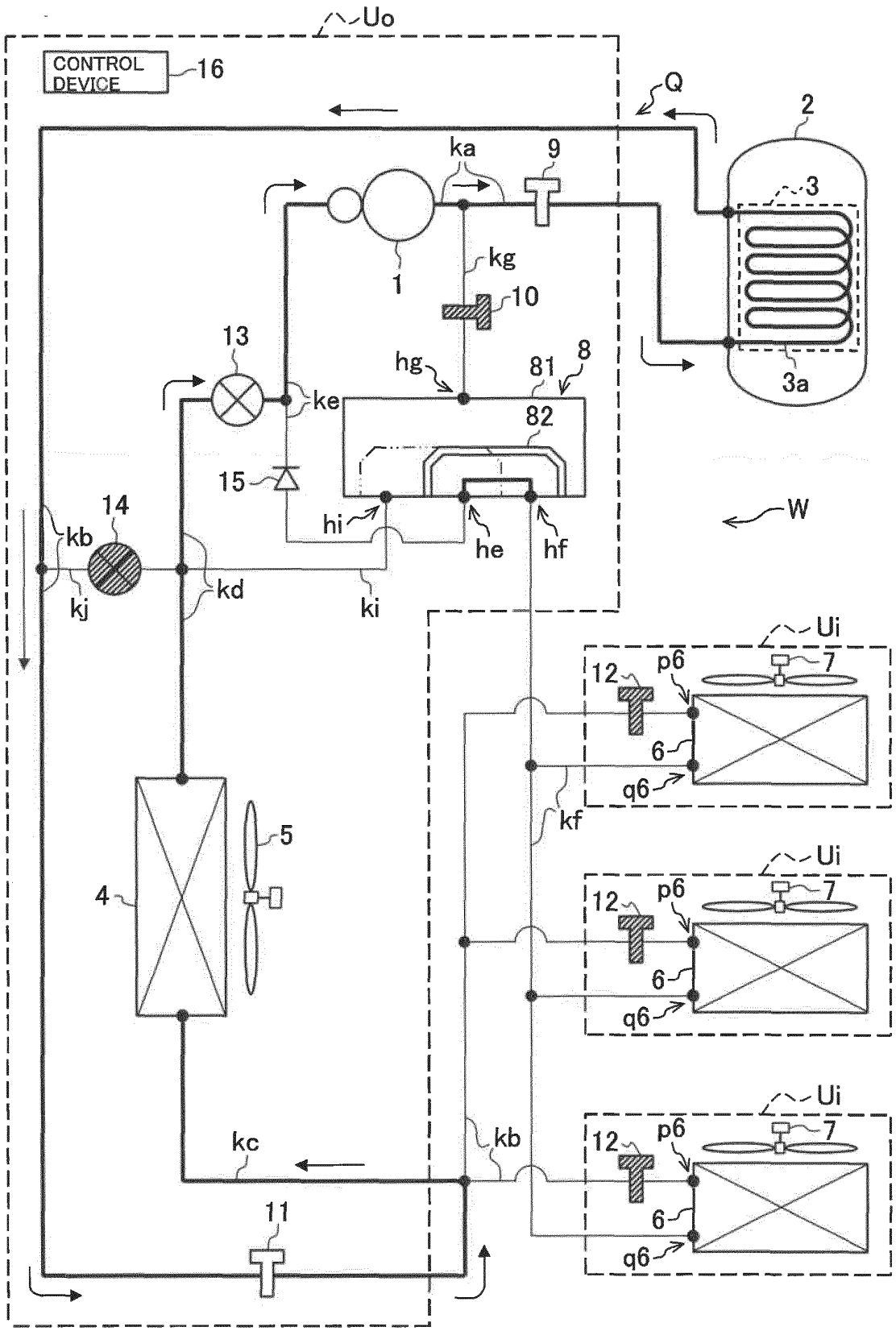

Uo
CONTROL DEVICE
16
Q
2
ka
9
3
1
kg
10
13
hg
81
8
ke
82
3a
15
14
hi
he
hf
W
kb
kj
kd
ki
Ui
12
p6
7
6
q6
kf
5
4
kc
11

FIG. 7

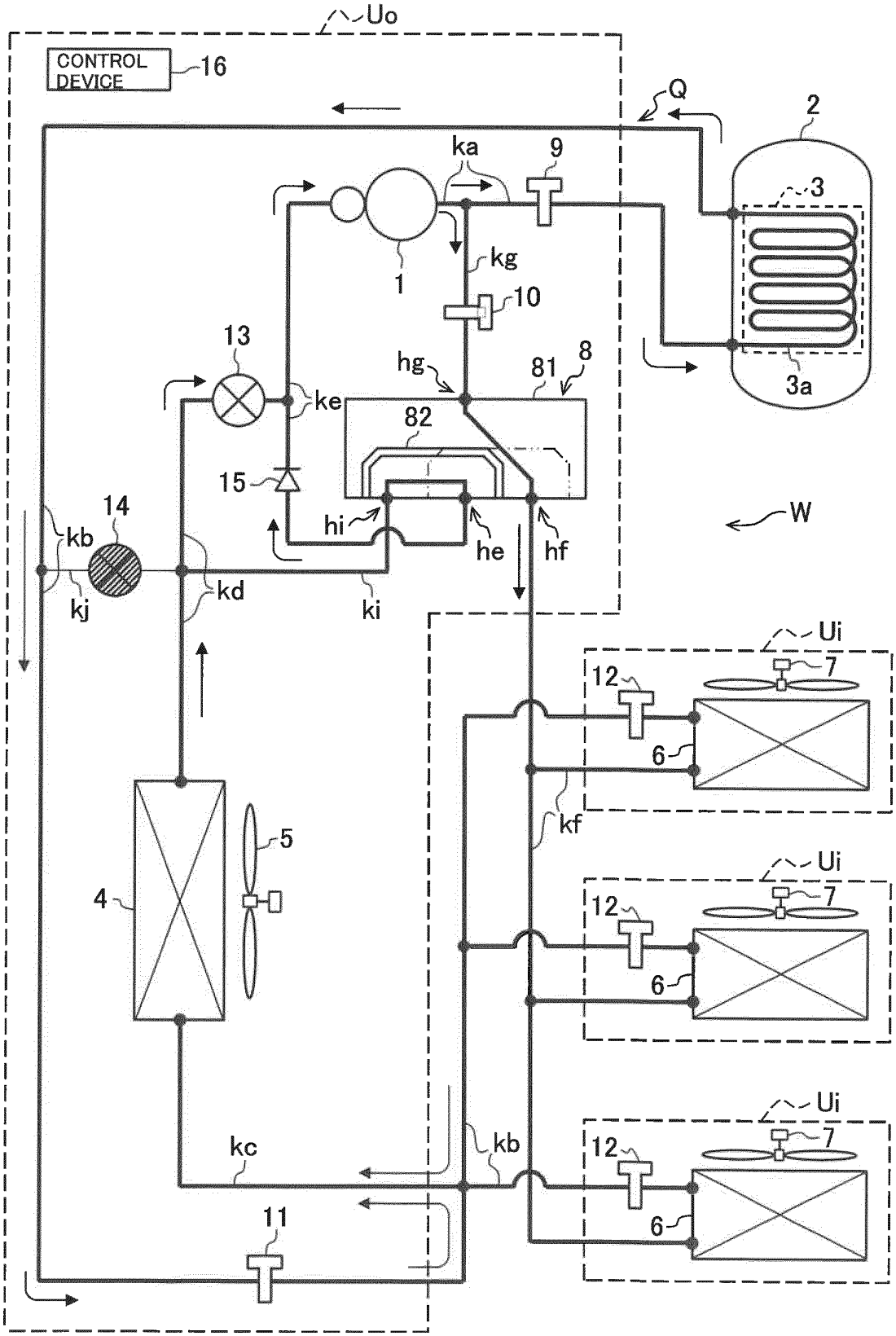

Uo
CONTROL DEVICE
16
Q
2
ka
9
3
kg
1
10
13
hg
81
8
ke
82
3a
15
14
hi
he
hf
W
kb
kd
kj
ki
Ui
12
7
6
kf
5
4
kc
11

FIG. 8

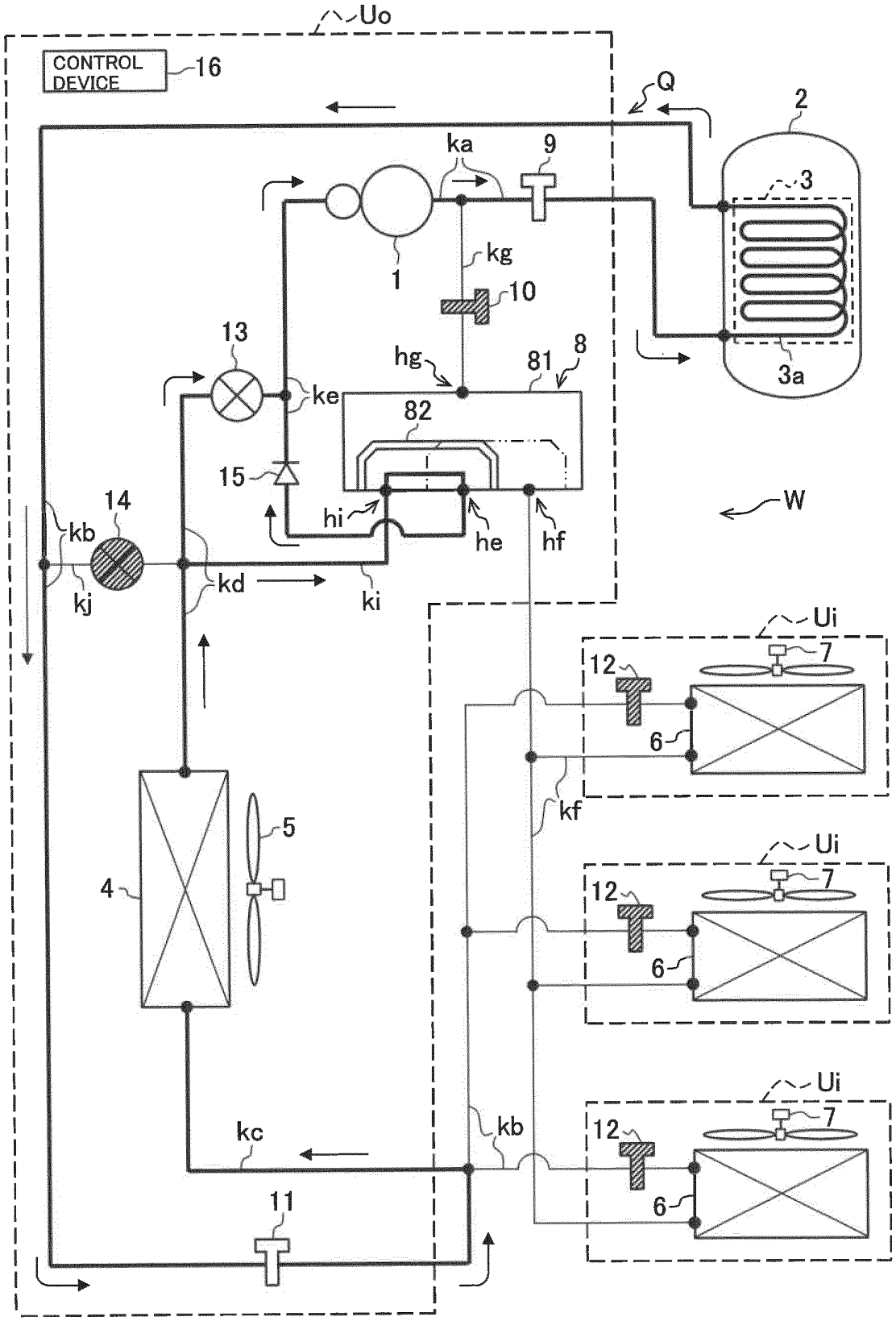
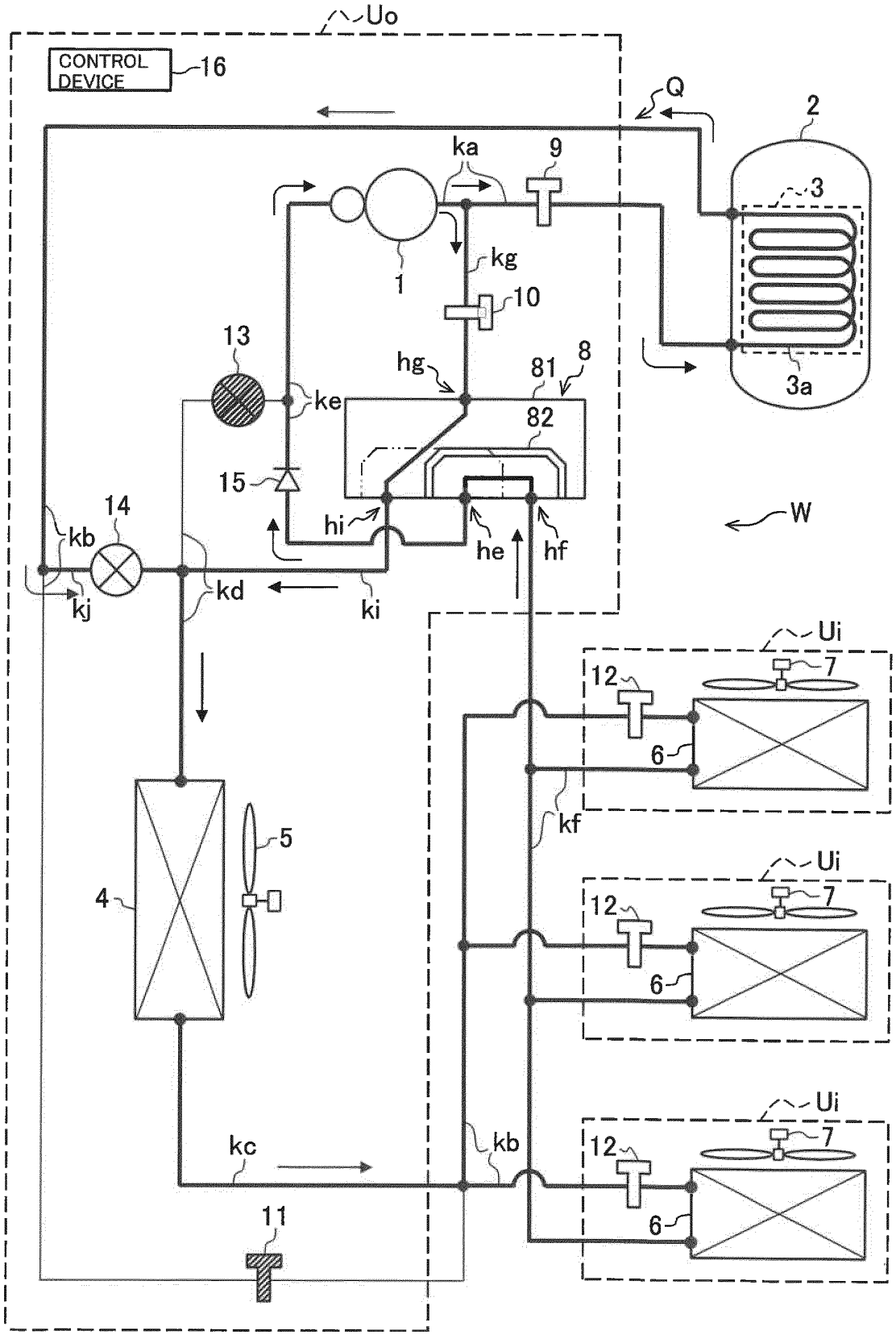

Uo
CONTROL DEVICE
16
Q
2
ka
9
3
1
kg
10
13
hg
81
8
ke
82
3a
15
14
hi
he
hf
W
kb
kj
kd
ki
Ui
12
7
6
kf
5
4
kc
11

FIG. 9


Uo
CONTROL DEVICE
16
Q
2
ka
9
3
kg
1
10
13
hg
81
8
ke
82
3a
15
14
hi
he
hf
W
kb
kd
ki
kj
Ui
12
7
6
kf
5
4
kc
11

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2018/035793

A. CLASSIFICATION OF SUBJECT MATTER
Int. Cl. F25B29/00(2006.01)i, F25B41/04(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. F25B29/00, F25B41/04

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 1971-2018
Registered utility model specifications of Japan 1996-2018
Published registered utility model applications of Japan 1994-2018

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.
Y A	JP 5-296604 A (DAIKIN INDUSTRIES, LTD.) 09 November 1993, paragraphs [0007]-[0029], fig. 1-6 (Family: none)	1-5, 10-13, 15-16 6-9, 14, 17-19
Y	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 38542/1986 (Laid-open No. 149765/1987) (NIPPON GAKKI CO., LTD.) 22 September 1987, fig. 1, 2 (Family: none)	1-5, 10-13, 15-16
Y	JP 2001-235248 A (SANYO ELECTRIC CO., LTD.) 31 August 2001, fig. 1-4 (Family: none)	1-5, 10-13, 15-16

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
27.11.2018	11.12.2018

Name and mailing address of the ISA/	Authorized officer
Japan Patent Office 3-4-3, Kasumigaseki, Chiyoda-ku, Tokyo 100-8915, Japan	Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- JP 2013213612 A **[0003]**