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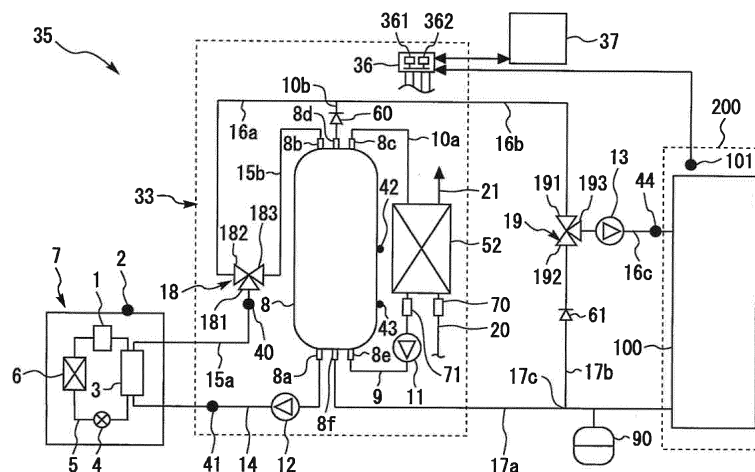
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(54) **HEATING MEDIUM CIRCULATION SYSTEM**

(57) A heating medium circulation system 35 includes a heat pump device 7 that heats a heating medium, a heat storage tank 8 that stores the heated heating medium, supply channels 16b and 16c through which the heating medium supplied to an indoor-heating terminal 100 flows, a first flow channel 16a through which the heating medium flowing out from the heat pump device 7 is caused to flow into the supply channel 16b without passing through the heat storage tank 8, a second flow chan-

nel 15b through which the heating medium flowing out from the heat pump device 7 is caused to flow into the heat storage tank 8, a three-way valve 18 that switches between the first flow channel 16a and the second flow channel 15b, a third flow channel 10b through which the heating medium flowing out from the heat storage tank 8 is caused to flow into the supply channel 16b, and a first check valve 60 that is disposed in the third flow channel 10b.

FIG. 1



Description

[Technical Field]

[0001] The present invention relates to a heating medium circulation system.

[Background Art]

[0002] A heat storage hot-water supply and air conditioning device disclosed in PTL 1 shown below includes a heat storage tank that stores a heating medium that is heated or cooled by a heat pump device, and an air conditioning heat exchanger. The heat storage hot-water supply and air conditioning device is capable of circulating the heating medium from the heat pump device or the heat storage tank to the air conditioning heat exchanger.

[Citation List]

[Patent Literature]

[0003] [PTL 1] Japanese Patent No. 5253582

[Summary of Invention]

[Technical Problem]

[0004] The conventional system described above switches between an operation in which the heating medium is supplied from the heat pump device to the air conditioning heat exchanger and an operation in which the heating medium is supplied from the heat storage tank to the air conditioning heat exchanger using two three-way valves (a heat storage switching valve (19) and a heat discharge switching valve (20)). Consequently, a problem arises in that a device configuration is complicated.

[0005] The present invention has been made in order to solve the above problem, and an object thereof is to provide a heating medium circulation system capable of enabling, using a simple device configuration, an operation in which a heating medium is caused to flow into a supply channel leading to a heat demand section from a heat storage tank, and an operation in which the heating medium heated by heating means is caused to flow into the supply channel without passing through the heat storage tank.

[Solution to Problem]

[0006] A heating medium circulation system according to the present invention includes: heating means configured to heat a heating medium; a heat storage tank configured to store the heating medium heated by the heating means; a supply channel through which the heating medium supplied to a heat demand section flows; a first flow

channel through which the heating medium flowing out from the heating means is caused to flow into the supply channel without passing through the heat storage tank; a second flow channel through which the heating medium flowing out from the heating means is caused to flow into the heat storage tank; flow channel switching means configured to switch between the first flow channel and the second flow channel; a third flow channel through which the heating medium flowing out from the heat storage tank is caused to flow into the supply channel; and a check valve disposed in the third flow channel.

[Advantageous Effects of Invention]

[0007] According to the heating medium circulation system of the present invention, it becomes possible to enable, using the simple device configuration, the operation in which the heating medium is caused to flow into the supply channel leading to the heat demand section from the heat storage tank, and the operation in which the heating medium heated by the heating means is caused to flow into the supply channel without passing through the heat storage tank.

[Brief Description of Drawings]

[0008]

Fig. 1 is a view showing a heating medium circulation system according to Embodiment 1.

Fig. 2 is a view showing an example of a circulation path of a heating medium in a first circulation operation of the heating medium circulation system shown in Fig. 1.

Fig. 3 is a view showing an example of a circulation path of the heating medium in a second circulation operation of the heating medium circulation system shown in Fig. 1.

[Description of Embodiment]

[0009] Hereinbelow, an embodiment will be described with reference to the drawings. Common or corresponding elements in the drawings are designated by the same reference numerals, and the duplicate description thereof will be simplified or omitted.

Embodiment 1.

[0010] Fig. 1 is a view showing a heating medium circulation system 35 according to Embodiment 1. As shown in Fig. 1, the heating medium circulation system 35 includes a heat pump device 7 and a tank unit 33. The heat pump device 7 is an example of heating means that heats a heating medium. A heat storage tank 8 is installed inside the casing of the tank unit 33. The heat storage tank 8 stores the heating medium heated by the heat pump device 7. The heating medium in the present in-

vention may be water. The heating medium in the present invention may also be a fluid heating medium other than water such as, e.g., a calcium chloride aqueous solution, an ethylene glycol aqueous solution, or alcohol. In the heat storage tank 8, a thermal stratification in which the upper side has a high temperature and the lower side has a low temperature can be formed due to a difference in the density of the heating medium caused by a difference in temperature.

[0011] The heat pump device 7 and the tank unit 33 are connected to each other via a fourth flow channel 14, a fifth flow channel 15a, and electrical wiring (the depiction thereof is omitted). The tank unit 33 may be installed outdoors or may also be installed indoors. The heat pump device 7 may be installed outdoors. The heating medium circulation system 35 of the present embodiment has a configuration in which the heat pump device 7 and the tank unit 33 are separated from each other. Instead of this configuration, the tank unit 33 may be integrated with the heat pump device 7.

[0012] The heat pump device 7 includes a refrigerant circuit in which a compressor 1, a first heat exchanger 3, a decompression device 4, and a second heat exchanger 6 are annularly connected by refrigerant piping 5. A refrigerant sealed in the refrigerant circuit may be, e.g., CO₂. The heat pump device 7 performs an operation of a heat pump cycle using the refrigerant circuit. In the first heat exchanger 3, heat is exchanged between a refrigerant having high temperature and high pressure compressed by the compressor 1 and the heating medium flowing in from the fourth flow channel 14. The decompression device 4 expands the high-pressure refrigerant having passed through the first heat exchanger 3 to turn the high-pressure refrigerant into a low-pressure refrigerant. The decompression device 4 may be an expansion valve.

The second heat exchanger 6 causes heat to be exchanged between the low-pressure refrigerant and a fluid. The fluid may be any of, e.g., outside air, groundwater, wastewater, and solar-heated water. The heat pump device 7 may include a blower or a pump (the depiction thereof is omitted) for sending the fluid to the second heat exchanger 6. The heat pump device 7 in the present embodiment includes an outside air temperature sensor 2 that detects outside air temperature.

[0013] The heating means in the present invention is not limited to the heat pump device 7. The heating means may also be a combustion heater that performs heating by using heat of combustion of fuel such as gas, kerosene, heavy oil, or coal. The heating means may also be a device that heats the heating medium using solar heat.

[0014] A control device 36 is provided inside the tank unit 33. Valves, pumps, actuators such as the compressor 1 and the like, and sensors of the tank unit 33 and the heat pump device 7 are electrically connected to the control device 36. The control device 36 controls various operations described later.

[0015] A terminal device 37 has the function of receiv-

ing operations of a user related to change of operation commands and set values. The terminal device 37 is an example of an operation terminal or a user interface. The control device 36 and the terminal device 37 are connected to each other so as to be capable of bidirectional data communication by using wired or wireless communication. The terminal device 37 is equipped with a display section that displays information on the state of the heating medium circulation system 35 or the like, an operation section operated by the user such as a switch or the like, a speaker, and a microphone, though the depiction thereof is omitted. The terminal device 37 may be installed indoors. The heating medium circulation system 35 may include a plurality of the terminal devices 37 that are installed at different places.

[0016] The tank unit 33 further includes various components and piping described below in addition to the heat storage tank 8 and the control device 36. A plurality of tank temperature sensors 42 and 43 are mounted to the surface of the heat storage tank 8 at positions having different heights. The control device 36 can calculate the amount of stored heat and the amount of a high-temperature heating medium in the heat storage tank 8 by detecting the distribution of the temperature of the heating medium in the heat storage tank 8 using the tank temperature sensors 42 and 43. Two tank temperature sensors 42 and 43 are mounted in the configuration shown in the drawing, but three or more tank temperature sensors may be mounted to the heat storage tank 8.

[0017] The control device 36 may control start and stop timings of a heat accumulating operation based on the amount of stored heat in the heat storage tank 8. The heat accumulating operation is the operation in which the heating medium heated by the heat pump device 7 is caused to flow into the heat storage tank 8.

[0018] The heat storage tank 8 includes a first outlet 8a, an inlet 8b, a second outlet 8c, a third outlet 8d, a first return port 8e, and a second return port 8f. The first outlet 8a, the first return port 8e, and the second return port 8f are positioned in the lower portion of the heat storage tank 8. The inlet 8b, the second outlet 8c, and the third outlet 8d are positioned in the upper portion of the heat storage tank 8.

[0019] The fourth flow channel 14 has a first end connected to the first outlet 8a of the heat storage tank 8, and a second end connected to the inlet of the heating medium of the first heat exchanger 3 of the heat pump device 7. A first circulation pump 12 capable of circulating the heating medium to the heat pump device 7 is connected to some midpoint of the fourth flow channel 14. In the configuration shown in the drawing, the first circulation pump 12 is disposed inside the tank unit 33. Instead of this configuration, the first circulation pump 12 may be disposed inside the heat pump device 7. A temperature sensor 41 that detects a heat pump inlet temperature serving as the temperature of the heating medium flowing into the heat pump device 7 is mounted to the fourth flow channel 14.

[0020] A three-way valve 18 includes an inlet 181, a first outlet 182, and a second outlet 183. The three-way valve 18 can switch the flow channel between a state in which the inlet 181 is caused to communicate with the first outlet 182 and the second outlet 183 is closed and a state in which the inlet 181 is caused to communicate with the second outlet 183 and the first outlet 182 is closed. The three-way valve 18 is an example of flow channel switching means.

[0021] The fifth flow channel 15a has a first end connected to the outlet of the heating medium of the first heat exchanger 3 of the heat pump device 7, and a second end connected to the inlet 181 of the three-way valve 18. A temperature sensor 40 that detects a heat pump outlet temperature serving as the temperature of the heating medium flowing out from the heat pump device 7 is mounted to the fifth flow channel 15a. A second flow channel 15b has a first end connected to the second outlet 183 of the three-way valve 18, and a second end connected to the inlet 8b of the heat storage tank 8.

[0022] A mixing valve 19 includes a first inlet 191, a second inlet 192, and an outlet 193. The mixing valve 19 can cause the heating medium in which the heating medium flowing in from the first inlet 191 is mixed with the heating medium flowing in from the second inlet 192 to flow out from the outlet 193. The mixing valve 19 can adjust a mixing ratio of the heating medium flowing in from the first inlet 191 and the heating medium flowing in from the second inlet 192. The mixing valve 19 can also set the mixing ratio of the heating medium flowing in from the second inlet 192 to substantially zero. The mixing valve 19 may also be able to set the mixing ratio of the heating medium flowing in from the first inlet 191 to substantially zero. In the configuration shown in the drawing, the mixing valve 19 is disposed outside the tank unit 33. Instead of this configuration, the mixing valve 19 may be disposed inside the tank unit 33.

[0023] An indoor-heating terminal 100 heats a room 200 by releasing heat of the heating medium into the room 200. The indoor-heating terminal 100 may include, as an indoor-heating appliance, at least one of a floor heating panel installed under a floor, a radiator or a panel heater installed on an indoor wall surface, and a fan convactor. In the case where the indoor-heating terminal 100 includes a plurality of the indoor-heating appliances, a method of connecting the indoor-heating appliances may be series connection, parallel connection, or a combination of the series connection and the parallel connection. The indoor-heating terminal 100 is an example of a heat demand section that demands heat. The heating medium circulation system 35 of the present embodiment includes a room temperature sensor 101 that detects the room temperature of the room 200.

[0024] Each of a supply channel 16b and a supply channel 16c is a flow channel through which the heating medium supplied to the indoor-heating terminal 100 flows. The upstream end of the supply channel 16b is positioned inside the tank unit 33. The downstream end

of the supply channel 16b is connected to the first inlet 191 of the mixing valve 19. The upstream end of the supply channel 16c is connected to the outlet 193 of the mixing valve 19. The downstream end of the supply channel 16c is connected to the inlet of the heating medium of the indoor-heating terminal 100. A second circulation pump 13 capable of circulating the heating medium to the indoor-heating terminal 100 is connected to some midpoint of the supply channel 16c.

[0025] In the following description, the temperature of the heating medium supplied to the indoor-heating terminal 100, i.e., the temperature of the heating medium flowing into the indoor-heating terminal 100 is referred to as a "supply temperature". In the present embodiment, the supply temperature can be detected by a temperature sensor 44 disposed in the supply channel 16c.

[0026] A first flow channel 16a has a first end connected to the first outlet 182 of the three-way valve 18, and a second end communicating with the upstream end of the supply channel 16b. A third flow channel 10b has a first end connected to the third outlet 8d of the heat storage tank 8, and a second end communicating with the upstream end of the supply channel 16b. The confluence of the second end of the first flow channel 16a, the second end of the third flow channel 10b, and the upstream end of the supply channel 16b forms a T-junction.

[0027] The first flow channel 16a is the flow channel for causing the heating medium flowing out from the heat pump device 7 to flow into the supply channel 16b without passing through the heat storage tank 8. The second flow channel 15b is the flow channel for causing the heating medium flowing out from the heat pump device 7 to flow into the heat storage tank 8. The three-way valve 18 can switch between a first state in which the heating medium can flow through the first flow channel 16a and the second flow channel 15b is closed and a second state in which the heating medium can flow through the second flow channel 15b and the first flow channel 16a is closed.

[0028] The third flow channel 10b is the flow channel for causing the heating medium flowing out from the heat storage tank 8 to flow into the supply channel 16b. A first check valve 60 that prevents backflow is disposed in the third flow channel 10b. With the first check valve 60, it is possible to reliably prevent the heating medium from flowing into the heat storage tank 8 from the first flow channel 16a through the third flow channel 10b.

[0029] A return channel 17a is the flow channel through which the heating medium having passed through the indoor-heating terminal 100 flows. The upstream end of the return channel 17a is connected to the outlet of the heating medium of the indoor-heating terminal 100. The downstream end of the return channel 17a is connected to the second return port 8f of the heat storage tank 8. The heating medium having passed through the indoor-heating terminal 100 is caused to flow into the heat storage tank 8 from the second return port 8f through the return channel 17a.

[0030] A branch portion 17c is formed at some midpoint

of the return channel 17a. The upstream end of a bypass channel 17b communicates with the return channel 17a at the branch portion 17c. The downstream end of the bypass channel 17b is connected to the second inlet 192 of the mixing valve 19. The bypass channel 17b is the flow channel for causing the heating medium having passed through the indoor-heating terminal 100 to flow into the supply channel 16c again without passing through the heat pump device 7 and the heat storage tank 8. It is possible to return at least part of the flow of the heating medium flowing out from the outlet of the indoor-heating terminal 100 to the inlet of the indoor-heating terminal 100 through the bypass channel 17b.

[0031] The mixing valve 19 enables adjustment of the flow rate of the heating medium flowing through the bypass channel 17b. The mixing valve 19 is an example of flow rate adjustment means that adjusts the flow rate of the heating medium flowing through the bypass channel 17b.

[0032] A second check valve 61 that prevents backflow is disposed in the bypass channel 17b. The second check valve 61 reliably prevents the heating medium in the bypass channel 17b from flowing toward the branch portion 17c from the mixing valve 19.

[0033] In the present embodiment, a reservoir tank 90 capable of temporarily storing the heating medium is connected to some midpoint of the return channel 17a. In the case where the heating medium in the circuit of the heating medium circulation system 35 expands due to temperature, the redundant heating medium can be stored in the reservoir tank 90.

[0034] The tank unit 33 has a water heat exchanger 52. The water heat exchanger 52 has a primary-side flow channel through which the heating medium flows, and a secondary-side flow channel through which water flows. A conduit 10a has a first end connected to the second outlet 8c of the heat storage tank 8, and a second end connected to the primary-side inlet of the water heat exchanger 52. A conduit 9 has a first end connected to the primary-side outlet of the water heat exchanger 52, and a second end connected to the first return port 8e of the heat storage tank 8. A third circulation pump 11 capable of circulating the heating medium to the water heat exchanger 52 is connected to some midpoint of the conduit 9. A flow rate sensor 71 that detects the flow rate of the heating medium passing through the water heat exchanger 52 is disposed at some midpoint of the conduit 9.

[0035] The downstream end of a water supply pipe 20 is connected to the secondary-side inlet of the water heat exchanger 52. The upstream side of the water supply pipe 20 is connected to a water source such as, e.g., a waterworks. A flow rate sensor 70 that detects the flow rate of water passing through the water heat exchanger 52 is disposed at some midpoint of the water supply pipe 20. The upstream end of a hot water supply pipe 21 is connected to the secondary-side outlet of the water heat exchanger 52. The downstream side of the hot water supply pipe 21 is connected to a hot water supply terminal

(the depiction thereof is omitted). The hot water supply terminal may include at least one of, e.g., a faucet, a bathtub, and a shower in a bath.

[0036] In the water heat exchanger 52, heat is exchanged between a high-temperature heating medium supplied from the heat storage tank 8 and water supplied from the water supply pipe 20. The following operation is performed in a hot water supply operation for supplying hot water to the hot water supply pipe 21. When the hot water supply terminal on the downstream side of the hot water supply pipe 21 is opened, water is caused to flow in the water supply pipe 20, the water heat exchanger 52, and the hot water supply pipe 21 due to water pressure of the water source. The control device 36 can detect whether or not hot water is supplied using the flow rate sensor 70 installed in the water supply pipe 20. When the start of hot water supply is detected, the control device 36 operates the third circulation pump 11 to supply the high-temperature heating medium to the water heat exchanger 52 from the upper portion of the heat storage tank 8. Hot water heated in the water heat exchanger 52 is supplied to the hot water supply terminal through the hot water supply pipe 21. The heating medium that is reduced in temperature while it passes through the water heat exchanger 52 flows into the heat storage tank 8 from the first return port 8e through the conduit 9.

[0037] The output or the rotation speed of at least one of the first circulation pump 12, the second circulation pump 13, and the third circulation pump 11 may be variable. At least one of the first circulation pump 12, the second circulation pump 13, and the third circulation pump 11 may include a pulse width modulation control DC motor capable of varying the output or the rotation speed in response to a speed command voltage from the control device 36.

[0038] In the hot water supply operation, the control device 36 may control the operation of the third circulation pump 11 such that the flow rate detected by the flow rate sensor 71 is equal to a predetermined flow rate. In the hot water supply operation, the control device 36 may control the operation of the third circulation pump 11 such that the temperature of hot water flowing through the hot water supply pipe 21 is equal to a target value.

[0039] The following operation is performed in the heat accumulating operation. The three-way valve 18 is switched such that the heating medium can flow through the second flow channel 15b. The heat pump device 7 and the first circulation pump 12 are operated. The heating medium flowing out from the first outlet 8a of the heat storage tank 8 flows into the heat pump device 7 through the fourth flow channel 14. The heating medium heated by the heat pump device 7 flows into the heat storage tank 8 from the inlet 8b through the fifth flow channel 15a and the second flow channel 15b. Thus, in the heat accumulating operation, the heating medium circulates through the heat storage tank 8, the fourth flow channel 14, the heat pump device 7, the fifth flow channel 15a, the second flow channel 15b, and the heat storage tank

8 in this order.

[0040] The control device 36 can control the heat pump outlet temperature by controlling the operation of at least one of the heat pump device 7 and the first circulation pump 12. A user can set hot water temperature by operating the terminal device 37. In the heat accumulating operation, the control device 36 may control the operation of at least one of the heat pump device 7 and the first circulation pump 12 such that the heat pump outlet temperature detected by the temperature sensor 40 is not less than the hot water temperature set by the user. With this, it is possible to set the temperature of the heating medium stored in the heat storage tank 8 to a proper temperature corresponding to the hot water temperature set by the user.

[0041] In the heat accumulating operation, it is possible to increase the temperature of a low-temperature heating medium in the lower portion of the heat storage tank 8 to a target temperature while the low-temperature heating medium passes through the heat pump device 7 once. Hereinafter, such a heat accumulating operation is referred to as a "once-through heat accumulating operation". The once-through heat accumulating operation is enabled by circulating the heating medium at a relatively low flow rate. In the once-through heat accumulating operation, the temperature of the heating medium is increased from, e.g., 20°C to 60°C while the heating medium passes through the heat pump device 7 once. By performing the once-through heat accumulating operation, the layer of the heated high-temperature heating medium and the layer of the low-temperature heating medium that is not heated yet can be stacked on each other in the heat storage tank 8.

[0042] In the case where the heat pump device 7 has a CO₂ refrigerant, a COP (Coefficient Of Performance), i.e., energy efficiency is improved by performing the once-through heat accumulating operation.

[0043] As an indoor-heating operation for heating the room 200, the heating medium circulation system 35 of the present embodiment can execute two types of the indoor-heating operations that are a first circulation operation and a second circulation operation. Fig. 2 is a view showing an example of the circulation path of the heating medium in the first circulation operation of the heating medium circulation system 35 shown in Fig. 1. Fig. 3 is a view showing an example of the circulation path of the heating medium in the second circulation operation of the heating medium circulation system 35 shown in Fig. 1.

[0044] First, the first circulation operation will be described. The following operation is performed in the first circulation operation in the example shown in Fig. 2. The three-way valve 18 is switched such that the heating medium can flow through the first flow channel 16a. The heat pump device 7 and the first circulation pump 12 are operated. The heating medium flowing out from the first outlet 8a of the heat storage tank 8 flows into the heat pump device 7 through the fourth flow channel 14. The

heating medium heated by the heat pump device 7 is supplied to the indoor-heating terminal 100 through the fifth flow channel 15a, the first flow channel 16a, the supply channel 16b, and the supply channel 16c. The heating medium having passed through the indoor-heating terminal 100 flows into the heat storage tank 8 from the second return port 8f through the return channel 17a. Thus, in the first circulation operation, the heating medium circulates through the heat storage tank 8, the fourth flow channel 14, the heat pump device 7, the fifth flow channel 15a, the first flow channel 16a, the supply channel 16b, the supply channel 16c, the indoor-heating terminal 100, the return channel 17a, and the heat storage tank 8 in this order.

[0045] The first circulation operation may be performed in the following manner. The control device 36 may control the supply temperature for the indoor-heating terminal 100 by controlling the operation of at least one of the heat pump device 7 and the first circulation pump 12. The control device 36 may control the operation of at least one of the heat pump device 7 and the first circulation pump 12 such that the supply temperature detected by the temperature sensor 44 is equal to a target value. The user may operate the terminal device 37 to thereby set the target value of the supply temperature. The control device 36 may determine the target value of the supply temperature according to the outside air temperature detected by the outside air temperature sensor 2. The control device 36 may determine the target value of the supply temperature according to the outside air temperature detected by the room temperature sensor 101.

[0046] The following state is established in the first circulation operation in the example shown in Fig. 2. The mixing valve 19 is in a state in which the heating medium does not flow through the bypass channel 17b, i.e., a state in which the mixing ratio of the heating medium flowing in from the second inlet 192 is substantially zero. The flow rate of the heating medium passing through the first heat exchanger 3 of the heat pump device 7 is equal to the flow rate of the heating medium passing through the indoor-heating terminal 100.

[0047] When the velocity of flow of the heating medium flowing in the first heat exchanger 3 exceeds a given threshold value, the heating medium may corrode the first heat exchanger 3. In order to reliably prevent the corrosion of the first heat exchanger 3, there are cases where an upper limit is set on the flow rate of the heating medium passing through the first heat exchanger 3. An example of the upper limit includes 8 L per minute.

[0048] In the example shown in Fig. 2, the flow rate of the heating medium passing through the indoor-heating terminal 100 is equal to the flow rate of the heating medium passing through the first heat exchanger 3. Therefore, the upper limit of the flow rate of the heating medium passing through the indoor-heating terminal 100 is equal to the upper limit of the flow rate of the heating medium passing through the first heat exchanger 3.

[0049] There are cases where the proper supply tem-

perature for the indoor-heating terminal 100 differs depending on the type of the indoor-heating appliance of the indoor-heating terminal 100. In the case where the indoor-heating terminal 100 includes, e.g., a radiator, a relatively high supply temperature is preferable. Even with the limitation resulting from the upper limit of the flow rate of the heating medium passing through the indoor-heating terminal 100, it becomes possible to output indoor-heating power requested by the user by supplying the heating medium having a relatively high temperature to the indoor-heating terminal 100.

[0050] Next, the second circulation operation will be described. The following operation is performed in the second circulation operation in the example shown in Fig. 3. The three-way valve 18 is switched such that the first outlet 182 to which the first flow channel 16a is connected is closed. That is, the three-way valve 18 is switched such that the heating medium can flow through the second flow channel 15b. The second circulation pump 13 is operated. The heating medium flowing out from the third outlet 8d of the heat storage tank 8 is supplied to the indoor-heating terminal 100 through the third flow channel 10b, the supply channel 16b, and the supply channel 16c. The heating medium having passed through the indoor-heating terminal 100 flows through the return channel 17a. At least part of the heating medium having passed through the indoor-heating terminal 100 flows into the bypass channel 17b from the branch portion 17c, and flows into the indoor-heating terminal 100 again through the mixing valve 19 and the supply channel 16c. The heating medium that has not flowed into the bypass channel 17b at the branch portion 17c flows through the return channel 17a, and flows into the heat storage tank 8 from the second return port 8f. Thus, in the second circulation operation, the heating medium flows through the heat storage tank 8, the third flow channel 10b, the supply channel 16b, the supply channel 16c, and the indoor-heating terminal 100 in this order.

[0051] In the present embodiment, the heat accumulating operation described above and the second circulation operation can be executed concurrently and simultaneously. With this, the advantage is achieved that the second circulation operation can be executed even in the case where the amount of stored heat in the heat storage tank 8 is insufficient. Fig. 3 shows a state in which the heat accumulating operation and the second circulation operation are concurrently executed. In Fig. 3, the heat pump device 7 and the first circulation pump 12 are operated in order to perform the heat accumulating operation.

[0052] The second circulation operation may be performed in the following manner. The control device 36 may control the flow rate of the heating medium passing through the indoor-heating terminal 100 by controlling the operation of the second circulation pump 13. The control device 36 may control the supply temperature for the indoor-heating terminal 100 by controlling the mixing ratio in the mixing valve 19. The control device 36 may

control the mixing valve 19 such that the supply temperature detected by the temperature sensor 44 is equal to the target value. The user may operate the terminal device 37 to thereby set the target value of the supply temperature. The control device 36 may determine the target value of the supply temperature according to the outside air temperature detected by the outside air temperature sensor 2. The control device 36 may determine the target value of the supply temperature according to the outside air temperature detected by the room temperature sensor 101.

[0053] According to the second circulation operation, the limitation resulting from the upper limit of the flow rate of the heating medium passing through the first heat exchanger 3 is not imposed on the flow rate of the heating medium passing through the indoor-heating terminal 100. Consequently, in the second circulation operation, the flow rate of the heating medium passing through the indoor-heating terminal 100 can be made higher than that in the first circulation operation. For example, in the case where the upper limit of the flow rate of the heating medium passing through the first heat exchanger 3 is 8 L per minute, the flow rate of the heating medium passing through the indoor-heating terminal 100 can be made equal to or higher than 9 L per minute in the second circulation operation.

[0054] For example, in the case where the indoor-heating terminal 100 includes an appliance for floor heating, a relatively low supply temperature is preferable. The relatively low supply temperature is, e.g., about 35°C. In the case where the supply temperature is relatively low, as compared with the case where the supply temperature is relatively high, the indoor-heating power requested by the user may not be outputted unless the flow rate of the heating medium passing through the indoor-heating terminal 100 is increased. According to the second circulation operation, it is possible to increase the flow rate of the heating medium passing through the indoor-heating terminal 100, and hence it becomes possible to output the indoor-heating power requested by the user even with the relatively low supply temperature.

[0055] The control device 36 may perform control in the following manner in the heat accumulating operation and the second circulation operation. The control device 36 may control the operations of the first circulation pump 12 and the second circulation pump 13 such that the flow rate of the heating medium passing through the heat pump device 7 in the heat accumulating operation is not more than the flow rate of the heating medium passing through the indoor-heating terminal 100 in the second circulation operation. With this, the temperature of the heating medium flowing into the heat storage tank 8 from the heat pump device 7 and the supply temperature for the indoor-heating terminal 100 can be set to proper values. The control device 36 may control the operation of at least one of the heat pump device 7, the first circulation pump 12, and the mixing valve 19 such that the heat pump outlet temperature detected by the temperature

sensor 40 is not less than the supply temperature for the indoor-heating terminal 100. With this, it is possible to reliably prevent the heating medium having a temperature lower than the supply temperature for the indoor-heating terminal 100 from flowing into the heat storage tank 8 from the heat pump device 7. The control device 36 may perform control in the above manner in the case where the heat accumulating operation and the second circulation operation are performed concurrently and simultaneously. The control device 36 may perform control in the above manner in the case where the heat accumulating operation and the second circulation operation are performed separately and individually at different occasions.

[0056] A configuration may be adopted in which the user can choose the first circulation operation or the second circulation operation according to the type of the indoor-heating terminal 100. For example, a configuration may be adopted in which the user can operate the terminal device 37 to thereby preset the execution of the first circulation operation or the second circulation operation in the indoor-heating operation.

[0057] For example, in the case where the amount of stored heat in the heat storage tank 8 is sufficient, the control device 36 may execute only the second circulation operation without executing the heat accumulating operation.

[0058] According to the present embodiment, the following effects can be obtained by providing the first check valve 60 in the third flow channel 10b. It is possible to enable, using a simple device configuration, the second circulation operation in which the heating medium is caused to flow into the supply channel 16b leading to the indoor-heating terminal 100 from the heat storage tank 8, and the first circulation operation in which the heating medium heated by the heat pump device 7 is caused to flow into the supply channel 16b without passing through the heat storage tank 8. The first check valve 60 is lower in cost than a flow channel switching valve. The first check valve 60 operates automatically, and hence the control device 36 does not need to control the first check valve 60.

[0059] The heating medium circulation system 35 of the present embodiment may execute a circulation heat accumulating operation instead of the above-described once-through heat accumulating operation. The following state is established in the circulation heat accumulating operation. The total volume of the heating medium passing through the heat pump device 7 in one heat accumulating operation is not less than the capacity of the heat storage tank 8. For example, the total volume of the heating medium passing through the heat pump device 7 in one heat accumulating operation may be about several times to ten times the capacity of the heat storage tank 8. An increase in the temperature of the heating medium when the heating medium passes through the heat pump device 7 once is small. For example, the increase in the temperature thereof in one passage may

be 5°C. The heating medium in the heat storage tank 8 is heated by the heat pump device 7 a plurality of times, and the temperature of the heating medium increases stepwise and reaches the target temperature.

[0060] Depending on the type of the refrigerant of the heat pump device 7, the COP can be improved by performing the circulation heat accumulating operation. For example, in the case where the heat pump 7 has R410A as the refrigerant, the COP can be improved by reducing an increase in temperature in one passage by performing the circulation heat accumulating operation.

[0061] The control device 36 may perform control in the following manner in the circulation heat accumulating operation and the second circulation operation. The control device 36 may control the operations of the first circulation pump 12 and the second circulation pump 13 such that the flow rate of the heating medium passing through the heat pump device 7 in the circulation heat accumulating operation is not more than the flow rate of the heating medium passing through the indoor-heating terminal 100 in the second circulation operation. With this, the COP of the circulation heat accumulating operation can be improved and, at the same time, the supply temperature for the indoor-heating terminal 100 can be set to a proper temperature. The control device 36 may perform control in the above manner in the case where the circulation heat accumulating operation and the second circulation operation are executed concurrently and simultaneously. The control device 36 may perform control in the above manner in the case where the circulation heat accumulating operation and the second circulation operation are executed separately and individually at different occasions.

[0062] The individual functions of the control device 36 may be implemented by processing circuitry. The processing circuitry of the control device 36 may include at least one processor 361 and at least one memory 362. In the case where the processing circuitry includes at least one processor 361 and at least one memory 362, the individual functions of the control device 36 may be implemented by software, firmware, or a combination of software and firmware. At least one of the software and the firmware may be described as a program. At least one of the software and the firmware may be stored in at least one memory 362. At least one processor 361 may implement the individual functions of the control device 36 by reading and executing a program stored in at least one memory 362. At least one memory 362 may include a non-volatile or volatile semiconductor memory, a magnetic disk, or the like.

[0063] The processing circuitry of the control device 36 may include at least one dedicated hardware. In the case where the processing circuitry includes at least one dedicated hardware, the processing circuitry may be, e.g., a single circuit, a composite circuit, a programmed processor, a parallel-programmed processor, an ASIC (Application Specific Integrated Circuit), an FPGA (Field-Programmable Gate Array), or a combination thereof.

The functions of the individual sections of the control device 36 may be implemented individually by the processing circuitry. In addition, the functions of the individual sections of the control device 36 may also be implemented collectively by the processing circuitry. Part of the individual functions of the control device 36 may be implemented by dedicated hardware, and the other part thereof may be implemented by software or firmware. The processing circuitry may implement the individual functions of the control device 36 by using hardware, software, firmware, or a combination thereof.

[0064] The configuration is not limited to the configuration in which the operation of the heating medium circulation system 35 is controlled by a single control device, and a configuration may be adopted in which a plurality of control devices cooperate with each other to control the operation of the heating medium circulation system 35.

[Reference Signs List]

[0065]

1	compressor	
2	outside air temperature sensor	
3	first heat exchanger	
4	decompression device	
5	refrigerant piping	
6	second heat exchanger	
7	heat pump device	
8	heat storage tank	
10b	third flow channel	
11	third circulation pump	
12	first circulation pump	
13	second circulation pump	
14	fourth flow channel	
15a	fifth flow channel	
15b	second flow channel	
16a	first flow channel	
16b,16c	supply channel	
17a	return channel	
17b	bypass channel	
18	three-way valve	
19	mixing valve	
33	tank unit	
35	heating medium circulation system	
36	control device	
37	terminal device	
60	first check valve	
61	second check valve	
100	indoor-heating terminal	
101	room temperature sensor	

Claims

1. A heating medium circulation system comprising:

heating means configured to heat a heating medium;
a heat storage tank configured to store the heating medium heated by the heating means;
a supply channel through which the heating medium supplied to a heat demand section flows;
a first flow channel through which the heating medium flowing out from the heating means is caused to flow into the supply channel without passing through the heat storage tank;
a second flow channel through which the heating medium flowing out from the heating means is caused to flow into the heat storage tank;
flow channel switching means configured to switch between the first flow channel and the second flow channel;
a third flow channel through which the heating medium flowing out from the heat storage tank is caused to flow into the supply channel; and
a check valve disposed in the third flow channel.

2. The heating medium circulation system according to Claim 1, further comprising:

means configured to control a first circulation operation in which the heating medium flows through the heating means, the first flow channel, and the supply channel in this order, and a second circulation operation in which the heating medium flows through the heat storage tank, the third flow channel, and the supply channel in this order.

3. The heating medium circulation system according to Claim 2, wherein

the flow channel switching means switches to the first flow channel, and the heating medium heated by the heating means flows into the supply channel without passing through the heat storage tank in the first circulation operation.

4. The heating medium circulation system according to Claim 2 or 3, further comprising:

a bypass channel through which the heating medium having passed through the heat demand section is caused to flow into the supply channel without passing through the heating means and the heat storage tank; and
flow rate adjustment means configured to adjust a flow rate of the heating medium flowing through the bypass channel.

5. The heating medium circulation system according to any one of Claims 2 to 4, further comprising:

a fourth flow channel through which the heating medium flowing out from the heat storage tank is caused to flow into the heating means; and
a return channel through which the heating me-

dium having passed through the heat demand section is caused to flow into the heat storage tank, wherein the heating medium circulates through the heat storage tank, the third flow channel, the supply channel, the heat demand section, the return channel, and the heat storage tank in this order in the second circulation operation, and a heat accumulating operation in which the heating medium circulates through the heat storage tank, the fourth flow channel, the heating means, the second flow channel, and the heat storage tank in this order, and the second circulation operation are concurrently executable.

6. The heating medium circulation system according to any one of Claims 2 to 5, further comprising: means configured to perform control such that a temperature of the heating medium flowing out from the heating means in a heat accumulating operation in which the heating medium heated by the heating means is caused to flow into the heat storage tank is not less than a hot water supply temperature set by a user.
7. The heating medium circulation system according to any one of Claims 2 to 6, further comprising: means configured to perform control such that a temperature of the heating medium flowing out from the heating means in a heat accumulating operation in which the heating medium heated by the heating means is caused to flow into the heat storage tank is not less than a temperature of the heating medium supplied to the heat demand section in the second circulation operation.
8. The heating medium circulation system according to any one of Claims 2 to 7, further comprising: means configured to perform control such that a flow rate of the heating medium passing through the heating means in a heat accumulating operation in which the heating medium heated by the heating means is caused to flow into the heat storage tank is not more than a flow rate of the heating medium passing through the heat demand section in the second circulation operation.
9. The heating medium circulation system according to any one of Claims 2 to 7, further comprising: means configured to perform control such that a flow rate of the heating medium passing through the heating means in a circulation heat accumulating operation in which a total volume of the heating medium having passed through the heating means in one heat accumulating operation is not less than a capacity of the heat storage tank is not less than a flow rate of the heating medium passing through the heat demand section in the second circulation operation.

FIG. 1

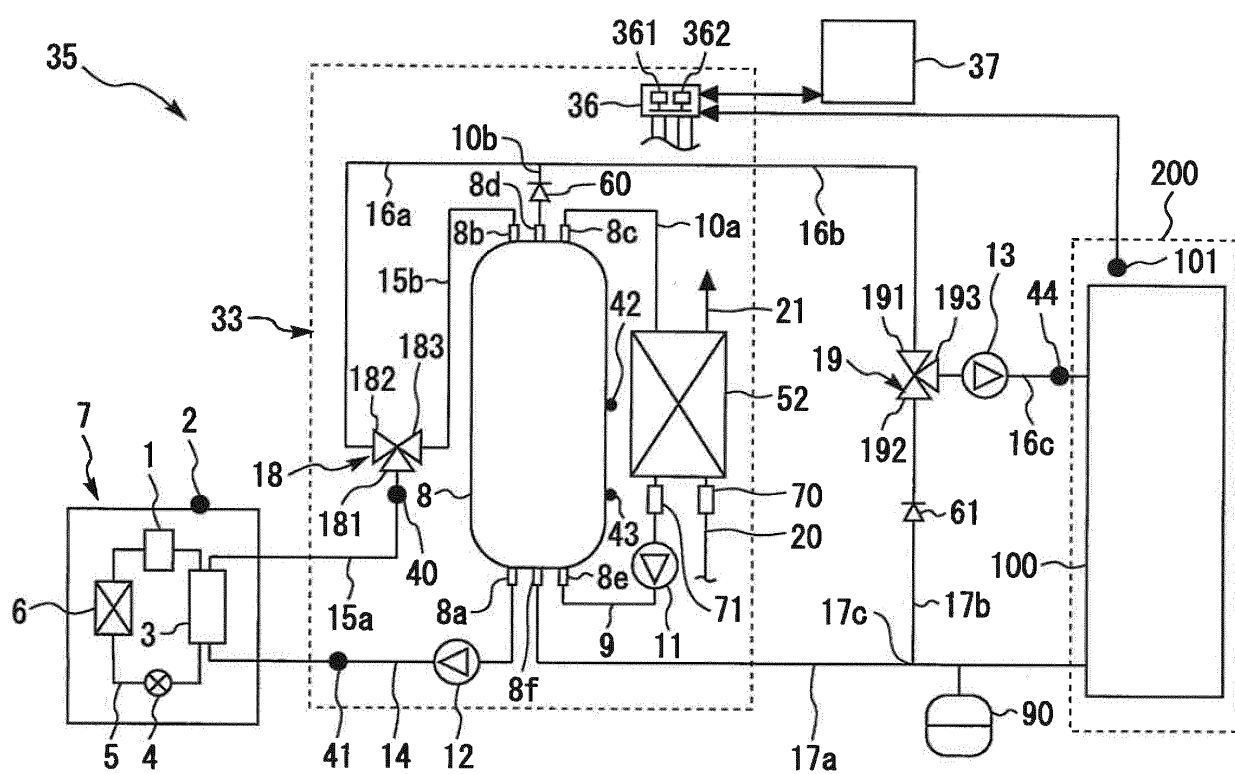


FIG. 2

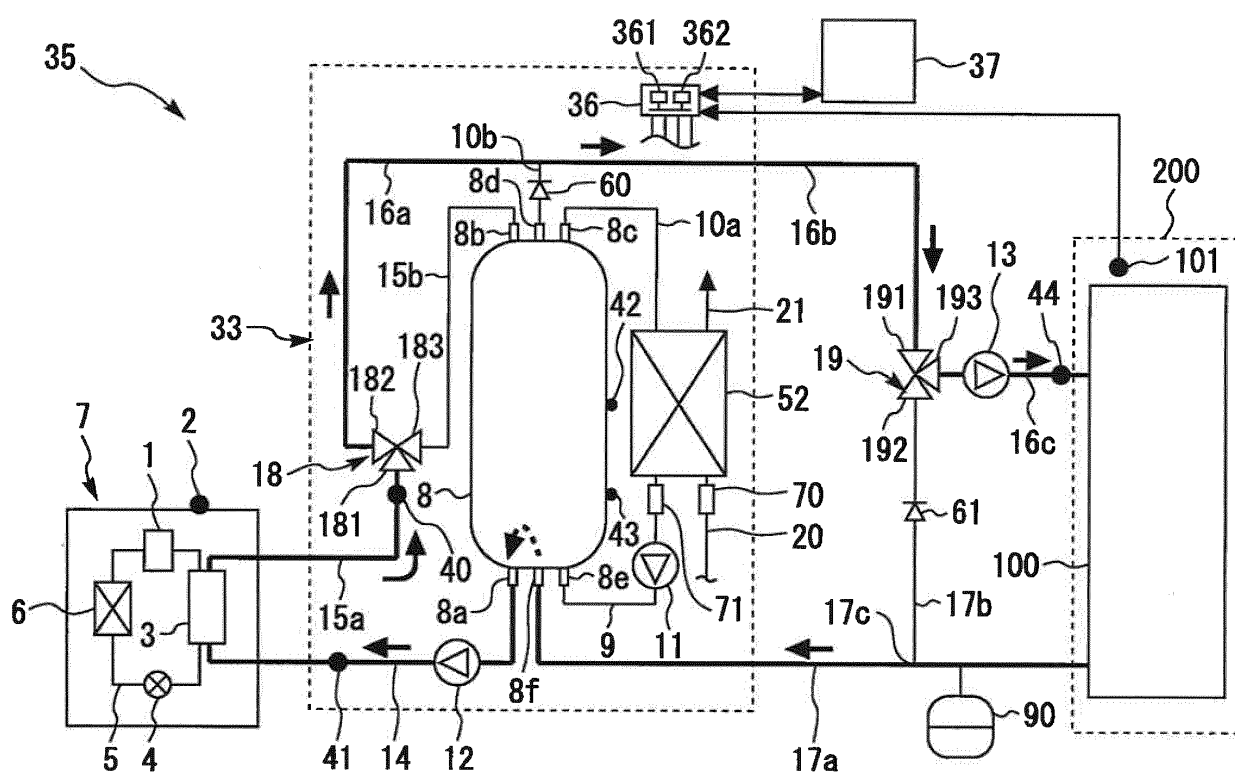
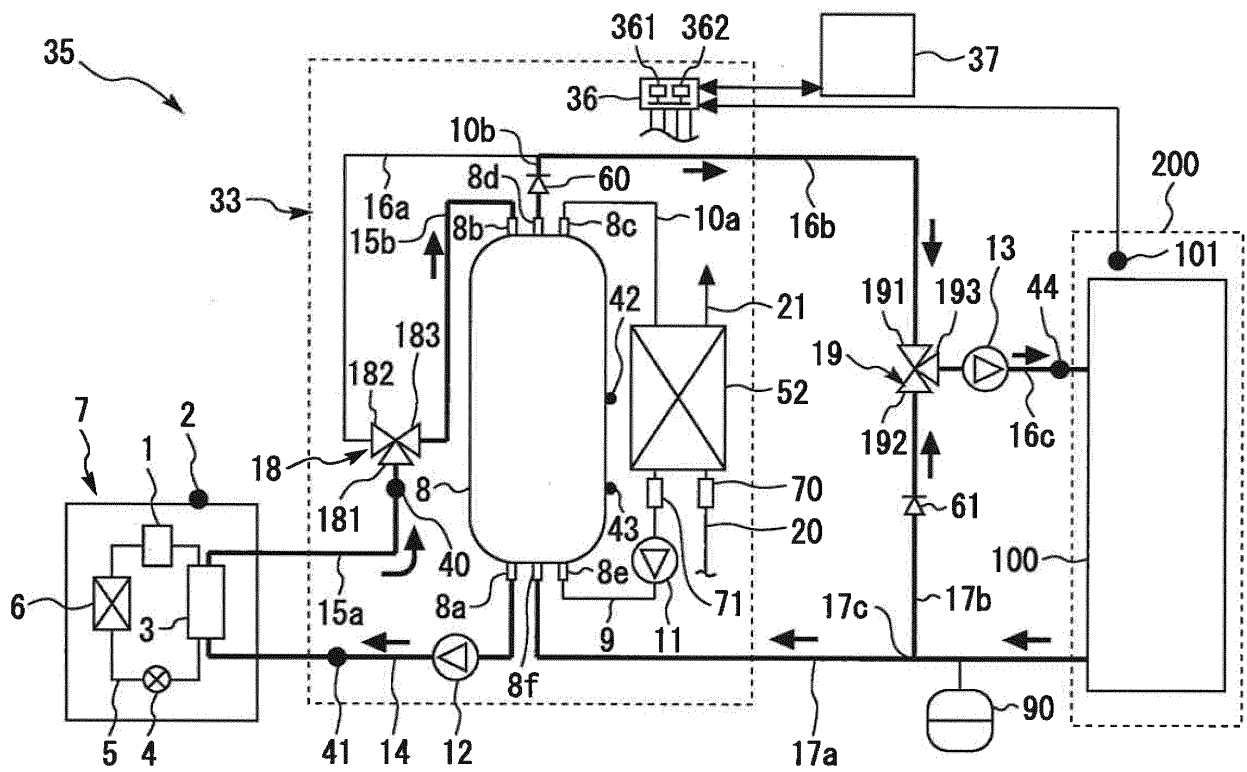


FIG. 3



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2016/083414

A. CLASSIFICATION OF SUBJECT MATTER

F24H1/18(2006.01)i, F24H4/02(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)

F24H1/18, F24H4/02

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2017

Kokai Jitsuyo Shinan Koho 1971-2017 Toroku Jitsuyo Shinan Koho 1994-2017

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.
A	JP 2012-237492 A (Mitsubishi Electric Corp.), 06 December 2012 (06.12.2012), paragraphs [0011] to [0035]; fig. 1 to 6 (Family: none)	1-9
A	JP 2008-256346 A (Matsushita Electric Industrial Co., Ltd.), 23 October 2008 (23.10.2008), claims 1 to 2; paragraphs [0017] to [0064]; fig. 1 to 6 (Family: none)	1-9
A	JP 2014-062714 A (Rinnai Corp.), 10 April 2014 (10.04.2014), paragraph [0033]; fig. 3 & KR 10-2014-0039997 A	1-9

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

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Date of the actual completion of the international search
01 February 2017 (01.02.17)Date of mailing of the international search report
14 February 2017 (14.02.17)Name and mailing address of the ISA/
Japan Patent Office
3-4-3, Kasumigaseki, Chiyoda-ku,
Tokyo 100-8915, Japan

Authorized officer

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INTERNATIONAL SEARCH REPORT

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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2016-183838 A (Mitsubishi Electric Corp.), 20 October 2016 (20.10.2016), paragraphs [0009] to [0057] (Family: none)	1-9
A	JP 2011-257105 A (The Tokyo Electric Power Co., Inc.), 22 December 2011 (22.12.2011), fig. 1, 3 to 4 (Family: none)	1-9
A	JP 5253582 B2 (Mitsubishi Electric Corp.), 31 July 2013 (31.07.2013), paragraphs [0013] to [0075]; fig. 1 to 12 & WO 2011/040387 A1	1-9

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REFERENCES CITED IN THE DESCRIPTION

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