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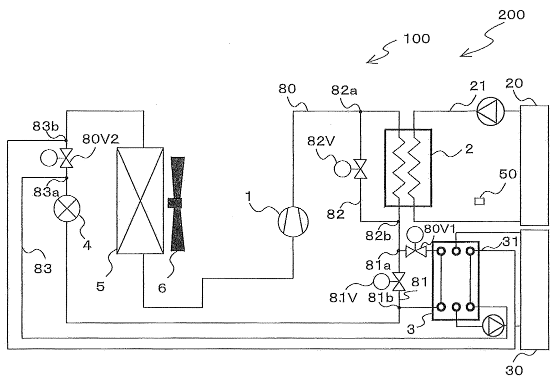
(54) **HEAT PUMP HOT WATER SUPPLY SYSTEM**

(57) A heat pump hot-water supply system includes a heat pump water heater (100) including a main circuit (80), in which a compressor (1) configured to compress refrigerant, a gas cooler (2), a first solenoid valve (80V1), a regenerative heat exchanger (3), an expansion valve (4), and an air heat exchanger (5) are connected in the stated order, a hot-water supply tank (20) including a heat medium for exchanging heat with the refrigerant flowing through the gas cooler (2), and a heat storage tank (30) including a heat medium for exchanging heat with the refrigerant flowing through the regenerative heat exchanger (3). The heat pump water heater (100) includes a first bypass (81) formed to branch off the main circuit (80) at a first branching portion (81 a) located on an outlet side of the gas cooler (2) and an inlet side of the first solenoid valve (80V1), and to merge with the main circuit (80) at a first merging portion (81 b) located on an outlet side of the regenerative heat exchanger (3) and an inlet side of the expansion valve (4); and a control unit (50) configured to switch the first solenoid valve (80V1) to be opened or closed.

FIG. 2



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Description

Technical Field

[0001] The present invention relates to a heat pump hot-water supply system, and more particularly, to a heat pump hot-water supply system using heat of condensation of refrigerant and other heat energy.

Background Art

[0002] In recent years, in response to the trend toward regulating the use of chlorofluorocarbon refrigerants, a heat pump apparatus using a natural refrigerant is under fierce development. Among others, a heat pump apparatus using carbon dioxide (CO_2) as a refrigerant has become increasingly popular year after year. CO_2 has the characteristics of having an ozone depletion potential of 0 and a global warming potential of 1, and hence can reduce a load on the environment. Moreover, CO_2 has excellent safety of being nontoxic and incombustible, is easily available, and is relatively inexpensive. Further, as opposed to a fluorocarbon-based refrigerant, CO_2 has a characteristic that CO_2 on the high-pressure side, which is discharged from a compressor, transitions to a supercritical state exceeding a critical point. In other words, when transferring heat to another fluid (e.g., water, air, or the refrigerant) by exchanging heat, CO_2 in this supercritical state remains in the supercritical state without being condensed. CO_2 having such characteristics suffers a small loss by transitioning between the states, and is suitable for, among others, a heat pump apparatus with high temperature is required. Therefore, there has been proposed a heat pump water heater, which uses CO_2 as a refrigerant, and is configured to heat water to a high temperature of 90 degrees centigrade or more utilizing the advantages of CO_2.

[0003] Moreover, there has been proposed a hot-water supply system using a heat pump water heater, which is configured to heat water by heat of condensation of refrigerant (see Patent Literature 1, for example). The hot-water supply system disclosed in Patent Literature 1 includes the heat pump water heater, and a burning appliance as an auxiliary hot-water supply unit using gas or oil as a fuel.

Citation List

Patent Literature

[0004] Patent Literature 1: Japanese Patent No. 4139827

Summary of Invention

Technical Problem

[0005] However, in the invention disclosed in Patent Literature 1, when a hot-water supply load is temporarily increased, and the burning appliance is operated, the heat pump water heater has a small instantaneous capacity, and hence has extremely small operation factor. Therefore, there has been a problem of leading to a reduction in efficiency in terms of primary converted energy, and to an increase in discharge amount of CO_2. Moreover, when the heat is to be stored in a hot-water storage tank in the night and other times when the load is small without operating the burning appliance, there have been problems in that a capacity of the hot-water storage tank is increased, and hence in that an installation space is increased, with the result that an initial investment is increased.

[0006] The present invention has been made in view of the above-mentioned problems, and therefore has an object to provide a heat pump hot-water supply system that is more inexpensive and smaller in installation space than in the related art. Solution to Problem

[0007] According to one embodiment of the present invention, there is provided a heat pump hot-water supply system including: a heat pump water heater including a main circuit, in which a compressor configured to compress a refrigerant, a gas cooler, a first solenoid valve, a regenerative heat exchanger, an expansion valve, and an air heat exchanger are connected in the stated order; a hot-water supply tank including a heat medium for exchanging heat with the refrigerant flowing through the gas cooler; and a heat storage tank including a heat medium for exchanging heat with the refrigerant flowing through the regenerative heat exchanger, the heat pump water heater including: a first bypass, which is formed to branch off the main circuit at a first branching portion located on an outlet side of the gas cooler and an inlet side of the first solenoid valve, and to merge with the main circuit at a first merging portion located on an outlet side of the regenerative heat exchanger and an inlet side of the expansion valve; and a control unit configured to switch the first solenoid valve to be opened or closed.

Advantageous Effects of Invention

[0008] According to the one embodiment of the present invention, the heat pump hot-water supply system includes the first bypass, which is formed to branch off the main circuit at the first branching portion located on the outlet side of the gas cooler and the inlet side of the first solenoid valve, and to merge with the main circuit at the first merging portion located on the outlet side of the regenerative heat exchanger and the inlet side of the expansion valve, and the control unit configured to switch the first solenoid valve to be opened or closed. Therefore, hot water stored in the hot-water supply tank can be heated without using a burning appliance configured to heat the hot water stored in the hot-water supply tank, and hence without increasing the capacity of the hot-water storage tank. Therefore, there can be obtained the heat pump hot-water supply system that is more inexpensive and smaller in installation space than in the related art.

Brief Description of Drawings

[0009]

[Fig. 1] Fig. 1 is a configuration diagram of a heat pump hot-water supply system 200 according to Embodiment 1 of the present invention.

[Fig. 2] Fig. 2 is a schematic diagram of the heat pump hot-water supply system 200 according to Embodiment 1 of the present invention.

[Fig. 3] Fig. 3 is a diagram for illustrating a specific configuration of a heat storage tank 30 of the heat pump hot-water supply system 200 according to Embodiment 1 of the present invention.

[Fig. 4] Fig. 4 is a schematic diagram of a heat pump hot-water supply system 200 according to Embodiment 2 of the present invention.

Description of Embodiments

[0010] Now, a heat pump water heater 100 according to the present invention is described in detail with reference to the drawings. Note that, the relationships between the sizes of components in the following drawings may be different from the actual relationships. Further, in the following drawings, components denoted by the same reference symbols correspond to the same or equivalent components. This is common throughout the description herein. In addition, the forms of the components described herein are merely examples, and the components are not limited to the description herein.

Embodiment 1

[0011] Fig. 1 is a configuration diagram of a heat pump hot-water supply system 200 according to Embodiment 1 of the present invention. Fig. 2 is a schematic diagram of the heat pump hot-water supply system 200 according to Embodiment 1 of the present invention.

[0012] As illustrated in Fig. 1, the heat pump hot-water supply system 200 includes a heat pump water heater 100, a hot-water supply tank 20, a hot-water supply circuit 21, a water supply unit 22, a heat storage tank 30, a heat storage circuit 31, and a water supply unit 32.

[0013] As illustrated in Fig. 2, the heat pump water heater 100 uses, as a refrigerant, a fluid exceeding a critical point on a high-pressure side of a refrigeration cycle, for example, CO_2. The heat pump water heater 100 includes a compressor 1, a gas cooler 2, a regenerative heat exchanger 3, an expansion valve 4, an air heat exchanger 5, a fan 6, a control unit 50, and a main circuit 80. The main circuit 80 is a circuit formed by connecting the compressor 1, the gas cooler 2, the regenerative heat exchanger 3, the expansion valve 4, and the air heat exchanger 5 in the stated order.

[0014] The compressor 1 is a compressor having a variable capacity, which is configured to compress the sucked refrigerant to be discharged as high-temperature, high-pressure refrigerant. The gas cooler 2 is configured to exchange heat between the refrigerant that has been discharged from the compressor 1 and is flowing through the main circuit 80, and a heat medium that is flowing through the hot-water supply circuit 21, and is provided on a discharge side of the compressor 1. The regenerative heat exchanger 3 is configured to exchange heat between the refrigerant flowing through the main circuit 80, and a heat medium flowing through the heat storage circuit 31. The heat medium that has exited the hot-water supply tank 20 and is flowing through the hot-water supply circuit 21 is hot water, for example. Moreover, the heat medium that has exited the heat storage tank 30 and is flowing through the heat storage circuit 31 is hot water, for example.

[0015] The expansion valve 4 is configured to decompress and expand the refrigerant flowing on the main circuit 80, and is provided on an outlet side of the regenerative heat exchanger 3 on the main circuit 80. The air heat exchanger 5 is configured to evaporate and gasify the refrigerant that has exited the expansion valve 4, and is provided on an outlet side of the expansion valve 4. The fan 6 is an air-sending unit configured to generate an air flow for introducing air into the air heat exchanger 5.

[0016] The hot-water supply tank 20 is configured to temporarily store hot water to be supplied. The hot-water supply circuit 21 is a circuit formed to pass through the hot-water supply tank 20 and the gas cooler 2. The water supply unit 22 is configured to send hot water, which is discharged from inside the hot-water supply tank 20, toward the gas cooler 2 side, and to return the hot water back to the hot-water supply tank 20.

[0017] The heat storage tank 30 is configured to store hot water at a temperature that is lower than a hot-water supply temperature (for example, temperature range of from 20 to 40 degrees centigrade). The heat storage circuit 31 is a circuit formed to pass through the heat storage tank 30 and the regenerative heat exchanger 3. The water supply unit 32 is configured to send hot water, which is discharged from inside the heat storage tank 30, toward the regenerative heat exchanger 3 side, and to return the hot water back to the heat storage tank 30.

[0018] The control unit 50 is configured to control a first solenoid valve 80V1, a second solenoid valve 80V2, a first bypass solenoid valve 81 V, and a second bypass solenoid valve 82V, for example, to be opened or closed. The control unit 50 includes, for example, hardware such as a circuit device configured to realize the above-mentioned function, or software to be executed on an arithmetic unit such as a microcontroller or a CPU.

[0019] The first solenoid valve 80V1 is a solenoid valve provided on an outlet side of the gas cooler 2 and an inlet side of the regenerative heat exchanger 3. The second solenoid valve 80V2 is a solenoid valve provided on the outlet side of the expansion valve 4 and an inlet side of the air heat exchanger 5.

[0020] A first bypass 81 is formed to branch off the main circuit 80 at a first branching portion 81 a located on the outlet side of the gas cooler 2 and an inlet side of the first solenoid valve 80V1, and to merge with the main circuit 80 at a first merging portion 81 b located on the outlet side of the regenerative heat exchanger 3 and an inlet side of the expansion valve 4. The first bypass solenoid valve 81 V is provided on the first bypass 81.

[0021] A second bypass 82 is formed to branch off the main circuit 80 at a second branching portion 82a located on the discharge side of the compressor 1 and an inlet side of the gas cooler 2, and to merge with the main circuit 80 at a second merging portion 82b located on the outlet side of the gas cooler 2 and the gas cooler 2 side of the first branching portion 81 a. The second bypass solenoid valve 82V is provided on the second bypass 82.

[0022] A third bypass 83 is formed to branch off the main circuit 80 at a third branching portion 83a located on the outlet side of the expansion valve 4 and an inlet side of the second solenoid valve 80V2, and to merge with the main circuit 80 at a third merging portion 83b located on an outlet side of the second solenoid valve 80V2 and the inlet side of the air heat exchanger 5.

[0023] Now, operation modes of the heat pump water heater 100 are described. Examples of the operation modes include, for example, (1) hot-water supply mode, (2) heat storage mode, (3) heat recovery and hot-water supply mode, and (4) simultaneous temperature retaining and heat storage mode.

(1) Hot-Water Supply Mode

[0024] The hot-water supply mode is a mode in which, in a case where there is a small or almost no hot-water supply load, low-temperature water in a lower portion of the hot-water supply tank 20 is increased in temperature, is further increased in temperature inside the heat pump water heater 100 to be high-temperature hot water, and is then returned to an upper portion of the hot-water supply tank 20. In the hot-water supply mode, the control unit 50 closes the first solenoid valve 80V1, opens the second solenoid valve 80V2, opens the first bypass solenoid valve 81 V, and closes the second bypass solenoid valve 82V.

[0025] When the hot-water supply mode is executed, the high-temperature, high-pressure refrigerant that has been discharged from the compressor 1 enters the gas cooler 2. The refrigerant that has entered the gas cooler 2 heats and increases a temperature of water to be supplied as hot water, which circulates through the hot-water supply circuit 21. The refrigerant then transitions to a low-temperature refrigerant state, and flows through the first bypass 81 to enter the expansion valve 4. The refrigerant that has entered the expansion valve 4 is decompressed and expanded to transition to a low-temperature, low-pressure two-phase refrigerant state, and exits from the expansion valve 4 to enter the air heat exchanger 5. The refrigerant, which has entered the air heat exchanger 5, exchanges heat with ambient air to transition to a gaseous state, and enters the compressor 1.

[0026] Meanwhile, when the water supply unit 22 is operated, the low-temperature water in the lower portion of the hot-water supply tank 20 passes through the hot-water supply circuit 21 to enter the gas cooler 2. The hot water that has entered the gas cooler 2 exchanges heat with the refrigerant flowing through the gas cooler 2 to be increased in temperature, and hence transition to high-temperature hot water, and passes through the hot-water supply circuit 21 to enter the upper portion of the hot-water supply tank 20.

(2) Heat Storage Mode

[0027] The heat storage mode is a mode in which, when an amount of hot water in the hot-water supply tank 20 is occupied by a certain threshold value or more of hot water (for example, 100%), hot water inside the heat storage tank 30 is increased in temperature. In the heat storage mode, the control unit 50 opens the first solenoid valve 80V1, opens the second solenoid valve 80V2, closes the first bypass solenoid valve 81 V, and opens the second bypass solenoid valve 82V.

[0028] When the heat storage mode is executed, the high-temperature, high-pressure refrigerant that has been discharged from the compressor 1 flows through the second bypass 82 to enter the regenerative heat exchanger 3. The refrigerant that has entered the regenerative heat exchanger 3 heats and increases a temperature of hot water circulating through the heat storage circuit 31 to transition to the low-temperature refrigerant state, and enters the expansion valve 4. The refrigerant that has entered the expansion valve 4 is decompressed and expanded to transition to the low-temperature, low-pressure two-phase refrigerant state, and enters the air heat exchanger 5. The refrigerant that has entered the air heat exchanger 5 exchanges heat with the ambient air to transition to the gaseous state, and enters the compressor 1.

[0029] Meanwhile, when the water supply unit 32 is operated, hot water stored inside the heat storage tank 30 passes through the heat storage circuit 31 to enter the regenerative heat exchanger 3. The hot water that has entered the regenerative heat exchanger 3 exchanges heat with the refrigerant flowing through the regenerative heat exchanger 3 to be heated and increased in temperature, and passes through the heat storage circuit 31 to enter the heat storage tank 30.

(3) Heat Recovery and Hot-Water Supply Mode

[0030] The heat recovery and hot-water supply mode is a mode in which, when the hot-water supply load is temporarily increased, and the amount of hot water in the hot-water supply tank 20 falls below the certain threshold value or less, hot water inside the regenerative heat exchanger 3 and the heat storage tank 30 is circulated using hot water in the heat storage tank 30 as a heat source, and a temperature of hot water inside the hot-water supply tank 20 is increased by the regenerative heat exchanger 3. In the heat recovery and hot-water supply mode, the control unit 50 closes the first solenoid valve 80V1, closes the second solenoid valve 80V2, opens the first bypass solenoid valve 81 V, and closes the second bypass solenoid valve 82V.

[0031] When the heat recovery and hot-water supply mode is executed, the high-temperature, high-pressure refrigerant that has been discharged from the compressor 1 enters the gas cooler 2. The refrigerant that has entered the gas cooler 2 heats and increases a temperature of hot water circulating through the hot-water supply circuit 21 to transition to the low-temperature refrigerant state, and passes through the first bypass 81 to enter the expansion valve 4. The refrigerant that has entered the expansion valve 4 is decompressed to transition to the low-temperature, low-pressure two-phase refrigerant state, and passes through the third bypass 83 to enter the regenerative heat exchanger 3. The refrigerant that has entered the regenerative heat exchanger 3 cools hot water circulating through the heat storage circuit 31 to be evaporated, and hence transition to the gaseous state, and enters the air heat exchanger 5. The refrigerant that has entered the air heat exchanger 5 exchanges heat with the ambient air to transition to the gaseous state, and enters the compressor 1.

[0032] Meanwhile, when the water supply unit 22 is operated, the low-temperature water in the lower portion of the hot-water supply tank 20 passes through the hot-water supply circuit 21 to enter the gas cooler 2. The hot water that has entered the gas cooler 2 exchanges heat with the refrigerant flowing through the gas cooler 2 to be increased in temperature, and hence transition to high-temperature hot water, and passes through the hot-water supply circuit 21 to enter the upper portion of the hot-water supply tank 20. Moreover, when the water supply unit 32 is operated, hot water stored in the heat storage tank 30 passes through the heat storage circuit 31 to enter the regenerative heat exchanger 3. The hot water that has entered the regenerative heat exchanger 3 exchanges heat with the refrigerant flowing through the regenerative heat exchanger 3 to be cooled, and passes through the heat storage circuit 31 to enter the heat storage tank 30.

(4) Simultaneous Temperature Retaining and Heat Storage Mode

[0033] The simultaneous temperature retaining and heat storage mode is a mode in which, when the hot-water supply load is small but the temperature needs to be increased again due to a reduction in temperature caused by heat loss and other factors, that is, when a temperature of water that enters from the hot-water supply tank 20 is higher than a certain threshold value (for example, 55 degrees centigrade), the temperature of hot water inside the hot-water supply tank 20 is increased again, and the temperature of hot water inside the heat storage tank 30 is increased. In the simultaneous temperature retaining and heat storage mode, the control unit 50 opens the first solenoid valve 80V1, opens the second solenoid valve 80V2, closes the first bypass solenoid valve 81 V, and closes the second bypass solenoid valve 82V.

[0034] When the simultaneous temperature retaining and heat storage mode is executed, the high-temperature, high-pressure refrigerant that has been discharged from the compressor 1 enters the gas cooler 2. The refrigerant that has entered the gas cooler 2 heats and increases the temperature of hot water circulating through the hot-water supply circuit 21 to transition to an intermediate-temperature refrigerant state, and enters the regenerative heat exchanger 3. The refrigerant that has entered the regenerative heat exchanger 3 heats and increases the temperature of hot water circulating through the heat storage tank 30 to transition to the low-temperature refrigerant state, and is discharged from the regenerative heat exchanger 3. The refrigerant that has been discharged from the regenerative heat exchanger 3 enters the expansion valve 4 to be decompressed, and hence transition to the low-temperature, low-pressure two-phase refrigerant state, and enters the air heat exchanger 5. The refrigerant that has entered the air heat exchanger 5 exchanges heat with the ambient air in the air heat exchanger 5 to transition to the gaseous state, and enters the compressor 1.

[0035] Meanwhile, when the water supply unit 22 is operated, the low-temperature water in the lower portion of the hot-water supply tank 20 passes through the hot-water supply circuit 21 to enter the gas cooler 2. The hot water that has entered the gas cooler 2 exchanges heat with the refrigerant flowing through the gas cooler 2 to be increased in temperature, and hence transition to high-temperature hot water, and passes through the hot-water supply circuit 21 to enter the upper portion of the hot-water supply tank 20. Moreover, when the water supply unit 32 is operated, hot water stored inside the heat storage tank 30 passes through the heat storage circuit 31 to enter the regenerative heat exchanger 3. The hot water that has entered the regenerative heat exchanger 3 exchanges heat with the refrigerant flowing through the regenerative heat exchanger 3 to be heated and increased in temperature, and passes through the heat storage circuit 31 to enter the heat storage tank 30.

[0036] Fig. 3 is a diagram for illustrating a specific configuration of the heat storage tank 30 of the heat pump hot-water supply system 200 according to Embodiment 1 of the present invention. As illustrated in Fig. 3, capsules 29 that are changed from a liquid phase to a solid phase at 20 to 40 degrees centigrade are stored in the heat storage tank 30. The capsules 29 are members encapsulating sodium acetate or other latent heat storage materials, for example. When such configuration is adopted, the heat storage tank 30 is configured such that hot water flows around the capsules 29. The capsules 29 may alternatively be formed of capsules of several hundred microns or less encapsulating a paraffin resin-based material or other latent heat storage materials, for example. In this case, the capsules 29 and the hot water in a mixture state are stored in the heat storage tank 30, and when in the heat recovery and hot-water supply mode and in the heat storage mode, the heat pump hot-water supply system 200 is configured such that the capsules 29 and the hot water in the mixture state circulate between the regenerative heat exchanger 3 and the heat storage tank 30.

[0037] As described above, the heat pump water heater 100 according to Embodiment 1 includes the heat pump water heater 100 including the main circuit 80, which is formed by connecting the compressor 1 configured to compress the refrigerant, the gas cooler 2, the first solenoid valve 80V1, the regenerative heat exchanger 3, the expansion valve 4, and the air heat exchanger 5 in the stated order, the hot-water supply tank 20 including the heat medium for exchanging heat with the refrigerant flowing through the gas cooler 2, and the heat storage tank 30 including the heat medium for exchanging heat with the refrigerant flowing through the regenerative heat exchanger 3. The heat pump water heater 100 includes the first bypass 81, which is formed to branch off the main circuit 80 at the first branching portion 81 a located on the outlet side of the gas cooler 2 and the inlet side of the first solenoid valve 80V1, and to merge with the main circuit 80 at the first merging portion 81 b located on the outlet side of the regenerative heat exchanger 3 and the inlet side of the expansion valve 4, and the control unit 50 configured to switch the first solenoid valve 80V1 to be opened or closed.

[0038] Therefore, as opposed to the related art, hot water stored in the hot-water supply tank 20 can be heated without using a burning appliance configured to heat the hot water stored in the hot-water supply tank 20, and hence without increasing the capacity of the hot-water supply tank 20. Therefore, there can be obtained the heat pump hot-water supply system 200 that is more inexpensive and smaller in installation space than in the related art.

[0039] Moreover, the control unit 50 can execute the heat recovery and hot-water supply mode by closing the first solenoid valve 80V1, closing the second solenoid valve 80V2, opening the first bypass solenoid valve 81 V, and closing the second bypass solenoid valve 82V. Through execution of the heat recovery and hot-water supply mode, the hot-water supply capacity can be increased especially in winter when the hot-water supply load is large. For example, in a hot-water supply mode in the related art, heat has been transferred from the low temperature of the ambient air to the water to be supplied as the hot water. However, with the addition of the heat recovery and hot-water supply mode, heat is transferred from intermediate-temperature water in the heat storage tank 30 to the water to be supplied as the hot water such that the heat is transferred more easily, and with an increase in evaporating temperature, a density of the refrigerant sucked by the compressor 1 is increased. As a result, the hot-water supply capacity is increased without changing the capacity of the compressor 1.

[0040] Moreover, the control unit 50 can execute the simultaneous temperature retaining and heat storage mode by opening the first solenoid valve 80V1, opening the second solenoid valve 80V2, closing the first bypass solenoid valve 81 V, and closing the second bypass solenoid valve 82V. Through execution of the simultaneous temperature retaining and heat storage mode, in the case where a CO_2 refrigerant is used, 55 degrees centigrade corresponding to an incurrent temperature at the outlet of the gas cooler in the related art are reduced to the temperature of the hot water inside the heat storage tank 30 with the provision of the regenerative heat exchanger 3, with the result that the amount of heat is increased, that an amount of heat/refrigerant conveying power is increased, and that efficient operation can be performed.

[0041] In the above description, there has been described the example in which the control unit 50 opens or closes the first solenoid valve 80V1, the second solenoid valve 80V2, the first bypass solenoid valve 81 V, and the second bypass solenoid valve 82V, but opening degrees of those solenoid valves can be determined appropriately in steps.

Embodiment 2

[0042] Fig. 4 is a schematic diagram of a heat pump hot-water supply system 200 according to Embodiment 2 of the present invention. In Embodiment 2, items not described otherwise in particular are similar to those in Embodiment 1, and the same functions and components are denoted by the same reference symbols.

[0043] As illustrated in Fig. 4, the heat pump hot-water supply system 200 includes a hot-water supply circuit 121, a water supply unit 122, a hot-water-to-be-supplied cycle circuit 131, a circulator pump 132, a connection circuit 141, a bypass connection circuit 151, a burning appliance 152, and a circulator pump 153.

[0044] The hot-water supply circuit 121 is a circuit formed to connect the gas cooler 2 and the regenerative heat exchanger 3. The water supply unit 122 is a circuit configured to guide hot water exiting from the heat storage tank 30 to the hot-water supply tank 20, and is provided on the hot-water supply circuit 121. The hot-water-to-be-supplied cycle circuit 131 is a circuit configured to circulate hot water that exits a load 190. The circulator pump 132 is a pump, which is configured to be operated when a temperature of water in the heat storage tank 30 is reduced to a predetermined value or less, and is provided on the hot-water-to-be-supplied cycle circuit 131.

[0045] The connection circuit 141 is a circuit configured to connect the hot-water supply tank 20 and the heat storage tank 30. The bypass connection circuit 151 is a circuit configured to connect the hot-water supply tank 20 and the heat storage tank 30, and is a circuit configured to guide hot water exiting from the heat storage tank

30 to the hot-water supply tank 20 to bypass the connection circuit 141.

[0046] The burning appliance 152 is configured to heat the hot water discharged from the heat storage tank 30, and to supply the heated hot water to the hot-water supply tank 20, and is provided on the bypass connection circuit 151. The burning appliance 152 serves as a backup unit for a case where heating is insufficient even when hot water is supplied by exchanging heat in the gas cooler 2. The circulator pump 153 is configured to supply the heat supplied from the burning appliance 152 to a subject to be heated, and is provided on the bypass connection circuit 151.

[0047] As described above, the heat pump hot-water supply system 200 according to Embodiment 2 further includes the connection circuit 141 configured to guide hot water exiting from the heat storage tank 30 to the hot-water supply tank 20, the bypass connection circuit 151 configured to guide hot water exiting from the heat storage tank 30 to the hot-water supply tank 20 to bypass the connection circuit 141, and the burning appliance 152, which is provided on the bypass connection circuit 151, and is configured to heat hot water that has exited the heat storage tank 30 and is flowing through the bypass connection circuit 151. Therefore, when the hot-water supply load is temporarily increased, the hot water inside the heat storage tank 30 passes through the bypass connection circuit 151 to be heated by the burning appliance 152, and then flows through the hot-water supply tank 20. Therefore, even when an excessive load is temporarily generated, hot water can be supplied to the hot-water supply tank 20.

Reference Signs List

[0048] 1 compressor 2 gas cooler 3 regenerative heat exchanger 4 expansion valve 5 air heat exchanger 6 fan 20 hot-water supply tank
21 hot-water supply circuit 22 water supply unit 29 capsule30 heat storage tank31 heat storage circuit 32 water supply unit 50 control unit 80 main circuit 80V1 first solenoid valve 80V2 second solenoid valve 81 first bypass 81V first bypass solenoid valve 81 a first branching portion 81 b first merging portion 82 second bypass 82V second bypass solenoid valve
82a second branching portion 82b second merging portion 83 third bypass
83a third branching portion 83b third merging portion 100 heat pump water heater 121 hot-water supply circuit 122 water supply unit 131 hot-water-to-be-supplied cycle circuit 132 circulator pump 141 connection circuit 151 bypass connection circuit 152 burning appliance 153 circulator pump 190 load
200 heat pump hot-water supply system

Claims

1. A heat pump hot-water supply system, comprising:

    a heat pump water heater including a main circuit, in which a compressor configured to compress refrigerant, a gas cooler, a first solenoid valve, a regenerative heat exchanger, an expansion valve, and an air heat exchanger are connected in the stated order;
    a hot-water supply tank including a heat medium for exchanging heat with the refrigerant flowing through the gas cooler; and
    a heat storage tank including a heat medium for exchanging heat with the refrigerant flowing through the regenerative heat exchanger,
    the heat pump water heater including

        a first bypass formed to branch off the main circuit at a first branching portion located on an outlet side of the gas cooler and an inlet side of the first solenoid valve, and to merge with the main circuit at a first merging portion located on an outlet side of the regenerative heat exchanger and an inlet side of the expansion valve, and
        a control unit configured to switch the first solenoid valve to be opened or closed.

2. The heat pump hot-water supply system of claim 1, further comprising:

    a first bypass solenoid valve provided on the first bypass;
    a second bypass formed to branch off the main circuit (80) at a second branching portion located on a discharge side of the compressor and an inlet side of the gas cooler, and to merge with the main circuit at a second merging portion located on the outlet side of the gas cooler and the gas cooler side of the first branching portion; and
    a second bypass solenoid valve, provided on the second bypass.

3. The heat pump hot-water supply system of claim 1 or 2, further comprising:

    a second solenoid valve provided on an outlet side of the expansion valve and an inlet side of the air heat exchanger; and
    a third bypass formed to branch off the main circuit (80) on the outlet side of the expansion valve and an inlet side of the second solenoid valve, and to merge with the main circuit on an outlet side of the second solenoid valve and the inlet side of the air heat exchanger.

4. The heat pump hot-water supply system of claim 3 as dependent on claim 2, wherein the control unit operates a hot-water supply mode, and is configured to, in the hot-water supply mode, close the first solenoid valve, open the second solenoid valve, open the first bypass solenoid valve, and close the second bypass solenoid valve.

5. The heat pump hot-water supply system of claim 3 as dependent on claim 2, wherein the control unit operates a heat storage mode, and is configured to, in the heat storage mode, open the first solenoid valve, open the second solenoid valve, close the first bypass solenoid valve, and open the second bypass solenoid valve.

6. The heat pump hot-water supply system of claim 3 as dependent on claim 2, wherein the control unit operates a heat recovery and hot-water supply mode, and is configured to, in the heat recovery and hot-water supply mode, close the first solenoid valve, close the second solenoid valve, open the first bypass solenoid valve, and close the second bypass solenoid valve.

7. The heat pump hot-water supply system of claim 3 as dependent on claim 2, wherein the control unit operates a simultaneous temperature retaining and heat storage mode, and is configured to, in the simultaneous temperature retaining and heat storage mode, open the first solenoid valve, open the second solenoid valve, close the first bypass solenoid valve, and close the second bypass solenoid valve.

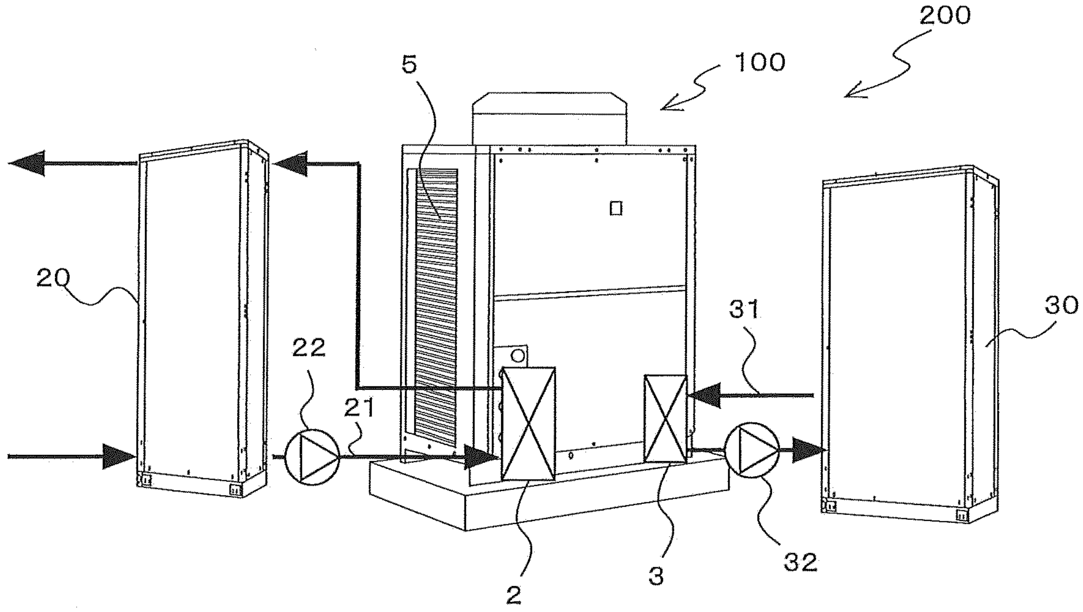
8. The heat pump hot-water supply system of any one of claims 1 to 7, wherein the heat medium in the heat storage tank comprises a heat storage medium that is changed in phase in a temperature range of from 20 to 40 degrees centigrade.

9. The heat pump hot-water supply system of any one of claims 1 to 8, further comprising:

    a connection circuit configured to guide hot water exiting from the heat storage tank to the hot-water supply tank;
    a bypass connection circuit configured to guide hot water exiting from the heat storage tank to the hot-water supply tank to bypass the connection circuit; and
    a burning appliance provided on the bypass connection circuit, and is configured to heat hot water that exited the heat storage tank and is flowing through the bypass connection circuit.

10. The heat pump hot-water supply system of any one of claims 1 to 9, wherein the refrigerant comprises carbon dioxide.

FIG. 1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5
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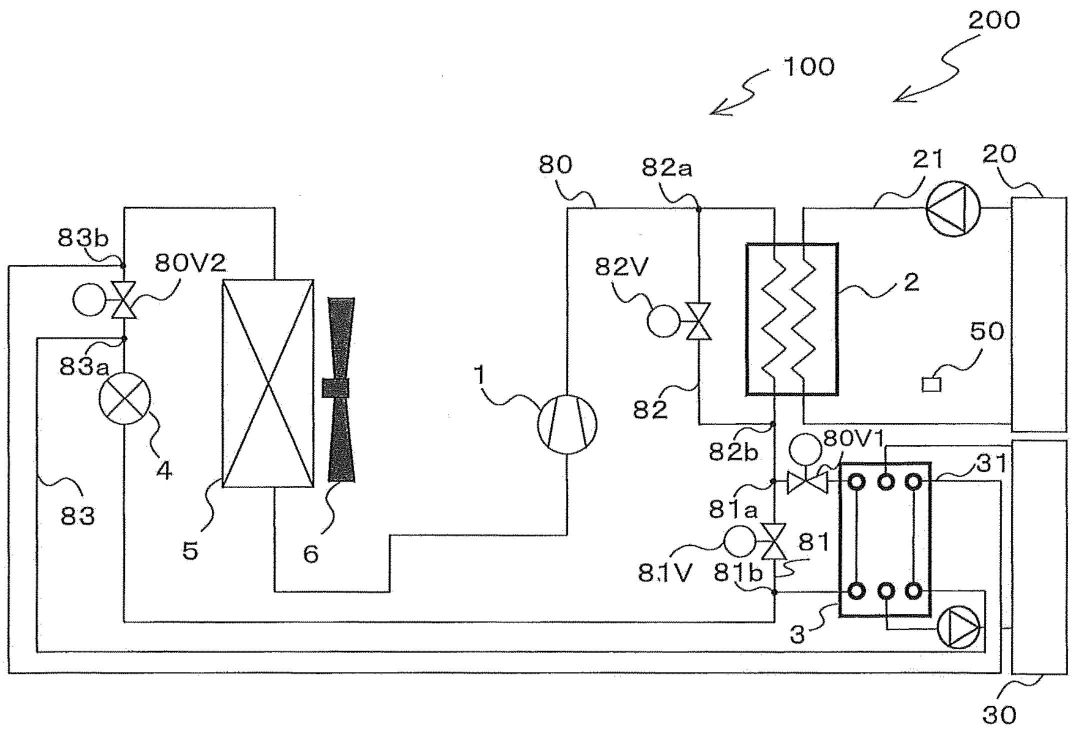
22
21
31
30
2
3
32

FIG. 2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82a
21
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83b
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82V
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50
83a
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82b
80V1
31
4
83
5
6
81a
81
81V
81b
3
30

FIG. 3

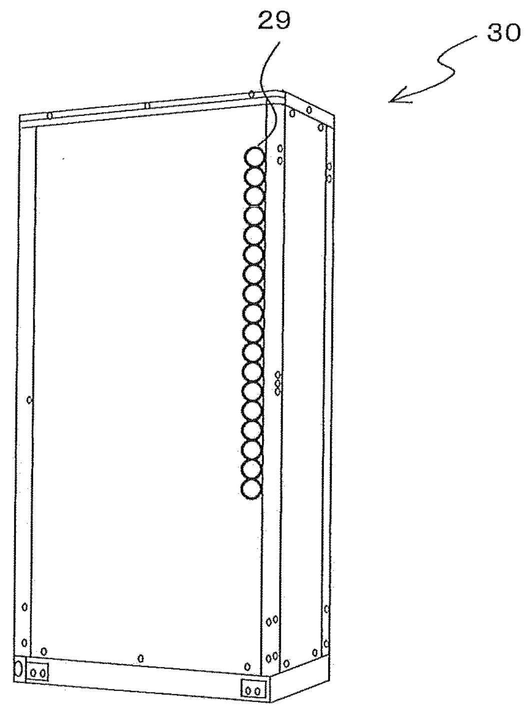
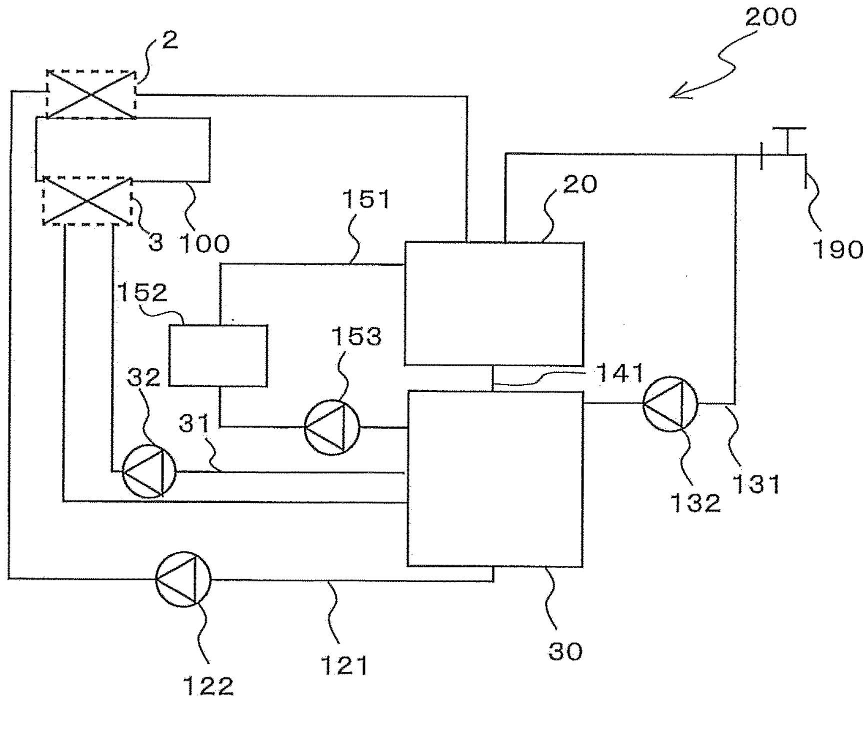


FIG. 4



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2015/065127

A. CLASSIFICATION OF SUBJECT MATTER
F24H1/00(2006.01)i, *F25B1/00*(2006.01)i, *F25B5/00*(2006.01)i, *F25B5/04*(2006.01)i, *F25B6/04*(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)
F24H1/00, F24H7/00, F25B1/00, F25B5/00, F25B5/04, F25B6/04

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	1996-2015
Kokai Jitsuyo Shinan Koho	1971-2015	Toroku Jitsuyo Shinan Koho	1994-2015

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 2003-65603 A (Sanyo Electric Co., Ltd.), 05 March 2003 (05.03.2003), entire text; all drawings (Family: none)	1-10
A	JP 2003-42538 A (Sanyo Electric Co., Ltd.), 13 February 2003 (13.02.2003), entire text; all drawings (Family: none)	1-10
A	JP 2005-42943 A (Hitachi, Ltd.), 17 February 2005 (17.02.2005), entire text; all drawings (Family: none)	1-10

☒ 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	Date of mailing of the international search report
29 June 2015 (29.06.15)	07 July 2015 (07.07.15)

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

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2015/065127

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 2012-167869 A (Panasonic Corp.), 06 September 2012 (06.09.2012), entire text; all drawings (Family: none)	1-10
A	JP 2008-292122 A (The Kansai Electric Power Co., Inc.), 04 December 2008 (04.12.2008), entire text; all drawings (Family: none)	1-10
A	JP 2006-349202 A (Takuma Co., Ltd.), 28 December 2006 (28.12.2006), entire text; all drawings (Family: none)	1-10
A	WO 2013/046720 A1 (Daikin Industries, Ltd.), 04 April 2013 (04.04.2013), entire text; all drawings & JP 2013-83421 A & JP 2013-83439 A & US 2014/0230477 A1 & EP 2767773 A1 & CN 103842733 A	1-10

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Patent documents cited in the description

- JP 4139827 B **[0004]**