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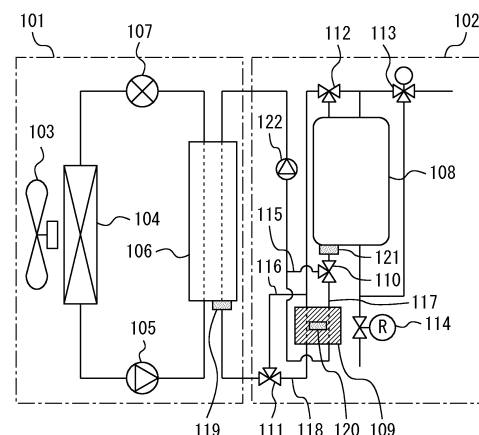
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(54) **HEAT PUMP WATER HEATER**

(57) A heat pump water heater includes a heat pump unit (101) a hot water storage tank (108) including a high temperature part and a low temperature part; a water inlet pipe (117) for supplying water from the low temperature part to the heat pump unit (101); a heat storage unit (109) that absorbs heat from water flowing through the water inlet pipe (117) and stores the heat; a first branch valve (110) provided between the low temperature part and the heat storage unit (109) to switch a flow path in the water inlet pipe (117); and a first bypass pipe (115) connecting a part between the heat storage unit (109) and the heat pump unit (101) to the first branch valve (110).

FIG. 1



Description

Field

[0001] The present disclosure relates to a heat pump water heater.

Background

[0002] PTL 1 discloses a heat pump water heater. The heat pump water heater disclosed in PTL 1 includes a heat storage unit for improving energy efficiency. The heat storage unit in PTL 1 absorbs heat from water supplied from a hot water storage tank to a heat pump unit, thereby decreasing the water input temperature of the water supplied to the heat pump unit. Accordingly, heat exchange efficiency of the heat pump unit is improved.

Citation List

Patent Literature

[0003] [PTL 1] JP 2013-213596 A

Summary

Technical Problem

[0004] In a configuration disclosed in PTL 1, when the temperature of water flowing from the hot water storage tank into the heat storage unit is higher than the temperature in the heat storage unit, the water input temperature of water supplied to the heat pump unit increases, and heat exchange efficiency of the heat pump unit decreases.

[0005] The present disclosure is made in view of solving the above-described problem. The present disclosure is intended to obtain a heat pump water heater that is advantageous for energy efficiency improvement.

Solution to Problem

[0006] A heat pump water heater according to the present disclosure includes a heat pump unit that heats water; a hot water storage tank including a high temperature part for storing water heated by the heat pump unit and a low temperature part for storing water having a temperature lower than the temperature of the water stored in the high temperature part; a water inlet pipe for supplying water from the low temperature part to the heat pump unit; a heat storage unit that absorbs heat from water flowing through the water inlet pipe and stores the heat; a first branch valve provided between the low temperature part and the heat storage unit to switch a flow path in the water inlet pipe; and a first bypass pipe connecting a part between the heat storage unit and the heat pump unit to the first branch valve. The first branch valve can switch between a flow path through which the low

temperature part is connected to the heat pump unit via the heat storage unit and a flow path through which the low temperature part is connected to the heat pump unit not via the heat storage unit but via the first bypass pipe.

Advantageous Effects

[0007] According to the present disclosure, it is possible to obtain a heat pump water heater that is advantageous for energy efficiency improvement.

Brief Description of the Drawings

[0008]

[Fig. 1]

Fig. 1 is a configuration diagram of a heat pump water heater of Embodiment 1.

[Fig. 2]

Fig. 2 is a functional block diagram of the heat pump water heater of Embodiment 1.

[Fig. 3]

Fig. 3 is a diagram illustrating an exemplary configuration for achieving functions of a control unit in Embodiment 1.

[Fig. 4]

Fig. 4 is a flowchart illustrating exemplary boiling operation of the heat pump water heater of Embodiment 1.

[Fig. 5]

Fig. 5 is a flowchart illustrating exemplary hot water output operation of the heat pump water heater of Embodiment 1.

Description of Embodiment

[0009] An embodiment will be described below with reference to the accompanying drawings. Note that common or corresponding elements in the drawings are denoted by the same reference sign, and duplicate description thereof is simplified or omitted in the present disclosure. Note that the present disclosure is not limited to the embodiment described below but may include any combination and modification of configurations disclosed by the embodiment below.

Embodiment 1

[0010] Fig. 1 is a configuration diagram of a heat pump water heater of Embodiment 1. Fig. 2 is a functional block diagram of the heat pump water heater of Embodiment 1. Fig. 2 selectively illustrates main functions of the heat pump water heater according to the present embodiment.

[0011] As illustrated in Fig. 1, the heat pump water heater according to the present embodiment is constituted by a heat pump unit 101 and a hot water storage unit 102. The heat pump unit 101 functions as a heating means for heating water. Water is supplied from the hot

water storage unit 102 to the heat pump unit 101. The heat pump unit 101 heats the water supplied from the hot water storage unit 102.

[0012] The heat pump unit 101 includes an air sending fan 103, an air heat exchanger 104, a compressor 105, a water heat exchanger 106, and a decompression device 107.

[0013] The air sending fan 103 is an instrument that sends air to cool the air heat exchanger 104. The air heat exchanger 104 performs heat exchange between air and a refrigerant. In the air heat exchanger 104, the refrigerant absorbs heat in the air. The refrigerant having absorbed the heat in the air heat exchanger 104 is transferred to the compressor 105.

[0014] The refrigerant transferred to the compressor 105 is compressed into a high-temperature and high-pressure state. The refrigerant compressed in the compressor 105 is transferred to the water heat exchanger 106. The water heat exchanger 106 performs heat exchange between water supplied from the hot water storage unit 102 and the high-temperature refrigerant. The water supplied from the hot water storage unit 102 to the heat pump unit 101 is heated in the water heat exchanger 106. The refrigerant subjected to the heat exchange in the water heat exchanger 106 is transferred to the decompression device 107.

[0015] Expansion, in other words, decompression of the refrigerant is performed in the decompression device 107. The refrigerant decompressed in the decompression device 107 is transferred to the air heat exchanger 104. In this manner, the refrigerant circulates in the heat pump unit 101.

[0016] In the present embodiment, the hot water storage unit 102 includes a hot water storage tank 108 that stores water and a heat storage unit 109 that stores heat. The hot water storage tank 108 includes a high temperature part for storing water heated by the heat pump unit 101, and a low temperature part for storing water having a temperature lower than the temperature of the water stored in the high temperature part. The heat storage unit 109 absorbs heat from water flowing through a water inlet pipe 117 for supplying water from the low temperature part of the hot water storage tank 108 to the heat pump unit 101 and stores the heat. The water input temperature of water supplied to the heat pump unit 101 can be decreased through the heat absorption by the heat storage unit 109. Accordingly, heat exchange efficiency of the heat pump unit 101 can be improved. Note that the heat storage unit 109 may be provided outside the heat pump unit 101.

[0017] The water inlet pipe 117 connects the low temperature part of the hot water storage tank 108 to the heat pump unit 101. In the present embodiment, the water inlet pipe 117 is routed through the heat storage unit 109. The water inlet pipe 117 is provided with a boiling pump 122. The boiling pump 122 is a pump for circulating water between the hot water storage tank 108 and the heat pump unit 101.

[0018] As illustrated in Fig. 1, the heat pump water heater according to the present embodiment includes a first branch valve 110 provided at the water inlet pipe 117. The first branch valve 110 is an instrument for switching a flow path in the water inlet pipe 117. The first branch valve 110 is provided between the low temperature part of the hot water storage tank 108 and the heat storage unit 109.

[0019] A first bypass pipe 115 is connected to the first branch valve 110. The first bypass pipe 115 connects a part between the heat storage unit 109 and the heat pump unit 101 to the first branch valve 110. The first bypass pipe 115 is a pipe branched from the water inlet pipe 117 between the heat storage unit 109 and the heat pump unit 101 and connected to the first branch valve 110.

[0020] The first branch valve 110 can switch between a flow path through which the low temperature part of the hot water storage tank 108 is connected to the heat pump unit 101 via the heat storage unit 109 and a flow path through which the low temperature part of the hot water storage tank 108 is connected to the heat pump unit 101 not via the heat storage unit 109 but via the first bypass pipe 115.

[0021] According to the present embodiment, water can be supplied from the hot water storage tank 108 to the heat pump unit 101 not via the heat storage unit 109 by controlling the first branch valve 110. Accordingly, the water input temperature of water supplied to the heat pump unit 101 can be prevented from being increased by the heat storage unit 109. According to the present embodiment, it is possible to obtain the heat pump water heater that is advantageous for energy efficiency improvement.

[0022] The heat pump water heater according to the present embodiment further includes a hot water outlet pipe 118 for supplying water from the heat pump unit 101 to the high temperature part of the hot water storage tank 108. The hot water outlet pipe 118 connects the high temperature part of the hot water storage tank 108 to the heat pump unit 101. The hot water outlet pipe 118 may be routed through the heat storage unit 109 as illustrated in Fig. 1. The heat storage unit 109 may absorb heat from water flowing through the hot water outlet pipe 118 and store the heat.

[0023] As illustrated in Fig. 1, the heat pump water heater according to the present embodiment includes a second branch valve 111 provided at the hot water outlet pipe 118. The second branch valve 111 is an instrument for switching a flow path in the hot water outlet pipe 118. The second branch valve 111 is provided between the heat pump unit 101 and the heat storage unit 109.

[0024] A second bypass pipe 116 is connected to the second branch valve 111. The second bypass pipe 116 connects a part between the heat storage unit 109 and the heat pump unit 101 to the second branch valve 111. The second bypass pipe 116 is a pipe branched from the hot water outlet pipe 118 between the heat storage unit 109 and the high temperature part of the hot water stor-

age tank 108 and connected to the second branch valve 111.

[0025] The second branch valve 111 can switch between a flow path through which the high temperature part of the hot water storage tank 108 is connected to the heat pump unit 101 via the heat storage unit 109 and a flow path through which the high temperature part of the hot water storage tank 108 is connected to the heat pump unit 101 not via the heat storage unit 109 but via the second bypass pipe 116.

[0026] The heat pump water heater according to the present embodiment may further include a third branch valve 112 provided at the hot water outlet pipe 118 between the high temperature part of the hot water storage tank 108 and the heat storage unit 109. The third branch valve 112 is connected to a mixed valve 113 connected to the high temperature part of the hot water storage tank 108. The mixed valve 113 has a function to adjust the water-output temperature of water supplied to a user by mixing outflow water from the high temperature part of the hot water storage tank 108 and low-temperature water from a water source such as urban water. The water source such as urban water is connected to the mixed valve 113. The water source such as urban water is also connected to the low temperature part of the hot water storage tank 108. For example, the hot water storage unit 102 includes a decompression valve 114 for adjusting the low-temperature water supplied from the water source such as urban water to a predetermined pressure.

[0027] As illustrated in Fig. 1, the heat pump water heater according to the present embodiment may include a heat-pump-unit outflow-water-temperature sensing unit 119, a heat-storage-unit temperature sensing unit 120, and a hot-water-storage-tank low-temperature-part outflow-water-temperature sensing unit 121. The heat-pump-unit outflow-water-temperature sensing unit 119 senses the temperature of water flowing out of the heat pump unit 101. The heat-storage-unit temperature sensing unit 120 senses the temperature in the heat storage unit 109. The hot-water-storage-tank low-temperature-part outflow-water-temperature sensing unit 121 senses the temperature of water flowing out of the low temperature part of the hot water storage tank 108. Note that a plurality of sensing units of each of these kinds may be provided.

[0028] For example, the heat pump water heater according to the present embodiment is controlled in accordance with results of sensing by the above-described sensing units. As illustrated in Fig. 2, the heat pump water heater according to the present embodiment may include a control unit 130 for controlling the heat pump water heater. The control unit 130 controls, for example, the first branch valve 110, the second branch valve 111, the third branch valve 112, and the like in accordance with results of sensing by the heat-pump-unit outflow-water-temperature sensing unit 119, the heat-storage-unit temperature sensing unit 120, and the hot-water-storage-tank low-temperature-part outflow-water-temperature

sensing unit 121.

[0029] Fig. 3 is a diagram illustrating an exemplary configuration for achieving functions of the control unit 130 in Embodiment 1. The functions of the control unit 130 are achieved by, for example, a processing circuit. The processing circuit may be a dedicated hardware 140. The processing circuit may include a processor 141 and a memory 142. Part of the processing circuit may be formed as the dedicated hardware 140, and the processing circuit may further include the processor 141 and the memory 142. In the example illustrated in Fig. 3, part of the processing circuit is formed as the dedicated hardware 40. In the example illustrated in Fig. 3, the processing circuit further includes the processor 141 and the memory 142.

[0030] Examples of the processing circuit, part of which is at least one dedicated hardware 140 include a single circuit, a composite circuit, a processor as a computer program, a processor as a parallel computer program, an ASIC, an FPGA, and a combination thereof.

[0031] When the processing circuit includes at least one processor 141 and at least one memory 142, each function of the control unit 130 is achieved by software, firmware, or combination of software and firmware.

[0032] The software and the firmware are written as computer programs and stored in the memory 142. The processor 141 achieves functions of each component by reading and executing a computer program stored in the memory 142. The processor 141 is also referred to as a central processing unit (CPU), a processing device, an arithmetic device, a microprocessor, a microcomputer, or a DSP. Examples of the memory 142 include non-transitory and transitory semiconductor memories such as a RAM, a ROM, a flash memory, an EPROM, and an EEPROM, a magnetic disk, a flexible disk, an optical disk, a compact disk, a mini disk, and a DVD.

[0033] In this manner, the processing circuit can achieve the functions of the control unit 130 by hardware, software, firmware, or combination thereof.

[0034] Exemplary operation of the heat pump water heater configured as described above will be described below. Fig. 4 is a flowchart illustrating exemplary boiling operation of the heat pump water heater of Embodiment 1. When the amount of remaining hot water in the hot water storage tank 108 becomes low, the heat pump unit 101 is operated to perform the boiling operation as necessary, and hot water storage in the hot water storage tank 108 is performed.

[0035] When the boiling operation starts (step S100), it is determined whether the temperature of water flowing out of the low temperature part of the hot water storage tank 108 is higher or lower than the temperature in the heat storage unit 109 (step S101). The determination is performed by the control unit 130 based on results of sensing by the above-described sensing units.

[0036] When the temperature of water flowing out of the low temperature part of the hot water storage tank 108 is higher than the temperature in the heat storage

unit 109, the first branch valve 110 connects the hot water storage tank 108 to the heat storage unit 109 and heat storage by the heat storage unit 109 is performed (step S102). When the temperature of water flowing out of the low temperature part of the hot water storage tank 108 is lower than the temperature in the heat storage unit 109, the first branch valve 110 connects the hot water storage tank 108 to the heat pump unit 101 not via the heat storage unit 109 and heat storage by the heat storage unit 109 is not performed (step S103).

[0037] Through the above-described operation, heat storage by the heat storage unit 109 is performed when the temperature in the heat storage unit 109 is lower than the temperature of water flowing out of the low temperature part of the hot water storage tank 108. Accordingly, the temperature of water input to the heat pump unit 101 can be decreased. Moreover, heat storage by the heat storage unit 109 is not performed when the temperature in the heat storage unit 109 is higher than the temperature of water flowing out of the low temperature part of the hot water storage tank 108. Accordingly, increase of the temperature of water input to the heat pump unit 101 due to the heat storage unit 109 can be avoided.

[0038] Fig. 5 is a flowchart illustrating exemplary hot water output operation of the heat pump water heater of Embodiment 1. The hot water output operation is operation that a heat pump water heater supplies hot water to the outside. Examples of the hot water output operation include various kinds of operation such as bathtub filling with hot water and outputting of hot water to an optional hot water supply terminal.

[0039] When the hot water output operation starts (step S200), it is determined whether the temperature of water flowing out of the heat pump unit 101 is higher or lower than the temperature in the heat storage unit 109 (step S201). The determination is performed by the control unit 130 based on results of sensing by the above-described sensing units.

[0040] When the temperature of water flowing out of the heat pump unit 101 is lower than the temperature in the heat storage unit 109, the second branch valve 111 connects the hot water storage tank 108 to the heat storage unit 109, thereby increasing the temperature of outflow water from the heat pump unit 101 (step S202). When the temperature of water flowing out of the heat pump unit 101 is higher than the temperature in the heat storage unit 109, the second branch valve 111 operates to connect the heat pump unit 101 to the high temperature part of the hot water storage tank 108 not via the heat storage unit 109 but via the second bypass pipe 116 (step S203). The outflow water from the heat pump unit 101 is mixed with outflow water from the high temperature part of the hot water storage tank 108, urban water, or the like at the mixed valve 113, and then is output. According to the present example, an energy loss can be reduced through heat exchange between outflow water from the heat storage unit 109 and the heat pump unit 101.

[0041] The above-described boiling operation may be

automatically started when the temperature of water flowing out of the heat pump unit 101 is higher than the temperature in the heat storage unit 109 and the temperature of water flowing out of the low temperature part of the hot water storage tank 108 is higher than the temperature in the heat storage unit 109. In the boiling operation, as described above, flow path control by the first branch valve 110 is executed in accordance with a result of determination of whether the temperature of water flowing out of the low temperature part of the hot water storage tank 108 is higher or lower than the temperature in the heat storage unit 109.

Industrial Applicability

[0042] A heat pump water heater according to the present disclosure is applicable to, for example, bathtub filling with hot water or outputting of hot water to an optional hot water supply terminal.

Reference Signs List

[0043]

- 101 Heat pump unit
- 102 Hot water storage unit
- 103 Air sending fan
- 104 Air heat exchanger
- 105 Compressor
- 106 Water heat exchanger
- 107 Decompression device
- 108 Hot water storage tank
- 109 Heat storage unit
- 110 First branch valve
- 111 Second branch valve
- 112 Third branch valve
- 113 Mixed valve
- 114 Decompression valve
- 115 First bypass pipe
- 116 Second bypass pipe
- 117 Water inlet pipe
- 118 Hot water outlet pipe
- 119 Heat-pump-unit outflow-water-temperature sensing unit
- 120 Heat-storage-unit temperature sensing unit
- 121 Hot-water-storage-tank low-temperature-part outflow-water-temperature sensing unit
- 130 Control unit
- 140 Dedicated hardware
- 141 Processor
- 142 Memory

Claims

1. A heat pump water heater comprising:
a heat pump unit heating water,

a hot water storage tank including a high temperature part for storing water heated by the heat pump unit and a low temperature part for storing water having a temperature lower than the water stored in the high temperature part,
 a water inlet pipe for supplying water from the low temperature part to the heat pump unit,
 a heat storage unit absorbing heat from water flowing through the water inlet pipe and storing the heat,
 a first branch valve provided between the low temperature part and the heat storage unit to switch a flow path in the water inlet pipe; and
 a first bypass pipe connecting a part between the heat storage unit and the heat pump unit to the first branch valve,
 the first branch valve can switch between a flow path through which the low temperature part is connected to the heat pump unit via the heat storage unit and a flow path through which the low temperature part is connected to the heat pump unit not via the heat storage unit but via the first bypass pipe.

2. The heat pump water heater according to claim 1, wherein

when the temperature of water flowing out of the low temperature part is higher than the temperature in the heat storage unit, the first branch valve switches the flow path in the water inlet pipe to the flow path through which the low temperature part is connected to the heat pump unit via the heat storage unit, and
 when the temperature of water flowing out of the low temperature part is lower than the temperature in the heat storage unit, the first branch valve switches the flow path in the water inlet pipe to the flow path through which the low temperature part is connected to the heat pump unit not via the heat storage unit but via the first bypass pipe.

3. The heat pump water heater according to claim 1 or 2, further comprising:

a hot water outlet pipe for supplying water from the heat pump unit to the high temperature part;
 a second branch valve provided between the heat pump unit and the heat storage unit to switch a flow path in the hot water outlet pipe; and
 a second bypass pipe connecting a part between the heat storage unit and the high temperature part to the second branch valve, wherein
 the heat storage unit absorbs heat from water flowing through the hot water outlet pipe and

stores the heat, and
 the second branch valve can switch between a flow path through which the high temperature part is connected to the heat pump unit via the heat storage unit and a flow path through which the high temperature part is connected to the heat pump unit not via the heat storage unit but via the second bypass pipe.

4. The heat pump water heater according to claim 3, wherein

when the temperature of water flowing out of the heat pump unit is lower than the temperature in the heat storage unit, the second branch valve switches the flow path in the hot water outlet pipe to the flow path through which the high temperature part is connected to the heat pump unit via the heat storage unit, and
 when the temperature of water flowing out of the heat pump unit is higher than the temperature in the heat storage unit, the second branch valve switches the flow path in the water inlet pipe to the flow path through which the high temperature part is connected to the heat pump unit not via the heat storage unit but via the second bypass pipe.

5. The heat pump water heater according to claim 3, wherein in a case in which hot water output is to be performed, the hot water output being such that water flowing out of the heat pump unit is mixed through a mixed valve and supplied to outside,

when the temperature of water flowing out of the heat pump unit is lower than the temperature in the heat storage unit, the second branch valve switches the flow path in the hot water outlet pipe to the flow path through which the high temperature part is connected to the heat pump unit via the heat storage unit, and
 when the temperature of water flowing out of the heat pump unit is higher than the temperature in the heat storage unit, the second branch valve switches the flow path in the water inlet pipe to the flow path through which the high temperature part is connected to the heat pump unit not via the heat storage unit but via the second bypass pipe.

FIG. 1

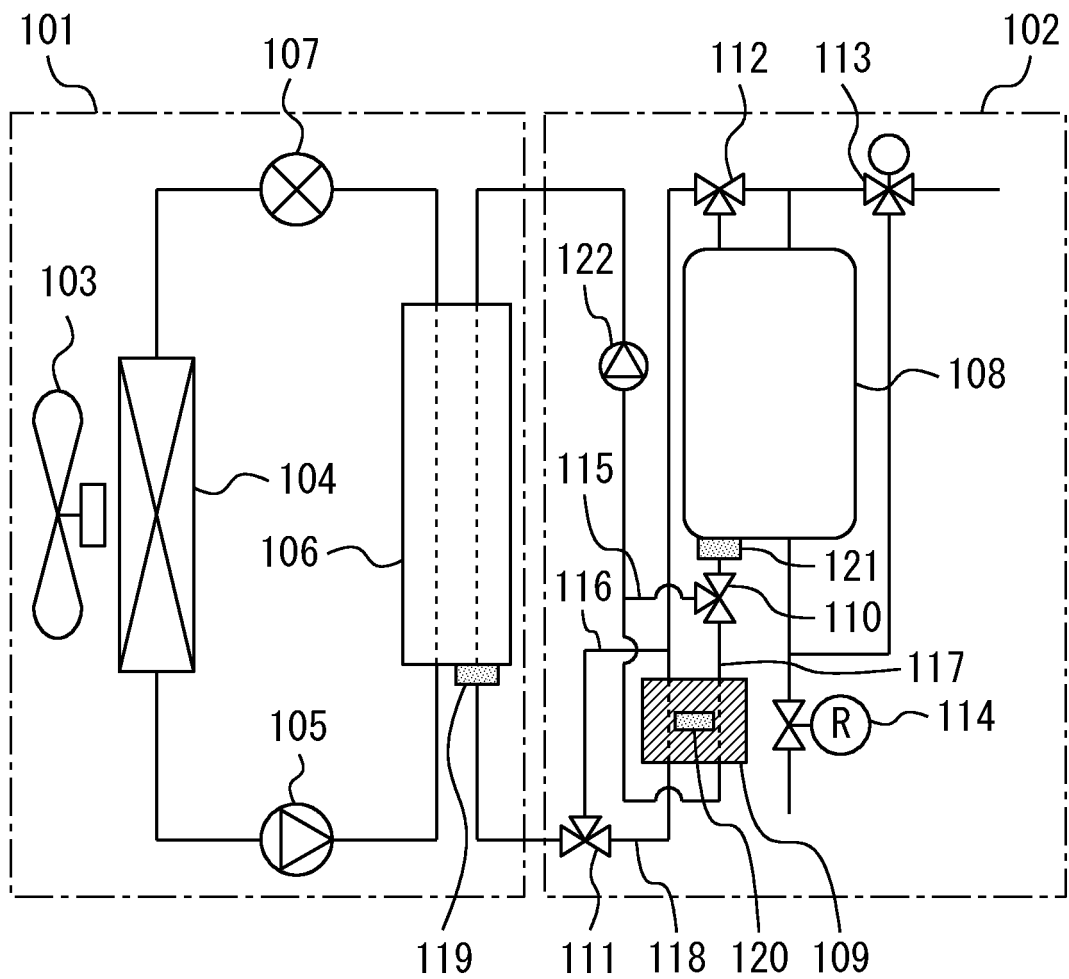


FIG. 2

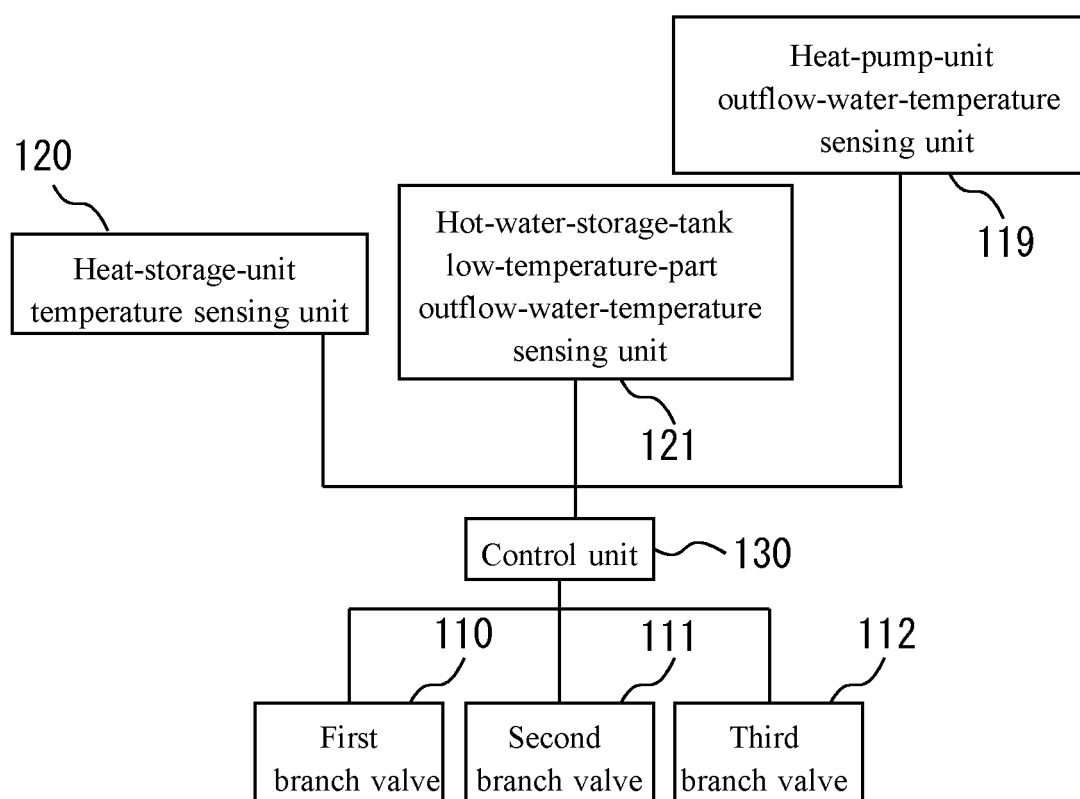


FIG. 3

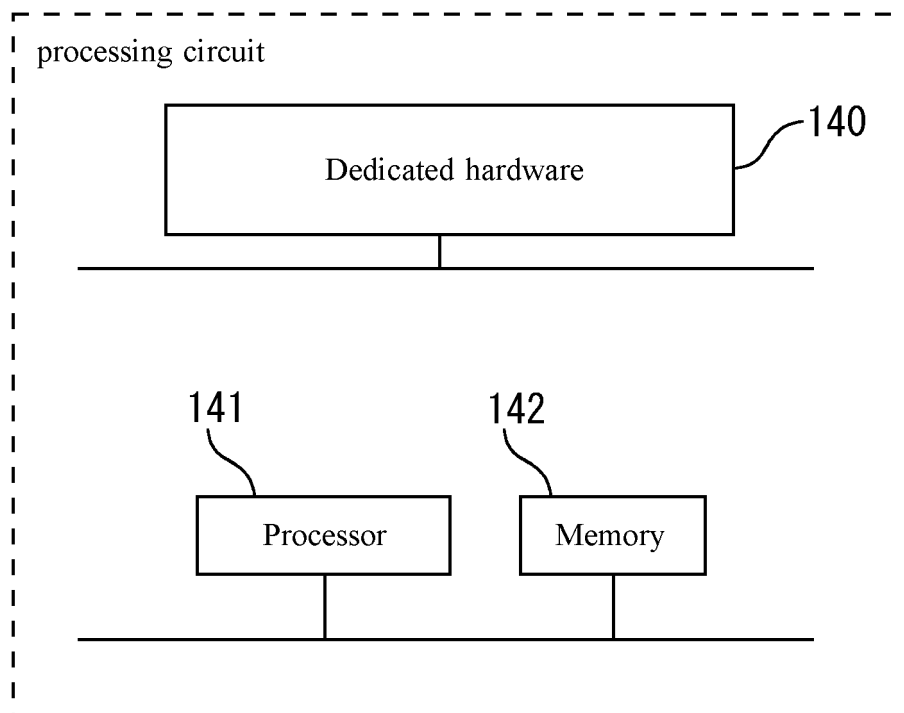


FIG. 4

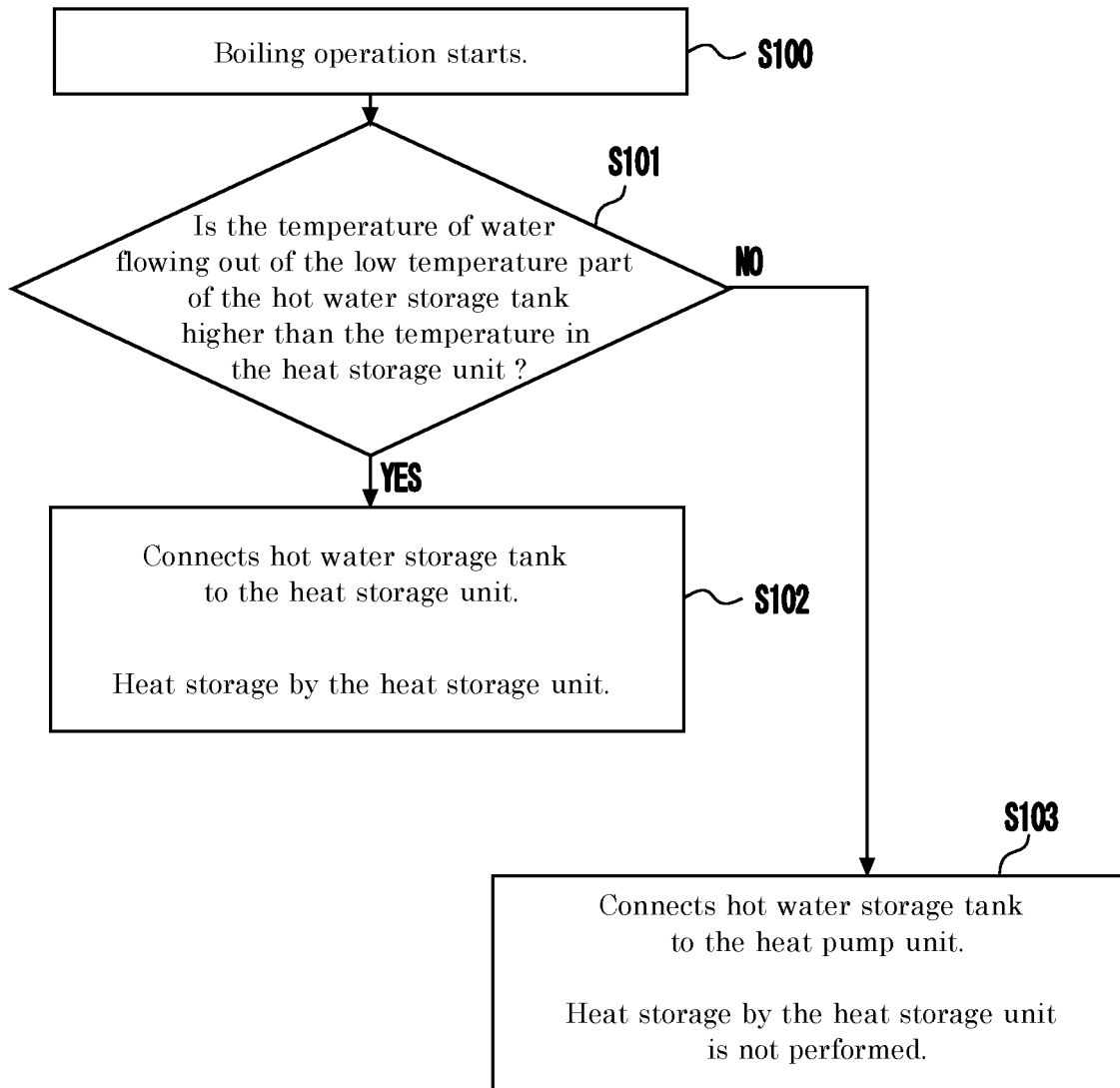
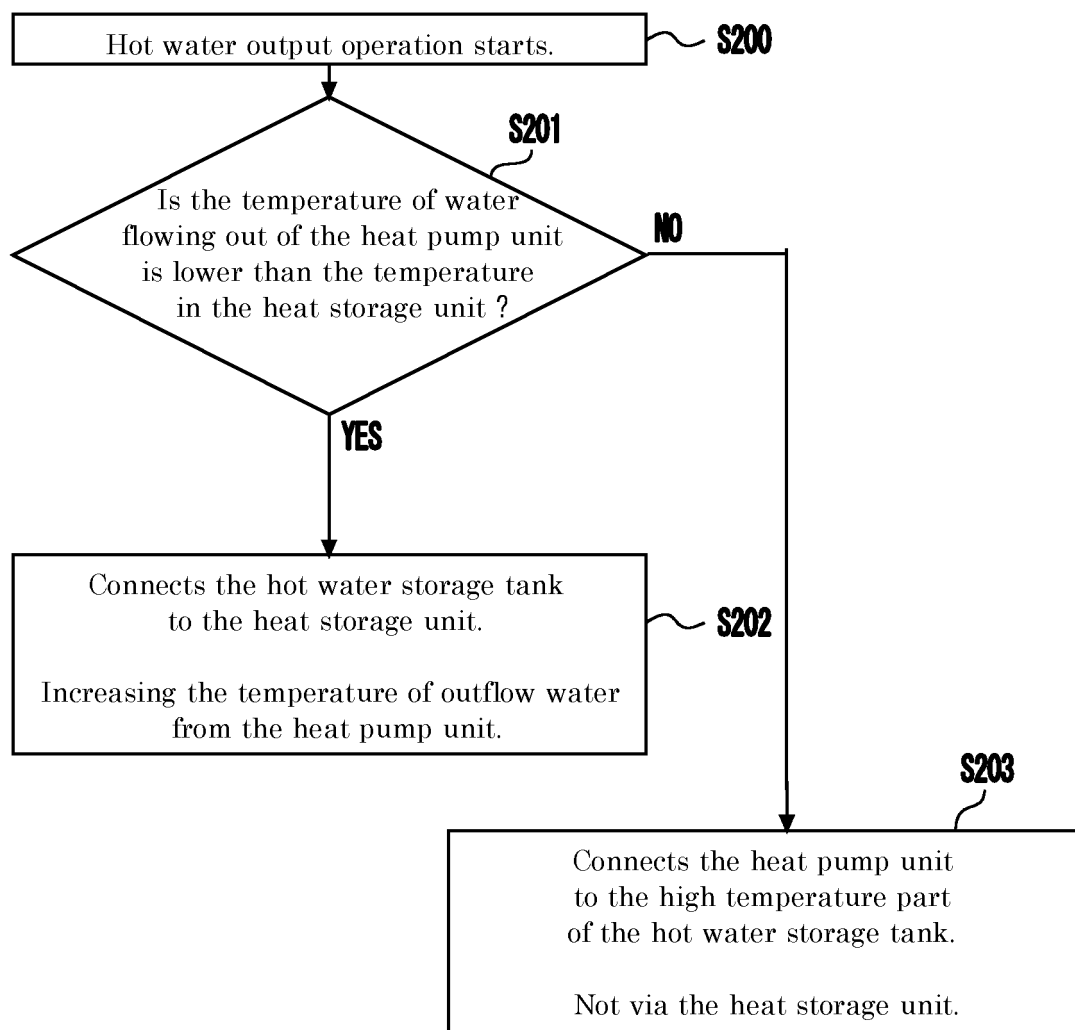


FIG. 5



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2021/024402

A. CLASSIFICATION OF SUBJECT MATTER

F24H 4/02(2006.01)i; F24H 4/04(2006.01)i; F24H 1/18(2006.01)i

FI: F24H4/04; F24H4/02 G; F24H4/02 N; F24H1/18 H

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)

F24H1/00-7/06; F28D20/00-20/02

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

Published examined utility model applications of Japan 1922-1996

Published unexamined utility model applications of Japan 1971-2021

Registered utility model specifications of Japan 1996-2021

Published registered utility model applications of Japan 1994-2021

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	JP 2013-213596 A (PANASONIC CORP) 17 October 2013 (2013-10-17) in particular, paragraphs [0023]-[0041], fig. 1	1-2 3-5
Y A	CN 105546851 A (SHANDONG UNIVERSITY OF TECHNOLOGY) 04 May 2016 (2016-05-04) in particular, paragraphs [0067]-[0069], fig. 1	1-2 3-5
Y A	CN 112524822 A (ZHEJIANG TAINENG POWER TECH CO LTD) 19 March 2021 (2021-03-19) in particular, paragraph [0034], fig. 1	1-2 3-5
Y A	JP 2003-35141 A (MITSUBISHI MOTORS CORP) 07 February 2003 (2003-02-07) in particular, paragraphs [0010]-[0013], fig. 1	1-2 3-5



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

02 September 2021 (02.09.2021)

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
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Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
JP 2013-213596 A	17 Oct. 2013	(Family: none)	
CN 105546851 A	04 May 2016	(Family: none)	
CN 112524822 A	19 Mar. 2021	(Family: none)	
JP 2003-35141 A	07 Feb. 2003	(Family: none)	

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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