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

(11) **EP 3 553 409 A1**

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

(43) Date of publication:
16.10.2019 Bulletin 2019/42

(21) Application number: **16923450.7**

(22) Date of filing: **08.12.2016**

(51) Int Cl.:
F24H 1/18 *(2006.01)*

(86) International application number:
PCT/JP2016/086524

(87) International publication number:
WO 2018/105080 (14.06.2018 Gazette 2018/24)

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

(71) Applicant: **Mitsubishi Electric Corporation**
Chiyoda-ku
Tokyo 100-8310 (JP)

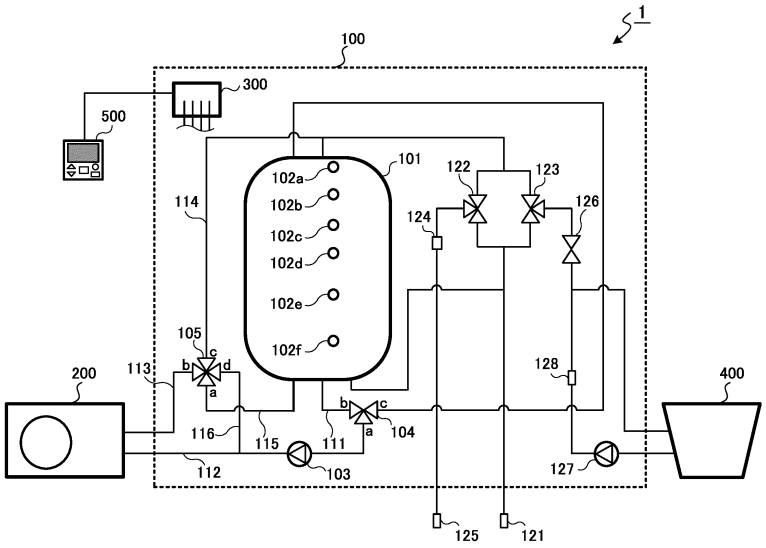
(72) Inventors:
- **KOYANO Takehiro**
  Tokyo 100-8310 (JP)
- **TOYOSHIMA Masaki**
  Tokyo 100-8310 (JP)
- **TAKAYAMA Keisuke**
  Tokyo 100-8310 (JP)

(74) Representative: **Studio Torta S.p.A.**
Via Viotti, 9
10121 Torino (IT)

(54) STORAGE-TYPE HOT WATER SUPPLY DEVICE

(57) A circulation pump (103) supplies to a heat pump unit (200) hot water obtained from a lower portion of a hot-water storage tank (101). The heat pump unit (200) generates high-temperature hot water by heating the supplied hot water. The tank (101) stores hot water having different temperature zones by receiving the high-temperature hot water from an upper portion. A temperature sensor (102a to 102f) detects the temperature of the hot water stored in the tank (101). A control device (300) causes equalization of the temperature of the stored hot water by causing hot water supplied from the circulation pump (103) to circulate through the tank (101). In a state in which the temperatures of the hot water are equalized, the control device (300) provides a notification of a temperature sensor (102a to 102f) that, among the temperature sensors (102a to 102f), detects an abnormal temperature.

FIG. 1



EP 3 553 409 A1

Description

Technical Field

[0001] The present disclosure relates to a storage-type hot water supply device.

Background Art

[0002] In a storage-type hot water supply device as represented by a heat pump-type hot water supply device, conventionally a water-heating operation is performed by taking hot water within a hot-water storage tank from a bottom portion of the hot-water storage tank, and returning to a top portion of the hot-water storage tank hot water at a high temperature obtained by passage through a heat pump-type heating means. Due to such a water-heating operation, within the hot-water storage tank, the interior of the hot-water storage tank stores hot water in a state in which the high temperature hot water gradually forms a layer at the top portion (stratified storage of hot water). In the storage-type hot water supply device, by use of multiple temperature sensors arranged in the hot-water storage tank, a temperature distribution of the hot water stored in the stratified state is acquired, and the accumulated heat amount in the hot-water storage tank is estimated.

[0003] For example, Patent Literature 1 mentions an invention of a hot water storage system (cogeneration system) that accurately estimates the accumulated heat amount (residual hot water amount) within the hot-water storage tank. In this hot water storage system, a temperature distribution between the temperature sensors is estimated by using a multi-degree function derived from the production of hot water and the consumption of hot water, and thus the accumulated heat amount within the hot-water storage tank is estimated accurately.

Citation List

Patent Literature

[0004] Patent Literature 1: Japanese Patent No. 5245807

Summary of Invention

Technical Problem

[0005] However, when accuracy of the temperature sensors (temperature detection accuracy) is low, the estimated values of the temperature distribution are adversely affected, and thus the invention mentioned in Patent Literature 1 suffers from inaccuracy in the estimated accumulated heat amount. That is, the output values of the temperature sensors installed in the hot-water storage tank are used for the temperatures serving as standards when estimating the temperature distribution. Thus when the accuracy of the temperature sensors is low, the estimated temperature distribution is inaccurate, and the finally estimated accumulated heat amount is also inaccurate. Further, although estimation is improved to a certain degree by installation of high accuracy temperature sensors (high temperature detection accuracy), such installation suffers from increased expense.

[0006] Thus technology is desired that is capable of accurately estimating the accumulated heat amount within the hot-water storage tank while suppressing increased expense.

[0007] In order to solve the aforementioned problem, an object of the present disclosure is to provide a storage-type hot water supply device capable of accurately estimating the accumulated heat amount within the hot-water storage tank.

Solution to Problem

[0008] In order to attain the aforementioned objective, the storage-type hot water supply device according to the present disclosure includes:

heating means for generating hot water;
a hot-water storage tank configured to receive the hot water generated by the heating means at an upper portion of the hot-water storage tank and store hot water having different temperature zones;
a plurality of temperature sensors spaced apart in a vertical direction of the hot-water storage tank and configured to detect temperatures of the hot water stored in the hot-water storage tank;
a pump configured to supply the hot water obtained from a lower portion of the hot-water storage tank; and
a control device configured to control the heating means and the pump,

wherein the control device includes

control means for circulating through the hot-water storage tank the hot water supplied from the pump and equalizing the temperatures of the hot water stored in the hot-water storage tank, and
notification means for providing a notification of a temperature sensor that, among the temperature sensors, detected an abnormal temperature in a state in which the temperatures of the hot water are equalized by the control means.

Advantageous Effects of Invention

[0009] According to the storage-type hot water supply device of the present disclosure, the temperatures of the hot water within the hot-water storage tank are equalized by the control means, and in this equalized state, the temperature sensors detect the same temperature. Thus if among the installed temperature sensors a temperature sensor exists that detects an abnormal temperature, notification of the abnormality can be provided. Further, when no notification is provided of an abnormality, or when the temperature sensor detecting an abnormal temperature is replaced, the temperature distribution of the hot water stored in the stratified state (hot water in different temperature zones) can be accurately understood, thereby enabling accurate estimation of the accumulated heat amount within the hot-water storage tank.

Brief Description of Drawings

[0010]

FIG. 1 illustrates configuration of a storage-type hot water supply device according to an embodiment of the present disclosure;
FIG. 2 is a block diagram for description of a connection structure of the storage-type hot water supply device;
FIG. 3 is a schematic drawing for description of a movement path of hot water during a water-heating operation;
FIG. 4 is a schematic drawing for description of a movement path of hot water during an equalizing operation;
FIG. 5 is a schematic drawing illustrating an example of relationships of temperatures acquired by temperature sensors; and
FIG. 6 is a block diagram for description of a connection structure of a storage-type hot water supply device according to another embodiment of the present disclosure.

Description of Embodiments

[0011] Embodiments of the present disclosure are described below in detail with reference to drawings. In the drawings used in the present disclosure, components that are the same or equivalent are assigned the same reference sign. Further, the present disclosure is not limited to the below listed embodiments, and various types of modifications are possible within a scope that does not depart from the gist of the present disclosure.

Configuration of Storage-type Hot Water Supply Device

[0012] FIG. 1 illustrates configuration of a storage-type hot water supply device 1 according to an embodiment of the present disclosure. The storage-type hot water supply device 1 is roughly divided into a hot-water storage unit 100 and a heat pump unit 200. The storage-type hot water supply device 1 is connected to a bathtub 400 and a remote controller 500.

[0013] The storage-type hot water supply device 1 accumulates in a hot-water storage tank 101 of the hot-water storage unit 100 hot water heated by the heat pump unit 200 that is a heating means. The heat pump unit 200, for example, includes a compressor, a water-cooling medium heat exchanger, an expansion valve, and an air heat exchanger. These components are connected in a loop and form a refrigeration cycle circuit (cooling medium circuit) for circulating the cooling medium.

[0014] The hot-water storage unit 100 is equipped mainly with the hot-water storage tank 101, temperature sensors 102 (102a to 102f), a circulation pump 103, switching valves 104 and 105, and a control device 300.

[0015] The temperature sensors 102 (102a to 102f) are arranged, spaced apart from each other, in the vertical direction of the hot-water storage tank 101, and detect the temperatures of the hot water stored in the stratified state (hot water of different temperature zones) within the hot-water storage tank 101. As described below, the control device 300 understands a temperature distribution of the hot water within the hot-water storage tank 101 on the basis of the temperatures detected by the temperature sensors 102. Then the control device 300 estimates an accumulated heat amount

within the hot-water storage tank 101 on the basis of the understood temperature distribution.

[0016] During the water-heating operation, the circulation pump 103 supplies to the heat pump unit 200 the hot water taken from the bottom portion (downward portion) of the hot-water storage tank 101, and the hot water heated by the heat pump unit 200 returns to the top portion (upward portion) of the hot-water storage tank 101. Further, during an equalizing operation as described below (operation to cause equalization of temperatures of the hot water within the hot-water storage tank 101), the circulation pump 103 returns the hot water taken from the bottom portion of the hot-water storage tank 101 to the top portion of the hot-water storage tank 101 without passing the hot water through the heat pump unit 200.

[0017] The switching valve 104 is a three-way valve and is equipped with three inlet-outlet water ports *a* to *c*. The inlet-outlet water port *a* is connected to the heat pump unit 200 via the circulation pump 103 and a delivery pipe 112 to a hear source unit. The inlet-outlet water port *b* is connected to the bottom portion of the hot-water storage tank 101 through a tank bottom water-intake pipe 111. The inlet-outlet water port *c* is connected to the top portion of the hot-water storage tank 101.

[0018] A switching valve 105 is a four-way valve that is equipped with four inlet-outlet water ports *a* to *d*. The inlet-outlet water port *a* is connected to the bottom portion of the hot-water storage tank 101 via a tank bottom portion water inlet pipe 115. The inlet-outlet water port *b* is connected to the heat pump unit 200 via a return pipe 113 from the heat source unit. The inlet-outlet water port c is connected to the top portion of the hot-water storage tank 101 via a tank top portion water inlet pipe 114. The inlet-outlet water port *d* is connected to the delivery pipe 112 to the heat source unit via a heat source unit bypass pipe 116.

[0019] Additionally, municipal tap water is supplied to the hot-water storage unit 100 via a water supply terminal 121. The water supply terminal 121 is connected to inlet ports of the mixing valves 122 and 123. The outlet port of the mixing valve 122 is connected to a hot water supply terminal 125 via a flow rate sensor 124. The outlet port of the mixing valve 123 is connected to the bathtub 400 via a solenoid valve 126. A bath circulation pump 127 circulates the hot water of the bathtub 400. A water level sensor 128 detects a water level of the bathtub 400.

[0020] The control device 300 controls overall operation of the storage-type hot water supply device 1. Further, the control device 300 is connected electrically to the remote controller 500. Details of the control device 300 are described below.

[0021] The remote controller 500 is used by a user for operating the storage-type hot water supply device 1 and for checking the operating state of the storage-type hot water supply device 1. For example, a display, an operation unit, a speaker, and a microphone may be mounted on the remote controller 500. For example, the operation unit receives a user operation and transmits content of the operation to the control device 300. Further, the display displays the operating state of the storage-type hot water supply device 1 on the basis of information obtained from the control device 300. Upon detection of an abnormality of the temperature sensor 102 in a below-described manner, the display displays a message for providing notification of the abnormality. At this time, an alarm sound may be output from the speaker. That is, notification of the abnormality of the temperature sensor 102 is provided by the display and/or the speaker.

[0022] The following description of the storage-type hot water supply device 1 is mainly centered on the control device 300. FIG. 2 is a block diagram for description of a connection structure of the storage-type hot water supply device 1. As illustrated in FIG. 2, the control device 300 performing control of the storage-type hot water supply device 1 is configured to include a measurer 301, a calculator 302, a controller 303, and a memory 304.

[0023] The temperature sensors 102 (102a to 102f), the flow rate sensor 124, and the water level sensor 128 are connected as inputs to the control device 300 configured in this manner. The remote controller 500 is connected to the control device 300 as input-output. Further, the heat pump unit 200, the circulation pump 103, and actuators of the switching valves 104 and 105, the mixing valves 122 and 123, and the solenoid valve 126, or the like are connected to the control device 300 as outputs.

[0024] The measurer 301 measures various amounts in accordance with information input from the temperature sensors 102, the flow rate sensor 124, and the water level sensor 128.

[0025] The calculator 302 calculates a control operation on the basis of the various amounts measured by the measurer 301. For example, the calculator 302 calculates the operation of the heat pump unit 200 in accordance with the accumulated heat amount within the hot-water storage tank 101. In addition, the calculator 302 performs a calculation for detection of the abnormality of the temperature sensors 102 and/or a calculation for obtaining a correction value for correction of the temperature sensors 102.

[0026] The controller 303, on the basis of the control operation calculated by the calculator 302, controls the heat pump unit 200, the circulation pump 103, and the actuators of the switching valves 104 and 105, the mixing valves 122 and 123, the solenoid valve 126, or the like.

[0027] The memory 304 stores various types of information that are predetermined constants and/or setting values transmitted from the remote controller 500. For example, upon detection of the abnormality of the temperature sensor 102 as described below, the memory 304 stores a correction formula that uses temperatures obtained from normally-operating temperature sensors 102 for prediction of a temperature to be detected by the abnormal temperature sensor

102. Upon obtaining of the correction value for correction of the temperature sensor 102 in the below-described manner, the memory 304 also stores the correction value. As may be required, the calculator 302 and/or the controller 303 can refer to the information stored in the memory 304 and can rewrite the information.

[0028] The measurer 301, the calculator 302, and the controller 303 configured in this manner are formed, for example, by a microcomputer. The memory 304 is formed, for example, from semiconductor memory.

Water-heating Operation

[0029] The water-heating operation of the storage-type hot water supply device 1 of the embodiment of the present disclosure is described below. The control device 300 controls the switching valves 104 and 105 in the below-described manner during the water-heating operation.

[0030] For the switching valve 104, the control device 300 opens the inlet-outlet water ports *a* and *b,* and blocks the inlet-outlet water port *c*. Further, for the switching valve 105, the control device 300 opens the inlet-outlet water ports *b* and *c*, and blocks the inlet-outlet water ports *a* and *d.*

[0031] In the state in which the switching valves 104 and 105 are controller in this manner, the control device 300 causes operation of the circulation pump 103. Due to such operation, as illustrated in FIG. 3, the hot water is introduced in turn from the bottom portion of the hot-water storage tank 101 to the switching valve 104, the circulation pump 103, the heat pump unit 200, the switching valve 105, and the top portion of the hot-water storage tank 101. The hot water taken from the bottom portion of the hot-water storage tank 101 in this manner is heated by the heat pump unit 200 serving as the heating means, and the control device 300 can send the heated hot water to the top portion of the hot-water storage tank 101. Due to the water-heating operation performed in this manner, the hot water within the hot-water storage tank 101 is stored in a stratified state (stratified storage of hot water) with high temperature hot water at the top portion.

Equalizing Operation

[0032] An equalizing operation is described below to equalize the temperatures of the hot water stored in the stratified state within the hot-water storage tank 101 after the water-heating operation performed in the above-described manner. The control device 300 controls the switching valves 104 and 105 in the below-described manner during the equalizing operation.

[0033] For the switching valve 104, the control device 300 opens the inlet-outlet water ports *a* and *b,* and blocks the inlet-outlet water port *c.* Further, for the switching valve 105, the control device 300 opens the inlet-outlet water ports *c* and *d*, and blocks the inlet-outlet water ports *a* and *b.*

[0034] In the state in which the switching valves 104 and 105 are controlled in this manner, the control device 300 causes operation of the circulation pump 103. Due to such operation, as illustrated in FIG. 4, the hot water is introduced in turn from the bottom portion of the hot-water storage tank 101 to the switching valve 104, the circulation pump 103, the switching valve 105, and the top portion of the hot-water storage tank 101. Due to the hot water taken from the bottom portion of the hot-water storage tank 101 circulating into the top portion of the hot-water storage tank 101 without passing through the heat pump unit 200, the control device 300 can equalize the temperatures of the hot water stored in the stratified state in the hot-water storage tank 101.

Notification of Abnormal Temperature Sensor

[0035] After execution of the aforementioned equalizing operation and temperatures of the hot water within the hot-water storage tank 101 becoming the same temperature, the control device 300 uses the temperature sensors 102 to measure the temperature of the hot water. Here, the temperatures acquired respectively from the temperature sensors 102a, 102b, 102c, 102d, 102e, and 102f are taken to be Ta, Tb, Tc, Td, Te, and Tf.

[0036] The control device 300 (calculator 302) uses these temperatures Ta to Tf to calculate an average value Tm of the acquired temperatures. Here, the control device 300 newly calculates an average value T'm (trim average value) of temperature after removing a temperature T' that has the largest deviation from the average value Tm.

[0037] When the deviation between the average value T'm and the temperature T' is outside the guaranteed operational range of the temperature sensor 102 (larger than a reference value), the temperature T' is determined to be an abnormal value, and the control device 300 provides notification of the abnormal target temperature sensor 102 via the connected remote controller 500. For example, the control device 300 controls the remote controller 500, and causes the display of the remote controller 500 to display a message indicating that the temperature sensor 102 is abnormal, or alternatively, causes an alarm sound to be output from the speaker of the remote controller 500.

[0038] Due to the equalizing operation, the temperatures of the hot water within the hot-water storage tank 101 are equalized, and the storage-type hot water supply device 1 detects the same temperature for the temperature sensors

102a to 102f in this state. Due to such operation, the temperature sensor 102 having greatly impaired accuracy among the installed temperature sensors 102 can be detected, and thus notification of the abnormality can be provided.

[0039] FIG. 5 illustrates an example of the relationships between the temperatures acquired by the temperature sensors 102, in the case in which an abnormal temperature is acquired by the temperature sensor 102c, that is to say, the case in which the temperature Tc is equal to the temperature T'. That is to say, the control device 300 (calculator 302) firstly uses the temperatures Ta to Tf to calculate the average value Tm. Thereafter, the control device 300 excludes the temperature Tc (equal to the temperature T') having the largest deviation from the average value Tm, and calculates the average value T'm (trim average value) using the remaining temperatures Ta, Tb, and Td to Tf. Then in the case in which the deviation between the temperature Tc (equal to the temperature T') and the average value T'm is not within the guaranteed operational range of the temperature sensor 102, the control device 300 provides notification of the abnormality of the temperature sensor 102c via the remote controller 500.

[0040] In the case in which an abnormal temperature sensor 102c is detected (notification provided) in this manner, during the normal water-heating operation, the control device 300 (calculator 302) may obtain a substitute temperature ETc as a substitute for the temperature Tc acquired from the temperature sensor 102c. For example, the control device 300 may obtain the temperature to be properly detected by the temperature sensor 102c, that is, the substitute temperature ETc of the abnormal sensor, by using the correction formula stored in the memory 304 and the temperatures acquired by the normally-operating temperature sensors 102 (such as the temperature sensor 102b and 102d) at the periphery.

[0041] In this case, the temperature distribution of the hot water stored in the stratified state within the hot-water storage tank 101 can be accurately understood by using the substitute temperature ETc as a substitute for the temperature Tc acquired by the temperature sensor 102c, and by using the temperatures Ta, Tb, and Td to Tf acquired by the other temperature sensors 102, and thus the accumulated heat amount within the hot-water storage tank 101 can be accurately estimated.

Correction of Temperature Sensor

[0042] Further, in the case in which an abnormality of the temperature sensors 102 is not detected, or the case in which the detected abnormal temperature sensor 102 is replaced, the control device 300 (calculator 302) corrects each of the temperature sensors 102a to 102f in the below-described manner.

[0043] Taking the uncertainty of the temperature detected by the temperature sensors 102 to be σ, an uncertainty σ' of the average value of the temperatures detected by N temperature sensors 102 is expressed by the below Formula 1.

$$\sigma' = \frac{\sigma}{\sqrt{N}} \qquad \ldots \quad \text{(Formula 1)}$$

[0044] Thus by using the uncertainty σ' and the average value Tm of the temperatures after the equalizing operation, the control device 300 (calculator 302) obtains the correction values for correction of each of the temperatures Ta to Tf acquired by the temperature sensors 102a to 102f, and thus the uncertainties of the temperatures detected by the temperature sensors 102 can be decreased. For example, in the case of correction of the temperature Ta (temperature sensor 102a), the control device 300 obtains a correction value Aa by the below-listed Formula 2.

$$Aa = (Tm - Ta) \times \sigma' \qquad \ldots \quad \text{(Formula 2)}$$

[0045] The control device 300 obtains respectively the correction values Ab to Af by a similar formula for the temperatures Tb to Tf (temperature sensors 102b to 102f).

[0046] The control device 300 stores in the memory 304 the correction values Aa to Af found in this manner. The control device 300 uses the correction values Aa to Af to correct respectively the temperatures Ta to Tf acquired by the temperature sensors 102a to 102f during the normal water-heating operation.

[0047] In this case, by using the correction values Aa to Af to correct Ta to Tf acquired by the temperature sensors 102, the temperature distribution of the hot water stored in the stratified state within the hot-water storage tank 101 can be accurately understood, and thus the accumulated heat amount within the hot-water storage tank 101 can be accurately estimated.

[0048] The aforementioned equalizing operation includes the possibility of decreasing the amount of the hot water capable of use within the hot-water storage tank 101. Thus the equalizing operation (notification and/or correction) envisions, for example, execution as an initiating operation when the storage-type hot water supply device 1 is initially installed in a new operating environment and is started up. That is, by execution of the equalizing operation as an initial

operation, the accuracy of the measurement function of the storage-type hot water supply device 1 can be improved without loss of convenience for the user.

[0049] Further, in order to cause further improvement of the accuracy of the measurement of the storage-type hot water supply device 1, the aforementioned temperature sensor 102 correction can be executed multiple times while repeating the aforementioned water-heating operation and the aforementioned equalization operation. In this case, the correction can be executed for each of the temperature zones, and the uncertainty of temperature detection of the temperature sensors 102 can be further decreased.

[0050] Further, in the aforementioned embodiment, equalizing of temperatures is described in which the circulation pump 103 is used to cause circulation of the hot water as the equaling operation within the hot-water storage tank 101 without passage through the heat pump unit 200. However, such operation is one example, and another method may be used to cause equalization of the temperature of the hot water within the hot-water storage tank 101. For example, the temperatures of the hot water within the hot-water storage tank 101 may be equalized by pump operation, for example. That is, the equalizing operation may be any operation that includes lowering the uncertainty of the detection of the temperature sensors.

Other Embodiments

[0051] Although the aforementioned embodiment is described for a case in which the control device 300 uses the remote controller 500 to report the abnormality of the temperature sensor 102, the control device 300 side may be equipped with the alarm means.

[0052] For example, as illustrated in FIG. 6, a control device 310 for performing control of the storage-type hot water supply device 1 is configured to include the measurer 301, the calculator 302, the controller 303, the memory 304, and the notifier 311. Further, the measurer 301 through the memory 304 are configured in the same manner as in the aforementioned control device 300 of FIG. 2, and thus description of such components is omitted.

[0053] When an abnormality of the temperature sensor 102 is detected similarly to the above description, the notifier 311 provides notification of the abnormality. For example, when the notifier 311 includes the display and/or the speaker and the abnormality of the temperature sensor 102 is detected, the notifier 311 performs actions such as the display of a message, output of an alarm sound, or the like in order to provide notification of the abnormality.

[0054] Also in this case, upon detection of a temperature sensor 102 having remarkable loss of accuracy among the installed temperature sensors 102, the storage-type hot water supply device 1 can provide notification of the abnormality.

[0055] A program for execution by the control devices 300 and 310 in the aforementioned embodiments may be stored and distributed on a computer-readable recording medium such as a compact disc read-only memory (CD-ROM), a digital versatile disc (DVD), a magneto-optical (MO) disc, a USB memory, a memory card, or the like computer-readable recording medium. Further, by installation of such a program on a specialized or general-purpose computer, the computer can be made to function as the control devices 300 and 310 in the aforementioned embodiments.

[0056] Further, the aforementioned program may be stored beforehand on a disc device of a server device on a communication network such as the Internet, and for example, may be superimposed on a carrier wave for downloading to the computer. Further, the aforementioned processing may be achieved also by executing while transferring the program via a communication network. Further, part or the entire program may be executed on a server device while information related to such processing is transmitted from and received by the computer via a communication network.

[0057] Further, when the above-described functions are achieved partly by an operating system (OS) or cooperatively with the OS and the application, the program other than the OS may be stored on the above recording medium for distribution or may be downloaded to the computer.

[0058] The foregoing describes some example embodiments for explanatory purposes. Although the foregoing discussion has presented specific embodiments, persons skilled in the art will recognize that changes may be made in form and detail without departing from the broader spirit and scope of the invention. Accordingly, the specification and drawings are to be regarded in an illustrative rather than a restrictive sense. This detailed description, therefore, is not to be taken in a limiting sense, and the scope of the invention is defined only by the included claims, along with the full range of equivalents to which such claims are entitled.

Industrial Applicability

[0059] The present disclosure can be used with advantage for a storage-type hot water supply device used within a household or facility.

Reference Signs List

[0060]

1	Storage-type hot water supply device
100	Hot-water storage unit
101	Hot-water storage tank
102 (102a to 102f)	Temperature sensor
103	Circulation pump
104, 105	Switching valve
111	Tank bottom water-intake pipe
112	Delivery pipe to heat source unit
113	Return pipe from heat source unit
114	Tank top portion water inlet pipe
115	Tank bottom portion water inlet pipe
116	Heat source unit bypass pipe
121	Water supply terminal
122, 123	Mixing valve
124	Flow rate sensor
125	Hot water supply terminal
126	Solenoid valve
127	Bath circulation pump
128	Water level sensor
200	Heat pump unit
300, 310	Control device
301	Measurer
302	Calculator
303	Controller
304	Memory
311	Notifier
400	Bathtub
500	Remote controller

Claims

1. A storage-type hot water supply device (1) comprising:

heating means (200) for generating hot water;
a hot-water storage tank (101) configured to receive the hot water generated by the heating means (200) at an upper portion of the hot-water storage tank (101) and store hot water having different temperature zones;
a plurality of temperature sensors (102) spaced apart in a vertical direction of the hot-water storage tank (101) and configured to detect temperatures of the hot water stored in the hot-water storage tank (101);
a pump (103) configured to supply the hot water taken from a lower portion of the hot-water storage tank (101); and
a control device (300, 310) configured to control the heating means (200) and the pump (103),
wherein the control device (300, 310) comprises

control means (303) for circulating through the hot-water storage tank (101) the hot water supplied from the pump (103) and equalizing the temperatures of the hot water stored in the hot-water storage tank (101), and
notification means (311) for providing a notification of a temperature sensor (102) that, among the temperature sensors (102), detected an abnormal temperature in a state in which the temperatures of the hot water are equalized by the control means (303).

2. The storage-type hot water supply device (1) according to claim 1, further comprising:

a switching valve (104, 105) configured to switch a supply destination of the hot water supplied by the pump (103) to one of the heating means (200) and the hot-water storage tank (101),
wherein the control means (303) (i) controls the switching valve (104, 105) during a water-heating operation and switches the supply destination of the hot water to the heating means (200) to cause the pump (103) to supply to the hot-water storage tank (101) the hot water that passes through the heating means (200), and (ii) controls the switching valve (104, 105) during an equalizing operation and switches the supply destination of

the hot water to the hot-water storage tank (101) to cause the pump (103) to supply to the hot-water storage tank (101) the hot water that does not pass through the heating means (200).

3. The storage-type hot water supply device (1) according to claim 1, wherein the notification means (311) obtains an average value of the temperatures detected by the temperature sensors (102) to specify a temperature that has a largest deviation from the average value, calculates a trim average value that excludes the specified temperature, and
when a deviation between the specified temperature and the calculated trim average value is larger than a reference value, provides a notification of an abnormality of the temperature sensor (102) corresponding to the specified temperature.

4. The storage-type hot water supply device (1) according to claim 1, wherein the control device (300, 310) further comprises calculation means (302) for calculating, based on a temperature detected by an adjacent temperature sensor (102) as a substitute for the temperature sensor (102) detected the abnormal temperature, a temperature to be detected by the temperature sensor (102) detected the abnormal temperature.

5. The storage-type hot water supply device (1) according to claim 1, wherein the control device (300, 310) further comprises calculation means (302) for calculating, for each of the temperatures detected by the temperature sensors (102) in a state in which the temperatures of the hot water are equalized by the control means (303), a correction value for correction of the temperatures detected by the temperature sensors (102).

FIG. 1

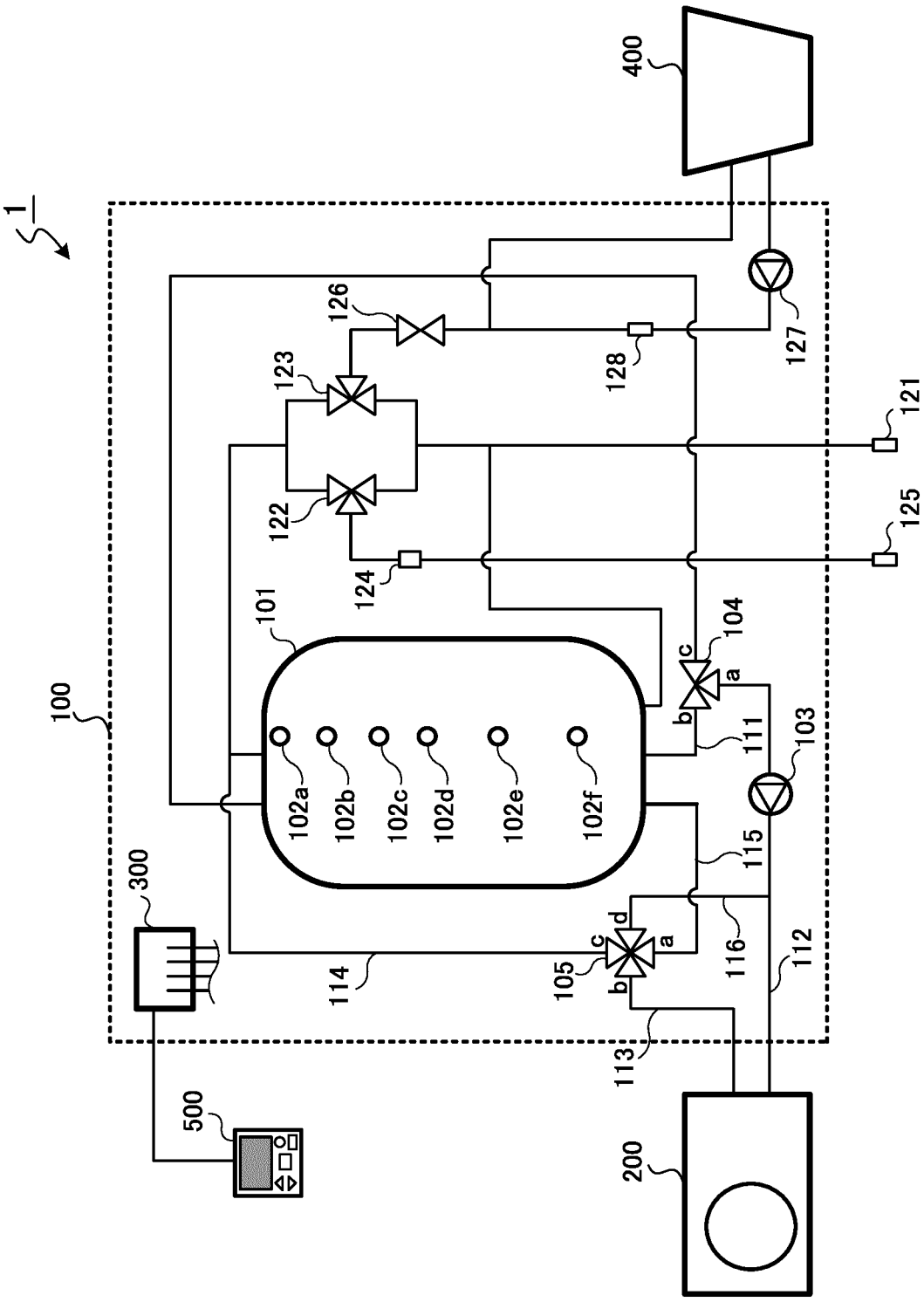

1
100
101
102a
102b
102c
102d
102e
102f
103
104
105
111
112
113
114
115
116
121
122
123
124
125
126
127
128
200
300
400
500
a
b
c
d

FIG. 2

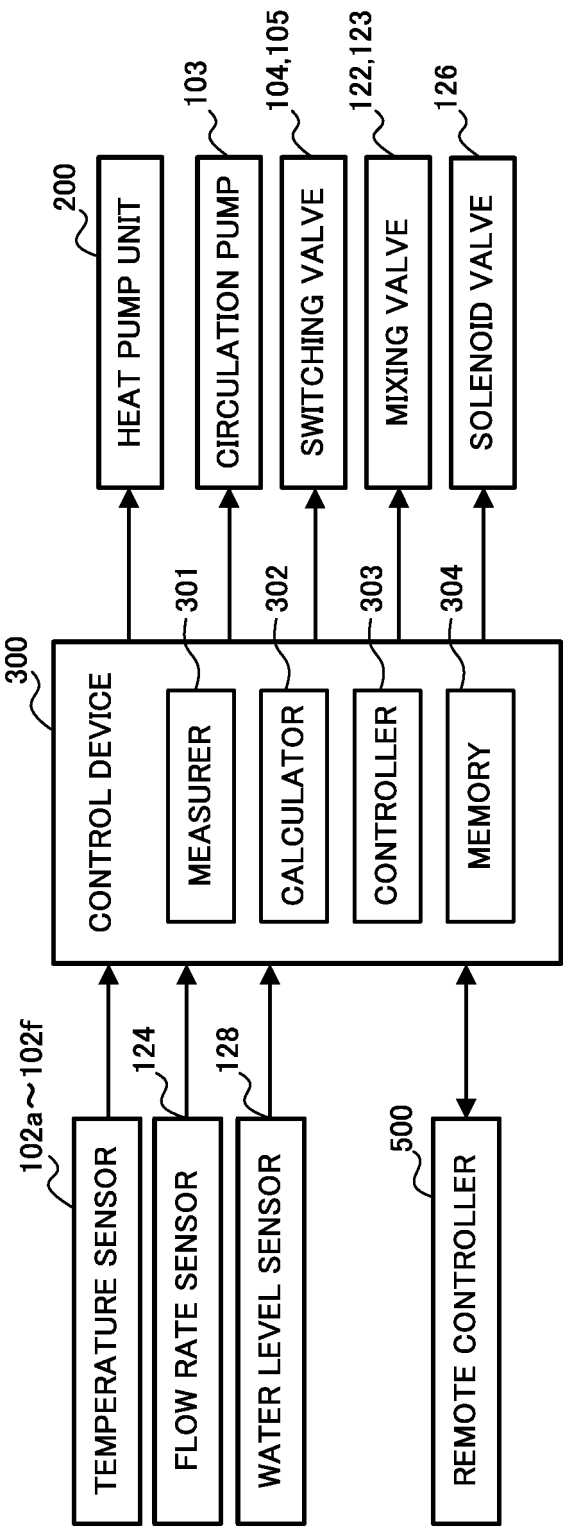

200
HEAT PUMP UNIT
103
CIRCULATION PUMP
104,105
SWITCHING VALVE
122,123
MIXING VALVE
126
SOLENOID VALVE
300
CONTROL DEVICE
301
MEASURER
302
CALCULATOR
303
CONTROLLER
304
MEMORY
102a~102f
TEMPERATURE SENSOR
124
FLOW RATE SENSOR
128
WATER LEVEL SENSOR
500
REMOTE CONTROLLER

FIG. 3

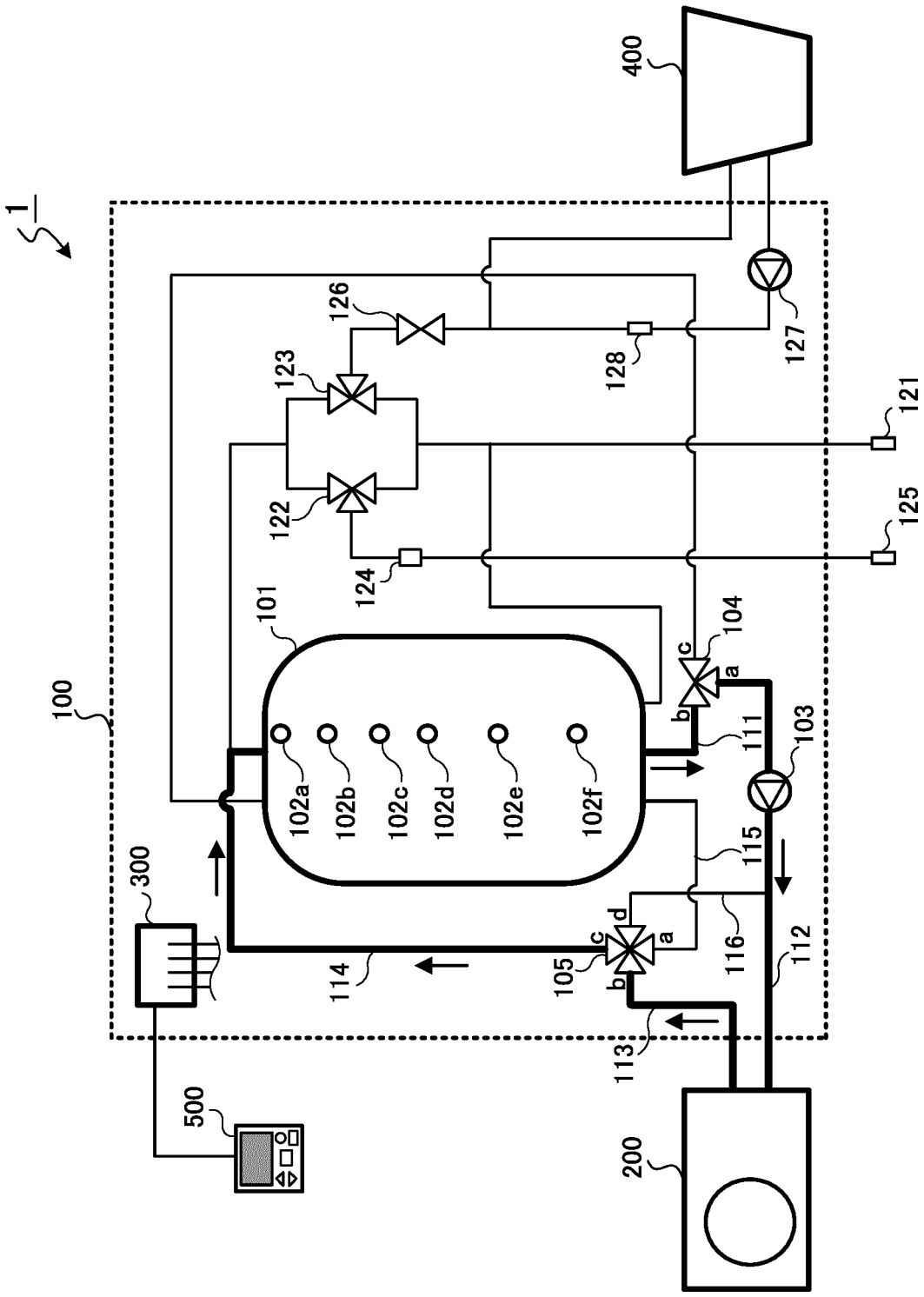

1
100
101
102a
102b
102c
102d
102e
102f
103
104
105
111
112
113
114
115
116
121
122
123
124
125
126
127
128
200
300
400
500
a
b
c
d

FIG. 4

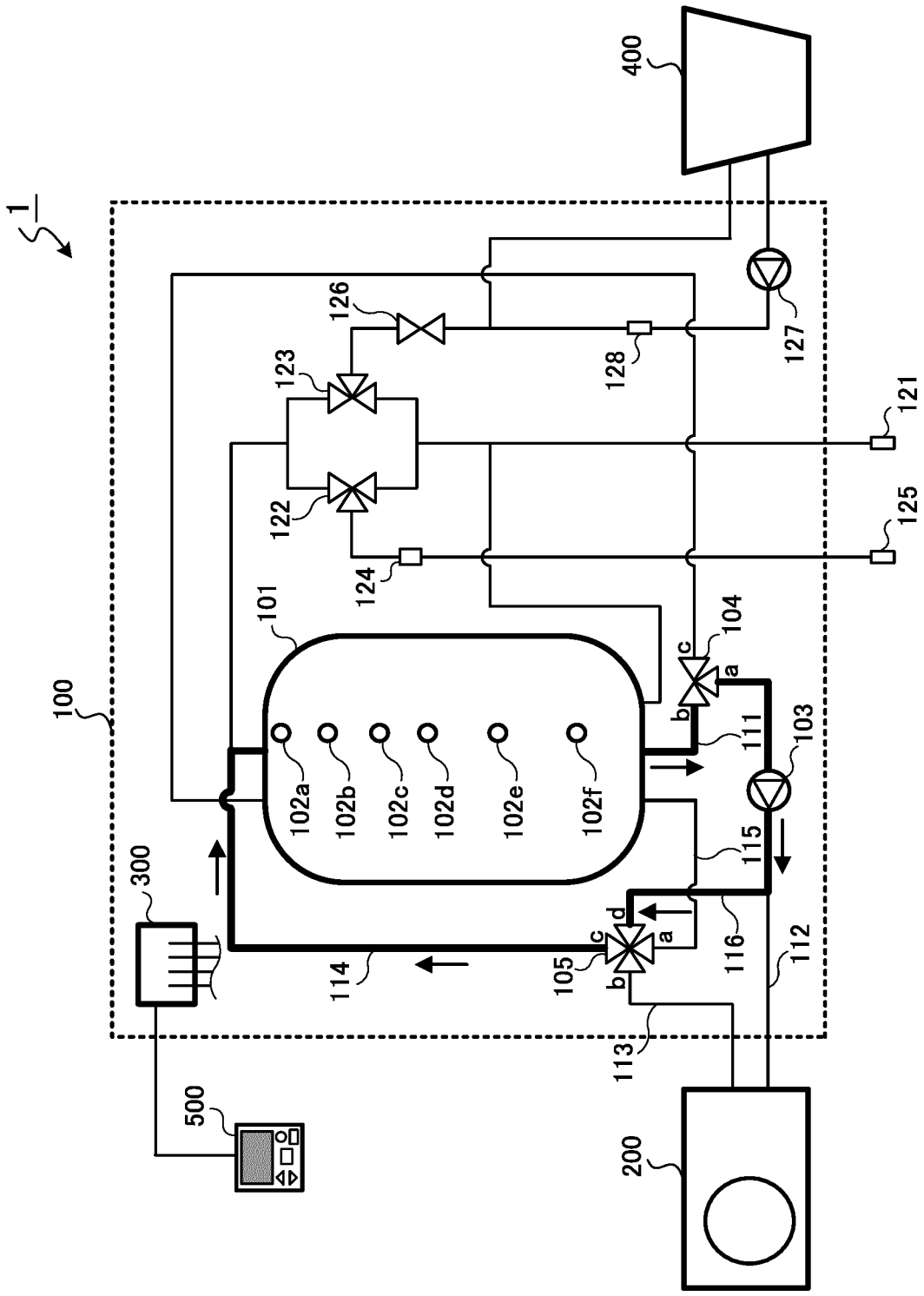

1
100
101
102a
102b
102c
102d
102e
102f
103
104
105
111
112
113
114
115
116
121
122
123
124
125
126
127
128
200
300
400
500
a
b
c
d

FIG. 5

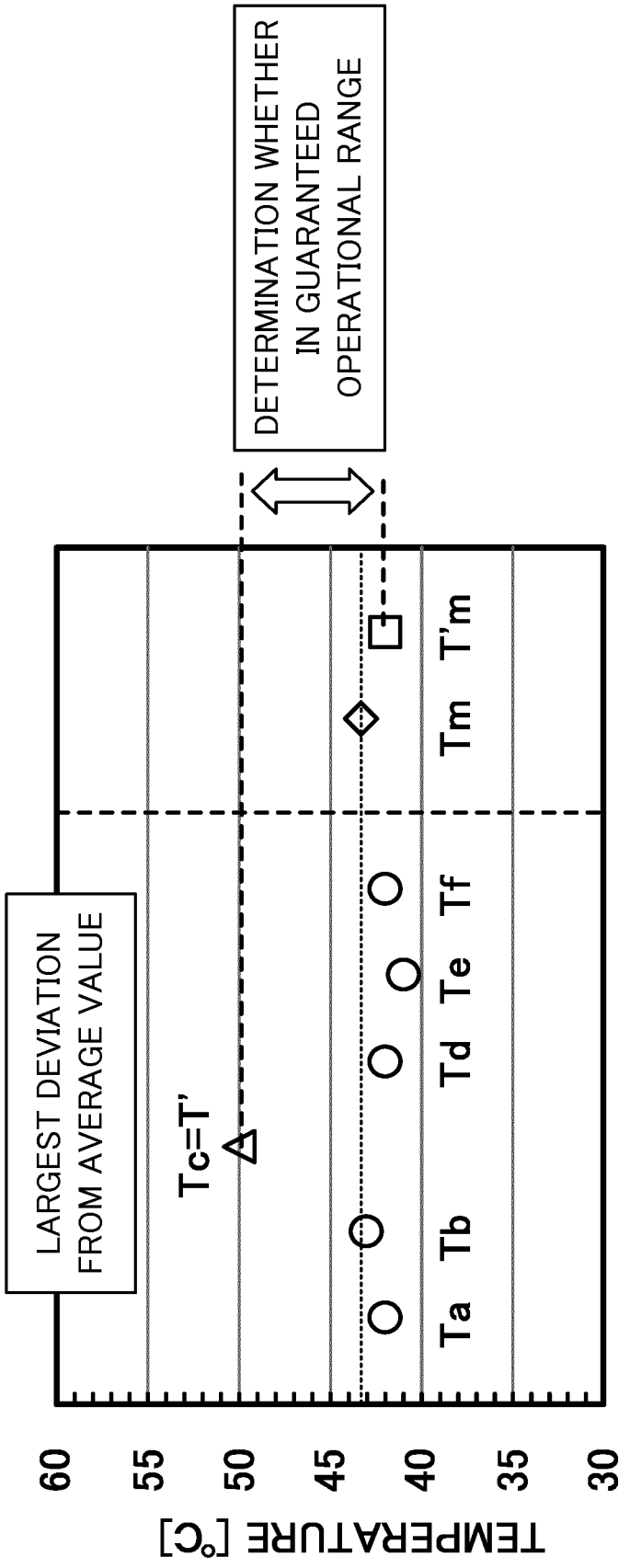
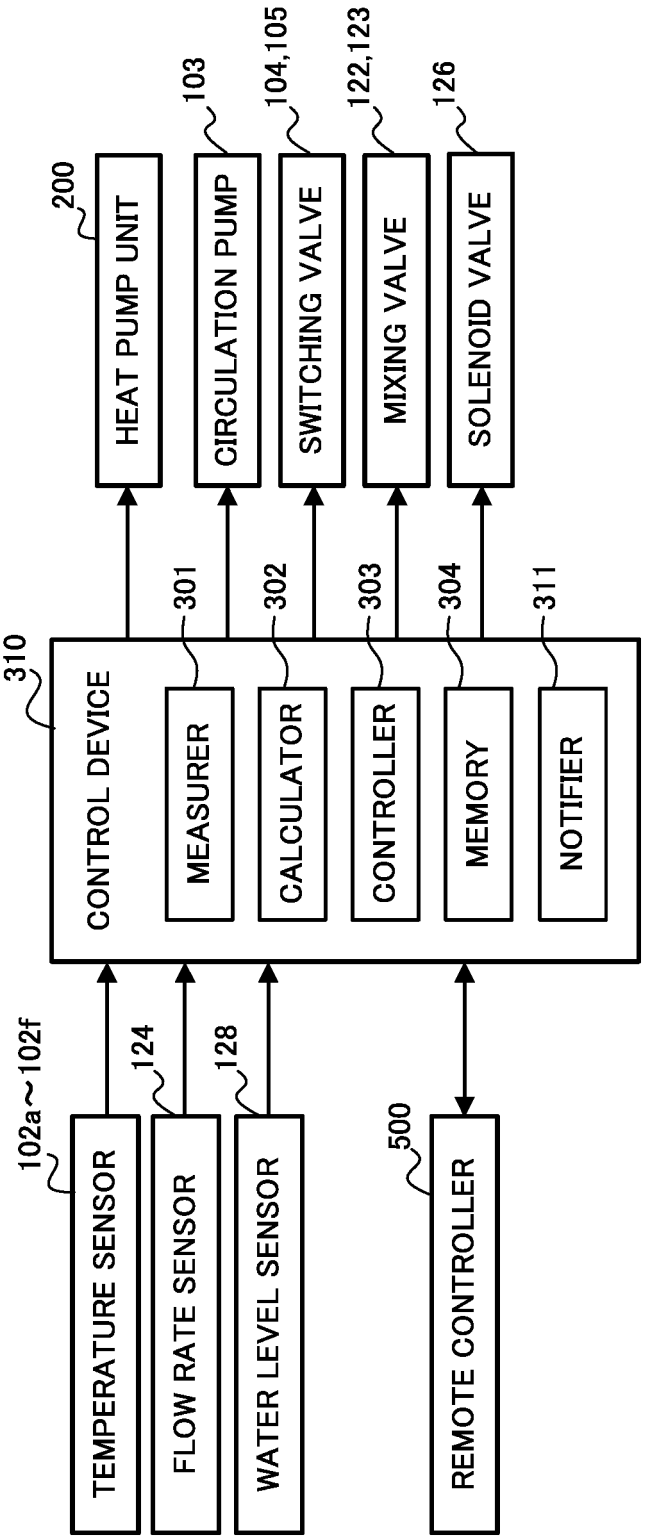

DETERMINATION WHETHER IN GUARANTEED OPERATIONAL RANGE
LARGEST DEVIATION FROM AVERAGE VALUE
Tc=T'
Ta Tb Td Te Tf Tm T'm
60 55 50 45 40 35 30
TEMPERATURE [°C]

FIG. 6


200
HEAT PUMP UNIT
103
CIRCULATION PUMP
104,105
SWITCHING VALVE
122,123
MIXING VALVE
126
SOLENOID VALVE
310
CONTROL DEVICE
301
MEASURER
302
CALCULATOR
303
CONTROLLER
304
MEMORY
311
NOTIFIER
102a~102f
TEMPERATURE SENSOR
124
FLOW RATE SENSOR
128
WATER LEVEL SENSOR
500
REMOTE CONTROLLER

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2016/086524

A. CLASSIFICATION OF SUBJECT MATTER
F24H1/18(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

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 10-141771 A (Sekisui Chemical Co., Ltd.), 29 May 1998 (29.05.1998), paragraph [0008]; fig. 1 (Family: none)	1-5
A	JP 7-120063 A (Kyushu Hen'atsuki Kabushiki Kaisha), 12 May 1995 (12.05.1995), paragraph [0021]; fig. 2 (Family: none)	1-5
A	JP 2009-36487 A (Toshiba Carrier Corp.), 19 February 2009 (19.02.2009), paragraph [0023]; fig. 1 (Family: none)	1-5

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

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

Date of the actual completion of the international search	Date of mailing of the international search report
14 February 2017 (14.02.17)	28 February 2017 (28.02.17)
Name and mailing address of the ISA/ Japan Patent Office 3-4-3,Kasumigaseki,Chiyoda-ku, Tokyo 100-8915,Japan	Authorized officer Telephone No.

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

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2016/086524

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 2007-309593 A (Matsushita Electric Industrial Co., Ltd.), 29 November 2007 (29.11.2007), paragraph [0019]; fig. 1 (Family: none)	1-5
A	JP 2009-103358 A (Aisin Seiki Co., Ltd.), 14 May 2009 (14.05.2009), paragraphs [0022], [0087] to [0089]; fig. 1 (Family: none)	1-5
A	JP 2003-56908 A (Noritz Corp.), 26 February 2003 (26.02.2003), paragraphs [0035] to [0037]; fig. 1 (Family: none)	1-5

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

REFERENCES CITED IN THE DESCRIPTION

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

Patent documents cited in the description

- JP 5245807 B **[0004]**