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(54) CONTROL DEVICE, CONTROL METHOD, AND COMPUTER PROGRAM

STEUERUNGSVORRICHTUNG, STEUERUNGSVERFAHREN UND COMPUTER PROGRAMM

DISPOSITIF DE COMMANDE, PROCÉDÉ DE COMMANDE, ET PROGRAMME D'ORDINATEUR

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(73) Proprietor: **Mitsubishi Heavy Industries Thermal Systems, Ltd.**
Tokyo 108-8215 (JP)

(72) Inventors:
- **TERAOKA Masahiro**
  Tokyo 108-8215 (JP)
- **OKADA Takuya**
  Tokyo 108-8215 (JP)

(74) Representative: **Intès, Didier Gérard André et al**
Cabinet Beau de Loménie
158 rue de l'Université
75340 Paris Cedex 07 (FR)

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Description

Technical Field

[0001] The present invention relates to a control device, a control method, and a computer program.

Background Art

[0002] There is a heat pump system in which each of a plurality of heat pump devices heats water circulating through water piping.

[0003] The related art is disclosed in PTL 1. The device disclosed in PTL 1 attempts to attain efficient operation and improvement in reliability in the heat pump system in which each of the plurality of heat pump devices heats water circulating through water piping.

Citation List

Patent Literature

[0004]

[PTL 1] Japanese Unexamined Patent Application Publication No. 2013-113556 A discloses a control device according to the preamble of claim 1, a control method according to the preamble of claim 4, and a computer program according to the preamble of claim 5.

[PTL 2] Japanese patent application JP 2014 070741 A relates to a heat source system and control method thereof. JP 2014 070741 A discloses a control device according to the preamble of claim 1, a control method according to the preamble of claim 4, and a computer program according to the preamble of claim 5.

Summary of Invention

Technical Problem

[0005] In a heat pump system in which each of a plurality of heat pump devices connected in series heats circulating water, the circulating water becomes higher in pressure at a high temperature as the heat pump device in the heat pump system is located further downstream in a water circulation path. Each of the heat pump devices needs to raise the temperature of water by performing heat exchange while the water passes through the inside of the device itself. In a case of reducing the manufacturing cost of the heat pump device which is used in this manner, in general, downsizing is considered in order to reduce a material cost. However, in a case where the heat pump device is downsized, the capacity (volume) of a heat exchanger through which a refrigerant passes is reduced. For this reason, the pressure of the refrigerant in the heat exchanger becomes higher as the heat pump device is located further downstream in the water circulation path and as the heat pump device becomes smaller.

[0006] As a result, in the heat exchanger of the heat pump device which is located furthest downstream, among the plurality of heat pump devices connected in series, expensive parts which can withstand the high pressure of the refrigerant are used, and thus it is difficult to reduce the manufacturing cost of the heat pump system.

[0007] The present invention has an object to provide a control device, a control method, and a computer program which can solve the above problem.

Solution to Problem

[0008] According to a first aspect of the present invention, there is provided a control device according to claim 1.

[0009] According to a second aspect of the present invention, in the control device according to the first aspect, the variation amount allocation determining unit may determine a variation amount allocated to the plurality of heat pump devices other than the most downstream heat pump device such that a variation amount allocated to the most downstream heat pump device at a timing when the temperature of the water at the output of the most downstream heat pump device exceeds a second set temperature is smaller than the variation amount at the normal time, in a case where the target temperature of the water at the output of the most downstream heat pump device exceeds the first set temperature.

[0010] According to a third aspect of the present invention, the control device according to the first or second aspects may further include: a variation amount allocation setting unit that sets the allocated variation amounts which are allocated to the most downstream heat pump device and the plurality of heat pump devices other than the most downstream heat pump device, on the basis of the allocated variation amount determined by the variation amount allocation determining unit.

[0011] According to a fourth aspect of the present invention, there is provided a control method according to claim 4.

[0012] According to a fifth aspect of the present invention, there is provided a computer program according to claim 5.

Advantageous Effects of Invention

[0013] According to the control device, the control method and the computer program described above, it is possible to use inexpensive parts in a heat exchanger of the heat pump device located furthest downstream, among a plurality of heat pump devices connected in series in a heat pump system, and it is possible to perform downsizing of the heat pump system and a reduction in the manufacturing cost of the heat pump system.

Brief Description of Drawings

[0014]

Fig. 1 is a diagram showing the configuration of a heat pump system according to a first embodiment of the present invention.
Fig. 2 is a diagram showing the configuration of a heat pump device according to the first embodiment of the present invention.
Fig. 3 is a diagram showing the configuration of a control device according to the first embodiment of the present invention.
Fig. 4 is a diagram showing a data table which is stored in a storage unit according to the first embodiment of the present invention.
Fig. 5 is a diagram showing a processing flow of the control device according to the first embodiment of the present invention.
Fig. 6 is a diagram showing the configuration of a heat pump system according to a second embodiment of the present invention.
Fig. 7 is a diagram showing the configuration of a control device according to a third embodiment of the present invention.

Description of Embodiments

<First Embodiment>

[0015] Hereinafter, embodiments will be described in detail with reference to the drawings.

[0016] The configuration of a heat pump system which is provided with a control device according to a first embodiment of the present invention will be described.

[0017] A heat pump system 1 according to the first embodiment of the present invention is provided with a facility 10, a first heat pump device 20a1, a second heat pump device 20a2, ..., a (n-1)-th heat pump device 20a(n-1), an n-th heat pump device 20an, a control device 30, and water piping 40, as shown in Fig. 1.

[0018] The facility 10 changes the temperature of water by ΔT. For example, the facility 10 is an office, a factory, or the like, and in the facility 10, the temperature of water is changed by ΔT by using an air conditioner, boiler equipment, a freezer, or the like. In a case of lowering the temperature of water by ΔT, it means cooling of water. In a case of raising the temperature of water by ΔT, it means heating of water.

[0019] The facility 10 outputs, for example, water with the temperature lowered by ΔT to the first heat pump device 20a1 through the water piping 40. Further, water is input from the n-th heat pump device 20an to the facility 10 through the water piping 40. For example, the water heated to a water temperature which is required for the facility 10 is supplied from the n-th heat pump device 20an to the facility 10 through the water piping 40.

[0020] The first heat pump device 20a1 heats the water input from the facility 10 by heat exchange. The first heat pump device 20a1 outputs the heated water to the second heat pump device 20a2 through the water piping 40.

[0021] The second heat pump device 20a2 heats the water input from the first heat pump device 20a1 by heat exchange. The second heat pump device 20a2 outputs the heated water to a third heat pump device 20a3 through the water piping 40.

[0022] Similarly, the third heat pump device 20a3 heats the water input from the second heat pump device 20a2 by heat exchange. The third heat pump device 20a3 outputs the heated water to a fourth heat pump device 20a4 through the water piping 40.

[0023] Similarly, the (n-1)-th heat pump device 20a(n-1) heats the water input from the (n-2)-th heat pump device 20a(n-2) by heat exchange. The (n-1)-th heat pump device 20a(n-1) outputs the heated water to the n-th heat pump device 20an through the water piping 40. The n-th heat pump device 20an is the most downstream heat pump device disposed furthest downstream in a water circulation path.

[0024] The n-th heat pump device 20an heats the water input from the (n-1)-th heat pump device 20a(n-1) by heat exchange. The n-th heat pump device 20an outputs the heated water to the facility 10 through the water piping 40. The first heat pump device 20a1, the second heat pump device 20a2, ..., the (n-1)-th heat pump device 20a(n-1), and the n-th heat pump device 20an are collectively referred to as a heat pump device 20.

[0025] In Fig. 1, an arrow in the water piping 40 indicates a flow direction of water in the water circulation path.

[0026] The control device 30 controls each of the first heat pump device 20a1, the second heat pump device 20a2, ..., and the n-th heat pump device 20an. Specifically, the control device 30 determines a target outlet water temperature in each of the first heat pump device 20a1, the second heat pump device 20a2, ..., and the (n-1)-th heat pump device 20a(n-1), that is, allocation of a variation amount in each heat pump device, on the basis of a temperature decrease ΔT of water in the facility 10, equipment capacity indicating the capacity of varying a water temperature, of each of the first heat pump device 20a1, the second heat pump device 20a2, ..., and the n-th heat pump device 20an, an input water temperature of the first heat pump device 20a1 disposed furthest upstream, and a target outlet water temperature of the n-th heat pump device 20an disposed furthest downstream. The allocation of the variation amount is an amount indicating the variation amount of a water temperature in which the variation amount ΔT of the water temperature in the facility 10 (in this case, the temperature decrease ΔT of water in the facility 10) is allocated to each of the first heat pump device 20a1, the second heat pump device 20a2, ..., and the (n-1)-th heat pump device 20a(n-1), and is a variation amount which is shown by a difference between the target outlet water temperature and the inlet water temperature in each heat pump device.

The control device 30 generates a control command for the allocation of the variation amount in each of the first heat pump device 20a1, the second heat pump device 20a2, ..., and the (n-1)-th heat pump device 20a(n-1) on the basis of each of the target outlet water temperature, the actually measured value of the inlet water temperature, and the actually measured value of the outlet water temperature in each of the first heat pump device 20a1, the second heat pump device 20a2, ..., and the (n-1)-th heat pump device 20a(n-1). The control device 30 transmits the generated control command to the corresponding heat pump device 20.

[0027] In Fig. 1, a broken line indicates a communication path between each of the heat pump devices 20 and the control device 30. The control device 30 transmits and receives information to and from the facility 10 through the communication path. The control device 30 transmits a control signal for the target outlet water temperature or the like to the heat pump device 20 through this communication path. The communication path may be wired or wireless.

[0028] The configuration of the heat pump device 20 according to this embodiment will be described.

[0029] Each of the heat pump devices 20 is provided with a compressor 201, a four-way valve 202, a water heat exchanger 203, an expansion valve 204, an air heat exchanger 205, an accumulator 206, a refrigerant pipe 207, a first temperature sensor 208, and a second temperature sensor 209, as shown in Fig. 2. The compressor 201, the four-way valve 202, the water heat exchanger 203, the expansion valve 204, the air heat exchanger 205, and the accumulator 206 are connected by the refrigerant pipe 207 to configure a refrigerant circuit.

[0030] The compressor 201 is provided between the four-way valve 202 and the accumulator 206. In the compressor 201, a motor is driven by an inverter. In the compressor 201, the rotational speed of the motor, that is, the discharge amount of the refrigerant is adjusted by the output frequency of the inverter.

[0031] The water heat exchanger 203 performs heat exchange between the water in the water piping 40 through which water flows from the heat pump device 20 on the upstream side to the heat pump device 20 on the downstream side, and the refrigerant in the refrigerant pipe 207 between the four-way valve 202 and the expansion valve 204.

[0032] The expansion valve 204 is provided between the water heat exchanger 203 and the air heat exchanger 205. The expansion valve 204 converts a liquid refrigerant having a pressure P, which is input at a certain temperature T, to a refrigerant having a pressure lower than the pressure P at a temperature lower than the temperature T.

[0033] The air heat exchanger 205 is provided between the four-way valve 202 and the expansion valve 204. The air heat exchanger 205 performs heat exchange between the outside air and the refrigerant.

[0034] The accumulator 206 is provided between the compressor 201 and the four-way valve 202. The accumulator 206 prevents the refrigerant that has not been completely gasified in an evaporator (the water heat exchanger 203 or the air heat exchanger 205) from being drawn into the compressor 201 in a liquid state.

[0035] The first temperature sensor 208 is provided at the inlet of the water piping 40 in the water heat exchanger 203 through which water flows from the heat pump device 20 on the upstream side (in the case of the first heat pump device 20a1, from the facility 10). The water temperature detected by the first temperature sensor 208 is transmitted to the control device 30 as the actually measured value of the inlet water temperature in the water piping 40.

[0036] The second temperature sensor 209 is provided at the outlet of the water piping 40 in the water heat exchanger 203 through which water flows to the heat pump device 20 on the downstream side (in the case of the n-th heat pump device 20an, to the facility 10). The water temperature detected by the second temperature sensor 209 is transmitted to the control device 30 as the actually measured value of the output water temperature in the water piping 40.

[0037] In the heat pump device 20, a heating operation and a cooling (or defrosting) operation are switched by switching the four-way valve 202 to change the flow direction of the refrigerant. At the time of the heating operation, the refrigerant discharged from the compressor 201 flows through the water heat exchanger 203, the expansion valve 204, the air heat exchanger 205, and the accumulator 206 in this order. The water heat exchanger 203 acts as a condenser and the air heat exchanger 205 acts as an evaporator. Then, the water heated in the water heat exchanger 203 is output to the next heat pump device 20 on the downstream side in the water circulation path or the facility 10 through the water piping 40.

[0038] The configuration of the control device 30 according to this embodiment will be described.

[0039] The control device 30 is provided with a communication unit 301, a storage unit 302, a communication control unit 303, a temperature variation control unit 304, a variation amount allocation determining unit 305, a variation amount reading unit 306, and a variation amount allocation setting unit 307, as shown in Fig. 3.

[0040] The communication unit 301 transmits and receives information necessary for the control device 30 to control each of the heat pump devices 20 to and from each of the heat pump devices 20. For example, the communication unit 301 receives the actually measured value of the inlet water temperature detected by the first temperature sensor 208 in each of the first heat pump device 20a1, the second heat pump device 20a2, ..., and the (n-1)-th heat pump device 20a(n-1), and the actually measured values of the outlet water temperature detected by the second temperature sensor 209 in each heat pump device. Further, the communication unit 301 transmits the control command to each of the first heat pump device

20a1, the second heat pump device 20a2, ..., and the (n-1)-th heat pump device 20a(n-1).

[0041] The storage unit 302 stores various kinds of information necessary for the processing to be performed by the control device 30. For example, a data table TBL1 showing the variation amount of the water temperature to be varied in all of the first heat pump device 20a1, the second heat pump device 20a2, ..., and the n-th heat pump device 20an is stored in the storage unit 302 in advance. The variation amount of the water temperature to be varied in all of the first heat pump device 20a1, the second heat pump device 20a2, ..., and the n-th heat pump device 20an is, for example, the variation amount ΔT of the water temperature to be cooled in the facility 10.

[0042] The communication control unit 303 controls communication which is performed by the control device 30 through the communication unit 301. Even in a case where the fact that the communication control unit 303 controls the communication which is performed through the communication unit 301 of the control device 30 is not specifically described in the following description, the communication control unit 303 controls the communication which is performed by the control device 30 through the communication unit 301.

[0043] The temperature variation control unit 304 determines the target outlet water temperature in each of the first heat pump device 20a1, the second heat pump device 20a2, ..., and the (n-1)-th heat pump device 20a(n-1) on the basis of the variation amount ΔT of the water temperature in the facility 10, the equipment capacity of each of the heat pump devices 20, the input water temperature of the first heat pump device 20a1 disposed furthest upstream, and the target outlet water temperature of the n-th heat pump device 20an disposed furthest downstream. The temperature variation control unit 304 generate a control command for each of the first heat pump device 20a1, the second heat pump device 20a2, ..., and the (n-1)-th heat pump device 20a(n-1) on the basis of the variation amount ΔT of the water temperature in the facility 10, the equipment capacity of each of the heat pump devices 20, the variation amount ΔT of the water temperature in the facility 10, and each of the target outlet water temperature, the actually measured value of the inlet water temperature, and the actually measured value of the outlet water temperature in each of the first heat pump device 20a1, the second heat pump device 20a2, ..., and the (n-1)-th heat pump device 20a(n-1). The control device 30 transmits the generated control command to the corresponding heat pump device 20 and controls the heat pump device 20. The temperature variation control unit 304 generates a control command for varying the temperature of water on the basis of the variation amount ΔT of the water temperature in the facility 10, the equipment capacity of each of the heat pump devices 20, the variation amount ΔT of the water temperature in the facility 10, and each of the target outlet water temperature, the actually measured value of the inlet water temperature, and the actually measured value of the outlet water temperature in each of the first heat pump device 20a1, the second heat pump device 20a2, ..., and the (n-1)-th heat pump device 20a(n-1) and performs control. Specifically, temperature variation control unit 304 generates a control command for varying the temperature of the water by the allocation of the variation amount which is set to each of the heat pump devices 20 by the variation amount allocation setting unit 307, and controls each of the heat pump devices 20.

[0044] The variation amount allocation determining unit 305 determines the allocation of the variation amounts of the heat pump devices 20 other than the n-th heat pump device 20an such that the variation amount allocated to the n-th heat pump device 20an is smaller than the variation amount allocated at the normal time, with respect to the allocation of the variation amounts of the n-th heat pump device 20an disposed furthest downstream in the water circulation path, among the heat pump devices 20, and each of the heat pump devices 20 other than the n-th heat pump device 20an.

[0045] For example, the variation amount allocation determining unit 305 equally divides the variation amount read from the storage unit 302 by the variation amount reading unit 306 by the number n of the heat pump devices 20, at the normal time, and determines the allocation of the variation amounts of the heat pump devices 20 other than the n-th heat pump device 20an such that the variation amount allocated to the n-th heat pump device 20an is smaller than the variation amount allocated at the normal time, at a predetermined timing.

[0046] Specifically, for example, in a case where the target temperature of water at the output of the n-th heat pump device 20an exceeds a first set temperature and each of the heat pump devices 20 heats the water and outputs the increased pressure, the variation amount allocation determining unit 305 determines the allocation of the variation amounts of the heat pump devices 20 other than the n-th heat pump device 20an such that the variation amount allocated to the n-th heat pump device 20an is smaller than the variation amount allocated at the normal time, at the predetermined timing. Further, for example, in a case where the target temperature of water at the output of the n-th heat pump device 20an exceeds the first set temperature and each of the heat pump devices 20 heats the water and outputs the increased pressure, the variation amount allocation determining unit 305 may determine the allocation of the variation amounts of the heat pump devices 20 other than the n-th heat pump device 20an such that the variation amount allocated to the n-th heat pump device 20an is smaller than the variation amount allocated at the normal time, at a timing when the actually measured value of the temperature of water at the output of the n-th heat pump device 20an exceeds a second set temperature.

[0047] The variation amount reading unit 306 reads the variation amount for varying the temperature of water in all of the first heat pump device 20a1, the second heat pump device 20a2, ..., and the n-th heat pump device

20an, from the storage unit 302. For example, the variation amount reading unit 306 reads the data table TBL1 from the storage unit 302.

[0048] The variation amount allocation setting unit 307 sets the allocation of the variation amounts to be allocated to the n-th heat pump device 20an and the heat pump devices 20 other than the n-th heat pump device 20an on the basis of the allocation of the variation amount determined by the variation amount allocation determining unit 305.

[0049] Next, the data table TBL1 which is stored in the storage unit 302 according to this embodiment will be described.

[0050] The data table TBL1 shows the variation amount ΔT for varying the temperature of water in all of the first heat pump device 20a1, the second heat pump device 20a2, ..., and the n-th heat pump device 20an. For example, the data table TBL1 shows the correspondence relationship between the respective facilities (the facility 10, a facility 300, ...) and the variation amount ΔT of the temperature of water in each facility, as shown in Fig. 4.

[0051] Next, the processing in the heat pump system 1 according to this embodiment will be described.

[0052] Here, a processing flow of Fig. 5 showing the processing of the control device 30 which heats water by controlling each of the heat pump devices 20 in a case where in the heat pump system 1 according to this embodiment, the facility 10 cools water and the temperature of the water is lowered by ΔT will be described. It is known in advance that the facility 10 cools water which is input from the n-th heat pump device 20an through the water piping 40 and lowers the temperature of the water by ΔT, and the storage unit 302 stores the variation amount ΔT in the data table TBL1. Here, the variation amount ΔT recorded in the data table TBL1 of the storage unit 302 by the facility 10 is the variation amount for varying the temperature of water in all of the first heat pump device 20a1, the second heat pump device 20a2, ..., and the n-th heat pump device 20an.

[0053] The variation amount reading unit 306 reads the variation amount ΔT corresponding to the facility 10 from the data table TBL1 of the storage unit 302 (step S1). For example, in the case of the data table TBL1 shown in Fig. 4, the variation amount reading unit 306 searches the facility 10 in order from the top of the facilities in the data table TBL1 to specify it and specifies and reads a variation amount $\Delta T1$ corresponding to the specified facility 10 as the variation amount ΔT of the facility 10.

[0054] The variation amount reading unit 306 outputs the read variation amount ΔT to the variation amount allocation determining unit 305.

[0055] If the variation amount ΔT is input from the variation amount reading unit 306, the variation amount allocation determining unit 305 determines the allocation of the variation amount of each of the heat pump devices 20 at the normal time on the basis of the input variation amount ΔT, the equipment capacity of each of the first heat pump device 20a1, the second heat pump device 20a2, ..., and the n-th heat pump device 20an, the input water temperature of the first heat pump device 20a1 disposed furthest upstream, and the target outlet water temperature of the n-th heat pump device 20an disposed furthest downstream (step S2). For example, the variation amount allocation determining unit 305 determines, at the normal time, allocation $\Delta T \div n$ of the variation amount obtained by equally dividing the variation amount ΔT by the number n of the heat pump devices 20 as the allocation of the variation amount of each of the heat pump devices 20.

[0056] The variation amount allocation determining unit 305 outputs the allocation of the variation amount of each of the heat pump devices 20 determined at the normal time to the variation amount allocation setting unit 307.

[0057] If the allocation of the variation amount of each of the heat pump devices 20 at the normal time is input from the variation amount allocation determining unit 305, the variation amount allocation setting unit 307 sets the input allocation of the variation amount of each of the heat pump devices 20 to each of the heat pump devices 20 (step S3). For example, in a case where the variation amount allocation determining unit 305 determines the allocation of the variation amount of each of the heat pump devices 20 to be $\Delta T \div n$, the variation amount allocation setting unit 307 sets the allocation of the variation amount of each of the heat pump devices 20 at the normal time to be $\Delta T \div n$.

[0058] If the variation amount allocation setting unit 307 sets the allocation of the variation amount of each of the heat pump devices 20 at the normal time, the temperature variation control unit 304 generates a control command for varying the temperature of water, on the basis of the variation amount ΔT of the water temperature in the facility 10, the equipment capacity of each of the heat pump devices 20, the variation amount ΔT of the water temperature in the facility 10, and each of the target outlet water temperature, the actually measured value of the inlet water temperature, and the actually measured value of the outlet water temperature in each of the first heat pump device 20a1, the second heat pump device 20a2, ..., and the (n-1)-th heat pump device 20a(n-1), and controls each of the heat pump devices 20 (step S4).

[0059] If the temperature variation control unit 304 generates a control command for varying the temperature of water and controls each of the heat pump devices 20 at the normal time, each of the heat pump devices 20 outputs water heated and having increased pressure to the heat pump device 20 on the downstream side in the water circulation path or the facility 10.

[0060] The variation amount allocation determining unit 305 determines whether or not the predetermined timing has been reached when each of the heat pump devices 20 heats water and outputs the increased pressure at the normal time (step S5). Specifically, for example, the variation amount allocation determining unit 305

determines whether or not a timing at which the target temperature of water at the output of the n-th heat pump device 20an exceeds the first set temperature and the actually measured value of the temperature of water at the output of the n-th heat pump device 20an exceeds the second set temperature has been reached. More specifically, for example, the variation amount allocation determining unit 305 determines whether or not a timing at which the target temperature of water at the output of the n-th heat pump device 20an exceeds the first set temperature, 55 degrees, (for example, the target temperature of water is 60 degrees) and the actually measured value of the temperature of water at the output of the n-th heat pump device 20an exceeds the second set temperature, 50 degrees, has been reached.

[0061] At the normal time, in a case where it is determined that the predetermined timing has not been reached (NO in step S5), the variation amount allocation determining unit 305 returns to the processing of step S5.

[0062] Further, at the normal time, in a case where it is determined that the predetermined timing has been reached when each of the heat pump devices 20 heats water and outputs the increased pressure (YES in step S5), at the determination timing (the predetermined timing), the variation amount allocation determining unit 305 determines the allocation of the variation amounts of the heat pump devices 20 other than the n-th heat pump device 20an such that the variation amount allocated to the n-th heat pump device 20an is smaller than the variation amount allocated at the normal time (step S6). For example, in a case where the variation amount allocation determining unit 305 has determined the allocation of the variation amount of each of the heat pump devices 20 at the normal time to be $\Delta T \div n$, at the predetermined timing, the variation amount allocation determining unit 305 determines the allocation of the variation amount of the n-th heat pump device 20an to be lower than $\Delta T \div n$ and performs a determination such that the allocation of the variation amounts of one or more heat pump devices 20 other than the n-th heat pump device 20an is increased by an amount corresponding to the decrease in the allocation of the variation amount of the n-th heat pump device 20an. More specifically, the variation amount allocation determining unit 305 determines the allocation of the variation amount which is lower than the allocation of the variation amount of the n-th heat pump device 20an at the normal time and can be easily realized per unit time even in the high-temperature and high-pressure state in the n-th heat pump device 20an.

[0063] The variation amount allocation determining unit 305 outputs the determined allocation of the variation amount of each of the heat pump device 20 to the variation amount allocation setting unit 307.

[0064] If the allocation of the variation amount of each of the heat pump devices 20 determined at the predetermined timing is input from the variation amount allocation determining unit 305, the variation amount allocation setting unit 307 sets the input allocation of the variation amount of each of the heat pump devices 20 to each of the heat pump devices 20 (step S7).

[0065] If the variation amount allocation setting unit 307 sets the allocation of the variation amount of each of the heat pump devices 20 determined at the predetermined timing, the temperature variation control unit 304 generates a control command for varying the temperature of water, on the basis of the variation amount ΔT of the water temperature in the facility 10, the equipment capacity of each of the heat pump devices 20, the variation amount ΔT of the water temperature in the facility 10, and each of the target outlet water temperature, the actually measured value of the inlet water temperature, and the actually measured value of the outlet water temperature in each of the first heat pump device 20a1, the second heat pump device 20a2, ..., and the (n-1)-th heat pump device 20a(n-1), and controls each of the heat pump devices 20 (step S8).

[0066] The number n of the heat pump devices 20 may be any number as long as it is two or more.

[0067] The processing of the control device 30 according to the first embodiment of the present invention has been described above. According to the processing of the control device 30 of this embodiment, the temperature variation control unit 304 generates a control command for varying the temperature of water, on the basis of the variation amount ΔT of the water temperature in the facility 10, the equipment capacity of each of the heat pump devices 20, the variation amount ΔT of the water temperature in the facility 10, and each of the target outlet water temperature, the actually measured value of the inlet water temperature, and the actually measured value of the outlet water temperature in each of the first heat pump device 20a1, the second heat pump device 20a2, ..., and the (n-1)-th heat pump device 20a(n-1), and controls each of the heat pump devices 20. The variation amount allocation determining unit 305 determines the allocation of the variation amount of the heat pump devices 20 other than the n-th heat pump device 20an such that the variation amount allocated to the n-th heat pump device 20an is smaller than the variation amount allocated at the normal time, with respect to the allocation of the variation amounts of the n-th heat pump device 20an disposed furthest downstream in the water circulation path, among the heat pump devices 20, and each of the heat pump devices 20 other than the n-th heat pump device 20an.

[0068] In this way, it is possible to use inexpensive parts in the heat exchanger of the heat pump device located furthest downstream, among the plurality of heat pump devices connected in series in the heat pump system, and it is possible to perform downsizing of the heat pump system and a reduction in the manufacturing cost of the heat pump system.

<Second Embodiment>

[0069] The configuration of a heat pump system which

is provided with a control device according to a second embodiment of the present invention will be described.

[0070] The heat pump system 1 according to this embodiment is provided with the facility 10, the first heat pump device 20a1, the second heat pump device 20a2, ..., the (n-1)-th heat pump device 20a(n-1), the n-th heat pump device 20an, the control device 30, and the water piping 40, as shown in Fig. 6, similar to the heat pump system 1 according to the first embodiment.

[0071] However, the facility 10 in this embodiment is provided with a temperature sensor 101, a temperature sensor 102, a temperature difference calculation unit 103, and a temperature difference transmitter 104, in addition to the facility 10 in the first embodiment.

[0072] The temperature sensor 101 is installed at an input portion of the water piping 40 from the n-th heat pump device 20an and detects the temperature of the water in the water piping 40.

[0073] The temperature sensor 102 is installed at an output portion of the water piping 40 to the first heat pump device 20a1 and detects the temperature of the water in the water piping 40.

[0074] The temperature difference calculation unit 103 calculates the decrease temperature ΔT of the water in the facility 10 by subtracting the temperature of the water detected by the temperature sensor 102 from the temperature detected by the temperature sensor 101.

[0075] The temperature difference transmitter 104 transmits the decrease temperature ΔT of the water in the facility 10 calculated by the temperature difference calculation unit 103 to the control device 30.

[0076] Each of the communication unit 301, the communication control unit 303, the temperature variation control unit 304, the variation amount allocation determining unit 305, the variation amount reading unit 306, and the variation amount allocation setting unit 307 provided in the control device 30 performs processing in real time by using the decrease temperature ΔT of the water in the facility 10, which is transmitted in real time by the temperature difference transmitter 104 through the communication unit 301, instead of the water temperature ΔT lowered by the facility 10, shown in the data table TBL1 stored in the storage unit 302. Others are the same as those in the control device 30 according to the first embodiment, and the processing flow of the control device 30 according to this embodiment is also the same as the processing flow of the control device 30 according to the first embodiment.

[0077] The processing of the control device 30 according to the second embodiment of the present invention has been described above. According to the processing of the control device 30 of this embodiment, the temperature variation control unit 304 generates a control command for varying the temperature of water, on the basis of the variation amount ΔT of the water temperature in the facility 10, the equipment capacity of each of the heat pump devices 20, the variation amount ΔT of the water temperature in the facility 10, and each of the target outlet water temperature, the actually measured value of the inlet water temperature, and the actually measured value of the outlet water temperature in each of the first heat pump device 20a1, the second heat pump device 20a2, ..., and the (n-1)-th heat pump device 20a(n-1), and controls each of the heat pump devices 20. The variation amount allocation determining unit 305 determines the allocation of the variation amount of the heat pump devices 20 other than the n-th heat pump device 20an such that the variation amount allocated to the n-th heat pump device 20an is smaller than the variation amount allocated at the normal time, with respect to the allocation of the variation amounts of the n-th heat pump device 20an disposed furthest downstream in the water circulation path, among the heat pump devices 20, and each of the heat pump devices 20 other than the n-th heat pump device 20an.

[0078] In this way, it is possible to use inexpensive parts in the heat exchanger of the heat pump device located furthest downstream, among the plurality of heat pump devices connected in series in the heat pump system, and it is possible to perform downsizing of the heat pump system and a reduction in the manufacturing cost of the heat pump system.

[0079] Further, the temperature sensor 101 is installed at the input portion of the water piping 40 from the n-th heat pump device 20an and detects the temperature of the water in the water piping 40. The temperature sensor 102 is installed at the output portion of the water piping 40 to the first heat pump device 20a1 and detects the temperature of the water in the water piping 40.

[0080] The temperature difference calculation unit 103 calculates the variation amount ΔT (the decrease temperature ΔT of the water) in the facility 10 by subtracting the temperature of the water detected by the temperature sensor 102 from the temperature detected by the temperature sensor 101. The temperature difference transmitter 104 transmits the variation amount ΔT in the facility 10 calculated by the temperature difference calculation unit 103 to the control device 30. Each of the communication unit 301, the communication control unit 303, the temperature variation control unit 304, the variation amount allocation determining unit 305, the variation amount reading unit 306, and the variation amount allocation setting unit 307 provided in the control device 30 performs processing in real time by using the variation amount ΔT in the facility 10, which is transmitted in real time by the temperature difference transmitter 104 through the communication unit 301, instead of the variation amount ΔT in the facility 10, shown in the data table TBL1 stored in the storage unit 302.

[0081] In this way, it is possible to more accurately determine the allocation of the variation amount.

<Third Embodiment>

[0082] The configuration of a heat pump system which is provided with a control device according to a third em-

bodiment of the present invention will be described.

[0083] The heat pump system 1 according to this embodiment is provided with the facility 10, the first heat pump device 20a1, the second heat pump device 20a2, ..., the (n-1)-th heat pump device 20a(n-1), the n-th heat pump device 20an, the control device 30, and the water piping 40, as shown in Fig. 1, similar to the heat pump system 1 according to the first embodiment.

[0084] However, the control device 30 according to this embodiment is provided with an outside air temperature measuring unit 308 in addition to the control device 30 according to the first embodiment, as shown in Fig. 7.

[0085] The outside air temperature measuring unit 308 detects the outside air temperature of the heat pump device 20 provided with the outside air temperature measuring unit 308.

[0086] The variation amount allocation determining unit 305 provided in the control device 30 acquires the outside air temperature detected by the outside air temperature measuring unit 308 provided in each of the heat pump devices 20. Then, the variation amount allocation determining unit 305 corrects the influence of the acquired outside air temperature on a temperature change of the water in each of the heat pump devices 20 and determines the allocation of the variation amount of each of the heat pump devices 20. Others are the same as those in the control device 30 according to the first embodiment, and the processing flow of the control device 30 according to this embodiment is also the same as the processing flow of the control device 30 according to the first embodiment.

[0087] The processing of the control device 30 according to the third embodiment of the present invention has been described above. According to the processing of the control device 30 of this embodiment, the temperature variation control unit 304 generates a control command for varying the temperature of water on the basis of the variation amount ΔT of the water temperature in the facility 10, the equipment capacity of each of the heat pump devices 20, the variation amount ΔT of the water temperature in the facility 10, and each of the target outlet water temperature, the actually measured value of the inlet water temperature, and the actually measured value of the outlet water temperature in each of the first heat pump device 20a1, the second heat pump device 20a2, ..., and the (n-1)-th heat pump device 20a(n-1), and controls each of the heat pump devices 20. The variation amount allocation determining unit 305 determines the allocation of the variation amount of the heat pump devices 20 other than the n-th heat pump device 20an such that the variation amount allocated to the n-th heat pump device 20an is smaller than the variation amount allocated at the normal time, with respect to the allocation of the variation amounts of the n-th heat pump device 20an disposed furthest downstream in the water circulation path, among the heat pump devices 20, and each of the heat pump devices 20 other than the n-th heat pump device 20an.

[0088] In this way, it is possible to use inexpensive parts in the heat exchanger of the heat pump device located furthest downstream, among the plurality of heat pump devices connected in series in the heat pump system, and it is possible to perform downsizing of the heat pump system and a reduction in the manufacturing cost of the heat pump system.

[0089] Further, the control device 30 is provided with the outside air temperature measuring unit 308 in addition to the control device 30 according to the first embodiment. The outside air temperature measuring unit 308 detects the outside air temperature of the heat pump device 20 provided with the outside air temperature measuring unit 308. The variation amount allocation determining unit 305 provided in the control device 30 acquires the outside air temperature detected by the outside air temperature measuring unit 308 provided in each of the heat pump devices 20. Then, the variation amount allocation determining unit 305 corrects the influence of the acquired outside air temperature on a temperature change of the water in each of the heat pump devices 20 and determines the allocation of the variation amount of each of the heat pump devices 20.

[0090] In this way, it is possible to more accurately determine the allocation of the variation amount.

[0091] The storage unit 302 in the embodiments of the present invention may be provided anywhere within a range where appropriate transmission and reception of information are performed. Further, a plurality of storage units 302 may be present in a range where appropriate transmission and reception of information are performed, and store data in a dispersed manner.

[0092] In the processing flows in the embodiments of the present invention, the order of processing may be changed within a range where appropriate processing is performed.

[0093] The embodiments of the present invention have been described. However, each of the speed control units 104 and 104a, the automatic train operation devices 102, 102a, and 102b, and the ATP device 20 described above has a computer system inside thereof. Further, the process of the processing described above is stored in a computer readable recording medium in the form of a program, and a computer reads and executes the program, whereby the above processing is performed. Here, the computer readable recording medium refers to a magnetic disk, a magnetooptical disc, a CD-ROM, a DVD-ROM, a semiconductor memory, or the like. Further, a configuration may be made such that the computer program is delivered to a computer through a communication line and the computer which has received the delivery executes the program.

[0094] Further, the computer program may be a so-called differential file (differential program) which is a file capable of realizing the above-described functions by a combination with a program already recorded in a computer system.

[0095] Several embodiments of the present invention

have been described. However, these embodiments are examples and do not limit the scope of the invention. In these embodiments, various omissions, substitutions, or changes may be made within a scope of the claims.

Industrial Applicability

[0096] According to the control device, the control method and the computer program described above, it is possible to use inexpensive parts in the heat exchanger of the heat pump device located furthest downstream, among the plurality of heat pump devices connected in series in the heat pump system, and it is possible to perform downsizing of the heat pump system and a reduction in the manufacturing cost of the heat pump system.

Reference Signs List

[0097]

1: heat pump system
10: facility
20: heat pump device
20a1: first heat pump device
20a2: second heat pump device
20a(n-1): (n-1)-th heat pump device
20an: n-th heat pump device
30: control device
40: water piping
102, 208: temperature sensor
103: temperature difference calculation unit
104: temperature difference transmitter
201: compressor
202: four-way valve
203: water heat exchanger
204: expansion valve
205: air heat exchanger
206: accumulator
207: refrigerant pipe
301: communication unit
302: storage unit
303: communication control unit
304: temperature variation control unit
305: variation amount allocation determining unit
306: variation amount reading unit
307: variation amount allocation setting unit
308: outside air temperature measuring unit

Claims

1. A control device (30) for controlling a plurality of heat pump devices (20a1, 20a2, ..., 20a(n-1), 20an) which are disposed in order in a circulation path to vary a temperature of circulating water, and which include a most downstream heat pump device (20an) disposed furthest downstream in the circulation path, the control device (30) comprising:

a temperature variation control unit (304) for performing control for varying the temperature of the water, on the basis of a variation amount of a water temperature in a facility (10), equipment capacity of each of the heat pump devices, a target outlet water temperature in each of the heat pump devices, an actually measured value of an inlet water temperature of each of the heat pump devices, and an actually measured value of an outlet water temperature of each of the heat pump devices;

a variation amount reading unit (306) for reading the variation amount which varies the temperature of the water in all of the plurality of heat pump devices (20a1, 20a2, ..., 20a(n-1), 20an) from a storage unit (302);

a variation amount allocation determining unit (305) for equally dividing the variation amount read from the storage unit (302) by the variation amount reading unit by the number of the plurality of heat pump devices, at the normal time, and determines a variation amount of water temperature to be allocated to the plurality of heat pump devices (20a1, 20a2, ..., 20a(n-1)) other than the most downstream heat pump device (20an) such that the variation amount to be allocated to the most downstream heat pump device (20an) is smaller than the variation amount at the normal time, at a predetermined timing; and

characterized in that the variation amount allocation determining unit is configured to determine the variation amount to be allocated to the plurality of heat pump devices (20a1, 20a2, ..., 20a(n-1)) other than the most downstream heat pump device (20an) such that the variation amount to be allocated to the most downstream heat pump device (20an) at a predetermined timing is smaller than the variation amount at the normal time when the variation amount allocation determining unit determines that a target temperature of the water at output of the most downstream heat pump device exceeds a first set temperature.

2. The control device (30) according to claim 1, wherein the variation amount allocation determining unit (305) is configured to determine the variation amount to be allocated to the plurality of heat pump devices (20a1, 20a2, ..., 20a(n-1)) other than the most downstream heat pump device (20an) such that the variation amount to be allocated to the most downstream heat pump device (20an) at a timing when the temperature of the water at the output of the most downstream heat pump device exceeds a second set temperature is smaller than the variation amount at the normal time, in a case where the target temperature of the water at the output of the most downstream

heat pump device exceeds the first set temperature.

3. The control device according to claims 1 or 2, further comprising:
a variation amount allocation setting unit (307) for setting the allocated variation amounts which are allocated to the most downstream heat pump device (20an) and the plurality of heat pump devices(20a1, 20a2, ..., 20a(n-1)) other than the most downstream heat pump device, on the basis of the allocated variation amount determined by the variation amount allocation determining unit (305).

4. A control method of a control device (30) that controls a plurality of heat pump devices (20a1, 20a2, ..., 20a(n-1), 20an) which are disposed in order in a circulation path to vary a temperature of circulating water, and which include a most downstream heat pump device (20an) disposed furthest downstream in the circulation path, the control method comprising the steps of:

performing control for varying the temperature of the water, on the basis of a variation amount of a water temperature in a facility (10), equipment capacity of each of the heat pump devices, a target outlet water temperature in each of the heat pump devices, an actually measured value of an inlet water temperature of each of the heat pump devices, and an actually measured value of an outlet water temperature of each of the heat pump devices;
characterized in that the control method comprises the steps of:

reading, from a storage unit (302), the variation amount by which the temperature of the water in the plurality of heat pump devices is varied;
equally dividing the variation amount by the number of the plurality of heat pump devices, at the normal time;
determining the variation amount to be allocated to the plurality of heat pump devices (20a1, 20a2, ..., 20a(n-1)) other than the most downstream heat pump device (20an) such that the variation amount to be allocated to the most downstream heat pump device (20an) is smaller than the variation amount at the normal time, at a predetermined timing; and
determining the variation amount of water temperature to be allocated to the plurality of heat pump devices (20a1, 20a2, ..., 20a(n-1)) other than the most downstream heat pump device (20an) such that the variation amount to be allocated to the most downstream heat pump device (20an) at a predetermined timing is smaller than the variation amount at the normal time when it is determined that a target temperature of the water at output of the most downstream heat pump device exceeds a first set temperature.

5. A computer program that causes a computer of a control device (30) that controls a plurality of heat pump devices (20a1, 20a2, ..., 20a(n-1), 20an) which are disposed in order in a circulation path to vary a temperature of circulating water, and which include a most downstream heat pump device (20an) disposed furthest downstream in the circulation path, to execute control for:

varying the temperature of the water, on the basis of a variation amount of a water temperature in a facility (10), equipment capacity of each of the heat pump devices, a target outlet water temperature in each of the heat pump devices, an actually measured value of an inlet water temperature of each of the heat pump devices, and an actually measured value of an outlet water temperature of each of the heat pump devices;
characterized in that it causes said computer to execute control for:

reading, from a storage unit (302), the variation amount by which the temperature of the water in the plurality of heat pump devices is varied;
equally dividing the variation amount by the number of the plurality of heat pump devices, at the normal time;
determining the variation amount to be allocated to the plurality of heat pump devices (20a1, 20a2, ..., 20a(n-1)) other than the most downstream heat pump device (20an) such that the variation amount to be allocated to the most downstream heat pump device (20an) is smaller than the variation amount at the normal time, at a predetermined timing; and
determining the variation amount of water temperature to be allocated to the plurality of heat pump devices (20a1, 20a2, ..., 20a(n-1)) other than the most downstream heat pump device (20an) such that the variation amount to be allocated to the most downstream heat pump device (20an) at a predetermined timing is smaller than the variation amount at the normal time when it is determined that a target temperature of the water at output of the most downstream heat pump device exceeds a first set temperature.

Patentansprüche

1. Steuervorrichtung (30) zum Steuern mehrerer Wärmepumpenvorrichtungen (20a1, 20a2, ..., 20a(n-1), 20an), die der Reihe nach in einem Umlaufpfad angeordnet sind, um eine Temperatur von umlaufendem Wasser zu ändern, und die eine am weitesten stromabwärtige Wärmepumpenvorrichtung (20an) umfasst, die am weitesten stromabwärts im Umlaufpfad angeordnet ist, wobei die Steuervorrichtung (30) Folgendes umfasst:

   eine Temperaturänderungs-Steuereinheit (304) zum Durchführen einer Steuerung zum Ändern der Temperatur des Wassers auf Basis einer Änderungsmenge einer Wassertemperatur in einer Anlage (10), einer Ausrüstungskapazität von jeder der Wärmepumpenvorrichtungen, einer Auslasswasser-Solltemperatur in jeder der Wärmepumpenvorrichtungen, eines tatsächlich gemessenen Werts einer Einlasswassertemperatur von jeder der Wärmepumpenvorrichtungen und einen tatsächlich gemessenen Werts einer Auslasswassertemperatur von jeder der Wärmepumpenvorrichtungen;
   eine Änderungsmengen-Erfassungseinheit (306), zum Erfassen der Änderungsmenge, die die Temperatur des Wassers in allen der mehreren Wärmepumpenvorrichtungen (20a1, 20a2, ..., 20a(n-1), 20an) aus einer Speichereinheit (302) erfasst;
   eine Änderungsmengen-Zuweisungsbestimmungseinheit (305) zum gleichmäßigen Teilen der von der Änderungsmengen-Erfassungseinheit aus der Speichereinheit (302) erfassten Änderungsmenge durch die Anzahl der mehreren Wärmepumpenvorrichtungen zur normalen Zeit, und zum Bestimmen einer Änderungsmenge der Wassertemperatur, die, außer der am weitesten stromabwärtigen Wärmepumpenvorrichtung (20an), den mehreren Wärmepumpenvorrichtungen (20a1, 20a2, ..., 20a(n-1)) zuzuweisen ist, so dass die der am weitesten stromabwärtigen Wärmepumpenvorrichtung (20an) zuzuweisende Änderungsmenge zu einem im Voraus bestimmten Zeitpunkt kleiner ist als die Änderungsmenge zur normalen Zeit; und
   dadurch gekennzeichnet, dass die Änderungsmengen-Zuweisungsbestimmungseinheit konfiguriert ist für Bestimmen der den mehreren Wärmepumpenvorrichtungen (20a1, 20a2, ..., 20a(n-1)), außer der am weitesten stromabwärtigen Wärmepumpenvorrichtung (20an), zuzuweisenden Änderungsmenge, so dass die der am weitesten stromabwärtigen Wärmepumpenvorrichtung (20an) zuzuweisende Änderungsmenge zu einem im Voraus bestimmten Zeitpunkt kleiner ist als die Änderungsmenge zur normalen Zeit, wenn die Änderungsmengen-Zuweisungsbestimmungseinheit bestimmt, dass eine Solltemperatur des Wassers am Auslass der am weitesten stromabwärtigen Wärmepumpenvorrichtung eine erste eingestellte Temperatur übersteigt.

2. Steuervorrichtung (30) nach Anspruch 1, wobei die die Änderungsmengen-Zuweisungsbestimmungseinheit (305) konfiguriert ist für Bestimmen der den mehreren Wärmepumpenvorrichtungen (20a1, 20a2, ..., 20a(n-1)), außer der am weitesten stromabwärtigen Wärmepumpenvorrichtung (20an), zuzuweisenden Änderungsmenge, so dass die der am weitesten stromabwärtigen Wärmepumpenvorrichtung (20an) zuzuweisende Änderungsmenge zu einem Zeitpunkt, wenn die Temperatur des Wassers am Auslass der am weitesten stromabwärtigen Wärmepumpenvorrichtung eine zweite eingestellte Temperatur übersteigt, niedriger ist als die Änderungsmenge zur normalen Zeit in einem Fall, wenn die Solltemperatur des Wassers am Auslass der am weitesten stromabwärtigen Wärmepumpenvorrichtung die erste eingestellte Temperatur übersteigt.

3. Steuervorrichtung nach Anspruch 1 oder 2, ferner aufweisend:
   eine Änderungsmengen-Zuweisungseinstelleinheit (307) zum Einstellen der der am weitesten stromabwärtigen Wärmepumpenvorrichtung (20an) und den mehreren der mehreren Wärmepumpenvorrichtungen (20a1, 20a2, ..., 20a(n-1)), außer der am weitesten stromabwärtigen Wärmepumpenvorrichtung, zugewiesenen Änderungsmengen auf Basis der zugewiesenen Änderungsmenge, die von der Änderungsmengen-Zuweisungsbestimmungseinheit (305) bestimmt worden ist.

4. Steuerverfahren einer Steuervorrichtung (30), die mehrere Wärmepumpenvorrichtungen (20a1, 20a2, ..., 20a(n-1), 20an) steuert, die der Reihe nach in einem Umlaufpfad angeordnet sind, um eine Temperatur des umlaufenden Wassers zu ändern, und die eine am weitesten stromabwärtige Wärmepumpenvorrichtung (20an) umfasst, die am weitesten stromabwärts im Umlaufpfad angeordnet ist, wobei das Steuerverfahren die folgenden Schritte umfasst:

   Durchführen einer Steuerung zum Ändern der Temperatur des Wassers auf Basis einer Änderungsmenge einer Wassertemperatur in einer Anlage (10), einer Ausrüstungskapazität von jeder der Wärmepumpenvorrichtungen, einer Auslasswasser-Solltemperatur in jeder der Wärmepumpenvorrichtungen, eines tatsächlich gemessenen Werts einer Einlasswassertemperatur von jeder der Wärmepumpenvorrichtungen und einen tatsächlich gemessenen Werts

einer Auslasswassertemperatur von jeder der Wärmepumpenvorrichtungen;
dadurch gekennzeichnet, dass das Steuerverfahren die folgenden Schritte umfasst:

Erfassen, aus einer Speichereinheit (302), der Änderungsmenge, um die die Temperatur des Wassers in allen der mehreren Wärmepumpenvorrichtungen geändert wird;
gleichmäßiges Teilen der Änderungsmenge durch die Anzahl der mehreren Wärmepumpenvorrichtungen zur normalen Zeit;
Bestimmen der den mehreren Wärmepumpenvorrichtungen (20a1, 20a2, ..., 20a(n-1)), außer der am weitesten stromabwärtigen Wärmepumpenvorrichtung (20an), zuzuweisenden Änderungsmenge, so dass die der am weitesten stromabwärtigen Wärmepumpenvorrichtung (20an) zuzuweisende Änderungsmenge zu einem im Voraus bestimmten Zeitpunkt kleiner ist als die Änderungsmenge zur normalen Zeit; und
Bestimmen der Änderungsmenge der Wassertemperatur, die, außer der am weitesten stromabwärtigen Wärmepumpenvorrichtung (20an), den mehreren Wärmepumpenvorrichtungen (20a1, 20a2, ..., 20a(n-1)) zuzuweisen ist, so dass die der am weitesten stromabwärtigen Wärmepumpenvorrichtung (20an) zuzuweisende Änderungsmenge zu einem im Voraus bestimmten Zeitpunkt kleiner ist als die Änderungsmenge zur normalen Zeit, wenn bestimmt ist, dass eine Solltemperatur des Wassers am Auslass der am weitesten stromabwärtigen Wärmepumpenvorrichtung eine erste eingestellte Temperatur übersteigt.

5. Computerprogramm, das einen Computer einer Steuervorrichtung (30), die mehrere Wärmepumpenvorrichtungen (20a1, 20a2, ..., 20a(n-1), 20an) steuert, die der Reihe nach in einem Umlaufpfad angeordnet sind, um eine Temperatur des umlaufenden Wassers zu ändern, und die eine am weitesten im Umlaufpfad angeordnete stromabwärtige Wärmepumpenvorrichtung (20an) umfasst, veranlasst zum Durchführen einer Steuerung für Folgendes:

Ändern der Temperatur des Wassers auf Basis einer Änderungsmenge einer Wassertemperatur in einer Anlage (10), einer Ausrüstungskapazität von jeder der Wärmepumpenvorrichtungen, einer Auslasswasser-Solltemperatur in jeder der Wärmepumpenvorrichtungen, eines tatsächlich gemessenen Werts einer Einlasswassertemperatur von jeder der Wärmepumpenvorrichtungen und einen tatsächlich gemessenen Werts einer Auslasswassertemperatur von jeder der Wärmepumpenvorrichtungen;
dadurch gekennzeichnet, dass das Programm den Computer veranlasst zum Durchführen der Steuerung für Folgendes:

Erfassen, aus einer Speichereinheit (302), der Änderungsmenge, um die die Temperatur des Wassers in allen der mehreren Wärmepumpenvorrichtungen geändert wird;
gleichmäßiges Teilen der Änderungsmenge durch die Anzahl der mehreren Wärmepumpenvorrichtungen zur normalen Zeit;
Bestimmen der den mehreren Wärmepumpenvorrichtungen (20a1, 20a2, ..., 20a(n-1)), außer der am weitesten stromabwärtigen Wärmepumpenvorrichtung (20an), zuzuweisenden Änderungsmenge, so dass die der am weitesten stromabwärtigen Wärmepumpenvorrichtung (20an) zuzuweisende Änderungsmenge zu einem im Voraus bestimmten Zeitpunkt kleiner ist als die Änderungsmenge zur normalen Zeit; und
Bestimmen der Änderungsmenge der Wassertemperatur, die, außer der am weitesten stromabwärtigen Wärmepumpenvorrichtung (20an), den mehreren Wärmepumpenvorrichtungen (20a1, 20a2, ..., 20a(n-1)) zuzuweisen ist, so dass die der am weitesten stromabwärtigen Wärmepumpenvorrichtung (20an) zuzuweisende Änderungsmenge zu einem im Voraus bestimmten Zeitpunkt kleiner ist als die Änderungsmenge zur normalen Zeit, wenn bestimmt ist, dass eine Solltemperatur des Wassers am Auslass der am weitesten stromabwärtigen Wärmepumpenvorrichtung eine erste eingestellte Temperatur übersteigt.

Revendications

1. Dispositif de commande (30) destiné à contrôler une pluralité de pompes à chaleur (20a1, 20a2, ..., 20a(n-1), 20an) qui sont disposées dans cet ordre sur un trajet de circulation afin de faire varier une température de l'eau en circulation, et qui comprennent une pompe à chaleur la plus en aval (20an) disposée la plus en aval sur le trajet de circulation, le dispositif de commande (30) comprenant :

une unité de contrôle de variation de la température (304) destinée à exécuter une commande afin de faire varier la température de l'eau, sur la base d'une quantité de variation d'une température de l'eau dans un système (10), de la capacité d'équipement de chacune des pompes

à chaleur, d'une température d'eau de sortie cible dans chacune des pompes à chaleur, d'une valeur réellement mesurée d'une température d'eau d'entrée de chacune des pompes à chaleur, et d'une valeur réellement mesurée d'une température d'eau de sortie de chacune des pompes à chaleur ;
une unité de lecture de quantité de variation (306) destinée à lire la quantité de variation qui fait varier la température de l'eau dans l'ensemble de la pluralité de pompes à chaleur (20a1, 20a2, ..., 20a(n-1), 20an) depuis une unité de stockage (302) ;
une unité de détermination d'affectation de quantité de variation (305) destinée à diviser de manière identique la quantité de variation lue depuis l'unité de stockage (302) par l'unité de lecture de quantité de variation par le nombre de la pluralité de pompes à chaleur, en temps normal, et qui détermine une quantité de variation de la température de l'eau à affecter à la pluralité de pompes à chaleur (20a1, 20a2, ..., 20a(n-1)) autres que la pompe à chaleur la plus en aval (20an) de sorte que la quantité de variation à affecter à la pompe à chaleur la plus en aval (20an) soit inférieure à la quantité de variation en temps normal, à un moment prédéterminé ; et
caractérisé en ce que l'unité de détermination d'affectation de quantité de variation est configurée pour déterminer la quantité de variation à affecter à la pluralité de pompes à chaleur (20a1, 20a2, ..., 20a(n-1)) autres que la pompe à chaleur la plus en aval (20an) de sorte que la quantité de variation à affecter à la pompe à chaleur la plus en aval (20an) soit inférieure à la quantité de variation en temps normal lorsque l'unité de détermination d'affectation de quantité de variation détermine qu'une température cible de l'eau à la sortie de la pompe à chaleur la plus en aval dépasse une première température définie.

2. Dispositif de commande (30) selon la revendication 1, dans lequel l'unité de détermination d'affectation de quantité de variation (305) est configurée pour déterminer la quantité de variation à affecter à la pluralité de pompes à chaleur (20a1, 20a2, ..., 20a(n-1)) autres que la pompe à chaleur la plus en aval (20an) de sorte que la quantité de variation à affecter à la pompe à chaleur la plus en aval (20an) à un moment auquel la température de l'eau à la sortie de la pompe à chaleur la plus en aval dépasse une seconde température définie soit inférieure à la quantité de variation en temps normal, lorsque la température cible de l'eau à la sortie de la pompe à chaleur la plus en aval dépasse la première température définie.

3. Dispositif de commande selon la revendication 1 ou 2, comprenant en outre :
une unité de définition d'affectation de quantité de variation (307) destinée à définir les quantités de variation affectées qui sont affectées à la pompe à chaleur la plus en aval (20an) et à la pluralité de pompes à chaleur (20a1, 20a2, ..., 20a(n-1)) autres que la pompe à chaleur la plus en aval, sur la base de la quantité de variation affectée déterminée par l'unité de détermination d'affectation de quantité de variation (305).

4. Procédé de commande d'un dispositif de commande (30) qui contrôle une pluralité de pompes à chaleur (20a1, 20a2,..., 20a(n-1), 20an) qui sont disposées dans cet ordre sur un trajet de circulation afin de faire varier une température de l'eau en circulation, et qui comprennent une pompe à chaleur la plus en aval (20an) disposée le plus en aval sur le trajet de circulation, le procédé de commande comprenant les étapes suivantes :

l'exécution d'une commande afin de faire varier la température de l'eau, sur la base d'une quantité de variation d'une température de l'eau dans un système (10), de la capacité d'équipement de chacune des pompes à chaleur, d'une température d'eau de sortie cible dans chacune des pompes à chaleur, d'une valeur réellement mesurée d'une température d'eau d'entrée de chacune des pompes à chaleur, et d'une valeur réellement mesurée d'une température d'eau de sortie de chacune des pompes à chaleur ;
caractérisé en ce que le procédé de commande comprend les étapes suivantes :

la lecture, depuis une unité de stockage (302), de la quantité de variation selon laquelle la température de l'eau dans la pluralité de pompes à chaleur est variée ;
la division identique de la quantité de variation par le nombre de la pluralité de pompes à chaleur, en temps normal ;
la détermination de la quantité de variation à affecter à la pluralité de pompes à chaleur (20a1, 20a2, ..., 20a(n-1)) autres que la pompe à chaleur la plus en aval (20an) de sorte que la quantité de variation à affecter à la pompe à chaleur la plus en aval (20an) soit inférieure à la quantité de variation en temps normal, à un moment prédéterminé ; et
la détermination de la quantité de variation de la température de l'eau à affecter à la pluralité de pompes à chaleur (20a1, 20a2, ..., 20a(n-1)) autres que la pompe à chaleur la plus en aval (20an) de sorte que la quantité de variation à affecter à la pompe

à chaleur la plus en aval (20an) à un moment prédéterminé soit inférieure à la quantité de variation en temps normal lorsqu'il est déterminé qu'une température cible de l'eau à la sortie de la pompe à chaleur la plus en aval dépasse une première température définie.

5. Programme informatique qui amène un ordinateur d'un dispositif de commande (30) qui contrôle une pluralité de pompes à chaleur (20a1, 20a2, ..., 20a(n-1), 20an) qui sont disposées sans cet ordre sur un trajet de circulation à faire varier une température de l'eau en circulation, et qui comprennent une pompe à chaleur la plus en aval (20an) disposée le plus en aval sur le trajet de circulation, à exécuter une commande destinée à :

faire varier la température de l'eau, sur la base d'une quantité de variation d'une température de l'eau dans un système (10), de la capacité d'équipement de chacune des pompes à chaleur, d'une température d'eau de sortie cible dans chacune des pompes à chaleur, d'une valeur réellement mesurée d'une température d'eau d'entrée de chacune des pompes à chaleur, et d'une valeur réellement mesurée d'une température d'eau de sortie de chacune des pompes à chaleur ;
caractérisé en ce qu'il amène ledit ordinateur à exécuter une commande destinée à :

lire, depuis une unité de stockage (302), la quantité de variation selon laquelle la température de l'eau dans la pluralité de pompes à chaleur est variée ;
diviser de manière identique la quantité de variation par le nombre de la pluralité de pompes à chaleur, en temps normal ;
déterminer la quantité de variation à affecter à la pluralité de pompes à chaleur (20a1, 20a2, ..., 20a(n-1)) autres que la pompe à chaleur la plus en aval (20an) de sorte que la quantité de variation à affecter à la pompe à chaleur la plus en aval (20an) soit inférieure à la quantité de variation en temps normal, à un moment prédéterminé ; et
déterminer la quantité de variation de la température de l'eau à affecter à la pluralité de pompes à chaleur (20a1, 20a2, ..., 20a(n-1)) autres que la pompe à chaleur la plus en aval (20an) de sorte que la quantité de variation à affecter à la pompe à chaleur la plus en aval (20an) à un moment prédéterminé soit inférieure à la quantité de variation en temps normal lorsqu'il est déterminé qu'une température cible de l'eau à la sortie de la pompe à chaleur la plus en aval dépasse une première température définie.

FIG. 1

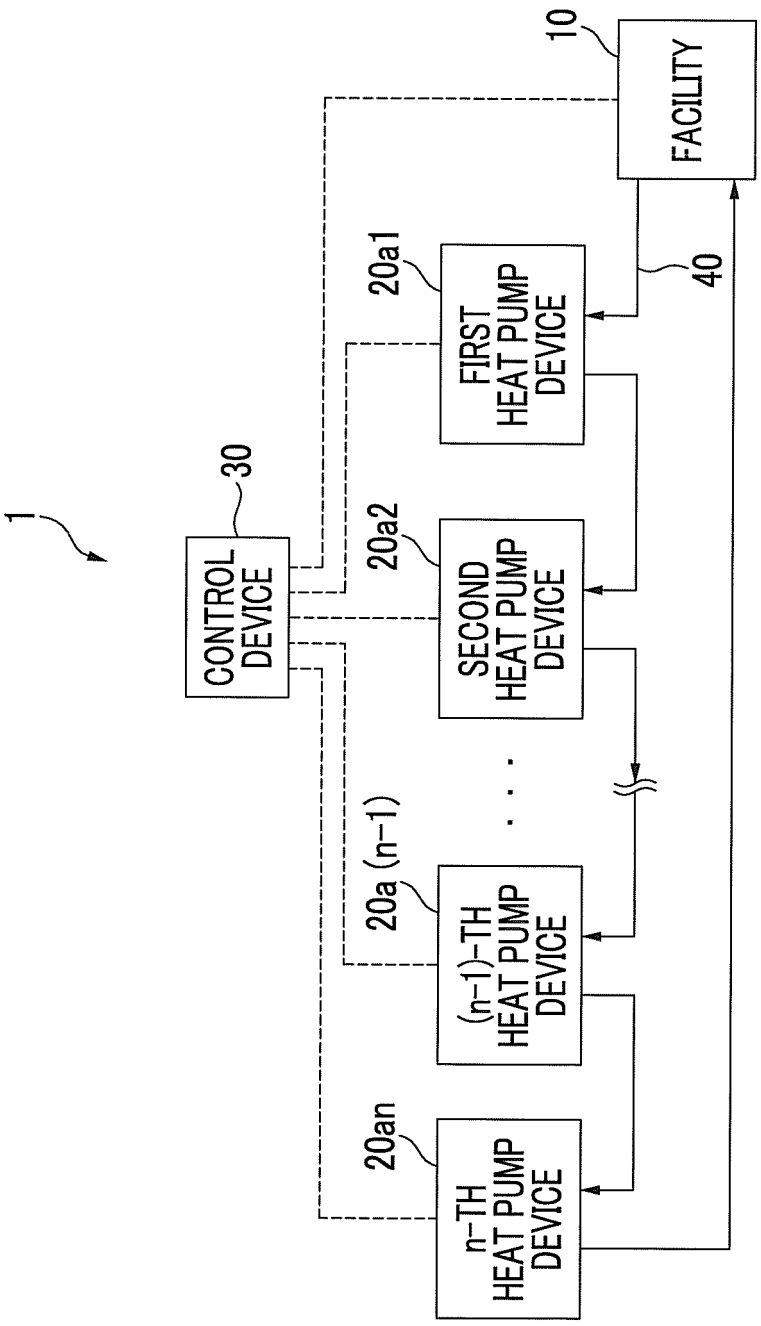

1
10
FACILITY
40
30
CONTROL DEVICE
20a1
FIRST HEAT PUMP DEVICE
20a2
SECOND HEAT PUMP DEVICE
. . .
20a (n−1)
(n−1)-TH HEAT PUMP DEVICE
20an
n-TH HEAT PUMP DEVICE

FIG. 2

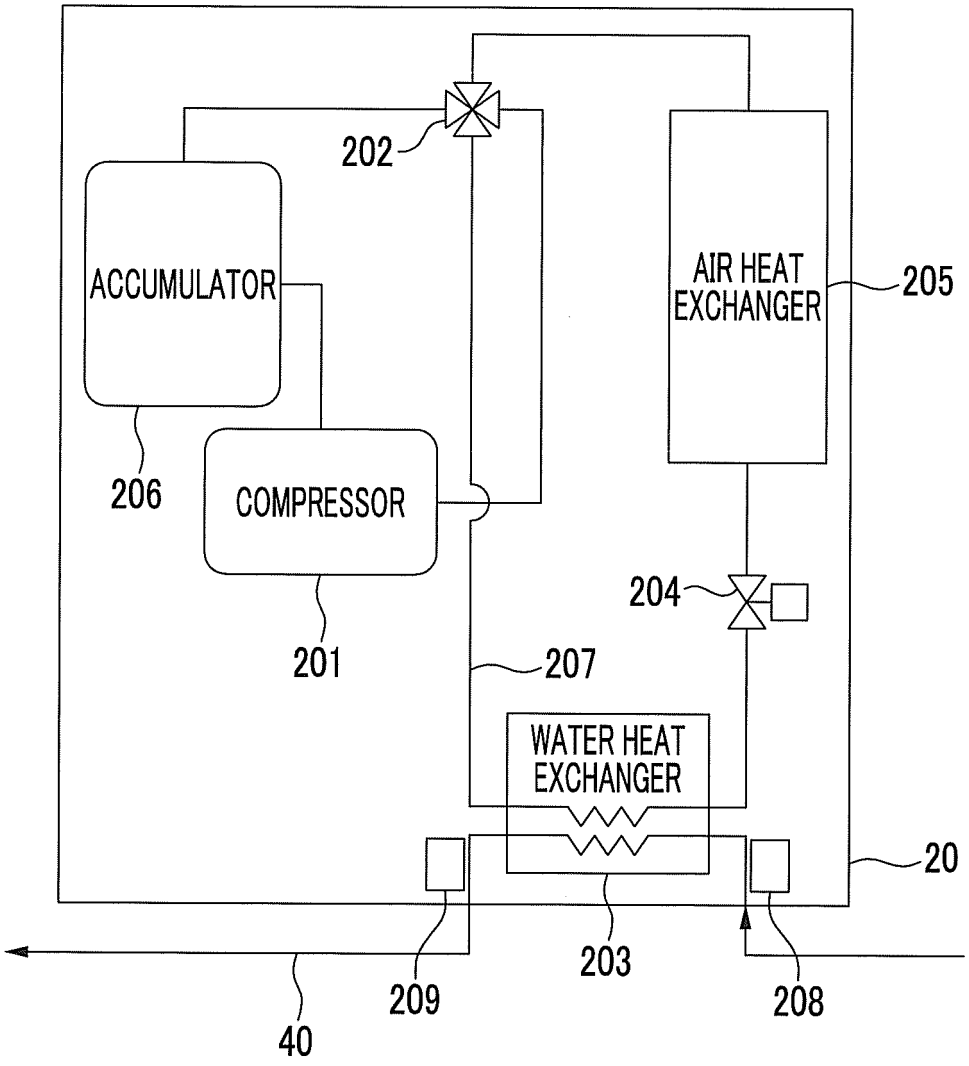

202
ACCUMULATOR
AIR HEAT EXCHANGER
205
206
COMPRESSOR
204
201
207
WATER HEAT EXCHANGER
20
203
209
208
40

FIG. 3

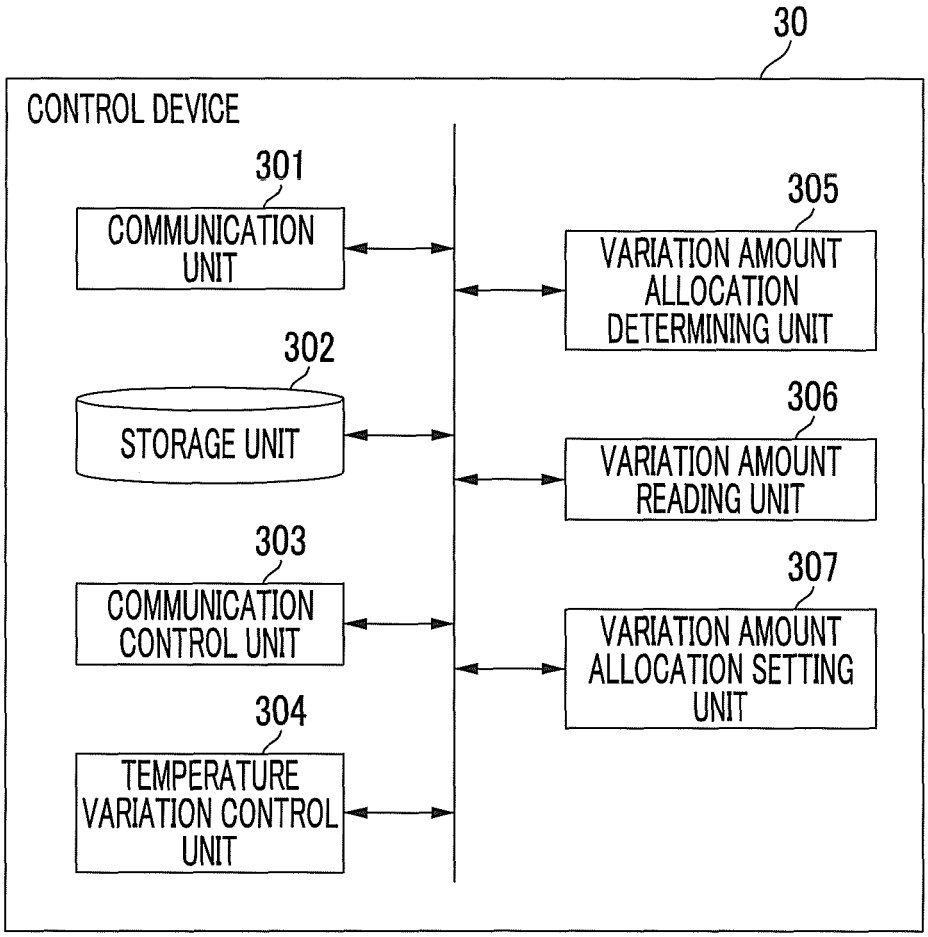


FIG. 4

TBL1

FACILITY	VARIATION AMOUNT ΔT
FACILITY 10	ΔT1
FACILITY 300	ΔT2
...	...

FIG. 5

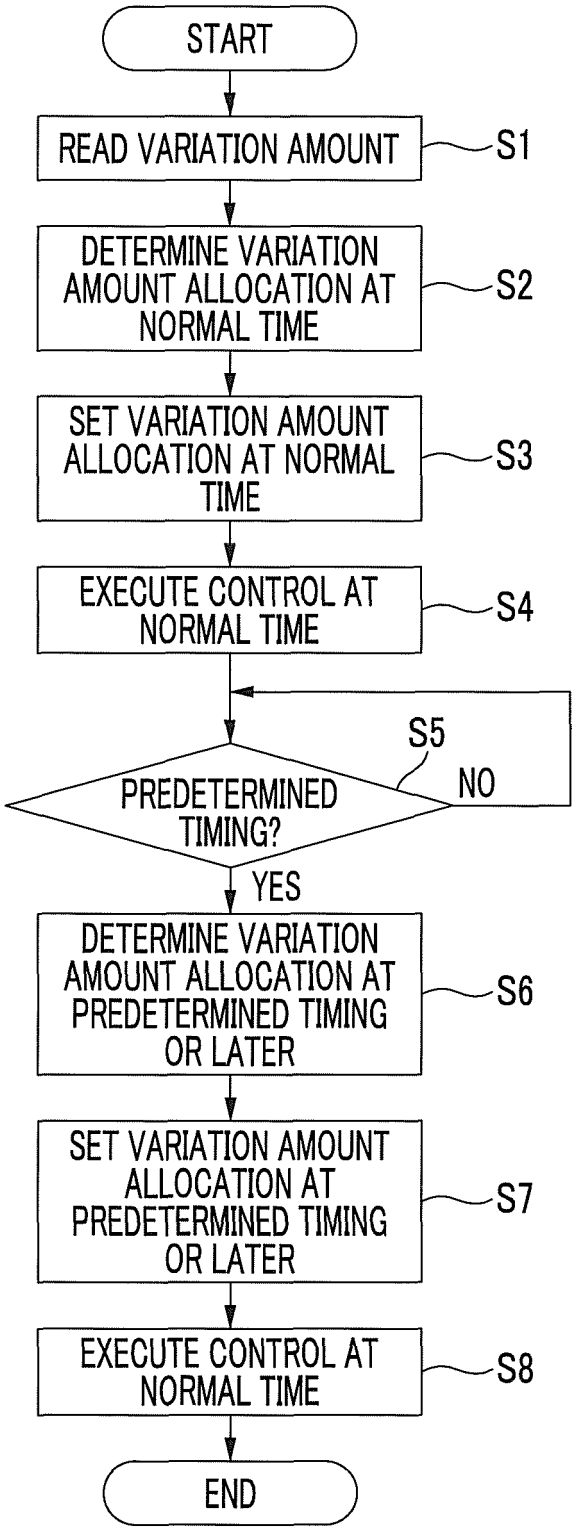

START
READ VARIATION AMOUNT
S1
DETERMINE VARIATION AMOUNT ALLOCATION AT NORMAL TIME
S2
SET VARIATION AMOUNT ALLOCATION AT NORMAL TIME
S3
EXECUTE CONTROL AT NORMAL TIME
S4
S5
PREDETERMINED TIMING?
NO
YES
DETERMINE VARIATION AMOUNT ALLOCATION AT PREDETERMINED TIMING OR LATER
S6
SET VARIATION AMOUNT ALLOCATION AT PREDETERMINED TIMING OR LATER
S7
EXECUTE CONTROL AT NORMAL TIME
S8
END

FIG. 6

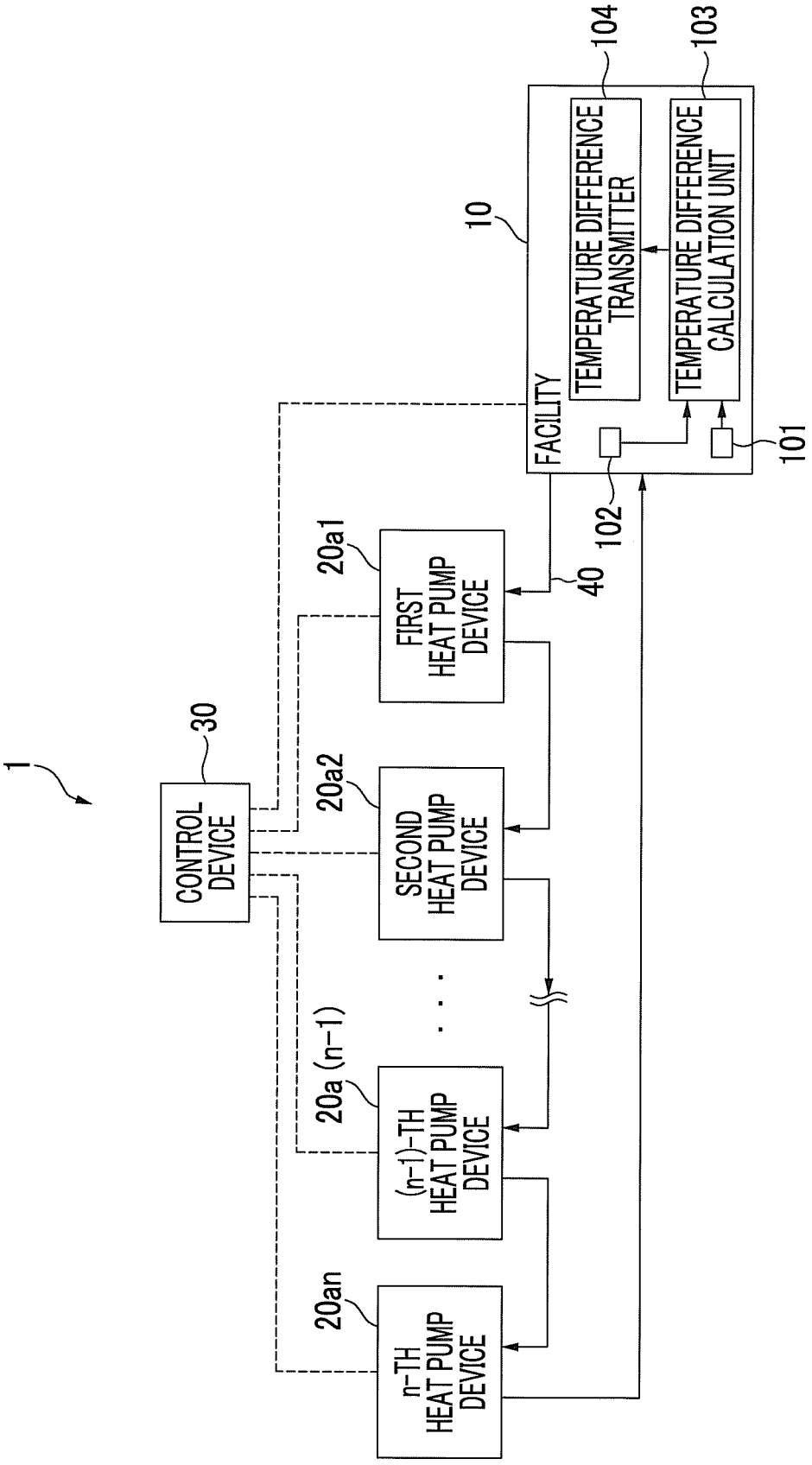
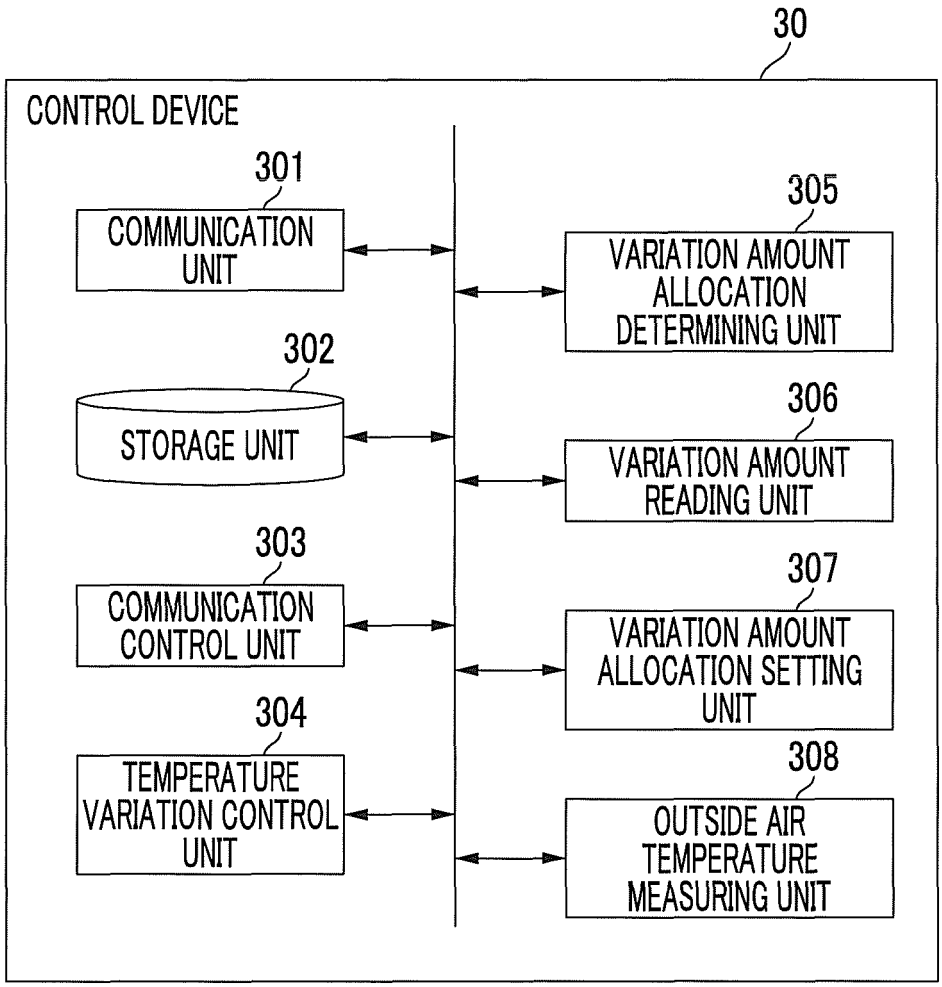

1
30
CONTROL DEVICE
20a1
FIRST HEAT PUMP DEVICE
20a2
SECOND HEAT PUMP DEVICE
20a (n-1)
(n-1)-TH HEAT PUMP DEVICE
20an
n-TH HEAT PUMP DEVICE
40
10
FACILITY
104
TEMPERATURE DIFFERENCE TRANSMITTER
103
TEMPERATURE DIFFERENCE CALCULATION UNIT
102
101

FIG. 7


30
CONTROL DEVICE
301
COMMUNICATION UNIT
302
STORAGE UNIT
303
COMMUNICATION CONTROL UNIT
304
TEMPERATURE VARIATION CONTROL UNIT
305
VARIATION AMOUNT ALLOCATION DETERMINING UNIT
306
VARIATION AMOUNT READING UNIT
307
VARIATION AMOUNT ALLOCATION SETTING UNIT
308
OUTSIDE AIR TEMPERATURE MEASURING UNIT

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2013113556 A **[0004]**
- JP 2014070741 A **[0004]**