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

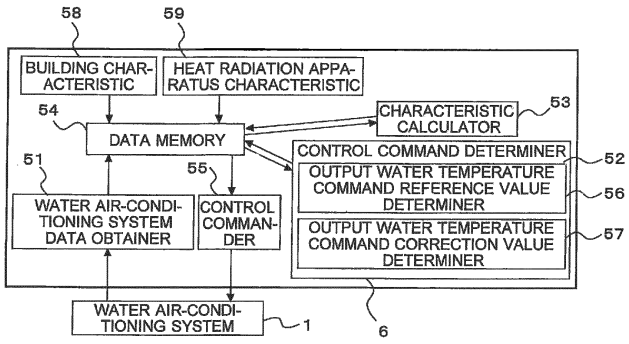
(72) Inventors:
- **UNO, Yoshitaka**
  Tokyo 100-8310 (JP)
- **NAKAI, Takahiro**
  Tokyo 100-8310 (JP)
- **YAMAMOTO, Takaya**
  Tokyo 100-8310 (JP)
- **MATSUZAWA, Koji**
  Tokyo 100-8310 (JP)
- **HATTORI, Taro**
  Tokyo 100-8310 (JP)
- **TAKAHASHI, Yoshihiro**
  Tokyo 100-8310 (JP)

(74) Representative: **Sajda, Wolf E.**
Meissner Bolte Patentanwälte
Rechtsanwälte Partnerschaft mbB
Postfach 86 06 24
81633 München (DE)

(54) AIR-CONDITIONING SYSTEM CONTROL DEVICE

(57) Improvement of responsiveness and stability of room temperature are achieved by learning each of a heat transfer characteristic of a building and a heat medium utilization apparatus characteristic from operation data even when, for example, a heat medium utilization apparatus to be connected is unknown. A control command determiner (52) includes an output water temperature command reference value determiner (56) configured to determine an output water temperature command reference value on the basis of a building characteristic (58) and a heat radiation apparatus characteristic (59) that are learned by a characteristic calculator (53), an outside air temperature, and a set temperature, and an output water temperature command correction value determiner (57) configured to determine an output water temperature command correction value on the basis of a correction coefficient, the set temperature, and an indoor temperature. The control command determiner (52) is configured to determine a control command for a water air-conditioning system (1) by adding the output water temperature command correction value to the output water temperature command reference value.

FIG. 3



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Description

Technical Field

[0001] The present invention relates to an air-conditioning system control device that is to be used for an air-conditioning system such as a water air-conditioning system, and is configured to achieve improvement of responsiveness and stability of room temperature.

Background Art

[0002] A water air-conditioning system generates hot water with a heat source at the time of a heating operation, and uses the generated hot water for supply of hot water to, for example, a shower or a bath, and for a heating operation by, for example, a radiator or a floor heating apparatus. Further, the water air-conditioning system generates cool water with the heat source at the time of a cooling operation, and uses the generated cool water for, for example, a radiator or floor cooling. Examples of the heat source used include a heat pump apparatus with high energy efficiency and an inexpensive boiler with low energy efficiency.

[0003] For example, at the time of a cooling-heating operation, the water air-conditioning system controls a command value for an output water temperature on the basis of a deviation between a set temperature and a measured indoor temperature.

[0004] In Patent Literature 1, there is a description of controlling a group of air-conditioning heat source apparatus on the basis of a relationship between an outside air temperature and a heat load of a building. An air-conditioning heat source system for a building disclosed in Patent Literature 1 improves responsiveness by performing feed-forward control of a group of air-conditioning heat source apparatus on the basis of the relationship between the outside air temperature and the heat load of the building, to thereby prevent wasteful consumption of air-conditioning energy and achieve energy saving.

[0005] In Patent Literature 2, there is a description of variably controlling a target value of a refrigerant physical quantity of an air-conditioning apparatus depending on air-conditioning load characteristics of a building. An air-conditioning apparatus disclosed in Patent Literature 2 controls the target value of a refrigerant physical quantity on the basis of an air-conditioning load of the building, to thereby stabilize capacity of a compressor and achieve reduction of temperature variation in an air-conditioned space.

List of Citations

Patent Literature

[0006]

Patent Literature 1: Japanese Unexamined Patent Application Publication JP 2013-092 327 A
Patent Literature 2: Japanese Patent JP 4 032 634 B2

Summary of the Invention

Technical Problem

[0007] The related-art air-conditioning heat source system for a building as disclosed in Patent Literature 1 performs feed-forward control on the basis of the relationship between the outside air temperature and the heat load of the building, and thus can improve responsiveness, prevent wasteful consumption of air-conditioning energy, and achieve energy saving.

[0008] However, for example, when a designed heat load and an actual heat load do not match, when a heat radiation apparatus to be connected is unknown, or when heat radiation apparatus having greatly different characteristics are used, such as a radiator and a floor cooling-heating apparatus, the related-art air-conditioning heat source system has a difficulty in performing appropriate control and improving responsiveness.

[0009] Meanwhile, the related-art air-conditioning apparatus as disclosed in Patent Literature 2 controls the target value of a refrigerant physical quantity on the basis of the learned air-conditioning load characteristics of the building, and thus can reduce temperature variation in the air-conditioned space even when the designed heat load and the actual heat load do not match. However, for example, when a heat radiation apparatus to be connected is unknown, or when heat radiation apparatus having greatly different characteristics are used, such as a radiator and a floor cooling-heating apparatus, the related-art air-conditioning apparatus has a difficulty in determining an appropriate target value of the

refrigerant physical quantity.

[0010] The present invention has been made to solve the problems described above, and an object of the present invention is to provide an air-conditioning system control device capable of achieving improvement of responsiveness and stability of room temperature by learning each of a heat transfer characteristic of a building and a heat medium utilization apparatus characteristic from operation data even when, for example, a heat medium utilization apparatus to be connected is unknown.

Solution to the Problem

[0011] According to one embodiment of the present invention, there is provided an air-conditioning system control device to be used for an air-conditioning system, the air-conditioning system including a heat pump apparatus, and a conveyance apparatus configured to supply a heat medium utilization apparatus with a heat medium heated or cooled by the heat pump apparatus, the air-conditioning system control device including an air-conditioning system data obtainer configured to obtain operation data on the air-conditioning system, a characteristic calculator configured to learn a heat transfer characteristic of a building and a heat medium utilization apparatus characteristic from the operation data on the air-conditioning system, and a control command determiner configured to determine a control command for the air-conditioning system such that an indoor temperature is equal to a set temperature, the control command determiner including a temperature command reference value determiner configured to determine a temperature command reference value on the basis of the heat transfer characteristic of the building and the heat medium utilization apparatus characteristic that are determined by the characteristic calculator, an outside air temperature, and the set temperature, and a temperature command correction value determiner configured to determine a temperature command correction value on the basis of a correction coefficient, the set temperature, and the indoor temperature, in which the control command determiner is configured to determine the control command for the air-conditioning system by adding the temperature command correction value to the temperature command reference value.

Advantageous Effects of the Invention

[0012] According to one embodiment of the present invention, the air-conditioning system control device learns each of the heat transfer characteristic of a building and the heat medium utilization apparatus characteristic from the operation data, and determines a temperature command on the basis of the learned two characteristics. Thus, improvement of responsiveness and stability of room temperature can be achieved even when, for example, a heat medium utilization apparatus to be connected is unknown.

Brief Description of the Drawings

[0013]

FIG. 1 is a diagram for illustrating an exemplary schematic configuration of a water air-conditioning system according to Embodiment 1 of the present invention.

FIG. 2 is a diagram for illustrating another exemplary schematic configuration of the water air-conditioning system according to Embodiment 1 of the present invention.

FIG. 3 is a diagram for illustrating an exemplary functional configuration of a water air-conditioning system control device according to Embodiment 1 of the present invention.

FIG. 4 is a graph for showing an example of a building characteristic according to Embodiment 1 of the present invention.

FIG. 5 is a graph for showing an example of a heat radiation apparatus characteristic according to Embodiment 1 of the present invention.

FIG. 6 is a graph for showing an example of an output water temperature command reference value according to Embodiment 1 of the present invention.

FIG. 7 is a graph for showing an exemplary changeable range of an output water temperature command according to Embodiment 1 of the present invention.

FIG. 8 is a graph for showing a range of change in the output water temperature command reference value according to Embodiment 1 of the present invention.

FIG. 9 is a diagram for illustrating exemplary control blocks of a control command determiner according to Embodiment 1 of the present invention.

FIG. 10 is a diagram for illustrating other exemplary control blocks of the control command determiner according to Embodiment 1 of the present invention.

FIG. 11 is a flowchart for illustrating an example of water air-conditioning system control command determination

processing among examples of control of the water air-conditioning system control device according to Embodiment 1 of the present invention.

FIG. 12 is a flowchart for illustrating an example of characteristic learning processing among the examples of control of the water air-conditioning system control device according to Embodiment 1 of the present invention.

FIG. 13 is a flowchart for illustrating an example of a series of operations for execution of control of a water air-conditioning system 1 among the examples of control of the water air-conditioning system control device according to Embodiment 1 of the present invention.

FIG. 14 is a diagram for illustrating an exemplary functional configuration of a water air-conditioning system control device according to Embodiment 2 of the present invention.

Description of Embodiments

[0014] Embodiments of the present invention are described below in detail with reference to the drawings.

[0015] Steps describing a program for performing operations of the embodiments of the present invention are pieces of processing to be performed in time series along the described order. However, the steps may not necessarily be processed in time series, and the steps may include pieces of processing to be executed in parallel or individually.

[0016] Further, there is no restriction on whether each function described in the embodiments of the present invention is implemented by hardware or software. In other words, each block diagram to be described in the embodiments of the present invention may be regarded as a block diagram of hardware or a functional block diagram of software. For example, each block diagram may be implemented by hardware such as a circuit device, or may be implemented by software to be executed on an arithmetic unit such as a processor (not shown).

[0017] Further, for each block of the block diagrams described in the embodiments of the present invention, as long as the function of each block is implemented, the configuration is not required to be separated into the blocks.

[0018] In each of Embodiments 1 and 2 of the present invention, items not particularly described are similar to those in Embodiments 1 and 2, and the same functions and configurations are described with use of the same reference signs. Further, each of Embodiments 1 and 2 of the present invention may be implemented alone or may be implemented in combination. In any of the cases, advantageous effects to be described below are produced. Further, various specific setting examples described in the embodiments of the present invention are merely examples, and the present invention is not particularly limited to the examples.

[0019] Further, heating is taken as an example in the following, but the present invention can be carried out similarly for cooling. In that case, a floor heating apparatus is replaced with a floor cooling apparatus in the following.

Embodiment 1

First Exemplary Configuration of Water Air-Conditioning System 1

[0020] FIG. 1 is a diagram for illustrating an exemplary schematic configuration of a water air-conditioning system 1 (air-conditioning system utilizing heat medium) according to Embodiment 1 of the present invention.

[0021] As illustrated in FIG. 1, the water air-conditioning system 1 includes a heat pump apparatus 2 (heat source), a radiator 4, a floor heating apparatus 5, and a pump 3 that are connected to one another by pipes to construct a heat medium circuit (conveyance apparatus). Water serving as a heat medium circulates through the circuit in a direction of the solid arrow illustrated in FIG. 1. Further, the water air-conditioning system 1 includes a water air-conditioning system control device 6 serving as an air-conditioning system control device configured to control the heat pump apparatus 2, the pump 3, and other apparatus. The water air-conditioning system control device 6 is configured to obtain various detection values from an output water temperature sensor 7, an indoor temperature sensor 8, a return water temperature sensor 9, a water flowrate sensor 10, and an outside air temperature sensor 11.

[0022] The radiator 4 and the floor heating apparatus 5, which are apparatus (heat medium utilization apparatus) that use hot water generated in the heat pump apparatus 2 or a boiler, are connected in parallel to the heat pump apparatus 2.

[0023] All the apparatus may be newly introduced to construct the water air-conditioning system 1. In other cases, for example, it is conceivable that the heat pump apparatus 2 and the water air-conditioning system control device 6 are newly introduced to the existing water air-conditioning system 1 in which a boiler is installed as the heat source, to thereby construct the water air-conditioning system 1.

Second Exemplary Configuration of Water Air-conditioning System 1

[0024] FIG. 2 is a diagram for illustrating another exemplary schematic configuration of the water air-conditioning system 1 (air-conditioning system utilizing heat medium) according to Embodiment 1 of the present invention.

[0025] As illustrated in FIG. 2, the water air-conditioning system 1 includes the heat pump apparatus 2 (heat source),

a three-way valve 12, a tank 13, the radiator 4, the floor heating apparatus 5, and the pump 3 that are connected to one another by pipes to construct a heat medium circuit (conveyance apparatus). Water serving as a heat medium circulates through the circuit in a direction of the solid arrow illustrated in FIG. 2. The water flows to the tank 13 via the three-way valve 12 at the time of a hot water supply operation.

[0026] On the other hand, the water flows to the radiator 4 and the floor heating apparatus 5 via the three-way valve 12 at the time of a heating operation. Further, the water air-conditioning system 1 includes the water air-conditioning system control device 6 configured to control the heat pump apparatus 2, the three-way valve 12, the pump 3, and other apparatus. The water air-conditioning system control device 6 is configured to obtain various detection values from the output water temperature sensor 7, the indoor temperature sensor 8, the return water temperature sensor 9, the water flowrate sensor 10, the outside air temperature sensor 11, and the tank temperature sensor 14.

[0027] The radiator 4, the floor heating apparatus 5, and the tank 13, which are apparatus (heat medium utilization apparatus) that use hot water generated in the heat pump apparatus 2 or a boiler, are connected in parallel to the heat pump apparatus 2.

[0028] All the apparatus may be newly introduced to construct the water air-conditioning system 1. In other cases, for example, it is conceivable that the heat pump apparatus 2 and the water air-conditioning system control device 6 are newly introduced to the existing water air-conditioning system 1 in which a boiler is installed as the heat source, to thereby construct the water air-conditioning system 1.

Functional Block Diagram, Outline

[0029] Next, with reference to FIG. 3, a description is given of functions implemented in the water air-conditioning system 1 described above. FIG. 3 is a diagram for illustrating an exemplary functional configuration of the water air-conditioning system control device 6 according to Embodiment 1 of the present invention.

[0030] As illustrated in FIG. 3, the water air-conditioning system control device 6 is configured to transmit and receive various kinds of data to and from the water air-conditioning system 1. For example, the water air-conditioning system control device 6 receives input information of the water air-conditioning system 1 from the water air-conditioning system 1. Further, for example, the water air-conditioning system control device 6 transmits a control command to the water air-conditioning system 1.

[0031] The water air-conditioning system control device 6 is configured to obtain a building characteristic 58 and a heat radiation apparatus characteristic 59 (heat medium utilization apparatus characteristic). The method of obtainment is described later. The building characteristic 58 represents various kinds of physical property values relating to a subject building in which the water air-conditioning system 1 is installed. The heat radiation apparatus characteristic 59 represents various kinds of physical property values relating to heat medium utilization apparatus such as the radiator 4 and the floor heating apparatus 5.

[0032] In short, the water air-conditioning system control device 6 controls the water air-conditioning system 1 installed in the subject building on the basis of the input information received from the water air-conditioning system 1, which is on the basis of various kinds of detection values, the building characteristic 58, and the heat radiation apparatus characteristic 59.

[0033] As illustrated in FIG. 3, the water air-conditioning system control device 6 includes, as its functional configuration, a data memory 54, a control command determiner 52, a characteristic calculator 53, a water air-conditioning system data obtainer 51, and a control commander 55. Further, the control command determiner 52 includes an output water temperature command reference value determiner 56 and an output water temperature command correction value determiner 57.

Functional Block Diagram, Details

[0034] Next, a description is given of details of each of the functions of the water air-conditioning system control device 6 with reference to FIG. 4 and FIG. 5. FIG. 4 is a graph for showing an example of the building characteristic 58 according to Embodiment 1 of the present invention. FIG. 5 is a graph for showing an example of the heat radiation apparatus characteristic 59 according to Embodiment 1 of the present invention.

Data Memory 54

[0035] The data memory 54 is configured to store various kinds of data obtained via the water air-conditioning system data obtainer 51. The data memory 54 stores, for example, the building characteristic 58 and the heat radiation apparatus characteristic 59. The data memory 54 provides input data for determination of a control command, which is formed of various kinds of stored data, to the control command determiner 52. The data memory 54 stores various kinds of calculation results of the control command determiner 52, for example, a control command for the water air-conditioning

system 1.

[0036] The data memory 54 provides the stored control command to the control commander 55. The data memory 54 provides input data for characteristic learning, which is formed of various kinds of stored data, to the characteristic calculator 53. The data memory 54 stores various kinds of calculation results of the characteristic calculator 53, for example, the building characteristic 58 and the heat radiation apparatus characteristic 59. The data memory 54 provides the stored building characteristic 58 and heat radiation apparatus characteristic 59 to the control command determiner 52.

Building Characteristic 58

[0037] A description is given below of the building characteristic 58 stored in the data memory 54 in detail. As shown in FIG. 4, the building characteristic 58 is a value representing a heat insulating property and airtightness of a building in which the water air-conditioning system 1 is installed. For example, the building characteristic 58 corresponds to a heat transfer characteristic included in Expression (1) given below. Expression (1) represents transfer of heat through a building, and is used to determine a heat transfer amount of the building using an outside air temperature and a set temperature of a room to be heated as input data. In other words, Expression (1) is a mathematical model serving as a building heat transfer amount prediction model for predicting the heat transfer amount of a building.

[Math. 1]

$$Q_h = \alpha(T_z - T_o) \cdots (1)$$

[0038] In Expression (1), Q_h represents the heat transfer amount of a building [kW], α represents the heat transfer characteristic of the building [kW/K], T_o represents the outside air temperature [K], and T_z represents the set temperature [K].

[0039] The building characteristic 58 may be a value calculated from, for example, structure data on the building, namely, building data such as materials of a wall, a thickness of the wall, an area of the wall, and a size of a room. The building characteristic 58 may be registered in advance in the data memory 54 through an operation (manual setting) of a user. Further, the building characteristic 58 may be updated as necessary from outside the water air-conditioning system control device 6.

Heat Radiation Apparatus Characteristic 59

[0040] A description is given below of the heat radiation apparatus characteristic 59 stored in the data memory 54 in detail. As shown in FIG. 5, the heat radiation apparatus characteristic 59 is a value representing a heat radiation characteristic of a heat radiation apparatus such as the radiator 4 and the floor heating apparatus 5 used in the water air-conditioning system 1. For example, the heat radiation apparatus characteristic 59 corresponds to a heat radiation characteristic included in Expression (2) given below.

[0041] Expression (2) represents the heat radiation characteristic of a heat radiation apparatus, and is used to determine a heat radiation amount of the heat radiation apparatus using the output water temperature as input data. In other words, Expression (2) is a mathematical model serving as a heat radiation apparatus heat radiation amount prediction model for predicting the heat radiation amount of a heat radiation apparatus.

Math. 2]

$$Q_e = \beta T_w \cdots (2)$$

[0042] In Expression (2), Q_e represents the heat radiation amount of the heat radiation apparatus [kW], β represents the heat radiation characteristic of the heat radiation apparatus [kW/K], and T_w represents the output water temperature [K].

[0043] The heat radiation apparatus characteristic 59 may be a value calculated from, for example, specification data on the heat radiation apparatus, namely, heat radiation apparatus data such as materials of the heat radiation apparatus, a thickness of the heat radiation apparatus, and a heat transfer area of the heat radiation apparatus.

[0044] The heat radiation apparatus characteristic 59 may be registered in advance in the data memory 54 through an operation (manual setting) of a user. Further, the heat radiation apparatus characteristic 59 may be updated as necessary from outside the water air-conditioning system control device 6.

Characteristic Calculator 53

[0045] The characteristic calculator 53 is configured to learn a characteristic used by the control command determiner 52. Specifically, the characteristic calculator 53 learns the building characteristic 58 and the heat radiation apparatus characteristic 59 used by the output water temperature command reference value determiner 56 of the control command determiner 52 from various kinds of input data obtained from the data memory 54 or various kinds of measurement data of the water air-conditioning system 1.

[0046] The building characteristic 58 may be determined by assigning various kinds of measurement data to a transformed version of Expression (1) given above when the building characteristic 58 is learned from the various kinds of measurement data.

[0047] Specifically, the heat transfer characteristic of the building is determined from Expression (3) and on the basis of the outside air temperature, the indoor temperature, and data on an amount of heat supplied to the building. The data on an amount of heat supplied to the building may be a value calculated from a density, specific heat, and flowrate of water, the output water temperature, and the return water temperature. Also, the heat transfer characteristic of the building may be learned on the basis of a summary value of the outside air temperature, the indoor temperature, and the data on an amount of heat supplied to the building for a predetermined period. For example, the predetermined period refers to 24 hours. The determined heat transfer characteristic of the building is defined as the building characteristic 58.

[Math. 3]

$$\alpha = \frac{\rho C_p V_w (T_w - T_{w,r})}{T_z - T_o} \quad \cdots (3)$$

[0048] In Expression (3), α represents the heat transfer characteristic of the building [kW/K], ρ represents the density of water [kg/L], C_p represents the specific heat of water [kJ/(kg·K)], V_w represents the flowrate of water [L/s], T_w represents the output water temperature [K], $T_{w,r}$ represents the return water temperature [K], T_o represents the outside air temperature [K], and T_z represents the indoor temperature [K].

[0049] The heat radiation apparatus characteristic 59 may be determined by assigning various kinds of measurement data to a transformed version of Expression (2) given above when the heat radiation apparatus characteristic 59 is learned from the various kinds of measurement data.

[0050] Specifically, the heat radiation characteristic of the heat radiation apparatus is determined from Expression (4) and on the basis of the output water temperature and data on an amount of heat supplied by the heat radiation apparatus. The data on an amount of heat supplied by the heat radiation apparatus may be a value calculated from the density, specific heat, and flowrate of water, the output water temperature, and the return water temperature.

[0051] Also, the heat radiation characteristic of the heat radiation apparatus may be learned on the basis of a summary value of the output water temperature and the data on an amount of heat supplied by the heat radiation apparatus for a predetermined period. For example, the predetermined period refers to 24 hours. The determined heat radiation characteristic of the heat radiation apparatus is defined as the heat radiation apparatus characteristic 59.

[Math. 4]

$$\beta = \frac{\rho C_p V_w (T_w - T_{w,r})}{T_w} \quad \cdots (4)$$

[0052] In Expression (4), β represents the heat radiation characteristic of the heat radiation apparatus [kW/K], ρ represents the density of water [kg/L], C_p represents the specific heat of water [kJ/(kg·K)], V_w represents the flowrate of water [L/s], T_w represents the output water temperature [K], and $T_{w,r}$ represents the return water temperature [K].

Control Command Determiner 52

[0053] The control command determiner 52 is configured to determine a control command for the water air-conditioning system 1. Specifically, the control command determiner 52 determines the output water temperature command for the water air-conditioning system 1 so that the indoor temperature to be controlled satisfies a preset indoor temperature. Thus, the control command determiner 52 includes the output water temperature command reference value determiner 56 and the output water temperature command correction value determiner 57 to execute the function described above.

[0054] A description is given below of functions of the control command determiner 52 with reference to FIG. 6 to FIG. 10. FIG. 6 is a graph for showing an example of an output water temperature command reference value according to

Embodiment 1 of the present invention. FIG. 7 is a graph for showing an exemplary changeable range of the output water temperature command according to Embodiment 1 of the present invention.

[0055] FIG. 8 is a graph for showing a range of change in the output water temperature command reference value according to Embodiment 1 of the present invention. FIG. 9 is a diagram for illustrating exemplary control blocks of the control command determiner 52 according to Embodiment 1 of the present invention. FIG. 10 is a diagram for illustrating other exemplary control blocks of the control command determiner 52 according to Embodiment 1 of the present invention.

Output Water Temperature Command Reference Value Determiner 56

[0056] The output water temperature command reference value determiner 56 is configured to determine the output water temperature command reference value on the basis of the set temperature of a space to be air-conditioned by the water air-conditioning system 1, which is obtained from the water air-conditioning system data obtainer 51, the outside air temperature, and an output water temperature command reference value characteristic determined on the basis of the building characteristic 58 and the heat radiation apparatus characteristic 59.

[0057] The output water temperature command reference value characteristic is as shown in FIG. 6, and corresponds to an output water temperature command reference value characteristic included in Expression (5) given below. Expression (5) represents an output water temperature required for the building, and is used to determine the output water temperature command reference value using the outside air temperature and the set temperature of the room to be heated as input data. In other words, Expression (5) is a mathematical model serving as an output water temperature command reference value prediction model for predicting the output water temperature required for the building.

[Math. 5]

$$T_{w,s} = \frac{\alpha}{\beta}(T_{set} - T_o) \cdot \cdot \cdot (5)$$

[0058] In Expression (5), $T_{w,s}$ represents the output water temperature command reference value [K], α represents the heat transfer characteristic of the building [kW/K], β represents the heat radiation characteristic of the heat radiation apparatus [kW/K], T_{set} represents the set temperature [K], and T_o represents the outside air temperature [K].

[0059] In Expression (5), the set temperature of the air-conditioned space and the outside air temperature are input to determine the output water temperature command reference value. As shown in FIG. 8, the output water temperature command reference value may be set to fall within a range from an output water temperature lower limit set value to an output water temperature upper limit set value, which are set in advance. For example, when the output water temperature upper limit set value is 50 °C, the output water temperature lower limit set value is 35 °C, and the calculated output water temperature command reference value is 60 °C, the output water temperature command reference value is 50 °C.

Output Water Temperature Command Correction Value Determiner 57

[0060] The output water temperature command correction value determiner 57 is configured to determine an output water temperature command correction value on the basis of the indoor temperature measured for the space to be air-conditioned by the water air-conditioning system 1, which is obtained from the water air-conditioning system data obtainer 51, the set temperature, and correction coefficients. The output water temperature command correction value is determined from Expression (6).

[0061] Expression (6) is used to determine the output water temperature command correction value using the indoor temperatures measured in current and previous control periods, the set temperatures in the current and previous control periods, and the correction coefficients as input data. In other words, Expression (6) is a mathematical model serving as a feed-back control model of the indoor temperature.

[Math. 6]

$$T_{w,a}(t) = T_{w,a}(t-1) + K_P\{(T_{set}(t) - T_z(t)) - (T_{set}(t-1) - T_z(t-1))\}$$

$$+ K_I(T_{set}(t) - T_z(t)) \cdot \cdot \cdot (6)$$

[0062] In Expression (6), t represents the current control period, t-1 represents the previous control period, $T_{w,a}$ represents the output water temperature command correction value [K], $T_{set}(t)$ represents the set temperature [K] of the control period t, $T_z(t)$ represents the indoor temperature [K] measured in the control period t, K_p represents a correction

coefficient 1, and K_1 represents a correction coefficient 2.

[0063] In Expression (6), the indoor temperatures measured in the current and previous control periods and the set temperatures in the current and previous control periods are input to determine the output water temperature command correction value.

[0064] The correction coefficients may be values calculated from data such as a time constant of room temperature responsiveness of the building, a target responsiveness time constant, and a control period. The correction coefficients may be registered in advance in the data memory 54 through an operation (manual setting) of a user. Further, the correction coefficients may be updated as necessary from outside the water air-conditioning system control device 6.

[0065] When the correction coefficients are to be determined from various kinds of measurement data, the water air-conditioning system 1 may be operated using a plurality of values of the correction coefficients held in advance, and then a summary value of a deviation between the indoor temperature and the set temperature in a predetermined period may be used for the determination. For example, the predetermined period refers to 24 hours.

[0066] As illustrated in FIG. 9, the control command determiner 52 adds the output water temperature command correction value to the output water temperature command reference value to obtain the output water temperature command. Alternatively, as illustrated in FIG. 10, the output water temperature command correction value may be added to the output water temperature command reference value to obtain the output water temperature command only at the time of initial activation or set temperature change, and the output water temperature command correction value may be added to the output water temperature command in the previous control period to obtain the output water temperature command in other cases.

[0067] As shown in FIG. 8, the output water temperature command may be set to fall within the range from the output water temperature lower limit set value to the output water temperature upper limit set value, which are set in advance. For example, when the output water temperature upper limit set value is 50 °C, the output water temperature lower limit set value is 35 °C, and the calculated output water temperature command is 60 °C, the output water temperature command value is 50 °C.

Water Air-conditioning System Data Obtainer 51

[0068] The water air-conditioning system data obtainer 51 is configured to obtain various kinds of data of the water air-conditioning system 1 via a communication medium, but the communication medium is not particularly limited. The communication medium may be, for example, implemented in a wired manner or a wireless manner. Specifically, the water air-conditioning system data obtainer 51 measures operation data on the water air-conditioning system 1 required by the control command determiner 52.

[0069] The operation data on the water air-conditioning system 1 is input information provided by the water air-conditioning system 1, and at least includes the indoor temperature of the room in which the water air-conditioning system 1 is installed. The operation data on the water air-conditioning system 1 may include the set temperature of the room in which the water air-conditioning system 1 is installed.

[0070] The water air-conditioning system data obtainer 51 may measure data not used in the control command determiner 52, for example, data necessary for independently calculating the building characteristic 58 and the heat radiation apparatus characteristic 59. Data that enables independent calculation of the building characteristic 58 and the heat radiation apparatus characteristic 59 may be, for example, the return water temperature at an inlet of the heat pump apparatus 2 installed in the water air-conditioning system 1, the flowrate of water at the inlet of the heat pump apparatus 2 installed in the water air-conditioning system 1, the output water temperature at an outlet of the heat pump apparatus 2 installed in the water air-conditioning system 1, the indoor temperature, and the outside air temperature. Further, if necessary, the water air-conditioning system data obtainer 51 may measure data from various kinds of sensors installed independently of the water air-conditioning system 1, for example, a temperature sensor configured to measure the indoor temperature.

Control Commander 55

[0071] The control commander 55 is configured to transmit a control command for the water air-conditioning system 1 to the water air-conditioning system 1. The control commander 55 is provided with a control command transmission period serving as a timing to transmit a control command regularly. Thus, the control commander 55 provides a control command to the water air-conditioning system 1 at control command transmission periods. Specifically, the control commander 55 obtains a control command stored in the data memory 54, converts the control command into a format appropriate for the water air-conditioning system 1, and provides the control command to the water air-conditioning system 1 at the control command transmission periods.

[0072] Next, a description is given of an exemplary operation of the water air-conditioning system control device 6 on the assumption of the functional configuration described above.

[0073] FIG. 11 is a flowchart for illustrating an example of water air-conditioning system control command determination processing among examples of control of the water air-conditioning system control device 6 according to Embodiment 1 of the present invention.

Water Air-Conditioning System Control Command Determination Processing

Step S11

[0074] The water air-conditioning system control device 6 determines the output water temperature command reference value on the basis of the set temperature, the outside air temperature, and the output water temperature command reference value characteristic. For example, Expression (5) given above is used to determine the output water temperature command reference value.

Step S 12

[0075] When the output water temperature command reference value does not fall within the range from the output water temperature lower limit set value to the output water temperature upper limit set value, the water air-conditioning system control device 6 corrects the output water temperature command reference value. That is, when the output water temperature command reference value exceeds the output water temperature upper limit set value, the water air-conditioning system control device 6 corrects the output water temperature command reference value into the same value as the output water temperature upper limit set value.

[0076] When the output water temperature command reference value falls below the output water temperature lower limit set value, the water air-conditioning system control device 6 corrects the output water temperature command reference value into the same value as the output water temperature lower limit set value. In other cases, the output water temperature command reference value is not corrected.

Step S 13

[0077] The water air-conditioning system control device 6 determines the output water temperature command correction value on the basis of the set temperature, the measured indoor temperature, and the correction coefficients. For example, Expression (6) given above is used to determine the output water temperature command correction value.

Step S 14

[0078] The water air-conditioning system control device 6 determines the output water temperature command on the basis of the output water temperature command reference value and the output water temperature command correction value. As illustrated in FIG. 9, the water air-conditioning system control device 6 adds the output water temperature command correction value to the output water temperature command reference value to obtain the output water temperature command.

[0079] Alternatively, as illustrated in FIG. 10, the output water temperature command correction value may be added to the output water temperature command reference value to obtain the output water temperature command only at the time of initial activation or set temperature change, and the output water temperature command correction value may be added to the output water temperature command in the previous control period to obtain the output water temperature command in other cases.

Step S15

[0080] When the output water temperature command does not fall within the range from the output water temperature lower limit set value to the output water temperature upper limit set value, the water air-conditioning system control device 6 corrects the output water temperature command, and ends the processing. That is, when the output water temperature command exceeds the output water temperature upper limit set value, the water air-conditioning system control device 6 corrects the output water temperature command into the same value as the output water temperature upper limit set value, and ends the processing.

[0081] When the output water temperature command falls below the output water temperature lower limit set value, the water air-conditioning system control device 6 corrects the output water temperature command into the same value as the output water temperature lower limit set value, and ends the processing. In other cases, the output water temperature command is not corrected, and the processing is ended.

[0082] FIG. 12 is a flowchart for illustrating an example of characteristic learning processing among the examples of

control of the water air-conditioning system control device 6 according to Embodiment 1 of the present invention.

Characteristic Learning Processing

Step S21

[0083] The water air-conditioning system control device 6 determines whether or not the water air-conditioning system 1 is in a stable state. When the water air-conditioning system control device 6 determines that the water air-conditioning system 1 is in a stable state, the water air-conditioning system control device 6 proceeds to Step S22. On the contrary, when the water air-conditioning system control device 6 determines that the water air-conditioning system 1 is not in a stable state, the water air-conditioning system control device 6 ends the characteristic learning processing.

[0084] Whether or not the water air-conditioning system 1 is in a stable state may be determined on the basis of whether or not the deviation between the indoor temperature and the set temperature falls within a predetermined range in a predetermined period. For example, the predetermined period is 30 minutes, and the predetermined range is 0.5 degree Celsius or less. In this case, when the set temperature is 20 °C and the indoor temperature is 20.5 °C continuously for 30 minutes, it is determined that the water air-conditioning system 1 is in a stable state.

Step S22

[0085] The water air-conditioning system control device 6 calculates the heat transfer characteristic of the building on the basis of the heat transfer characteristic of the building in the previous control period, the amount of heat radiated to the building, which is determined from the operation data on the water air-conditioning system 1, the measured indoor temperature, and the outside air temperature. For example, Expression (3) given above is used to calculate the heat transfer characteristic (building characteristic 58) of the building.

Step S23

[0086] The water air-conditioning system control device 6 calculates the heat radiation characteristic of the heat radiation apparatus on the basis of the heat radiation characteristic of the heat radiation apparatus in the previous control period, the amount of heat radiated to the building, which is determined from the operation data on the water air-conditioning system 1, and the measured output water temperature. For example, Expression (4) given above is used to calculate the heat radiation characteristic (heat radiation apparatus characteristic 59) of the heat radiation apparatus.

Step S24

[0087] The water air-conditioning system control device 6 calculates the output water temperature command reference value characteristic on the basis of the heat transfer characteristic of the building and the heat radiation characteristic of the heat radiation apparatus, and ends the processing. For example, the output water temperature command reference value characteristic is calculated as the one shown in FIG. 6, which is used for calculation of Expression (5) given above.

[0088] Next, a description is given of operations performed by the water air-conditioning system control device 6 to control the water air-conditioning system 1 on the assumption of the examples of operations of the water air-conditioning system control command determination processing and the characteristic learning processing described above. FIG. 13 is a flowchart for illustrating an example of a series of operations for execution of control of the water air-conditioning system 1 among the examples of control of the water air-conditioning system control device 6 according to Embodiment 1 of the present invention.

[0089] Processing of Step S54 corresponds to operations of the characteristic learning processing described with reference to FIG. 12. Thus, the characteristic learning processing corresponding to processing of Step S31 of FIG. 13 corresponds to the processing from Step S21 to Step S24 of FIG. 12. Further, processing of Step S56 corresponds to operations of the water air-conditioning system control command determination processing described with reference to FIG. 11. Thus, the control command determination processing corresponding to processing of Step S41 of FIG. 13 corresponds to the processing from Step S11 to Step S15 of FIG. 11.

Characteristic Learning Processing

Step S31

[0090] The water air-conditioning system control device 6 executes the characteristic learning processing.

Water Air-Conditioning System Control Command Determination Processing

Step S41

[0091] The water air-conditioning system control device 6 executes the water air-conditioning system control command determination processing.

Water Air-Conditioning System Control Processing

Step S51

[0092] The water air-conditioning system control device 6 determines whether or not the control period has arrived. When the control period has arrived, the water air-conditioning system control device 6 proceeds to Step S52. On the contrary, when the control period has not arrived yet, the water air-conditioning system control device 6 returns to Step S51.

Step S52

[0093] The water air-conditioning system control device 6 obtains the operation data on the water air-conditioning system.

Step S53

[0094] The water air-conditioning system control device 6 stores the operation data on the water air-conditioning system.

Step S54

[0095] The water air-conditioning system control device 6 learns the building characteristic 58, the heat radiation apparatus characteristic 59, and the output water temperature command reference value characteristic. Specifically, the water air-conditioning system control device 6 executes the processing of Step S31 described above to learn the building characteristic 58, the heat radiation apparatus characteristic 59, and the output water temperature command reference value characteristic.

Step S55

[0096] The water air-conditioning system control device 6 stores the building characteristic 58, the heat radiation apparatus characteristic 59, and the output water temperature command reference value characteristic.

Step S56

[0097] The water air-conditioning system control device 6 determines the control command for the water air-conditioning system 1. Specifically, the water air-conditioning system control device 6 executes the processing of Step S41 described above to determine the control command for the water air-conditioning system 1.

Step S57

[0098] The water air-conditioning system control device 6 stores the control command for the water air-conditioning system 1.

Step S58

[0099] The water air-conditioning system control device 6 determines whether or not the control command transmission period has arrived. When the control command transmission period has arrived, the water air-conditioning system control device 6 proceeds to Step S59. On the contrary, when the control command transmission period has not arrived yet, the water air-conditioning system control device 6 returns to Step S58.

Step S59

[0100] The water air-conditioning system control device 6 transmits a control command to the water air-conditioning system 1, and ends the processing.

Effect

[0101] In the configuration described above, the water air-conditioning system control device 6 determines the control command for the water air-conditioning system 1, to thereby be able to execute control of the water air-conditioning system 1 such that responsiveness and stability of room temperature are always kept high.

[0102] As described above, according to Embodiment 1, there is provided the water air-conditioning system control device 6 used for the water air-conditioning system 1, the water air-conditioning system 1 including the heat pump apparatus 2, and the heat medium circuit configured to supply the heat medium utilization apparatus with a heat medium heated by the heat pump apparatus 2, the water air-conditioning system control device 6 including the water air-conditioning system data obtainer 51 configured to obtain the operation data on the water air-conditioning system 1, the characteristic calculator 53 configured to learn the building characteristic 58 and the heat radiation apparatus characteristic 59 from the operation data on the water air-conditioning system 1, and the control command determiner 52 configured to determine the control command for the water air-conditioning system 1 such that the indoor temperature is equal to the set temperature, the control command determiner 52 including the output water temperature command reference value determiner 56 configured to determine the output water temperature command reference value on the basis of the building characteristic 58 and the heat radiation apparatus characteristic 59 that are learned by the characteristic calculator 53, the outside air temperature, and the set temperature, and the output water temperature command correction value determiner 57 configured to determine the output water temperature command correction value on the basis of the correction coefficients, the set temperature, and the indoor temperature, in which the control command determiner 52 is configured to determine the control command for the water air-conditioning system 1 by adding the output water temperature command correction value to the output water temperature command reference value.

[0103] With the configuration described above, the water air-conditioning system control device 6 sets control parameters on the basis of the learned building characteristic 58 and heat radiation apparatus characteristic 59, to thereby improve the responsiveness and stability of room temperature even when the heat radiation apparatus to be connected is unknown.

[0104] Further, in Embodiment 1, the building characteristic 58 is a value representing the heat insulating property and airtightness of the building in which the water air-conditioning system 1 is installed, and the heat radiation apparatus characteristic 59 is a value representing the heat radiation characteristic of a heat radiation apparatus used in the water air-conditioning system 1.

[0105] With the configuration described above, the water air-conditioning system control device 6 can learn the characteristics of the building in which the water air-conditioning system 1 is installed and the heat radiation apparatus connected to the water air-conditioning system 1 using the characteristic calculator 53.

[0106] Further, in Embodiment 1, the characteristic calculator 53 periodically learns the building characteristic 58 and the heat radiation apparatus characteristic 59 from the operation data on the water air-conditioning system 1.

[0107] With the configuration described above, it is possible to improve the responsiveness and stability of room temperature even when performances of the heat radiation apparatus and the building air-conditioning heat source system have changed due to, for example, degradation over time.

[0108] Further, in Embodiment 1, the control command determiner 52 uses the output water temperature command reference value determined by the output water temperature command reference value determiner 56 only at the time of initial activation or set temperature change.

[0109] With the configuration described above, it is possible to reduce variation in output water temperature command as much as possible when the outside air temperature changes frequently.

[0110] Further, in Embodiment 1, the control command determiner 52 uses the output water temperature command reference value determined by the output water temperature command reference value determiner 56 for each control period.

[0111] With the configuration described above, it is possible to keep the room temperature at the set temperature even when the outside air temperature changes.

[0112] Further, in Embodiment 1, the control command determiner 52 allows manual setting of the building characteristic 58 and the heat radiation apparatus characteristic 59.

[0113] With the configuration described above, it is possible to immediately keep the room temperature at the set temperature at the time of initial activation, replacement of the heat radiation apparatus, or insulation retrofit of the building.

[0114] According to the description given above, the water air-conditioning system control device 6 can always keep the control target space comfortable especially remarkably.

Embodiment 2

Variation of Functional Configuration of Water Air-Conditioning System Control Device 6

[0115] A difference from Embodiment 1 is that the control commander 55 is not provided. FIG. 14 is a diagram for illustrating an exemplary functional configuration of the water air-conditioning system control device 6 according to Embodiment 2 of the present invention.

[0116] As illustrated in FIG. 14, the control commander 55 is not provided in the water air-conditioning system control device 6 according to Embodiment 2. Thus, when a control command is transmitted from the data memory 54 to the water air-conditioning system 1, for example, a processor (not shown) or an integral controller (not shown) configured to integrally control the water air-conditioning system control device 6 may transmit the control command from the data memory 54 to the water air-conditioning system 1. Further, when the data memory 54 includes a data controller (not shown), the data controller (not shown) may transmit a control command from the data memory 54 to the water air-conditioning system 1.

[0117] Further, when a control command is transmitted from the control command determiner 52 to the water air-conditioning system 1, the control command determiner 52 may first obtain a control command, and then transmit the obtained control command to the water air-conditioning system 1.

[0118] In any of the cases, it is assumed that an identifier for identifying the water air-conditioning system 1, for example, an address of the water air-conditioning system 1 is set to the data memory 54 or the control command determiner 52 in advance. When the address of the water air-conditioning system 1 is not set to the data memory 54 or the control command determiner 52 in advance, the address of the water air-conditioning system 1 is only required to be set to the data memory 54 or the control command determiner 52 before transmission of the control command.

[0119] According to the description given above, the water air-conditioning system control device 6 can transmit a control command to the water air-conditioning system 1 even when the control commander 55 is not provided in the water air-conditioning system control device 6.

List of Reference Signs

[0120]

1	water air-conditioning system
2	heat pump apparatus
3	pump
4	radiator
5	floor heating apparatus
6	water air-conditioning system control device
7	output water temperature sensor
8	indoor temperature sensor
9	return water temperature sensor
10	water flowrate sensor
11	outside air temperature sensor
12	three-way valve
13	tank
14	tank temperature sensor
51	water air-conditioning system data obtainer
52	control command determiner
53	characteristic calculator
54	data memory
55	control commander
56	output water temperature command reference value determiner
57	output water temperature command correction value determiner
58	building characteristic
59	heat radiation apparatus characteristic

Claims

1. An air-conditioning system control device to be used for an air-conditioning system,

the air-conditioning system including

- a heat pump apparatus, and
- a conveyance apparatus configured to supply a heat medium utilization apparatus with a heat medium heated or cooled by the heat pump apparatus,

the air-conditioning system control device comprising:

- an air-conditioning system data obtainer configured to obtain operation data on the air-conditioning system;
- a characteristic calculator configured to learn a heat transfer characteristic of a building and a heat medium utilization apparatus characteristic from the operation data on the air-conditioning system; and
- a control command determiner configured to determine a control command for the air-conditioning system such that an indoor temperature is equal to a set temperature,

the control command determiner including

- a temperature command reference value determiner configured to determine a temperature command reference value on a basis of the heat transfer characteristic of the building and the heat medium utilization apparatus characteristic that are determined by the characteristic calculator, an outside air temperature, and the set temperature, and
- a temperature command correction value determiner configured to determine a temperature command correction value on a basis of a correction coefficient, the set temperature, and the indoor temperature,

the control command determiner being configured to determine the control command for the air-conditioning system by adding the temperature command correction value to the temperature command reference value.

2. The air-conditioning system control device of claim 1,
wherein the heat transfer characteristic of the building comprises a value representing a heat insulating property and airtightness of the building in which the air-conditioning system is installed, and
wherein the heat medium utilization apparatus characteristic comprises a value representing a heat radiation characteristic of the heat medium utilization apparatus used in the air-conditioning system.

3. The air-conditioning system control device of claim 1 or claim 2,
wherein the characteristic calculator is configured to periodically learn each of the heat transfer characteristic of the building and the heat medium utilization apparatus characteristic from the operation data on the air-conditioning system obtained by the air-conditioning system data obtainer.

4. The air-conditioning system control device of any one of claims 1 to 3,
wherein the control command determiner is configured to use the temperature command reference value determined by the temperature command reference value determiner only at a time of initial activation or set temperature change.

5. The air-conditioning system control device of any one of claims 1 to 3,
wherein the control command determiner is configured to use the temperature command reference value determined by the temperature command reference value determiner for each control period.

6. The air-conditioning system control device of any one of claims 1 to 5,
wherein the control command determiner is configured to allow manual setting of the heat transfer characteristic of the building and the heat medium utilization apparatus characteristic.

FIG. 1

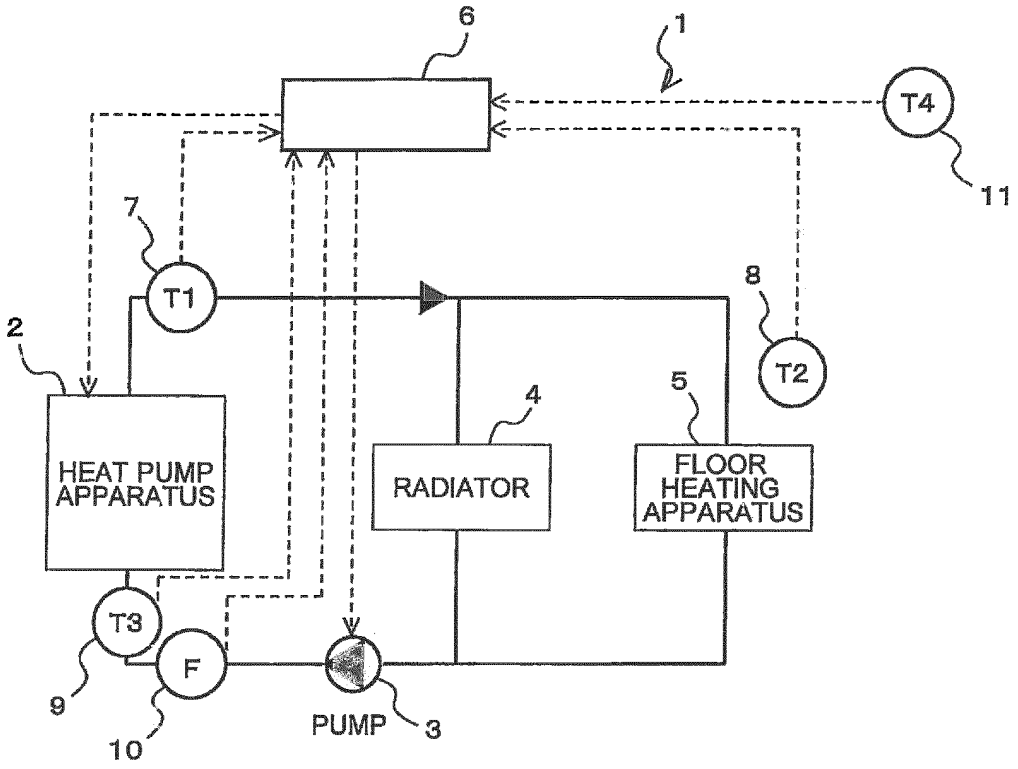

6
1
T4
11
7
T1
8
T2
2
4
5
HEAT PUMP APPARATUS
RADIATOR
FLOOR HEATING APPARATUS
T3
F
9
10
PUMP
3

FIG. 2

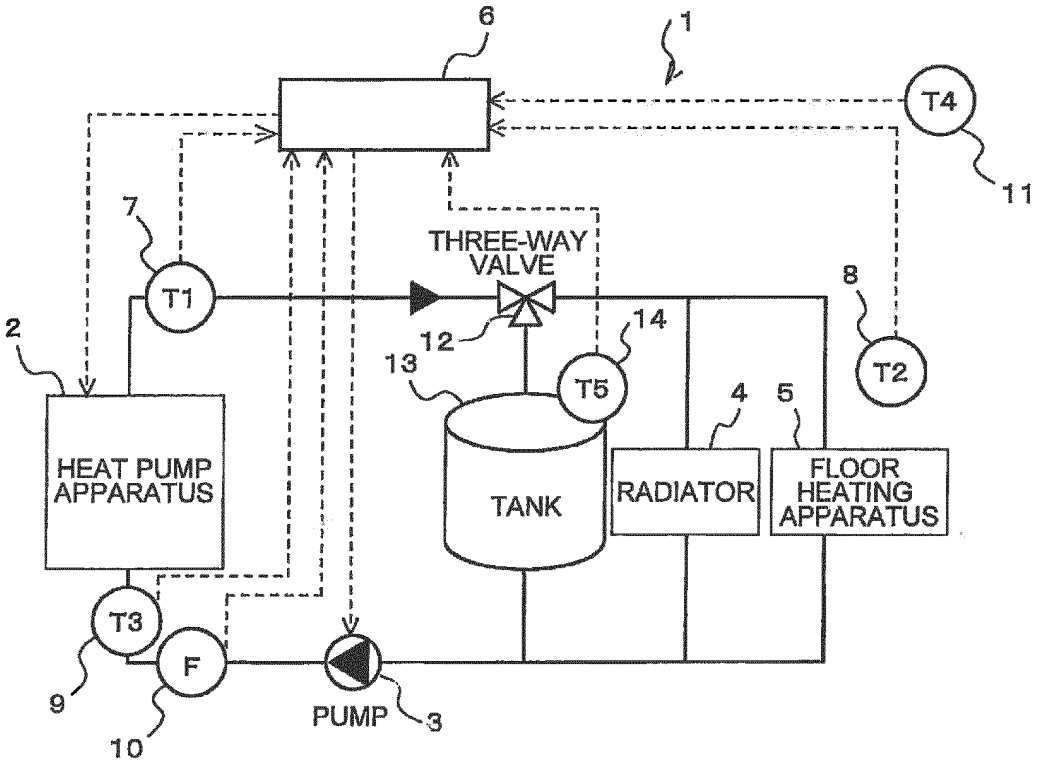

6
1
T4
11
7
THREE-WAY VALVE
8
T1
12
14
T2
2
13
T5
4
5
HEAT PUMP APPARATUS
TANK
RADIATOR
FLOOR HEATING APPARATUS
T3
F
9
10
PUMP
3

FIG. 3

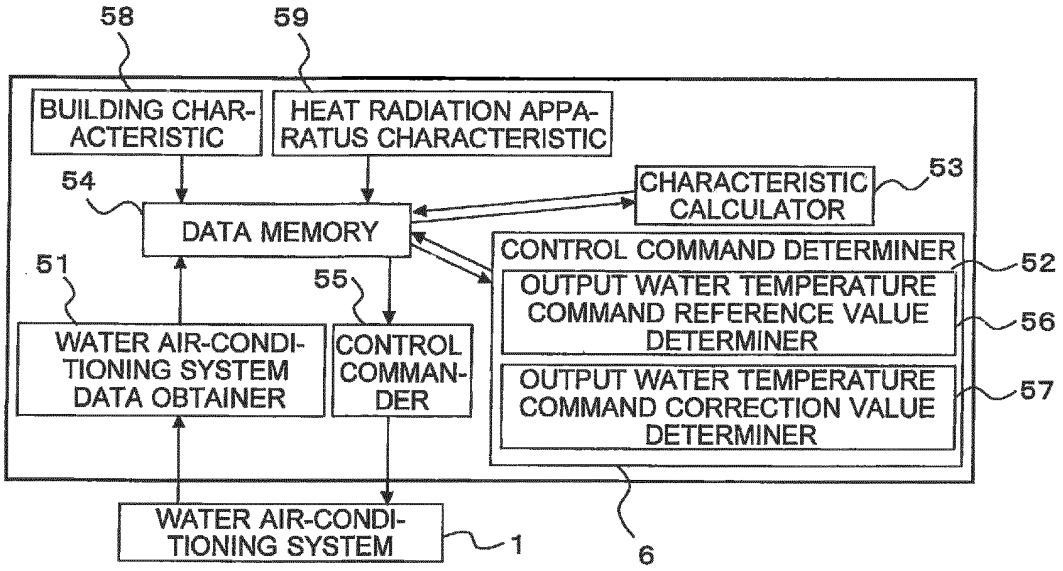


FIG. 4

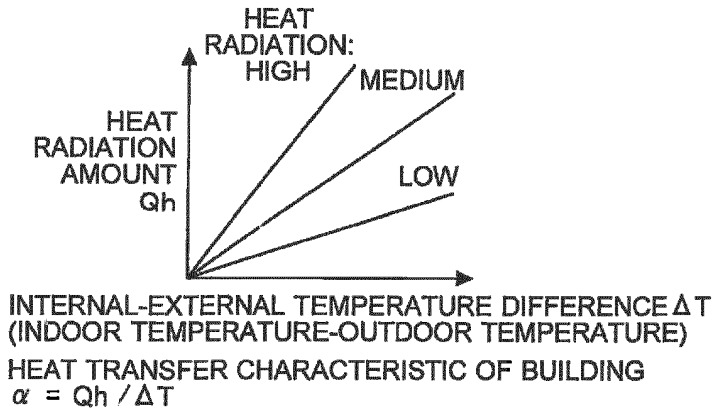


FIG. 5

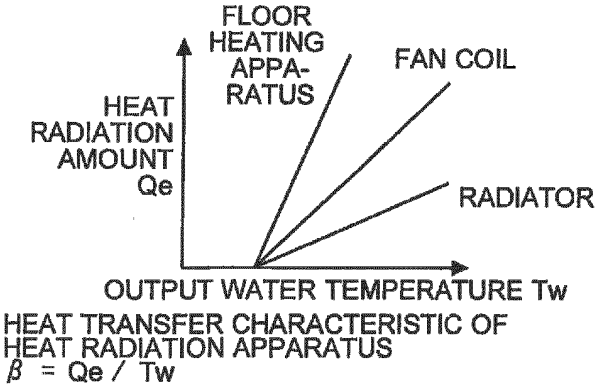


FIG. 6

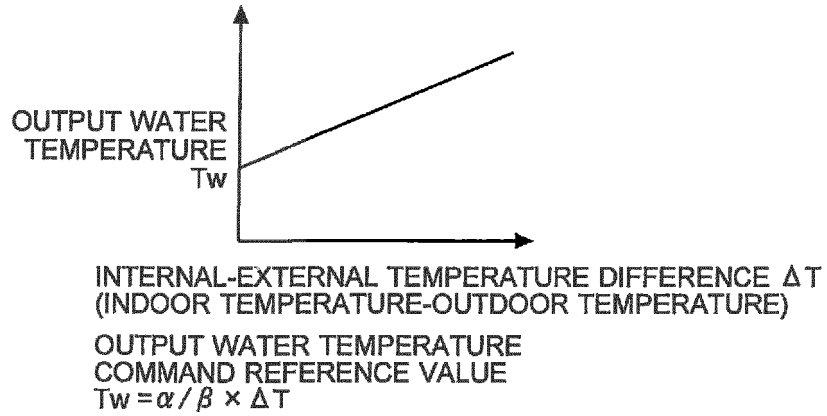


FIG. 7

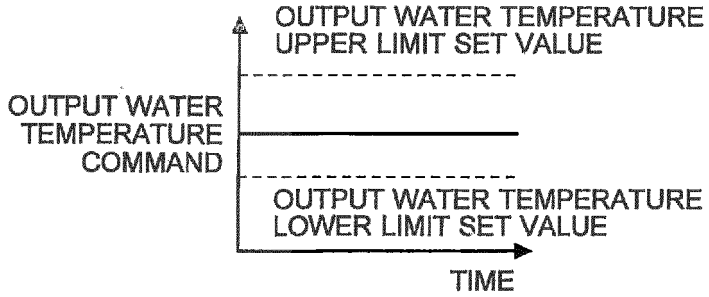


FIG. 8

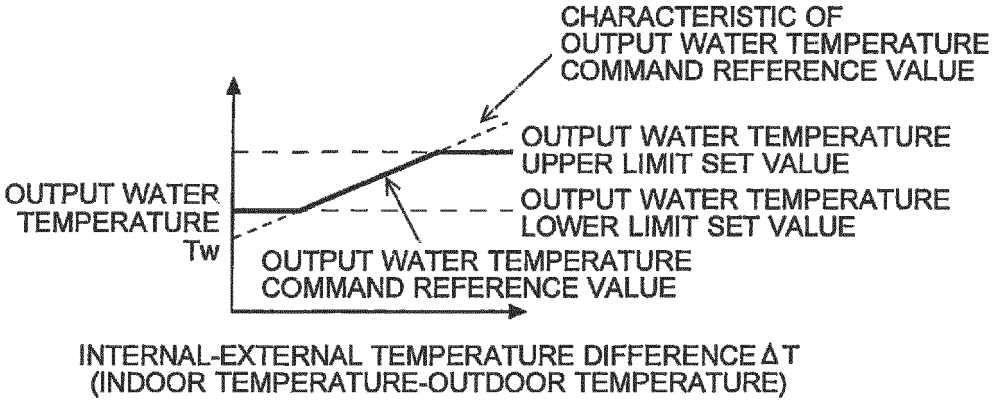


FIG. 9

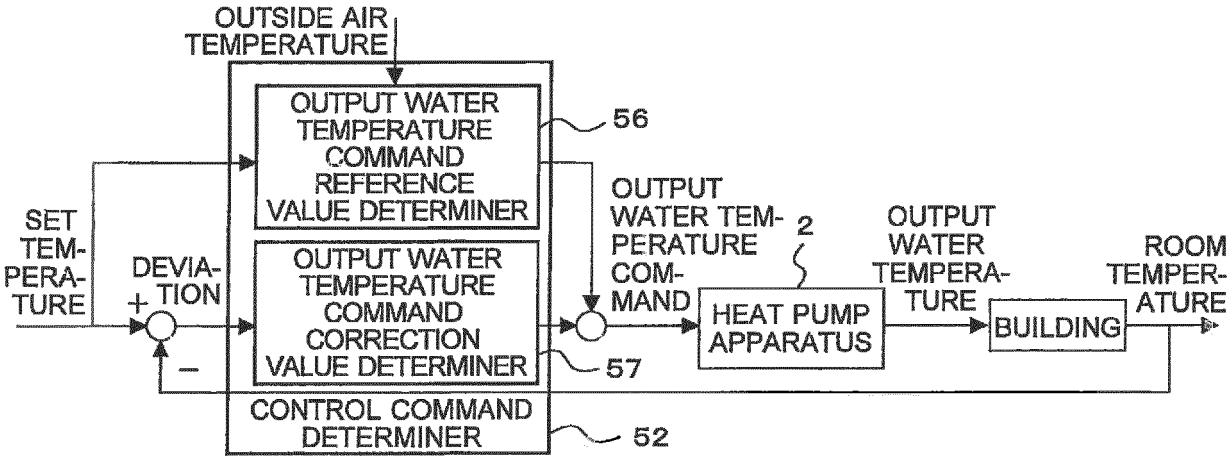

OUTSIDE AIR TEMPERATURE
OUTPUT WATER TEMPERATURE COMMAND REFERENCE VALUE DETERMINER
56
OUTPUT WATER TEMPERATURE COMMAND CORRECTION VALUE DETERMINER
57
CONTROL COMMAND DETERMINER
52
SET TEMPERATURE
DEVIATION
+
−
OUTPUT WATER TEMPERATURE COMMAND
2
HEAT PUMP APPARATUS
OUTPUT WATER TEMPERATURE
BUILDING
ROOM TEMPERATURE

FIG. 10

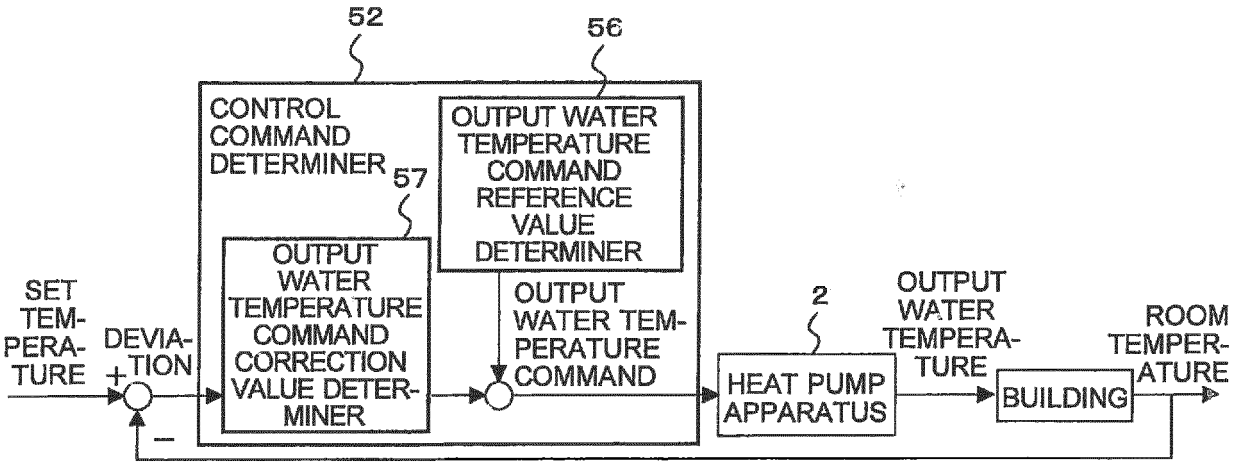

52
56
CONTROL COMMAND DETERMINER
57
OUTPUT WATER TEMPERATURE COMMAND REFERENCE VALUE DETERMINER
OUTPUT WATER TEMPERATURE COMMAND CORRECTION VALUE DETERMINER
OUTPUT WATER TEMPERATURE COMMAND
SET TEMPERATURE
DEVIATION
+
−
2
HEAT PUMP APPARATUS
OUTPUT WATER TEMPERATURE
BUILDING
ROOM TEMPERATURE

FIG. 11

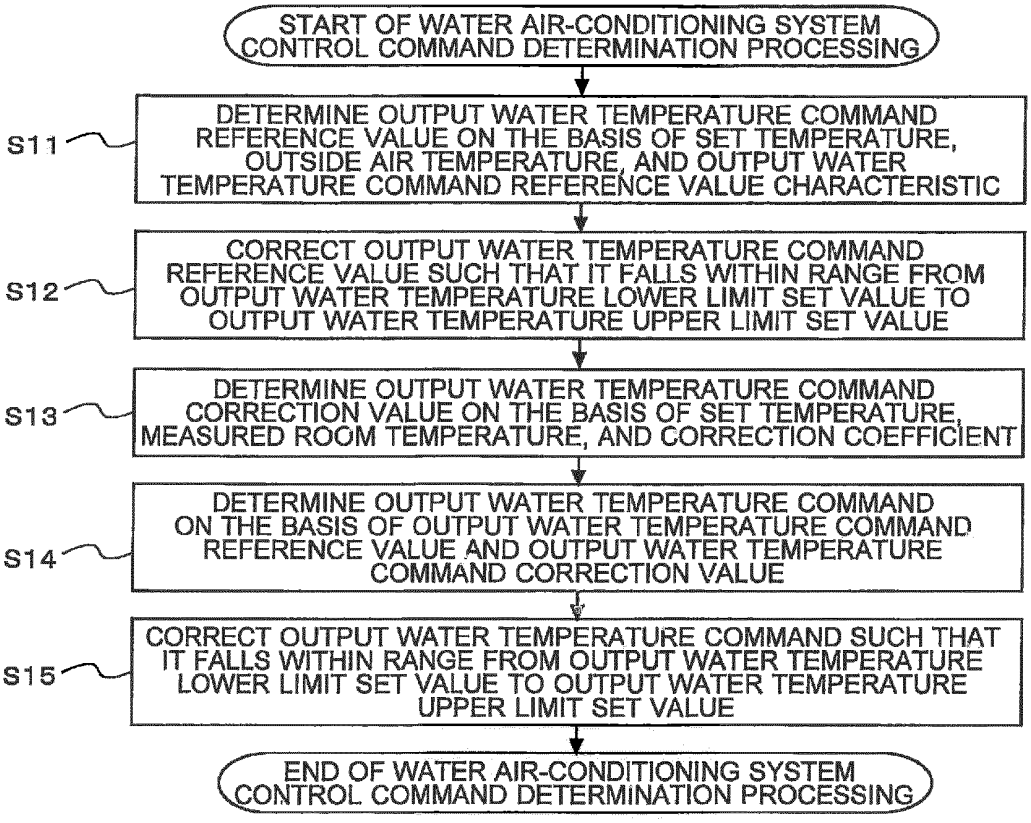

START OF WATER AIR-CONDITIONING SYSTEM CONTROL COMMAND DETERMINATION PROCESSING
S11
DETERMINE OUTPUT WATER TEMPERATURE COMMAND REFERENCE VALUE ON THE BASIS OF SET TEMPERATURE, OUTSIDE AIR TEMPERATURE, AND OUTPUT WATER TEMPERATURE COMMAND REFERENCE VALUE CHARACTERISTIC
S12
CORRECT OUTPUT WATER TEMPERATURE COMMAND REFERENCE VALUE SUCH THAT IT FALLS WITHIN RANGE FROM OUTPUT WATER TEMPERATURE LOWER LIMIT SET VALUE TO OUTPUT WATER TEMPERATURE UPPER LIMIT SET VALUE
S13
DETERMINE OUTPUT WATER TEMPERATURE COMMAND CORRECTION VALUE ON THE BASIS OF SET TEMPERATURE, MEASURED ROOM TEMPERATURE, AND CORRECTION COEFFICIENT
S14
DETERMINE OUTPUT WATER TEMPERATURE COMMAND ON THE BASIS OF OUTPUT WATER TEMPERATURE COMMAND REFERENCE VALUE AND OUTPUT WATER TEMPERATURE COMMAND CORRECTION VALUE
S15
CORRECT OUTPUT WATER TEMPERATURE COMMAND SUCH THAT IT FALLS WITHIN RANGE FROM OUTPUT WATER TEMPERATURE LOWER LIMIT SET VALUE TO OUTPUT WATER TEMPERATURE UPPER LIMIT SET VALUE
END OF WATER AIR-CONDITIONING SYSTEM CONTROL COMMAND DETERMINATION PROCESSING

FIG. 12

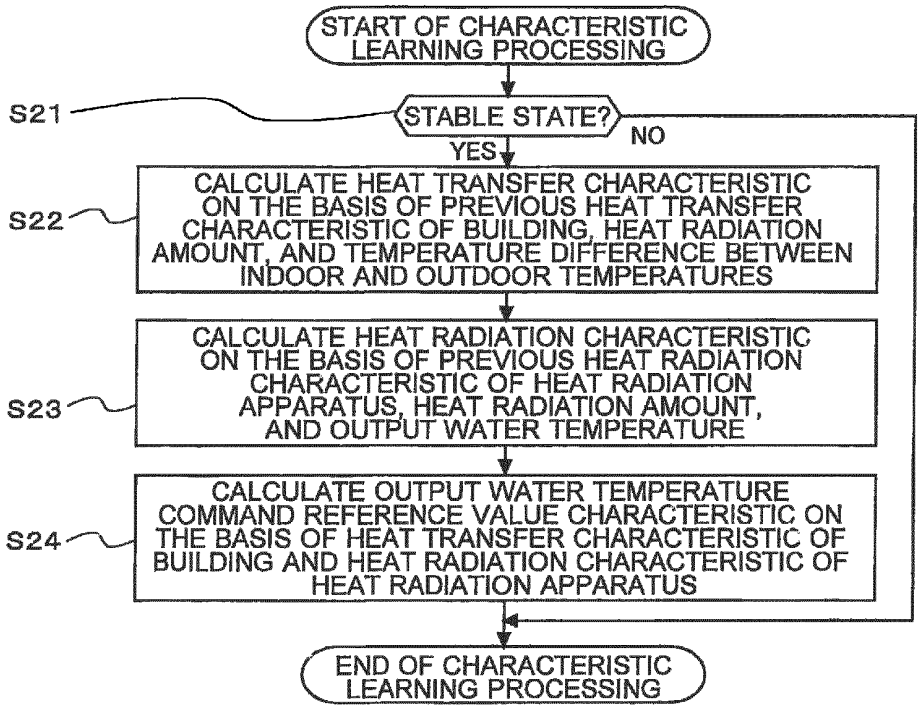

START OF CHARACTERISTIC LEARNING PROCESSING
S21
STABLE STATE?
NO
YES
S22
CALCULATE HEAT TRANSFER CHARACTERISTIC ON THE BASIS OF PREVIOUS HEAT TRANSFER CHARACTERISTIC OF BUILDING, HEAT RADIATION AMOUNT, AND TEMPERATURE DIFFERENCE BETWEEN INDOOR AND OUTDOOR TEMPERATURES
S23
CALCULATE HEAT RADIATION CHARACTERISTIC ON THE BASIS OF PREVIOUS HEAT RADIATION CHARACTERISTIC OF HEAT RADIATION APPARATUS, HEAT RADIATION AMOUNT, AND OUTPUT WATER TEMPERATURE
S24
CALCULATE OUTPUT WATER TEMPERATURE COMMAND REFERENCE VALUE CHARACTERISTIC ON THE BASIS OF HEAT TRANSFER CHARACTERISTIC OF BUILDING AND HEAT RADIATION CHARACTERISTIC OF HEAT RADIATION APPARATUS
END OF CHARACTERISTIC LEARNING PROCESSING

FIG. 13

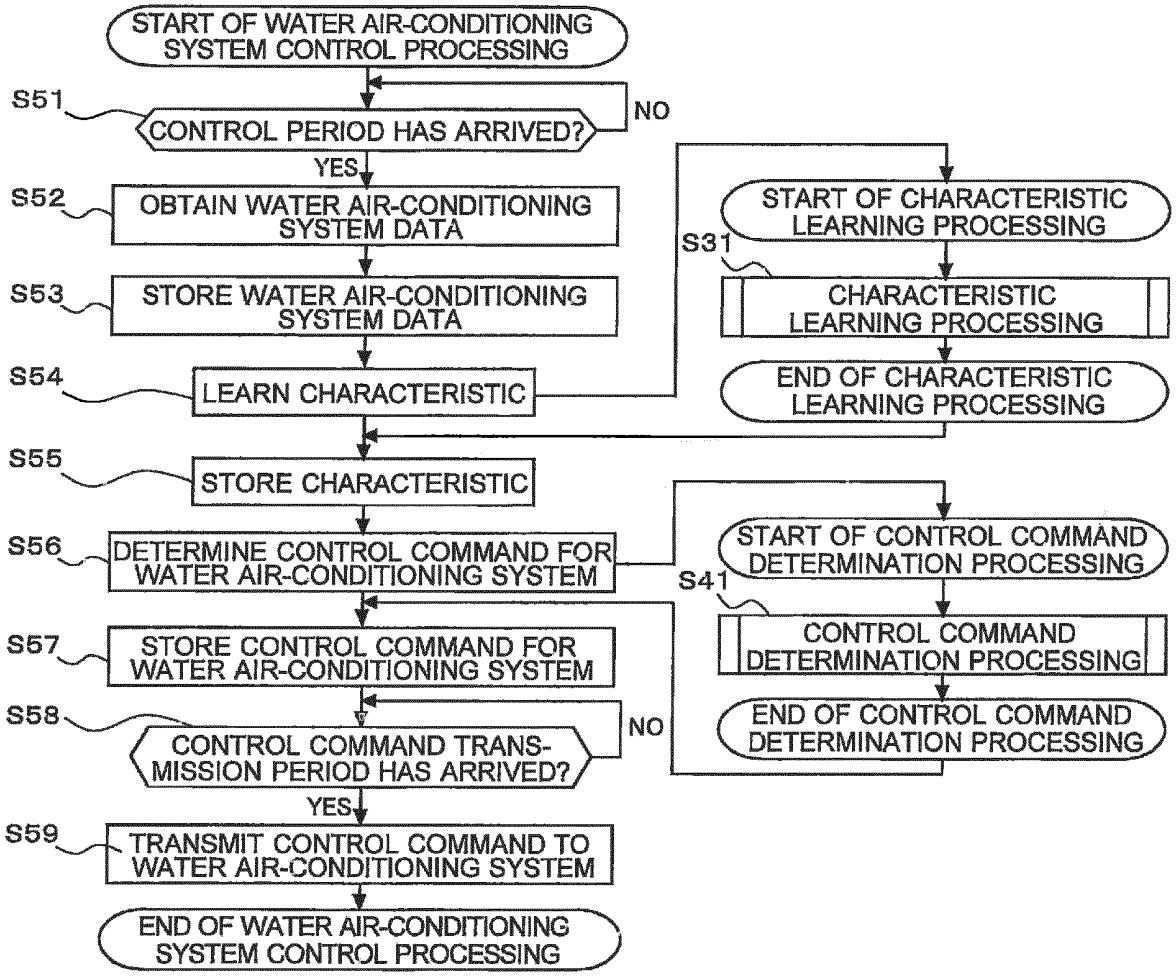
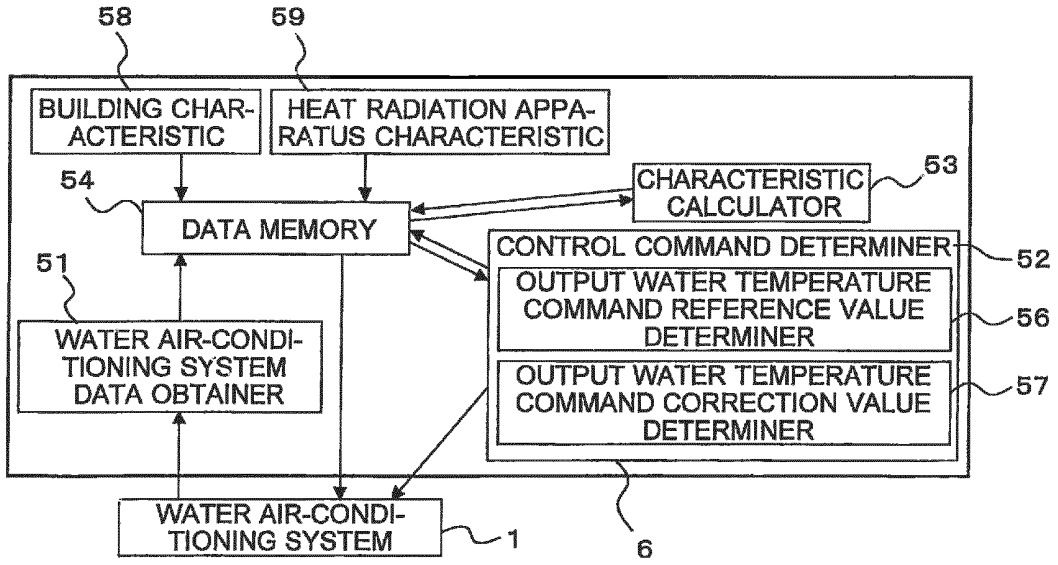

START OF WATER AIR-CONDITIONING SYSTEM CONTROL PROCESSING
S51
CONTROL PERIOD HAS ARRIVED?
NO
YES
S52
OBTAIN WATER AIR-CONDITIONING SYSTEM DATA
S53
STORE WATER AIR-CONDITIONING SYSTEM DATA
S54
LEARN CHARACTERISTIC
START OF CHARACTERISTIC LEARNING PROCESSING
S31
CHARACTERISTIC LEARNING PROCESSING
END OF CHARACTERISTIC LEARNING PROCESSING
S55
STORE CHARACTERISTIC
S56
DETERMINE CONTROL COMMAND FOR WATER AIR-CONDITIONING SYSTEM
START OF CONTROL COMMAND DETERMINATION PROCESSING
S41
CONTROL COMMAND DETERMINATION PROCESSING
END OF CONTROL COMMAND DETERMINATION PROCESSING
S57
STORE CONTROL COMMAND FOR WATER AIR-CONDITIONING SYSTEM
S58
CONTROL COMMAND TRANSMISSION PERIOD HAS ARRIVED?
NO
YES
S59
TRANSMIT CONTROL COMMAND TO WATER AIR-CONDITIONING SYSTEM
END OF WATER AIR-CONDITIONING SYSTEM CONTROL PROCESSING

FIG. 14


58
59
BUILDING CHARACTERISTIC
HEAT RADIATION APPARATUS CHARACTERISTIC
54
CHARACTERISTIC CALCULATOR
53
DATA MEMORY
CONTROL COMMAND DETERMINER
52
51
OUTPUT WATER TEMPERATURE COMMAND REFERENCE VALUE DETERMINER
56
WATER AIR-CONDITIONING SYSTEM DATA OBTAINER
OUTPUT WATER TEMPERATURE COMMAND CORRECTION VALUE DETERMINER
57
WATER AIR-CONDITIONING SYSTEM
1
6

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2015/060390

A. CLASSIFICATION OF SUBJECT MATTER
F24F11/02(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F24F11/02

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2015
Kokai Jitsuyo Shinan Koho 1971-2015 Toroku Jitsuyo Shinan Koho 1994-2015

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2002-147823 A (Daikin Industries, Ltd.), 22 May 2002 (22.05.2002), paragraphs [0074] to [0139]; fig. 1 to 9 & US 2003/0010047 A1 & WO 2002/039025 A1 & EP 1335167 A1 & DE 60119765 D & DE 60119765 T & AU 1276702 A & AU 763182 B & ES 2262688 T & CN 1395670 A	1-6
Y	JP 5-10568 A (Toshiba Corp.), 19 January 1993 (19.01.1993), paragraphs [0010] to [0018]; fig. 1 to 4 & US 5372015 A	1-6

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

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
25 June 2015 (25.06.15)	07 July 2015 (07.07.15)
Name and mailing address of the ISA/ Japan Patent Office 3-4-3,Kasumigaseki,Chiyoda-ku, Tokyo 100-8915,Japan	Authorized officer Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2015/060390

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 2012/101762 A1 (Mitsubishi Electric Corp.), 02 August 2012 (02.08.2012), paragraphs [0073] to [0084]; fig. 9 & US 2013/0289778 A1 & EP 2669589 A1 & CN 103328899 A	1-6
Y	JP 2011-214794 A (Mitsubishi Electric Corp.), 27 October 2011 (27.10.2011), paragraph [0077] (Family: none)	3-6

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2013092327 A **[0006]**
- JP 4032634 B **[0006]**