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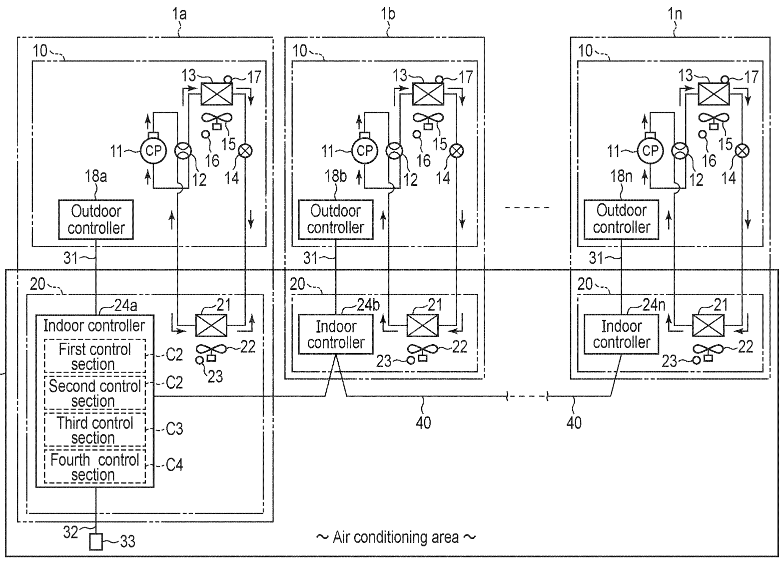
(54) AIR CONDITIONING DEVICE

(57) In the present invention, provided are a plurality of air conditioners which are disposed in the same air-conditioning area. If the maximum air conditioning capacity from among the air conditioning capacities of the plurality of air conditioners is a set value or greater, such maximum air conditioning capacity is controlled.



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Description

Technical Field

[0001] Embodiments described herein relate generally to an air conditioning apparatus comprising a plurality of air conditioners and air-conditioning one same air-conditioned area with the air conditioners.

Background Art

[0002] In an air conditioning apparatus comprising a plurality of air conditioners and air-conditioning one same air-conditioned area with the air conditioners, air conditioning load on each air conditioner is different depending on installation locations of the respective air conditioners, even in the same air-conditioned area. For example, the air conditioning load on the air conditioner installed in a place near a window is easily affected by the solar light and the outside air temperature, and the air conditioning load on the air conditioner installed in a place remote from a window is hardly affected by the solar light and the outside air temperature.

[0003] For this reason, the air conditioners running with a high air conditioning capacity and the air conditioners running with a low air conditioning capacity exist together even in the same air-conditioned area. The energy efficiency of the air conditioners running with a middle or low air conditioning capacity is desirable, but the energy efficiency of the air conditioners running with a high air conditioning capacity is low. The degradation of the energy efficiency leads to namely increase in the power consumption.

Citation List

Patent Literature

[0004] Patent Literature 1: JP 2011-89683 A

Summary of Invention

Technical Problem

[0005] Embodiments described herein aim to provide an air conditioning apparatus capable of securing desirable energy efficiency of a plurality of air conditioners, exerting an appropriate air conditioning capacity to sudden variation of the air conditioning load, and attempting the improvement of comfort.

Solution to Problem

[0006] An air conditioning apparatus of claim 1 comprises: a plurality of air conditioners arranged in one same air-conditioned area to control air conditioning capacities in accordance with air conditioning loads, respectively; and a controller which, when a maximum air conditioning capacity of the air conditioning capacities of the air conditioners is higher than or equal to a set value, inhibits the maximum air conditioning capacity.

Brief Description of Drawings

[0007]

FIG. 1 is a diagram showing a structure of an embodiment.
FIG. 2 is a flowchart showing control which a master unit executes in the embodiment.
FIG. 3 is a flowchart showing control which the master unit and the slave units execute in the embodiment.
FIG. 4 is a diagram showing a partial load factor of each air conditioner in a case where power linkage control is not executed in the embodiment.
FIG. 5 is a graph showing a relationship between a partial load factor and the energy efficiency of the air conditioner on a window side in FIG. 4.
FIG. 6 is a graph showing a relationship between a partial load factor and the energy efficiency of the air conditioner on a non-window side in FIG. 4.
FIG. 7 is a diagram showing a partial load factor of each air conditioner in a case where power linkage control is executed in the embodiment.
FIG. 8 is a graph showing a relationship between the partial load factor and the energy efficiency of the air conditioner on a window side in FIG. 7.
FIG. 9 is a graph showing a relationship between the partial load factor and the energy efficiency of the air conditioner on a non-window side in FIG. 7.
FIG. 10 is a chart showing variation of the partial load factor of each air conditioner and variation in the indoor temperature in the embodiment.

Mode for Carrying Out the Invention

[0008] One of embodiments will be described hereinafter with reference to the accompanying drawings.

[0009] As shown in FIG. 1, indoor units 20 of a plurality of air conditioners 1a, 1b, ... In configuring an air conditioning apparatus are arranged in one same air-conditioned area R.

[0010] An air conditioner 1a serving as a master unit comprises a heat-pump-type refrigerating cycle formed by sequentially connecting a compressor 11, a four-way valve 12, an outdoor heat exchanger 13, a decompression device, for example, electric expansion valve 14, and an indoor heat exchanger 21 by piping.

[0011] At the cooling operation, a refrigerant discharged from the compressor 11 flows into the outdoor heat exchanger (condenser) 13 through the four-way valve 12, the refrigerant flowing out from the outdoor heat exchanger 13 flows into the indoor heat exchanger (evaporator) 21 through the electric expansion valve 14, and the refrigerant flowing out from the indoor heat exchanger

21 is sucked into the compressor 11 through the four-way valve 12.

[0012] At the heating operation, the refrigerant discharged from the compressor 11 flows into the indoor heat exchanger (condenser) 21 through the four-way valve 12, the refrigerant flowing out from the indoor heat exchanger 21 flows into the outdoor heat exchanger (evaporator) 13 through the electric expansion valve 14, and the refrigerant flowing out from the outdoor heat exchanger 13 is sucked into the compressor 11 through the four-way valve 12, as represented by arrows, by change of the flow path of the four-way valve 12.

[0013] An outdoor fan 15 sucking outdoor air and passing the outdoor air to the outdoor heat exchanger 13 is arranged in the vicinity of the outdoor heat exchanger 13, and an outside air temperature sensor 16 detecting an outside air temperature To is arranged in a suction air path of the outdoor fan 15. An indoor fan 22 sucking the indoor air of the air-conditioned area and passing the air through the indoor heat exchanger 21 is arranged in the vicinity of the indoor heat exchanger 21, and an indoor temperature sensor 23 detecting a temperature (referred to as an indoor temperature) Ta of the indoor air is arranged in a suction path of the indoor fan 22.

[0014] The compressor 11, the four-way valve 12, the outdoor heat exchanger 13, the electric expansion valve 14, the outdoor fan 15, and the outside air temperature sensor 16 are accommodated in an outdoor unit 10 together with an outdoor controller 18a, and the indoor unit 21, the indoor fan 22, and the indoor temperature sensor 23 are accommodated in the indoor unit 20 together with an indoor controller 24a. The outdoor controller 18a and the indoor controller 24a are interconnected through a serial signal line 31 synchronous with a power supply voltage, and a remote control-type operator (simply referred to as a remote controller) 33 for the operation and for operating condition setting is connected to the indoor controller 24a through a cable 32. The remote controller 33 is attached onto a wall surface of the air-conditioned area or the like and can easily be controlled by the user.

[0015] The outdoor controller 18a is composed of a microcomputer and peripheral circuits thereof, controls the compressor 11, the four-way valve 12, the electric expansion valve 14, and the outdoor fan 15 in response to instructions from the indoor controller 24a, and sends data such as the detection temperature (referred to as an outside air temperature) To of the outside air temperature sensor 16 and the detection temperature (referred to as a heat exchanger temperature) Te of a heat exchange temperature sensor 17 to the indoor controller 24a by a serial signal line 31.

[0016] The indoor controller 24a is composed of a microcomputer and peripheral circuits thereof and controls the operation of the air conditioner 1a in accordance with control of the remote controller 33, the operating condition set by the remote controller 33, data transmitted from the outdoor controller 18a, and the like. That is, the indoor controller 24a recognizes a difference ΔT (= | Ts - Ta |) between a target indoor temperature Ts set with the remote controller 33 and a detected temperature (indoor temperature) Ta of the indoor temperature sensor 23 as air conditioning load of the air conditioner 1a, and executes indoor temperature control to control a capacity (operation frequency) of the compressor 11, i.e., an air conditioning capacity of the air conditioner 1a such that the air conditioning load ΔT becomes zero, i.e., the indoor temperature Ta becomes the target indoor temperature Ts.

[0017] A bus line 40 for control and for data transmission is connected between the indoor controller 24a and indoor controllers 24b to 24n.

[0018] Air conditioners 1b to In are merely different from the air conditioner 1a with respect to a feature of including outdoor controllers 18b to 18n and the indoor controllers 24b to 24n and the basic structure thereof is the same as that of the air conditioner 1a.

[0019] The indoor controllers 24b to 24n are composed of microcomputers and peripheral circuits thereof and control the operations of the respective air conditioners 1b to In in response to the data transmitted from the respective outdoor controllers 18b to 18n and the instruction from the indoor controller 24a. That is, the difference ΔT (= | Ts - Ta |) between the target indoor temperature Ts set with the remote controller 33 and the detected temperature (indoor temperature) Ta of each indoor temperature sensor 23 is recognized as the air conditioning load of each of the air conditioners 1b to In, and the capacities (operation frequencies) of the respective compressors 11, i.e., the air conditioning capacities of the air conditioners 1b to In are controlled, respectively, such that the air conditioning loads ΔT become zero.

[0020] When a group control mode of controlling the air conditioners 1a, 1b, ... In as one group is set with the remote controller 33, the indoor controller 24a of the air conditioner 1a functions as the master unit which is the center of the control, and the remaining air conditioners 1b to In and the indoor controllers 24b to 24n function as slave units following the instructions of the master unit.

[0021] The indoor controller 24a of the air conditioner 1a comprises a first control section C1, a second control section C2, a third control section C3, and a fourth control section C4 as main functions relating to the power linkage of the master unit and the slave units.

[0022] The first control section C1 executes communication with the indoor controllers 24a to 24n regularly as needed through the data bus line 40.

[0023] When the air conditioning capacity of the air conditioners 1b to In is detected by communication of the first control section C1 and the maximum air conditioning capacity (partial load factor L to be described later) of the air conditioning capacities of the air conditioner 1a and the air conditioners 1b to In is more than or equal to a set value and when a difference between the maximum air conditioning capacity and the minimum air conditioning capacity is more than or equal to a predetermined value, the second control section C2 gradually inhibits the maximum air conditioning capacity by a predetermined value (for example, 5%) and entrusts the operation of the remaining air conditions except the air conditioner which is targeted for the inhibition with the processing of air conditioning load ΔT' corresponding to the inhibition of this air conditioning capacity, by determining that the balance of high and low levels of each air conditioning load ΔT relating to the air conditioners 1a to In is not desirable for energy efficiency and should be solved. This control is referred to as power linkage control. That is, one or more remaining air conditioners except the air conditioner which is targeted for the inhibition of the air conditioning capacity takes in the air conditioning load ΔT' corresponding to the inhibition of the air conditioning capacity, additionally and naturally, as the increase in the air conditioning load ΔT of the air conditioner and processes the taken air conditioning load ΔT' together with the original air conditioning load ΔT by temporary increase of the course-like air conditioning capacity under normal indoor temperature control of the air conditioner. When remaining air conditioners except the air conditioner which is targeted for the inhibition of the air conditioning capacity is a plurality of air conditioners, the air conditioning load ΔT' is added in a state of being appropriately distributed to a plurality of air conditioners. Incidentally, at the inhibition of the air conditioning capacity, this second control section C2 determines the air conditioning capacity lower than the air conditioning capacity (the above-mentioned maximum air conditioning capacity) at the time of starting the inhibition by a predetermined value (for example, 20%) as a limit value (upper limit load factor Ls to be described later) of inhibition, and gradually inhibits the maximum air conditioning capacity toward the limit value by each predetermined value (5%).

[0024] When the air conditioning load ΔT of the air conditioner targeted for the inhibition becomes higher than or equal to the threshold value while the air conditioning capacity is being inhibited by the second control section C2, the third control section C3 gradually increases the air conditioning capacity which is being inhibited, toward a value corresponding to the current air conditioning load ΔT of the air conditioner targeted for the inhibition.

[0025] Incidentally, more specifically, when the air conditioning load ΔT of the air conditioner targeted for the inhibition continues a condition more than or equal to a first threshold (for example, 2°C) for a certain time (for example, 30 minutes) or reaches a second threshold value (> first threshold value) higher than the first threshold value, while the air conditioning capacity is being inhibited by the second control section C2, the third control section C3 gradually increases the air conditioning capacity which is being inhibited toward a value corresponding to the current air conditioning load ΔT of the air conditioner targeted for the inhibition by each predetermined value (5%) .

[0026] When the remote control 33 is operated while the air conditioning capacity is being inhibited by the second control section C2, the fourth control section C4 gradually increases the air conditioning capacity which is being inhibited toward a value corresponding to the current air conditioning load ΔT of the air conditioner targeted for the inhibition, similarly to the third control section C3.

[Control of Master Unit]

[0027] The control which the indoor controller 24a of the master unit executes will be described with reference to a flowchart of FIG. 2. Steps S1, S2 ... in the flowchart will be simply referred to as S1, S2 ...

[0028] When the start control of the cooling operation or the heating operation is executed with the remote controller 33 (YES in S1), the indoor controller 24a instructs the indoor controllers 24b to 24n to start the operation and notifies the indoor controllers 24b to 24n of a target indoor temperature (also referred to as a setting temperature) Ts set with the operation of the remote controller 33 (S2).

[0029] Then, the indoor controller 24a sets "0" to a control flag f that is an index of whether the power linkage control is being executed or not (S3) and detects each of the air conditioning capacities that the air conditioners 1a to In are currently exerting as a partial load factor L (%) (S4). The partial load factor L (%) refers to a rate of the air conditioning capacities that the air conditioners 1a to In actually exert to rated air conditioning capacities of the respective air conditioners 1a to 1n.

[0030] Then, since the control flag f is "0" at this time (YES in S5), the indoor controller 24a selects a maximum partial load factor (maximum air conditioning capacity) Lmax of the partial load factors (air conditioning capacities) L of the respective air conditioners 1a to In and determines whether the maximum partial load factor Lmax is in a high load factor condition of being higher than or equal to a set value (for example, 50%) or not (S6).

[0031] When the determination result of S6 is affirmative (YES in S6), the indoor controller 24a selects a minimum partial load factor (minimum air conditioning capacity) Lmin of the partial load factors L of the respective air conditioners 1a to In and determines whether a difference ΔL (= Lmax - Lmin) between the maximum partial load factor Lmax and the minimum partial load factor Lmin is in a state of being higher than or equal to a determined value (for example, 20%) or not (S7).

[0032] When the determination result of S7 is affirmative (YES in S7), the indoor controller 24a sets the partial load factor L lower than the maximum partial load factor Lmax by a predetermined value (for example, 20%) as an upper limit load factor of the power linkage control and notifies the indoor controller of the air conditioner (i.e., air conditioner targeted for the inhibition) running at the maximum partial load factor Lmax of the upper limit load factor Ls, by determining that the balance of the air conditioning loads ΔT of the air conditioners 1a to In is undesirable in energy efficiency and should be solved promptly (S8).

[0033] In accordance with the setting and notice of the upper limit load factor Ls, the indoor controller 24a sets "1" to the control flag f (S9) and monitors the stop control of the remote controller 33 (S10). When the stop control of the remote controller 33 is not executed (NO in S10), the indoor controller 24a monitors an "end of inhibition" notice from the room controller of the air conditioner (i.e., the air conditioner targeted for the inhibition) running with the maximum partial load factor Lmax (S12).

[0034] When the "end of inhibition" notice is not sent (NO in S12), the indoor controller 24a return to S4, detects the partial load factors L of the respective air conditioners 1a to In again (S4) and confirms the control flag f (S5). Since the control flag f at this time is "1" (NO in S5), the indoor controller 24a bypasses the processes of S6 to S9 and shifts to S10 and monitors the stop control of the remote controller 33 (S10).

[0035] When the "end of inhibition" notice is sent (YES in S12), the indoor controller 24a sets "0" to the control flag f (S13). Then, the indoor controller 24a returns to S4, and detects the partial load factors L of the respective air conditioners 1a to In again (S4), and confirms the control flag f (S5). Since the control flag f at this time is "0" (YES in S5), the indoor controller 24a repeats the processes of S6 to S10.

[0036] When the stop control of the remote controller 33 is executed (YES in S10), the indoor controller 24a instructs the indoor controllers 24b to 24n to stop the operation (S11).

[Control of Master Unit and Slave Units]

[0037] The control executed by the indoor controller 24a of the master unit and the indoor controllers 24b to 24n of the slave units will be described with reference to a flowchart of FIG. 3.

[0038] When the instruction to start the operation is sent (YES in S21), the indoor controllers 24a to 24n start the operations of air conditioners 1a to In (S22). Then, the indoor controllers 24a to 24n detect a difference ΔT (= | Ta - Ts |) between the detected temperature (indoor temperature) Ta of each indoor temperature sensor 23 and the target indoor temperature Ts as their respective air conditioning loads ΔT, and control the partial load factors (air conditioning capacities) L of the air conditioners 1a to In in accordance with the air conditioning loads ΔT, respectively (S23).

[0039] When a certain time, for example, 15 minutes have elapsed since the start of the operation and the operations of the air conditioners 1a to In become stable (YES in S24), the room controllers 24a to 24n monitor whether the upper limit load factor Ls is set and notified or not (S25). When the upper limit load factor Ls is not set and notified (NO in S25), the indoor controllers 24a to 24n monitor whether the instruction to stop the operation is sent or not (S35).

[0040] When the instruction to stop the operation is not sent (NO in S35), the indoor controllers 24a to 24n return to the process of S25 and monitors again whether the upper limit load factor Ls is set and notified or not (S25). When the instruction to stop the operation is sent (YES in S35), the indoor controllers 24a to 24n stop the operations of the air conditioners 1a to In (S36) .

[0041] The control in a case where, for example, the air conditioning load ΔT of the air conditioner 1b increases rapidly and the partial load factor L of the air conditioner 1b becomes the maximum partial load factor Lmax accordingly will be described below.

[0042] When the maximum partial load factor Lmax is in the high load factor state of being higher than or equal to the set value (YES in S6) and when the difference ΔT between the maximum partial load factor Lmax and the minimum partial load factor Lmin is in a state of being higher than or equal to the determined value (S7), the upper limit load factor Ls is set in the room controller 24a and is notified from the indoor controller 24a to the room controller 24b (S8).

[0043] When receiving the notice of the upper limit load factor Ls from the indoor controller 24a (YES in S25), the indoor controller 24b compares the upper limit load factor Ls with the partial load factor L (= Lmax) of the air conditioner 1b (S26). When the partial load factor L of the air conditioner 1b is higher than the upper limit load factor Ls (YES in S26), the indoor controller 24b inhibits the partial load factor L of the air conditioner 1b by a predetermined value (5%) (S27) .

[0044] In this inhibition, the air conditioning load ΔT' corresponding to the inhibition of the partial load factor L, of the air conditioning load ΔT of air conditioner 1b, is not processed in the air conditioner 1b. The processing of this air conditioning load ΔT' is entrusted to the operations of the air conditioners 1a and 1c to 1n present in the same air-conditioned area R.

[0045] That is, the air conditioners 1a and 1c to 1n take in air conditioning loads ΔT' untreated by inhibiting the partial load factor L of the air conditioner 1b, as the increase of the air conditioning loads ΔT of the respective air conditioners 1a and 1c to 1n, additionally and naturally, and process the taken air conditioning loads ΔT' together with the respective original air conditioning loads ΔT by temporary increase of each partial load factor L caused by the normal indoor temperature control of the air conditioners 1a and 1c to 1n. In this case, the air conditioners 1a and 1c to 1n only continue normal basic operations to control the respective partial load factors L in accordance with the respective air conditioning loads ΔT.

[0046] When 15 minutes have elapsed since start of the inhibition of the partial load factor L of the air conditioner 1b (YES in S28), the indoor controller 24b discriminates whether the air conditioning load ΔT of the air conditioner 1b continues the state of being higher than or equal to the first threshold value (2°C) for a certain time (30 minutes) or not (S29). When the determination result is negative (NO in S29), the indoor controller 24b determines whether the air conditioning load ΔT of the air conditioner 1b reaches a second threshold value (3°C) and continues the state for a predetermined time (1 minute) or not (S30). When the determination result is negative (NO in S30), the indoor controller 24b determines whether the remote controller 33 is operated or not (S31). When the determination result is negative (NO in S31), the indoor controller 24b returns to S26 and compares the partial load factor L with the upper limit load factor Ls again (S26).

[0047] When the partial load factor L is higher than the upper limit load factor Ls (YES in S26), the indoor controller 24b further inhibits the partial load factor L by a predetermined value (5%) (S27) and shifts to the determinations of S28 to S31. When all the determination results of S29, S30, and S31 are negative, inhibiting the partial load factor L by the predetermined value (5%) in S27 is repeated every 15 minutes.

[0048] When the inhibition advances and the partial load factor L becomes lower than or equal to the upper limit load factor Ls (NO in S26), the room controller 24b shifts to the determination of S29 without executing the processes of S27 and S28, and waits for either of the determination results of S30 and S31 being affirmative while keeping the inhibited state of the partial load factor L.

[0049] When the air conditioning load ΔT of the air conditioner 1b continues in the state of being higher than or equal to the first (2°C) for a certain time (30 minutes) (YES in S29), the indoor controller 24b increases the partial load factor L which is being inhibited, by a predetermined value (5%), toward a value corresponding to the current air conditioning load ΔT of the air conditioner 1b targeted for inhibition, by determining that the indoor temperature Ta detected by the air conditioner 1b can hardly be maintained at the target indoor temperature Ts in the condition that the capacity of the air conditioner 1b is slightly short (32).

[0050] When the air conditioning load ΔT of the air conditioner 1b exceeds the first threshold value (2°C) and reaches the second threshold value (3°C) and the state continues for a predetermined time (1 minute) (NO in S29 and YES in S30), the indoor controller 24b increases the partial load factor L which is being inhibited, by a predetermined value (5%), toward a value corresponding to the current air conditioning load ΔT of the air conditioner 1b targeted for inhibition, by determining that shortage of the capacity of the air conditioner 1b is serious and the room temperature Ta at the room controller 24b cannot be maintained at the target indoor temperature Ts (32).

[0051] In the cooling, since even a small rise in the indoor temperature Ta causes unpleasant feeling, the determination processes of S29 and S30 relating to the variation of the air conditioning load ΔT are essential. In the heating, since a small decrease in the indoor temperature Ta does not cause unpleasant feeling, the processes of S29 and S30 relating to the variation of the air conditioning load ΔT do not need to be executed.

[0052] When any type of operation to the remote controller 33 is executed by a resident of the air-conditioned area R (NO in S29, NO in S30, and YES in S31), the indoor controller 24b increases the partial load factor L which is being inhibited, by a predetermined value (5%), toward a value corresponding to the current air conditioning load ΔT of the air conditioner 1b targeted for inhibition, by determining that the comfortability of the air-conditioned area R becomes worse (S32).

[0053] Following the increase of the partial load factor L in S32, the indoor controller 24b determines whether the increased partial load factor L reaches the value corresponding to the current air conditioning load ΔT of the air conditioner 1b targeted for control or not (S33). When the determination result is negative (NO in S33), the indoor controller 24b repeats the increase of the partial load factor L in S32 (S32).

[0054] When the determination result is affirmative (YES in S33), the indoor controller 24b notifies the indoor controller 24a of "end of inhibition" (S34) and monitors the instruction to stop the operation from the indoor controller 24a (S35). When the instruction to stop the operation is not sent (NO in S35), the indoor controller 24b returns to S25 and monitors whether a new upper limit load factor Ls is set and notified or not (S25). When the instruction to stop the operation is sent (YES in S35), the indoor controller 24b stops the operation of the air conditioner 1b (S36).

[0055] As described above, when the air conditioning load ΔT of the air conditioner 1b increases rapidly and the partial load factor L (= Lmax) of the air conditioner 1b increases in a high load factor state of being higher than or equal to the set value and when the difference ΔL between the partial load factor L (= Lmax) and the minimum partial load factor Lmin of the air conditioner 1b is in the state of being higher than or equal to the predetermined value (20%), the partial load factor L of the air conditioner 1b is inhibited and the air conditioning load ΔT' corresponding to the inhibition of the partial load factor L is processed by the basic operation under the normal indoor temperature control of the remaining air conditioners 1a and 1c to 1n except the air conditioner 1b targeted for inhibition, by determining that the balance of the air conditioning loads ΔT of the respective air conditioners 1a to 1n is undesirable in energy efficiency and should be solved promptly, inhibits partial load factor L of air conditioner 1b and, therefore, even if the air conditioning load ΔT of the air conditioner 1b increases rapidly, the appropriate air conditioning capacity that is not delayed in response to the rapid increase of the air conditioning load ΔT of the air conditioner 1b can be obtained while preventing degradation of the energy efficiency of the air conditioner 1b and while maintaining the desirable energy efficiencies of the air conditioners 1a and 1c to 1n. Comfortability of the air-conditioned area R is improved.

[0056] when the partial load factor L (= Lmax) is inhibited, the inhibition is gradually executed by each predetermined value and, therefore, sudden decrease of the indoor temperature Ta of a place where the air conditioner targeted for inhibition is present can be prevented. Uncomfortable feeling is not given to the resident in the air-conditioned area R.

[0057] When the partial load factor L (= Lmax) which is being inhibited increases toward the value corresponding to the current air conditioning load ΔT of the air conditioner targeted for inhibition, the increase is gradually executed by each predetermined value and, therefore, sudden increase of the power consumption of the air conditioner targeted for inhibition can be prevented.

[0058] As shown in FIG. 4, when the air conditioner 1a is arranged at a place near a window which is well exposed to solar light and the air conditioner 1b is arranged at a place remote from the window and these air conditioners 1a and 1b execute the cooling operation, the air conditioning load ΔT of the air conditioner 1a becomes larger than the air conditioning load ΔT of the air conditioner 1b. In accordance with this, the air conditioner 1a runs with the high air conditioning capacity of, for example, partial load factor L = 80%, and the air conditioner 1b runs with the low air conditioning capacity of, for example, partial load factor L = 30%. In this case, as shown in FIG. 5 and FIG. 6, the energy efficiency of the air conditioner 1b running with a low air conditioning capacity is desirable, but the energy efficiency of the air conditioner 1a running with a high air conditioning capacity decreases.

[0059] When the power linkage control of the embodiment is executed in such a situation, the air conditioner 1a shifts from the running of the previous partial load factor L = 80% to the running with the middle air conditioning capacity of the partial load factor L = 60%, and the air conditioner 1b shifts from the running of the previous partial load factor L = 30% to the running with the middle air conditioning capacity of the partial load factor L = 50%, as shown in FIG. 7. In this case, as shown in FIG. 8 and FIG. 9, the energy efficiency of the air conditioner 1a increases and becomes desirable, and the energy efficiency of the air conditioner 1b is also kept in a preferable condition. That is, the overall energy efficiency of the air conditioning apparatus is improved.

[0060] Comparison of variations of the partial load factors L of the respective air conditioners 1a and 1b and variation of the indoor temperature Ta at a place where the air conditioner 1a is arranged are shown in FIG. 10 in a case where the power linkage control of the embodiment is provided and a case where the power linkage control is not provided is shown in FIG. 10.

[0061] In the above-described embodiment, when the maximum partial load factor Lmax is higher than or equal to the set value and the difference between the maximum partial load factor Lmax and the minimum partial load factor Lmin is larger than or equal to the predetermined value, the maximum partial load factor Lmax is inhibited but, when the maximum partial load factor Lmax is higher than or equal to the set value, the maximum partial load factor Lmax may be promptly controlled to be inhibited.

[0062] The above embodiments and modified example described herein have been presented by way of example only, and are not intended to limit the scope of the inventions. Indeed, the novel embodiments described herein may be embodied in a variety of other forms; furthermore, various omissions, substitutions and changes in the form of the embodiment described herein may be made without departing from the spirit of the invention. The accompanying claims and their equivalents are intended to cover such forms or modifications as would fall within the scope and spirit of the inventions.

Reference Signs List

[0063] 1a to 1n. . . Air conditioner, 10. . . Outdoor unit, 11... Compressor, 13... Outdoor heat exchanger, 18a, 18b, ... 18n... Outdoor controller, 20... Indoor unit, 24a to 24n... Indoor controller, 33... Remote controller, 40... Bus line.

Claims

1. An air conditioning apparatus **characterized by** comprising:

    a plurality of air conditioners arranged in one same air-conditioned area to control air conditioning capacities in accordance with air conditioning loads, respectively; and
    controller configured to inhibiting the maximum air conditioning capacity when a maximum air conditioning capacity of the air conditioning capacity of each of the air conditioners is higher than or equal to a set value.

2. The air conditioning apparatus of claim 1, **characterized in that**
    one or more remaining air conditioners except the air conditioner targeted for the inhibition, of each of the air conditioners, processes the air conditioning load corresponding to the inhibition of the air conditioning capacity as the air conditioning load of the air conditioner.

3. The air conditioning apparatus of claim 1, **characterized in that**
    the controller inhibits the maximum air conditioning capacity when the maximum air conditioning capacity is higher than or equal to the set value and a difference between the maximum air conditioning capacity and a minimum air conditioning capacity is larger than or equal to a predetermined value.

4. The air conditioning apparatus of claim 1, **characterized in that**
    the controller gradually inhibits the maximum air conditioning capacity by each predetermined value.

5. The air conditioning apparatus of claim 1, **characterized in that**
when the air conditioning load of the air conditioner targeted for the inhibition becomes higher than or equal to a threshold value while inhibiting the maximum air conditioning capacity, the controller gradually increases the air conditioning capacity which is being inhibited, toward a value corresponding to the air conditioning load of the air conditioner targeted for the inhibition.

6. The air conditioning apparatus of claim 1, **characterized in that**
when the air conditioning load of the air conditioner targeted for the inhibition continues in a state of being higher than or equal to a first threshold value or reaches a second threshold value higher than the first threshold value while inhibiting the maximum air conditioning capacity, the controller gradually increases the air conditioning capacity which is being inhibited, toward a value corresponding to the air conditioning load of the air conditioner targeted for the inhibition.

7. The air conditioning apparatus of claim 1, **characterized in that**

each of the air conditioners controls the air conditioning capacity such that each suction air temperature becomes a target indoor temperature set with an operation unit, and
when the operation unit is operated while inhibiting the maximum air conditioning capacity, the controller gradually increases the air conditioning capacity which is being inhibited, toward a value corresponding to the air conditioning load of the air conditioner targeted for the inhibition.

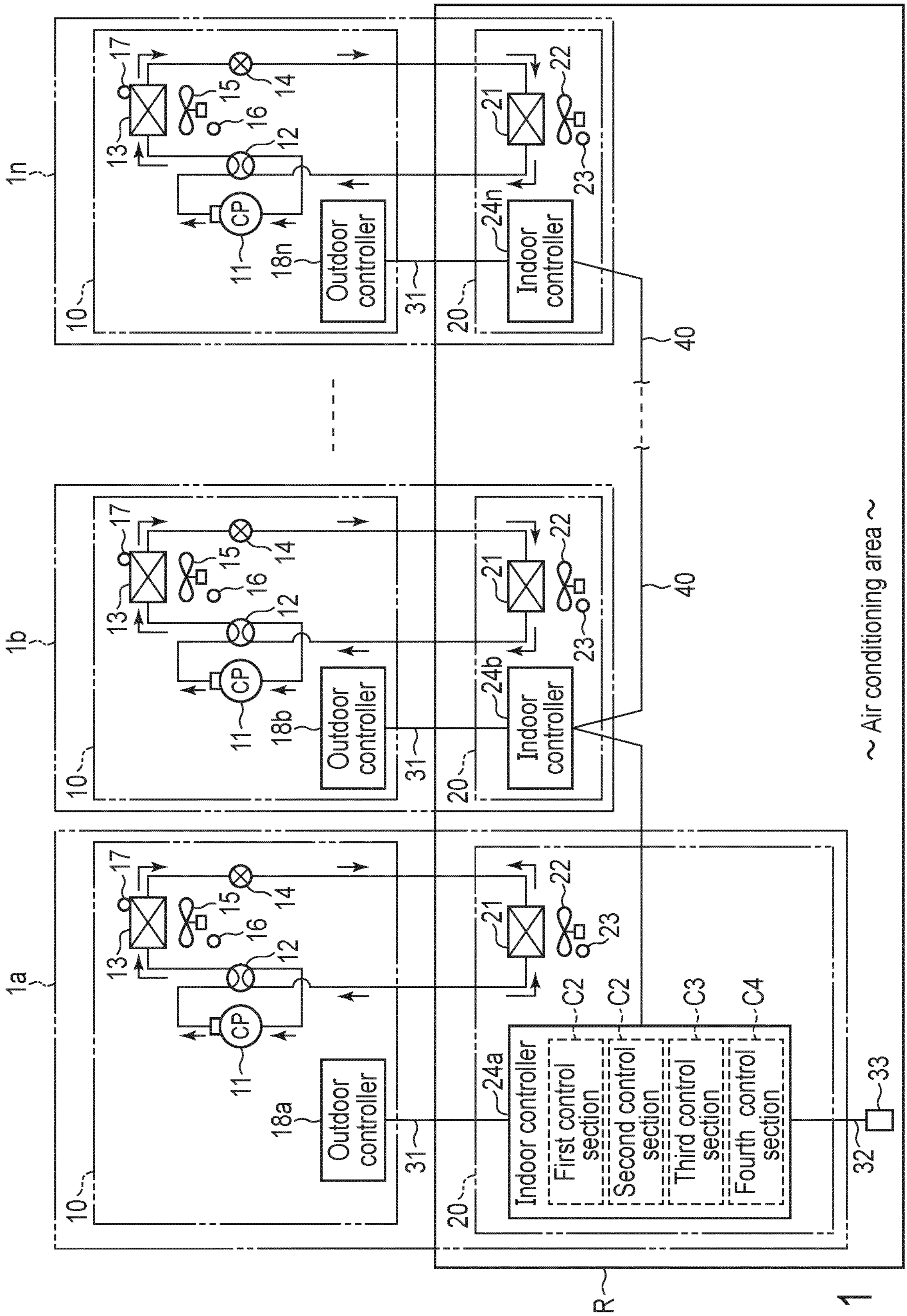

1a
1b
1n
10
11
CP
12
13
14
15
16
17
18a
18b
18n
Outdoor controller
20
21
22
23
24a
24b
24n
Indoor controller
First control section
Second control section
Third control section
Fourth control section
C2
C2
C3
C4
31
32
33
40
~ Air conditioning area ~
R

FIG. 1

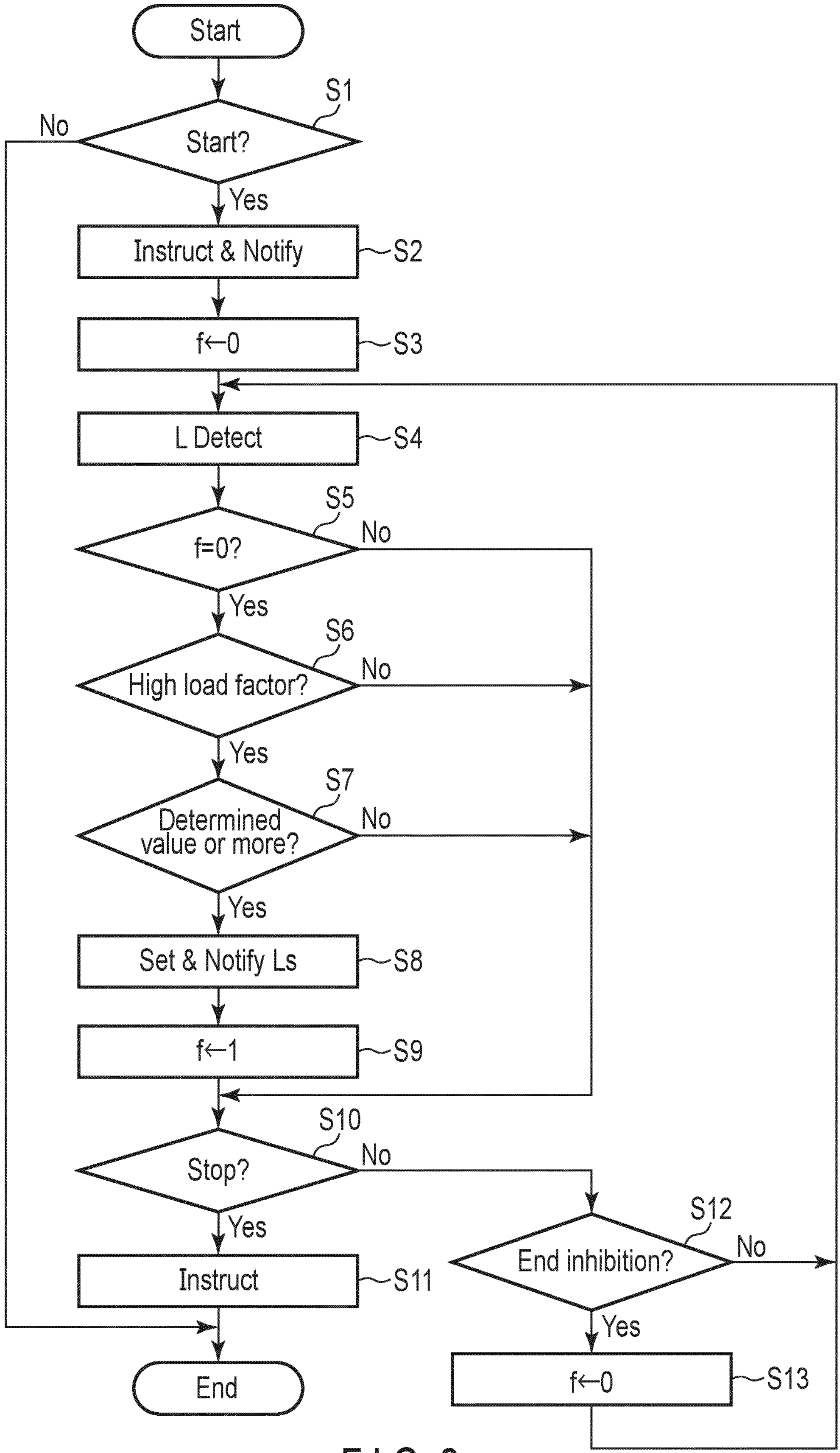
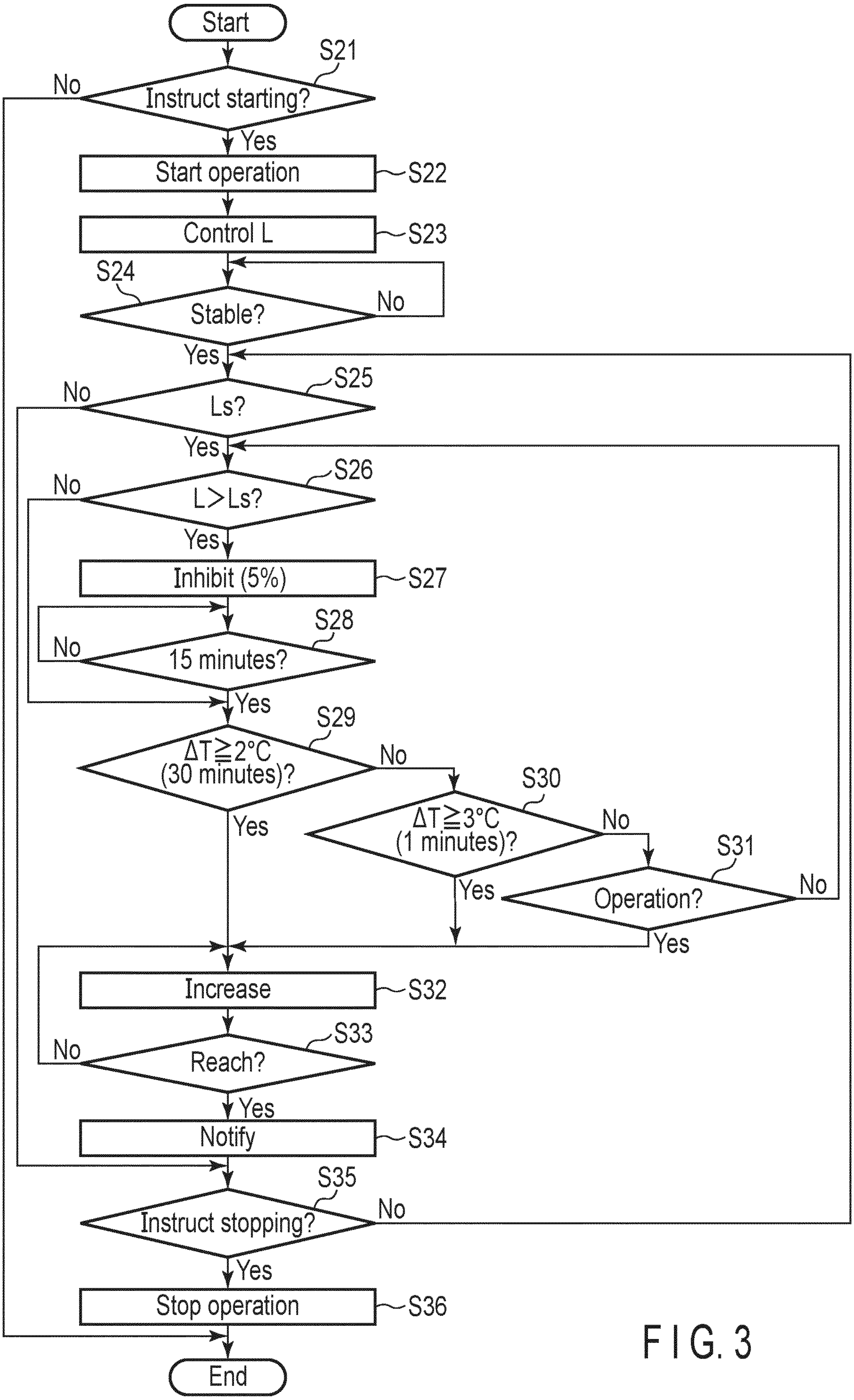

Start
S1
No
Start?
Yes
Instruct & Notify
S2
f←0
S3
L Detect
S4
S5
No
f=0?
Yes
S6
No
High load factor?
Yes
S7
No
Determined value or more?
Yes
Set & Notify Ls
S8
f←1
S9
S10
No
Stop?
Yes
Instruct
S11
S12
No
End inhibition?
Yes
f←0
S13
End

FIG. 2


Start
S21
Instruct starting?
No
Yes
Start operation
S22
Control L
S23
S24
Stable?
No
Yes
S25
Ls?
No
Yes
S26
L>Ls?
No
Yes
Inhibit (5%)
S27
S28
15 minutes?
No
Yes
S29
ΔT≧2°C (30 minutes)?
No
Yes
S30
ΔT≧3°C (1 minutes)?
No
Yes
S31
Operation?
No
Yes
Increase
S32
S33
Reach?
No
Yes
Notify
S34
S35
Instruct stopping?
No
Yes
Stop operation
S36
End

F I G. 3

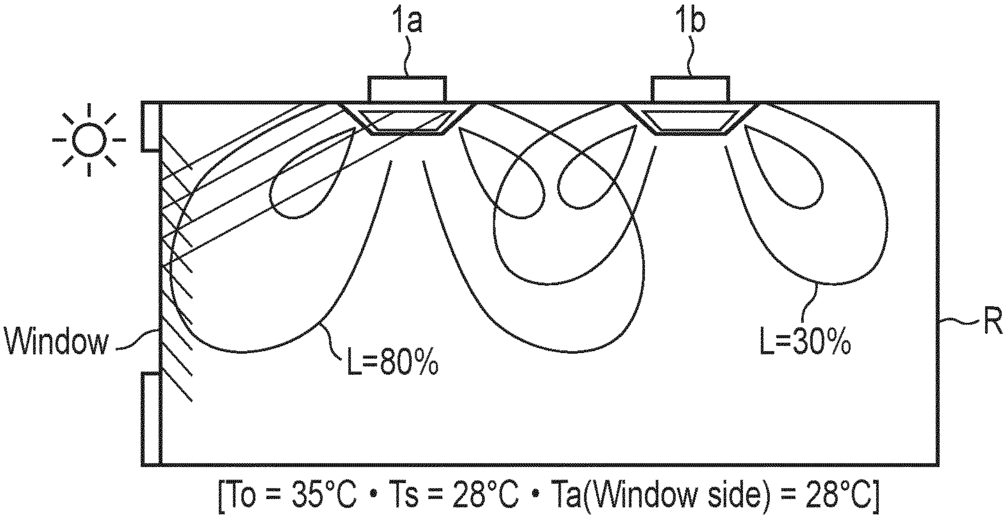

1a
1b
Window
L=80%
L=30%
R
[To = 35°C • Ts = 28°C • Ta(Window side) = 28°C]

FIG. 4

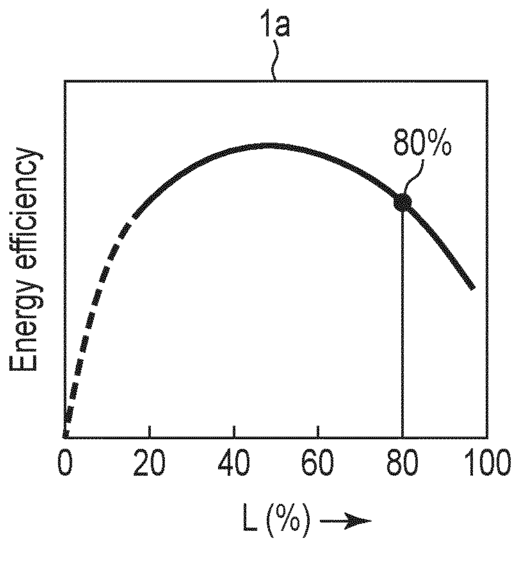
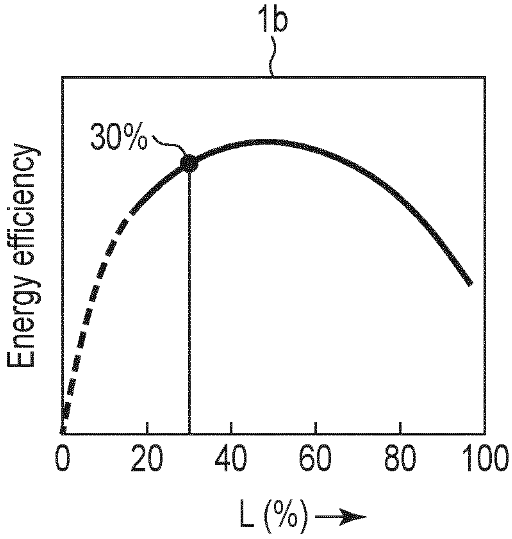
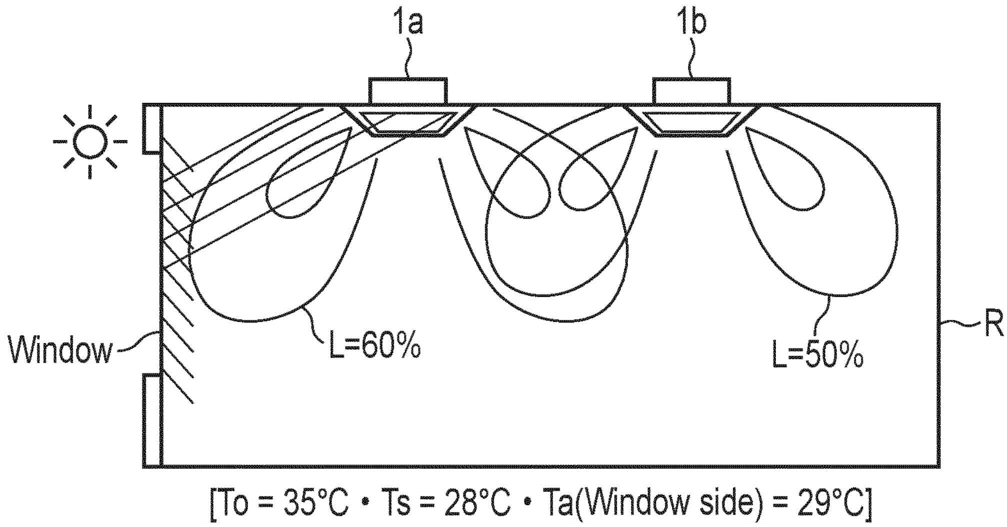

1a
80%
Energy efficiency
0
20
40
60
80
100
L (%)

FIG. 5


1b
30%
Energy efficiency
0
20
40
60
80
100
L (%)

F I G. 6


1a
1b
Window
L=60%
L=50%
R
[To = 35°C • Ts = 28°C • Ta(Window side) = 29°C]

F I G. 7

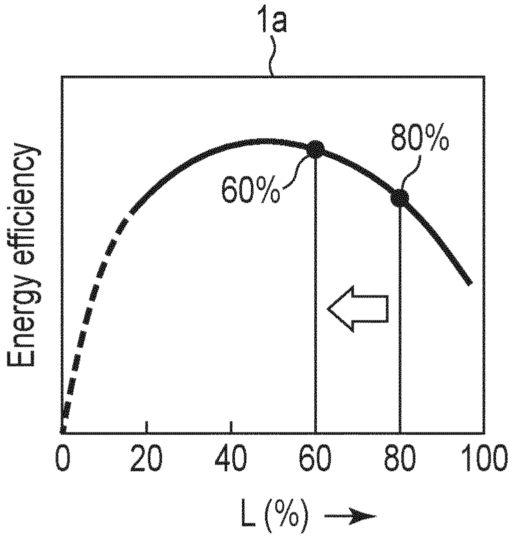

1a
Energy efficiency
60%
80%
0
20
40
60
80
100
L (%)

FIG. 8

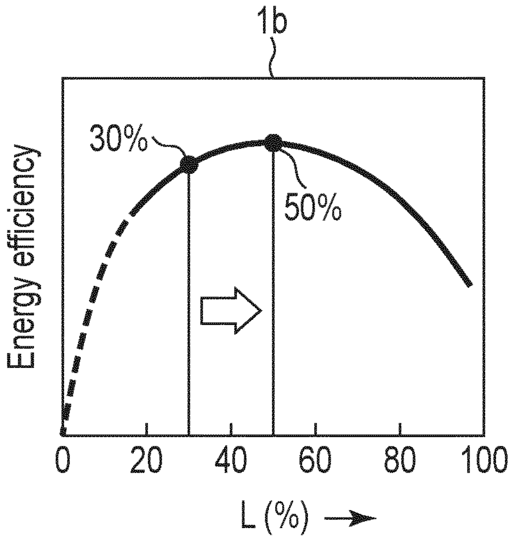
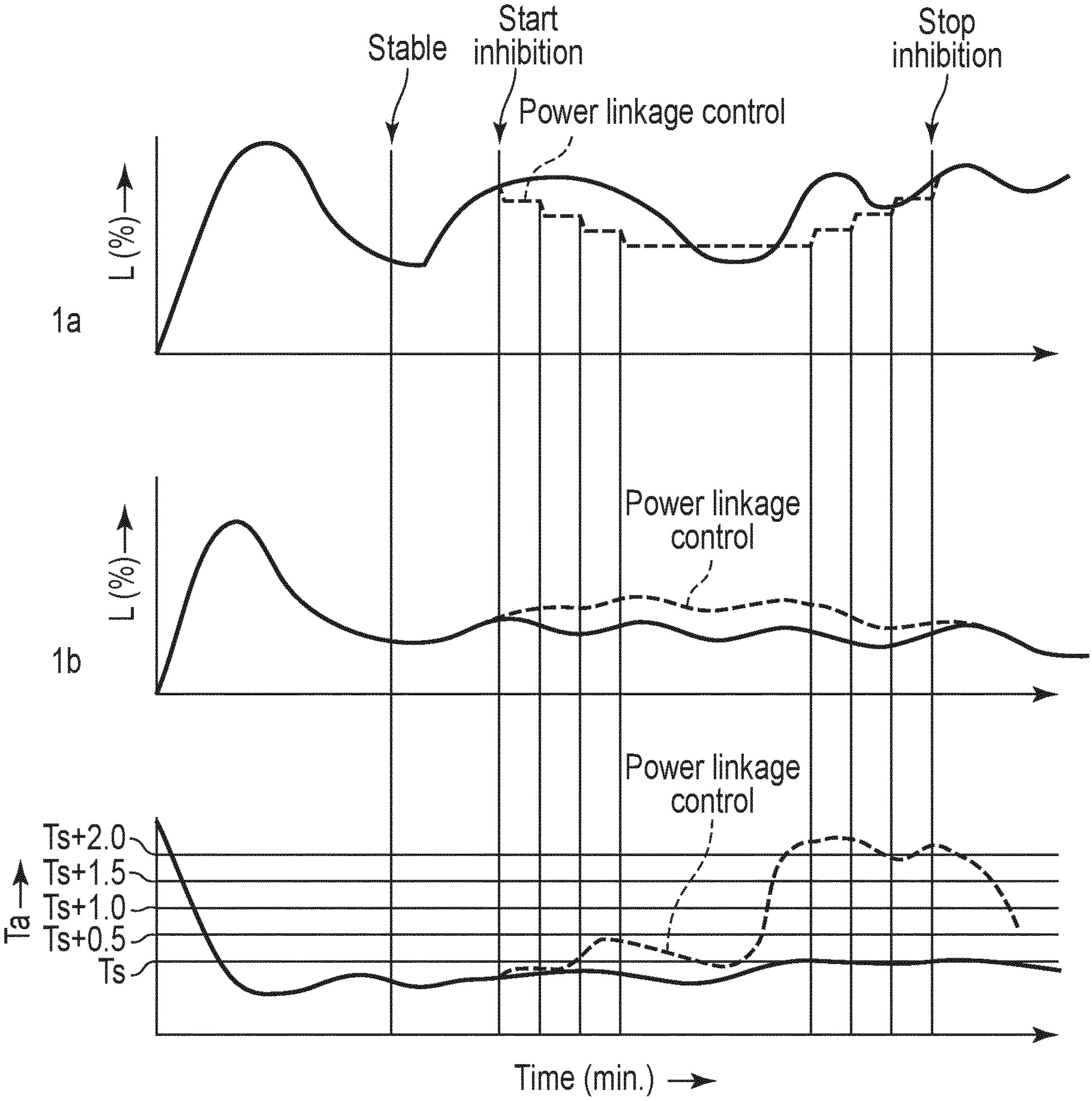

1b
Energy efficiency
30%
50%
0
20
40
60
80
100
L (%)

FIG. 9


Stable
Start inhibition
Stop inhibition
Power linkage control
L (%)
1a
Power linkage control
L (%)
1b
Power linkage control
Ta
Ts+2.0
Ts+1.5
Ts+1.0
Ts+0.5
Ts
Time (min.)

F I G. 10

INTERNATIONAL SEARCH REPORT

International application No. PCT/JP2019/047475

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl. F24F11/46(2018.01)i, F24F11/54(2018.01)i, F24F140/50(2018.01)n
FI: F24F11/54, F24F11/46, F24F140:50

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)
Int. Cl. F24F11/00-11/89

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

Published examined utility model applications of Japan	1922-1996
Published unexamined utility model applications of Japan	1971-2020
Registered utility model specifications of Japan	1996-2020
Published registered utility model applications of Japan	1994-2020

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.
X Y	JP 2007-71401 A (HITACHI, LTD.) 22 March 2007, paragraphs [0014]-[0037], fig. 1-6	1-2 3-7
Y	JP 2010-261617 A (MITSUBISHI ELECTRIC CORP.) 18 November 2010, paragraphs [0012]-[0084], fig. 6	3-4
Y	JP 2010-121798 A (MITSUBISHI ELECTRIC CORP.) 03 June 2010, paragraphs [0013]-[0033], fig. 1-3	5-7
A	JP 2011-89683 A (MITSUBISHI ELECTRIC CORP.) 06 May 2011, entire text, all drawings	1-7

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

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

Date of the actual completion of the international search	Date of mailing of the international search report
21.01.2020	04.02.2020

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

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

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2019/047475

Patent Documents referred to in the Report	Publication Date	Patent Family	Publication Date
JP 2007-71401 A	22.03.2007	(Family: none)	
JP 2010-261617 A	18.11.2010	(Family: none)	
JP 2010-121798 A	03.06.2010	US 2010/0125370 A1 paragraphs [0025]-[0046], fig. 1-3 EP 2336660 A1 CN 101737867 A CN 102705908 A	
JP 2011-89683 A	06.05.2011	US 2011/0093121 A1 EP 2314942 A2 CN 102042656 A	

Form PCT/ISA/210 (patent family annex) (January 2015)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2011089683 A **[0004]**