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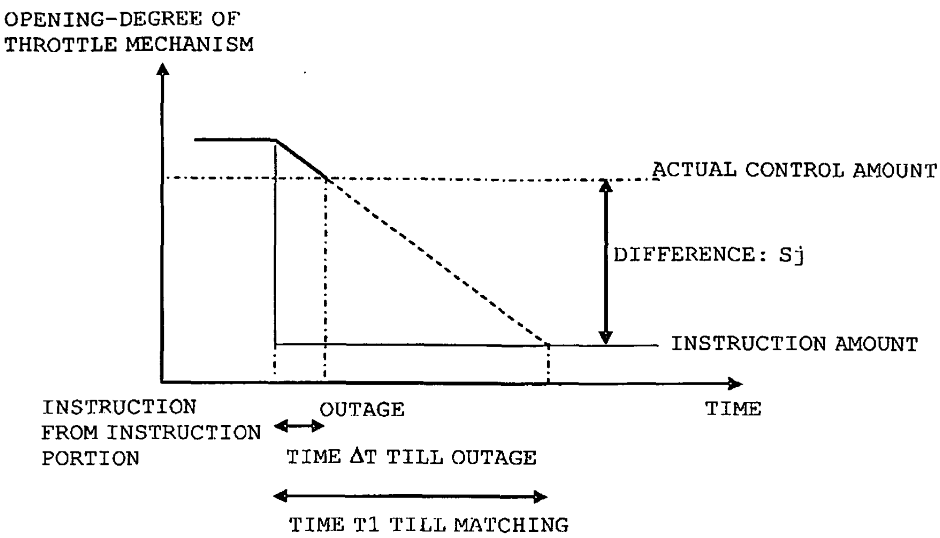
(54) **AIR CONDITIONER**

(57) An air conditioner that can start in a short time after power recovery and can maintain an optimal refrigerating cycle in a short time is provided.

An air conditioner 100 according to the present invention has a main refrigerant circuit in which a compressor 1, a heat-source-side heat exchanger 3, a high-pressure-side of a supercooling heat exchanger 4, a first throttle mechanism 5, and a use-side heat exchanger 6 are connected in series and a bypass circuit branching between the supercooling heat exchanger 4 and the first throttle mechanism 5 and connected to a suction side of the compressor 1 through the second throttle mechanism 8 and a low-pressure side of the supercooling heat exchanger 4, and a control portion 50 that compares the number of outages of this air conditioner 100 with a predetermined specified number of times determined in advance and determines necessity of initialization of the first throttle mechanism 5 and the second throttle mechanism 8 after power recovery.

F I G. 3



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Description

Technical Field

[0001] The present invention relates to an air conditioner that performs a cooling operation or a heating operation using a refrigerating cycle, and particularly to an air conditioner that is capable of maintaining a proper refrigerating cycle by controlling a throttle mechanism as appropriate, which is one of constituent elements of the refrigerating cycle.

Background Art

[0002] Hitherto, there have been air conditioners that are equipped for times of power outage. As such an apparatus, there has been proposed "an air conditioner including a refrigerant circuit provided with at least one compressor of variable capacity, a heat-source-side heat exchanger, an expansion valve, and a use-side heat exchanger sequentially connected by piping in an annular shape, in which operation state detecting means that detects an operation state of predetermined devices including at least the compressor and the expansion valve held by the refrigerant circuit, operation state storage means that stores the operation state detected by the operation state detecting means, power supply/outage detecting means that detects power feeding and outage of a power supply supplied to the refrigerant circuit, and predetermined device control means that controls the predetermined devices by setting the operation state before the outage stored in the operation state storage means at a control target value" (See Patent Document 1, for example).

[0003] In such an air conditioner, if outage occurs, an instruction amount to the throttle mechanism might be different from an actual control amount of the throttle mechanism in many cases. Thus, in the prior-art technology, after the outage of the air conditioner, a control amount of the throttle mechanism is initialized so that the instruction amounts of all the throttle mechanisms match the control amounts. Therefore, during the operation of the initialization of the throttle mechanism, an operation of the air conditioner cannot be resumed but is kept in a stopped state. However, if quick restoration of capability is requested after recovery of power to the air conditioner, a part of or the whole of the initialization of all the throttle mechanisms is omitted and the operation is continued without matching the instruction amount with the control amount.

[0004]

[Patent Document 1] Japanese Unexamined Patent Application Publication No. 2007-255759 (pages 4 and 5, Figs. 1 and 2 and the like)

Disclosure of Invention

Problems to be Solved by the Invention

[0005] With a control method of a throttle mechanism in a prior-art air conditioner or the like, a difference between an instruction amount and a control amount of the throttle mechanism becomes large each time the air conditioner loses power, and it might take a long time for a refrigerating cycle after power recovery to reach an optimal refrigerating cycle. Therefore, the refrigerating cycle after the power recovery cannot exhibit a predetermined capability quickly in some cases. Also, if an operation is continued while the instruction amount and the control amount of the throttle mechanism do not match, a failure might occur in the device.

[0006] The present invention was made in order to solve the above problems and an object thereof is to provide an air conditioner that can be started in a short time after power recovery and also can maintain an optimal refrigerating cycle after a short time.

Means for Solving the Problems

[0007] An air conditioner according to the present invention is an air conditioner having a compressor, a heat-source-side heat exchanger, a plurality of throttle mechanisms, and a use-side heat exchanger and is provided with a control portion that determines necessity of/ initialization of the plurality of throttle mechanisms after power recovery by comparing the number of outages of this air conditioner with a predetermined specified number of times set in advance.

[0008] The air conditioner according to the present invention is an air conditioner having a compressor, a heat-source-side heat exchanger, a plurality of throttle mechanisms, and a use-side heat exchanger and is provided with a control portion that modifies an instruction amount of an opening-degree to the plurality of throttle mechanisms after power recovery by comparing time AT from when an instruction of an opening-degree was given to the plurality of throttle mechanisms to when outage occurs in this air conditioner and a required time T1 until the instruction amount of the opening-degree to the plurality of throttle mechanisms matches an actual control amount of the opening-degree.

[0009] The air conditioner according to the present invention has a main refrigerant circuit in which a compressor, a heat-source-side heat exchanger, a high-pressure-side of a supercooling heat exchanger, a first throttle mechanism, and a use-side heat exchanger are connected in series and a bypass circuit branching between the supercooling heat exchanger and the first throttle mechanism and connected to a suction side of the compressor through a second throttle mechanism and a low-pressure side of the supercooling heat exchanger and is provided with a control portion that modifies an instruction amount of an opening-degree to the first throttle mechanism and the second throttle mechanism after power recovery by comparing an overheat-degree at an outlet of the use-side heat exchanger before and after the outage and the overheat-degree at an outlet of a bypass path side of the supercooling heat exchanger before and after the outage, respectively.

Advantages

[0010] According to the air conditioner according to the present invention, a refrigerating cycle can be started in a short time after power recovery and can be maintain optimal after a short time.

Brief Description of Drawings

[0011]

[Fig. 1] Fig. 1 is a refrigerant circuit diagram illustrating a refrigerant circuit configuration of an air conditioner according to Embodiment 1.
[Fig. 2] Fig. 2 is a graph illustrating a relationship between a control amount of a second throttle mechanism and a change of a refrigerating cycle.
[Fig. 3] Fig. 3 is a graph illustrating a relationship between the control amount of the second throttle mechanism and time at outage.
[Fig. 4] Fig. 4 is a flowchart illustrating a flow of processing of initialization of a throttle mechanism at occurrence of outage.
[Fig. 5] Fig. 5 is a refrigerant circuit diagram illustrating a refrigerant circuit configuration of an air conditioner according to Embodiment 2.
[Fig. 6] Fig. 6 is a flowchart illustrating a flow of processing on modification of an instruction amount of the throttle mechanism at occurrence of outage.
[Fig. 7] Fig. 7 is a refrigerant circuit diagram illustrating a refrigerant circuit configuration of an air conditioner according to Embodiment 3.
[Fig. 8] Fig. 8 is a graph illustrating a relationship between a control amount and an overheat-degree of the throttle mechanism.
[Fig. 9] Fig. 9 is a flowchart illustrating a flow of processing on modification of an instruction amount of the throttle mechanism at occurrence of outage. Reference Numerals

[0012] 1 compressor, 2 four-way valve, 3 heat-source-side heat exchanger, 4 supercooling heat exchanger, 5 first throttle mechanism, 6 use-side heat exchanger, 7 accumulator, 8 second throttle mechanism, 9 power portion, 50 control portion, 51 power-supply detecting means, 52 storage device, 52a storage device, 52b storage device, 61 high-pressure sensor, 62 low-pressure sensor, 65 first temperature sensor, 66 second temperature sensor, 100 air conditioner, 200 air conditioner, 300 air conditioner Best Modes for Carrying Out the Invention

[0013] Embodiments of the present invention will be described below while referring to the attached drawings.

Embodiment 1.

[0014] Fig. 1 is a refrigerant circuit diagram illustrating a refrigerant circuit configuration of an air conditioner 100 according to Embodiment 1 of the present invention. On the basis of Fig. 1, a refrigerant circuit configuration and an operation of the air conditioner 100 will be described. This air conditioner 100 performs a cooling operation or a heating operation using a refrigerating cycle (heat pump cycle) in which a refrigerant is circulated. Including Fig. 1, size relationships among individual constituent members might be different from the actual ones in the following drawings.

[0015] The air conditioner 100 is provided with a main refrigerant circuit in which a compressor 1, a four-way valve 2, a heat-source-side heat exchanger 3, a high-pressure-side channel of an supercooling heat exchanger 4, a first throttle mechanism 5, a use-side heat exchanger 6, and an accumulator 7 are connected by refrigerant piping in series. Also, the air conditioner 100 is provided with a bypass circuit in which a refrigerant pipeline branches on a downstream side of the supercooling heat exchanger 4 (downstream side in a flow direction of a refrigerant during a cooling operation), passes through the second throttle mechanism 8 and a low-pressure-side channel of the supercooling heat exchanger

4, and merged with a refrigerant pipeline that connects the four-way valve 2 and the accumulator 7.

[0016] The compressor 1 enables an air-conditioning operation to be performed by compressing a sucked low-temperature and low-pressure refrigerant, discharging the refrigerant as a high-temperature and high-pressure refrigerant and circulating the refrigerant in a system. This compressor 1 is configured as a type of compressor capable of frequency control by using an inverter in general, and it may be configured as a type of compressor having a constant rotation speed. The four-way valve 2 switches the refrigerant channel between the cooling operation and the heating operation. That is, when the four-way valve 2 is controlled, the flow direction of the refrigerant flowing through the refrigerant circuit is reversed between the cooling operation and the heating operation.

[0017] The heat-source-side heat exchanger 3 functions as a condenser (radiator) during the cooling operation and as an evaporator during the heating operation and condenses and liquefies the refrigerant or evaporates and gasifies the refrigerant through heat exchange with ambient air. The heat-source-side heat exchanger 3 is constructed in conjunction with a fan (not shown) in general and its condensing capability or evaporating capability is controlled by the rotation speed of the fan. The supercooling heat exchanger 4 has a function of performing heat exchange between the refrigerant flowing through the main refrigerant circuit (high-pressure-side) and the refrigerant flowing through the bypass circuit (low-pressure side), to remove the supercooled state of the refrigerant flowing through the main refrigerant circuit and to make control of the first throttle mechanism 5 stable. The supercooling heat exchanger 4 is represented by a double-pipe structure but is not limited to that and may be composed of a plate-type heat exchanger.

[0018] The first throttle mechanism 5 has functions of a decompression valve and an expansion valve and decompresses and expands the refrigerant. This first throttle mechanism 5 is assumed to be configured as a throttle mechanism capable of variable control of an opening-degree represented by an electronic expansion valve, for example. The use-side heat exchanger 6 functions as an evaporator during the cooling operation and a condenser (radiator) during the heating operation and performs heat exchange between the refrigerant and air (air supplied from the fan, not shown) so as to evaporate and gasify or to condense and liquefy the refrigerant.

[0019] The accumulator 7 is installed on the suction side of the compressor 1 and retains excess refrigerant generated by an operation state. In Embodiment 1, a case in which the accumulator 7 is provided is described as an example, but not limited to that. For example, a configuration may be adopted in which the accumulator 7 is not provided and a liquid receiver (receiver) is provided between the heat-source-side heat exchanger 3 and the supercooling heat exchanger 4. Alternatively, both the accumulator 7 and the liquid receiver may be provided. The second throttle mechanism 8 has a function of a decompression valve or an expansion valve and decompresses and expands the refrigerant. This second throttle mechanism 8 is assumed to be configured as a throttle mechanism capable of variable control of an opening-degree represented by an electronic expansion valve, for example.

[0020] The air conditioner 100 is provided with a control portion 50 that integrally controls the entire air conditioner 100. This control portion 50 is provided with an instruction portion that instructs specific throttle opening-degrees of the first throttle mechanism 5 and the second throttle mechanism 8 and initializes the throttle opening-degrees of the first throttle mechanism 5 and the second throttle mechanism 8. Also, the control portion 50 executes control of a driving frequency of the compressor 1 and switching control of the four-way valve 2 in accordance with the operation state and a mode. That is, the control portion 50 controls each actuator (the compressor 1, the fan, not shown, the first throttle mechanism 5, the second throttle mechanism 8, and the four-way valve 2) on the basis of an operation instruction from a user.

[0021] Also, the air conditioner 100 is provided with power-supply detecting means 51 that can detect outage/power recovery by detecting a power voltage of a power portion 9. This power-supply detecting means 51 may be of any type as long as it can detect the outage/power recovery by detecting the power voltage of the power portion 8 that connects the compressor 1 to the power supply on site. The detecting means 51 may be attached to an electric component other than the power portion 9 of the compressor 1. Moreover, the air conditioner 100 is provided with a storage device 52 that can store information on the number of times outage/power recovery has been detected by the power-supply detecting means 51. This storage device 52 is preferably includes nonvolatile memory such as a flash memory. The storage device 52 may be built into the control portion 50.

[0022] Examples of a refrigerant used in the air conditioner 100 include a nonazeotropic refrigerant mixture, a pseudo azeotropic refrigerant mixture, a single refrigerant and the like. Examples of a nonazeotropic refrigerant mixture include R407C (R32/R125/R134a) and the like, which are HFC (hydrofluorocarbon) refrigerants. Since this nonazeotropic refrigerant mixture is a mixture of refrigerants with different boiling points, it has a characteristic that composition ratios of a liquid-phase refrigerant and a gas-phase refrigerant are different. Examples of a pseudo azeotropic refrigerant mixture include R410A (R32/R125). R404A (R125/R143a/R134a) and the like, which are HFC (hydrofluorocarbon) refrigerants. This pseudo azeotropic refrigerant mixture has a characteristic of having an operation pressure that is approximately 1.6 times that of R22 in addition to characteristics similar to those of a nonazeotropic refrigerant mixture.

[0023] Also, examples of a single refrigerant include R22, which is an HCFC (hydrochlorofluorocarbon) refrigerant, and R134a, which is an HFC refrigerant, and the like. Since this single refrigerant is not a mixture, it has a characteristic of being easy to handle. Particularly, it is pointed out that a HCFC refrigerant such as the refrigerant R22 or the like used in a prior-art air conditioner has a higher ozone depletion potential than a HFC refrigerant, and its adverse effect on the environment is large. Due to such a background, transition to refrigerants with smaller ozone depletion potentials such as HFC refrigerants, natural refrigerants and the like has been promoted.

[0024] The flow of the refrigerant in a cooling mode will be described. This air conditioner 100 is capable of performing a cooling operation or a heating operation in accordance with of an instruction from a user. If the air conditioner 100 performs the cooling operation, the control portion 50 switches the four-way valve 2 so that a high-temperature and high-pressure refrigerant discharged from the compressor 1 flows into the heat-source-side heat exchanger 3. In this state, the operation of the compressor 1 is started. The control portion 50 controls throttle opening-degrees of the first throttle mechanism 5 and the second throttle mechanism 8, but control amounts will be described in Fig. 2.

[0025] The high-temperature and high-pressure refrigerant gas discharged from the compressor 1 flows into the heat-source-side heat exchanger 3 through the four-way valve 2. The refrigerant gas having flowed into the heat-source-side heat exchanger 3 is condensed and liquefied by air supplied from the fan (not shown). The condensed and liquefied high-pressure refrigerant flows through the high-pressure-side channel of the supercooling heat exchanger 4. Then, a part of the refrigerant having flowed out of the supercooling heat exchanger 4 flows into the bypass circuit side. The refrigerant having flowed into the bypass circuit side is decompressed and expanded by the second throttle mechanism 8 and becomes a low-pressure refrigerant. This refrigerant flows through the low-pressure-side channel of the super-cooling heat exchanger 4. At this time, in the supercooling heat exchanger 4, the high-pressure refrigerant flowing through the high-pressure-side channel and the low-pressure refrigerant flowing through the low-pressure-side channel exchange heat.

[0026] Therefore, the high-pressure refrigerant flowing through the high-pressure-side channel is further cooled by the low-pressure refrigerant flowing through the low-pressure-side channel, and the supercooling degree is increased. The high-pressure refrigerant cooled in the supercooling heat exchanger 4 is decompressed and expanded by the first throttle mechanism 5, becomes a low-pressure refrigerant and flows into the use-side heat exchanger 6. The low-pressure refrigerant having flowed into the use-side heat exchanger 6 is evaporated and gasified by air supplied from the fan (not shown). The evaporated and gasified low-pressure refrigerant passes through the four-way valve 2, merges with the low-pressure refrigerant having flowed through the bypass circuit the upstream of the accumulator 7 and flows into the accumulator 7. Then, the refrigerant is sucked into the compressor 1 again.

[0027] Fig. 2 is a graph illustrating the relationship between a control amount (throttle opening-degree) of the second throttle mechanism 8 and a change of the refrigerating cycle (state transition of the refrigerant). On the basis of Fig. 2, the change of the refrigerating cycle on the basis of the control amount of the second throttle mechanism 8 will be described. In Fig. 2, the horizontal axis indicates the control amount of the second mechanism 8 and the vertical axis indicates the change of the refrigerating cycle (state of the refrigerant), respectively. In Fig. 2, the control amount of the second throttle device 8 is shown as an example, but the control amount of the first throttle device 5 can be similarly described.

[0028] In the cooling mode executed by the air conditioner 100, as described above, the refrigerant having flowed into the bypass circuit is decompressed and expanded by the second throttle mechanism 8, becomes a low-pressure refrigerant and flows into the low-pressure-side channel of the supercooling heat exchanger 4. If the throttle opening-degree of the second throttle mechanism 8 is smaller (a range of too small in Fig. 2) than an optimal value (an appropriate range shown in Fig. 2), a heat exchange amount with a high-pressure refrigerant is insufficient in the supercooling heat exchanger 4, a supercooling degree is small, which leads to an insufficient degree of supercooling, and the capability of the air conditioner 100 is lowered. Also, if the throttle opening-degree of the second throttle mechanism 8 is further decreased, the high pressure of the refrigerant is excessively raised, which might lead to an abnormally high pressure.

[0029] On the other hand, if the throttle opening-degree of the second throttle mechanism 8 is larger than the optimal value (a range of excess in Fig. 2), the refrigerant having been condensed and liquefied in the heat-source-side heat exchanger 3 excessively flows into the accumulator 7 through the bypass circuit. Then, a liquid-back amount to the compressor 1 might be excessive or the supercooling degree might be insufficient, and the capability of the air conditioner 100 is also lowered.

[0030] Fig. 3 is a graph illustrating the relationship between a control amount of the second throttle mechanism 8 and time during outage. On the basis of Fig. 3, a time-series difference between an instruction amount of the second throttle mechanism 8 and the control amount generated during outage will be described. In Fig. 3, the horizontal axis indicates time and the vertical axis indicates the throttle opening-degree of the second throttle device 8, respectively. In this Fig. 3, the control amount of the second throttle mechanism 8 during outage is shown as an example, but the control amount of the first throttle device 5 during outage can be similarly described.

[0031] If an instruction regarding a throttle opening-degree is transmitted from the instruction portion of the control portion 50 to the second throttle device 8, the actual control amount of the second throttle device 8 is changed to the transmitted instruction amount. However, it takes a predetermined time T1 till the actual control amount reaches the instruction amount. If outage occurs during this time T1, power is not supplied to the second throttle device 8, and a difference between the actual control amount and the instruction amount is caused. In Fig. 3, the difference between the actual control amount caused in one outage and the instruction amount is indicated by Sj.

[0032] As this Fig. 3, a method of calculating the difference Sj between the instruction amount of the throttle mechanism (the first throttle mechanism 5 and the second throttle mechanism 8) and the control amount will be described. Supposing that a throttle opening-degree margin per unit time of the throttle mechanism is ΔSj, a required time till the instruction amount matches the control amount is T1, and time from when an instruction is given from the instruction portion to when the outage occurs is ΔT, the difference Sj between the instruction amount and the control amount can be calculated by using the following equation:

[Equation 1]

$$Sj = \begin{cases} \Delta Sj \times (\Delta T - T1) & \Delta T < T1 \\ 0 & \Delta T \geq T1 \end{cases}$$

[0033] Fig. 4 is a flowchart illustrating the flow of processing of initialization of the throttle mechanism (a first throttle device 5 and a second throttle device 8) at the occurrence of outage. On the basis of Fig. 4, the initialization of the throttle mechanism at the occurrence of outage, which is a characteristic matter of the air conditioner 100 according to Embodiment 1 will be described. From an allowable range of the control amount of the throttle mechanism and the difference Sj between the instruction amount caused by one outage and the control amount, the number of outages that are allowed without initializing the throttle mechanism is stored in the storage device 52 in advance as a specified number of times.

[0034] If outage/power recovery occurs (Step S1), the control portion 50 reads the number of outages from the storage device 52, counts up by +1, and writes the number of outages counted up by +1 in the storage device 52 so as to execute counting-up of the number of outages (Step S2). Then, the control portion 50 compares the number of outages with the specified number of outages stored in advance (Step S3). If the number of outages is smaller than the specified number of outages (Step S3; Yes), the control portion 50 initializes only the first throttle mechanism 5 (Step S4). On the other hand, if the number of outages is not less than the specified number of outages (Step S3; NO), the control portion 50 initializes only the second throttle mechanism 8 (Step S5). As described above, since the throttle mechanism is initialized, time for initialization can be kept short, and also, the optimal refrigerating cycle can be maintained. The initialization of the first throttle mechanism 5 and the second throttle mechanism 8 may be performed in the opposite order.

[0035] As described above, the air conditioner 100 has at least the compressor 1, the heat-source-side heat exchanger 3, the plurality of throttle mechanisms (the first throttle mechanism 5, the second throttle mechanism 8), and the use-side heat exchanger 6 is provided with the control portion 50 that determines necessity of initialization of the plurality of throttle mechanisms after power recovery by comparing the number of outages with the predetermined specified number of outages. Specifically, the air conditioner 100 has the main refrigerant circuit in which the compressor 1, the heat-source-side heat exchanger 3, the high-pressure-side of the supercooling heat exchanger 4, the first throttle mechanism 5, and the use-side heat exchanger 6 are connected in series and the bypass circuit branching at between the supercooling heat exchanger 4 and the first throttle mechanism 5 and connected to the suction side of the compressor 1 through the second throttle mechanism 8 and the low-pressure side of the supercooling heat exchanger 4.

[0036] Then, the control portion 50 initializes the first throttle mechanism 5 or the second throttle mechanism 8 if the number of outages is smaller than the specified number and initializes either the first throttle mechanism 5 or the second throttle mechanism 8, which has not been initialized, if the number of outages is not less than the specified number.

Embodiment 2.

[0037] Fig. 5 is a refrigerant circuit diagram illustrating a refrigerant circuit configuration of an air conditioner 200 according to Embodiment 2 of the present invention. On the basis of Fig. 5, a refrigerant circuit configuration and an operation of the air conditioner 200 will be described. This air conditioner 200 performs the cooling operation or the heating operation using the refrigerating cycle through which the refrigerant is circulated. In Embodiment 2, a difference from Embodiment 1 will be mainly described and the same portions as in Embodiment 1 are given the same reference numerals.

[0038] This air conditioner 200 is different from the air conditioner 100 according to Embodiment 1 in the function of a storage device (hereinafter referred to as a storage device 52a) and a method of modifying the instruction amount of the throttle mechanism. The storage device 52a stores the instruction amount from the instruction portion immediately before occurrence of outage and the time from when the instruction is instructed to when the outage occurs in the case of outage. This storage device 52a is preferably composed of a nonvolatile memory such as a flash memory. The storage device 52a may be built in the control portion 50. Also, the flow of the refrigerant in the cooling mode of the air conditioner 200 according to Embodiment 2 and the relationship between the opening-degree of the throttle mechanism and the change of the refrigerating cycle are the same as in the air conditioner 100 according to Embodiment 1.

[0039] Fig. 6 is a flowchart illustrating a flow of processing for modification of the instruction amount of the throttle mechanism (the first throttle device 5 and the second throttle device 8) at occurrence of outage. On the basis of Fig. 6, modification of the instruction amount of the throttle mechanism at occurrence of outage, which is a characteristic matter of the air conditioner 200 according to Embodiment 2, will be described. As described in Fig. 3, it is assumed that the required time until the instruction amount matches the control amount is T1 and time from when an instruction is given from the instruction portion to when the outage occurs is ΔT in the case of occurrence of outage, and they are used in Fig. 6.

[0040] If outage/power recovery occurs (Step S11), the control portion 50 detects time AT from then the instruction is transmitted from the instruction portion to when the outage occurs in the case of occurrence of outage (step S12). And the control portion 50 compares the time ΔPT with the time T1 until the instruction amount matches the control amount (Step S13). If ΔT is not less than T1 (Step S13; NO), the control portion 50 leaves the throttle opening-degree of the throttle mechanism as it is (Step S14). On the other hand, if ΔT is shorter than T1 (Step S13; Yes), the control portion 50 calculates a difference between ΔT and T1 and modifies the instruction amount of the throttle mechanism by adding a difference between the instruction amount stored in the storage device 52a and the control amount to the instruction amount (Step S15).

[0041] As described above, since the control amount of the throttle mechanism is modified, the time required for modification of the control amount can be kept to a short time, and the optimal refrigerating cycle can be maintained. The modification of the instruction amount of the throttle mechanism at Step S15 is supposed to include not only modification of the control amounts of both the first throttle mechanism 5 and the second throttle mechanism 8 but also modification of one of the control amounts of the first throttle mechanism 5 or the second throttle mechanism 8.

Embodiment 3.

[0042] Fig. 7 is a refrigerant circuit diagram illustrating a refrigerant circuit configuration of an air conditioner 300 according to Embodiment 3 of the present invention. On the basis of Fig. 7, a refrigerant circuit configuration and an operation of the air conditioner 300 will be described. This air conditioner 300 performs the cooling operation or the heating operation using the refrigerating cycle through which the refrigerant is circulated. In Embodiment 3, a difference from Embodiment 1 and Embodiment 2 will be mainly described and the same portions as in Embodiment 1 and Embodiment 2 are given the same reference numerals.

[0043] This air conditioner 300 is different in installation of various sensors and the initialization processing of the throttle mechanism from the air conditioner 100 according to Embodiment 1 and the air conditioner 200 according to Embodiment 2. Also, the function of a storage device (hereinafter referred to as a storage device 52b) is different from those in the air conditioner 100 according to Embodiment 1 and the air conditioner 200 according to Embodiment 2. The storage device 52b stores the control amount and an overheat-degree SH1 of the first throttle mechanism 5 immediately before the outage and the control amount of the second throttle mechanism 8 and an overheat-degree SH2 in the case of occurrence of outage. The control amount and the overheat-degree to be stored may be data used in tests and researches in advance instead of those immediately before outage. This storage device 52b is preferably composed of a nonvolatile memory such as a flash memory. The storage device 52b may be built in the control portion 50.

[0044] On the discharge side of the compressor 1, a high-pressure sensor 61 that detects the pressure (high pressure) of the refrigerant discharged from the compressor 1 is disposed. On the suction side of the compressor 1, a low-pressure sensor 62 that detects the pressure (low pressure) of the refrigerant sucked into the compressor 1 is disposed. On the outlet side of the use-side heat exchanger 6 (outlet side in the flow of the refrigerant during the cooling operation), a first temperature sensor 65 that detects the temperature of the refrigerant is disposed. In a path that merges with the path between the accumulator 7 and the four-way valve 2 from the outlet of the supercooling heat exchanger 4 on the bypass circuit, a second temperature sensor 66 that detects the temperature of the refrigerant is disposed.

[0045] Information detected by various sensors (the high-pressure sensor 61, the low-pressure sensor 62, the first temperature sensor 65, and the second temperature sensor 66) is transmitted to the control portion 50. Then, the control portion 50 controls the first throttle mechanism 5 and the second throttle mechanism 8 to target throttle opening-degrees on the basis of information from the various sensors. The flow of the refrigerant in the cooling mode of the air conditioner 300 and the relationship between the opening-degree of the throttle mechanism and the change of the refrigerating cycle are the same as those in the air conditioner 100 according to Embodiment 1.

[0046] A calculation of the overheat-degree (the overheat-degree SH1 and the overheat-degree SH2) of the refrigerant on the refrigerating cycle of the air conditioner 300 will be described.
A saturated temperature is calculated from a relational expression of a pressure - saturated temperature determined for each refrigerant using a pressure value detected by the low-pressure sensor 62. Then, by subtracting the saturated temperature from the temperatures detected by the first temperature sensor 65 and the second temperature sensor 66,

the overheat-degree can be calculated. The calculation equation is as follows:

[Equation 2]

SH1 = (detected temperature by first temperature sensor) - (saturated temperature calculated from low-pressure sensor)

[Equation 3]

SH2 = (detected temperature by second temperature sensor) - (saturated temperature calculated from low-pressure sensor)

[0047] Figs. 8 are graphs illustrating a relationship between the control amount of the throttle mechanism and the overheat-degree. On the basis of Figs. 8, the relationship between the control amount of the throttle mechanism and the overheat-degree will be described. Fig. 2(a) shows the relationship between the control amount of the first throttle mechanism 5 and the overheat-degree SH1, and Fig. 2(b) shows the relationship between the control amount of the second throttle mechanism 8 and the overheat-degree SH2, respectively. Also, in Figs. 2, the horizontal axis indicates the control amount of the throttle mechanism and the vertical axis indicates the overheat-degree, respectively.

[0048] As shown in Figs. 8, it is known that the control amount of the throttle mechanism and the overheat-degree have a one-to-one relationship. That is, by determining one control amount of the throttle mechanism from Fig. 2(a) and Fig. 2(b), one overheat-degree corresponding to this one control amount is determined. Therefore, if the control amount of the throttle mechanism is known, the overheat-degree can be expected. Conversely, if the overheat-degree is known, the control amount of the throttle mechanism can be expected.

[0049] Fig. 9 is a flowchart illustrating a flow of processing of modification of the instruction amount of the throttle mechanism (the first throttle device 5 and the second throttle device 8) at occurrence of outage. On the basis of Fig. 9, modification of the instruction amount of the throttle mechanism at occurrence of outage, which is a characteristic matter of the air conditioner 300 according to Embodiment 3 will be described.

[0050] If outage/power recovery occurs (Step S21), the control portion 50 makes the storage device 52b store the control amount and the overheat-degree of the throttle mechanism immediately before the outage (Step S22). Then, the control portion 50 instructs the control amount of the throttle mechanism immediately before the outage stored in advance in the storage device 52b as the instruction amount. Then, the control portion 50 compares and checks the current overheat-degree with the overheat-degree immediately before the outage (Step S24). If the current overheat-degree is the same as the overheat-degree immediately before the outage (Step S24; No), the control portion 50 leaves the throttle opening-degree of the throttle mechanism as it is (Step S25). On the other hand, if the current overheat-degree is not the same as the overheat-degree immediately before the outage (Step 24; Yes), the control portion 50 calculates a difference in the corresponding control amounts from the difference in the overheat-degrees and makes it a modification amount (Step S26).

[0051] At this Step S26, the calculated modification amount is added to the current instruction amount and instructed so as to make it the control amount of the throttle mechanism. As described above, since the control amount of the throttle mechanism is modified, time required for modification of the instruction amount can be kept to a short time, and also, the optimal refrigerating cycle can be maintained. The modification of the instruction amount of the throttle mechanism at Step S26 is supposed to include not only the modification of the control amounts of both the first throttle mechanism 5 and the second throttle mechanism 8 but also the modification of one of the control amounts of the first throttle mechanism 5 or the second throttle mechanism 8.

[0052] That also applies to the control flow in which the instruction amount is instructed to the throttle mechanism of the case in which the overheat-degree stored in advance at Step S23 is obtained, the instruction amount at Step S23 is compared and checked at Step S24 with the control amount of the throttle mechanism stored in advance, and the difference between the instruction amount and the control amount is made the modification amount. Also, the characteristic matters of each embodiment may be combined in the control.

[0053] As described above, the air conditioner 300 has the main refrigerant circuit in which the compressor 1, the heat-source-side heat exchanger 5, the high-pressure-side of the supercooling heat exchanger 4, the first throttle mechanism 5, and the use-side heat exchanger 6 are connected in series and the bypass circuit branching between the supercooling heat exchanger 4 and the first throttle mechanism 5 and connected to the suction side of the compressor 1 through the second throttle mechanism 8 and the low-pressure side of the supercooling heat exchanger 4 and is provided with the control portion 50 that compares the overheat-degrees at the outlet of the use-side heat exchanger 6 before and after the outage and the overheat-degrees at the outlet on the bypass path side of the supercooling heat exchanger 4 before and after the outage, respectively, and modifies the instruction amounts of the opening-degrees of the first throttle mechanism 5 and the second throttle mechanism 8 after power recovery.

[0054] Then, if the overheat-degrees before and after the outage are not the same, the control portion 50 calculates the difference in the corresponding control amounts from the difference in the compared overheat-degrees and makes it the modification amounts of the opening-degrees of the first throttle mechanism 5 and the second throttle mechanism 8.

Claims

1. An air conditioner (100, 200, 300), having a compressor (1), a heat-source-side heat exchanger (3), a plurality of throttle mechanisms, and a use-side heat exchanger (6), comprising:

a control portion (50) that modifies, when outage occurs in the air conditioner (100, 200, 300), an instruction amount of an opening-degree to said plurality of throttle mechanisms after power recovery by comparing a time ΔT from when an instruction of an opening-degree is given to said plurality of throttle mechanisms to when the outage occurs with a required time T1 till when the instruction amount of the opening-degree to said plurality of throttle mechanisms matches an actual opening-degree control amount.

2. An air conditioner (100, 200, 300) comprising:

a main refrigerant circuit in which a compressor (1), a heat-source-side heat exchanger (3), a high-pressure-side of a supercooling heat exchanger (4), a first throttle mechanism (5), and a use-side heat exchanger (6) are connected in series; and

a bypass circuit branching at between said supercooling heat exchanger (4) and said first throttle mechanism (5) and made to connect to a suction side of said compressor (1) through a low pressure side of a second throttle mechanism (8) and said supercooling heat exchanger (4), wherein

a control portion (50) is provided that compares time ΔT from when an instruction of an opening-degree is given to said first throttle mechanism (5) and said second throttle mechanism (8) to when outage occurs at occurrence of outage in this air conditioner (100, 200, 300) with a required time T1 till when the instruction amount of the opening-degree to said first throttle mechanism (5) and said second throttle mechanism (8) match an actual opening-degree control amount and modifies the instruction amount of the opening-degree to said first throttle mechanism (5) and said second throttle mechanism (8) after power recovery.

3. The air conditioner of claim 2, wherein

if said ΔT is not less than said T1, the instruction amount of the opening-degree to said first throttle mechanism (5) and said second throttle mechanism (8) is not modified; and

if said ΔT is shorter than said T1, a difference between said instruction amount and the actual opening-degree control amount is added to the instruction amount of the opening-degree to said first throttle mechanism (5) and said second throttle mechanism (8) stored in advance, and the instruction amount of the opening-degree to at least either said first throttle mechanism (5) or said second throttle mechanism (8) is modified.

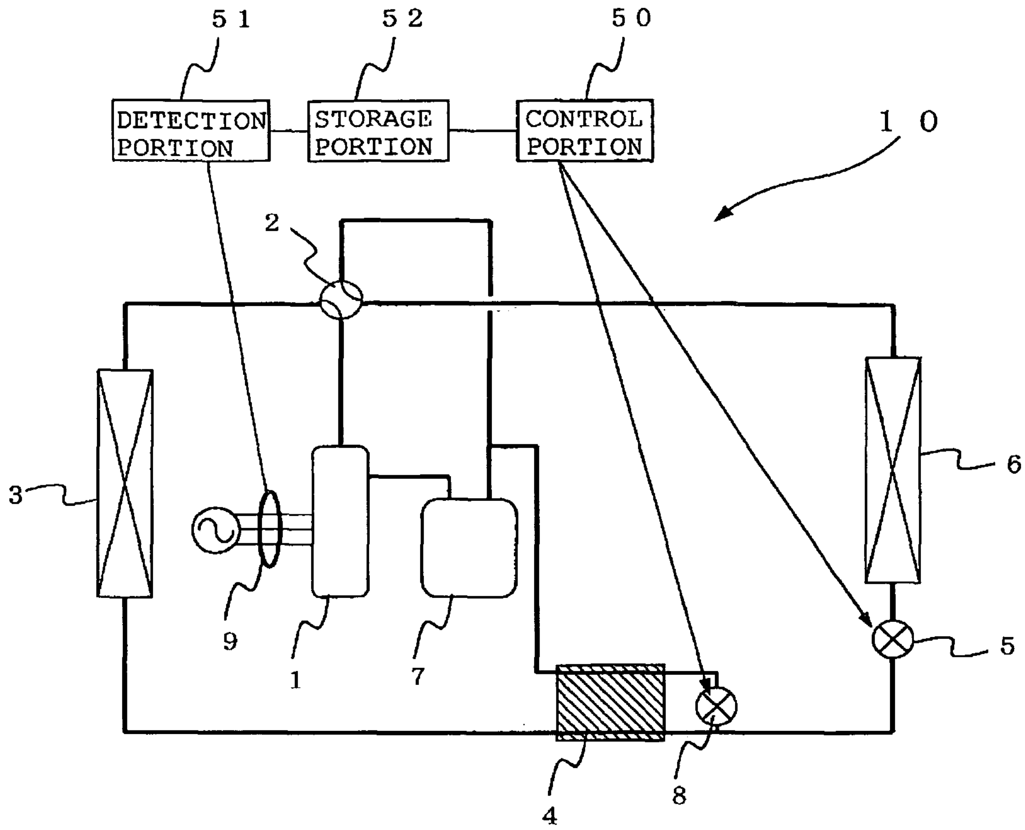
4. The air conditioner of any one of claims 1 to 3, wherein

a storage device (52, 52a, 52b) is provided that stores said number of outages, an instruction amount of the opening-degree to said first throttle mechanism (5) and said second throttle mechanism (8) and an actual control amount or said overheat-degree.

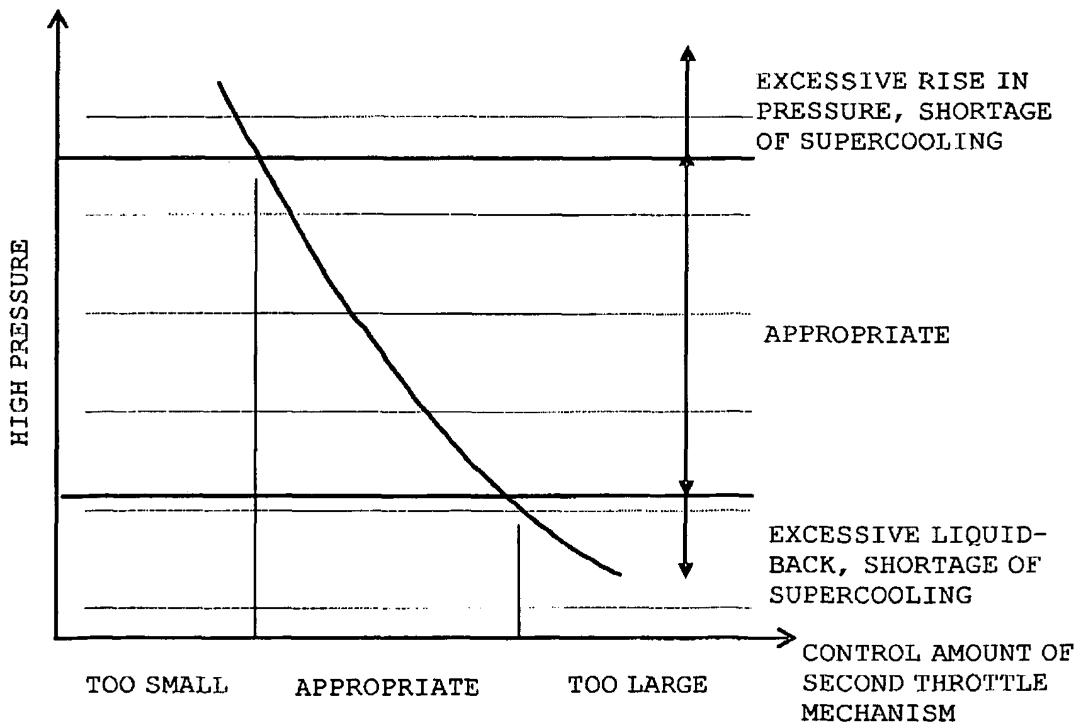
5. The air conditioner of any one of claims 1 to 4, wherein

power-source detecting means that can detect outage/power recovery by detecting a supply power source is provided.

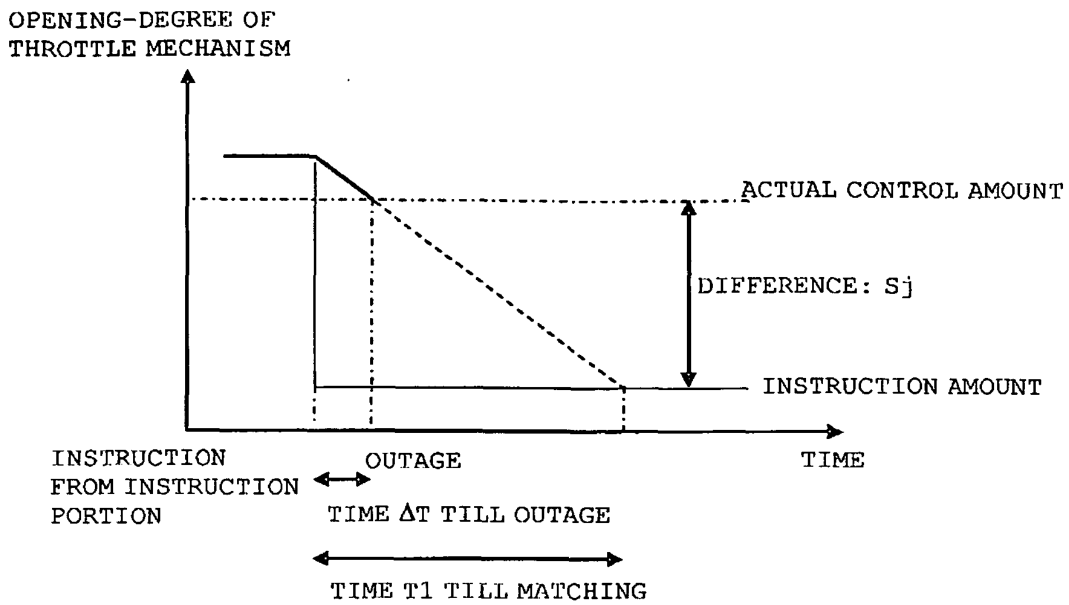
F I G. 1


5 1
5 2
5 0
DETECTION PORTION
STORAGE PORTION
CONTROL PORTION
1 0
2
3
6
9
1
7
5
4
8

F I G. 2


HIGH PRESSURE
EXCESSIVE RISE IN PRESSURE, SHORTAGE OF SUPERCOOLING
APPROPRIATE
EXCESSIVE LIQUID-BACK, SHORTAGE OF SUPERCOOLING
TOO SMALL
APPROPRIATE
TOO LARGE
CONTROL AMOUNT OF SECOND THROTTLE MECHANISM

F I G. 3


OPENING-DEGREE OF
THROTTLE MECHANISM
ACTUAL CONTROL AMOUNT
DIFFERENCE: Sj
INSTRUCTION AMOUNT
INSTRUCTION
FROM INSTRUCTION
PORTION
OUTAGE
TIME
TIME ΔT TILL OUTAGE
TIME T1 TILL MATCHING

F I G. 4

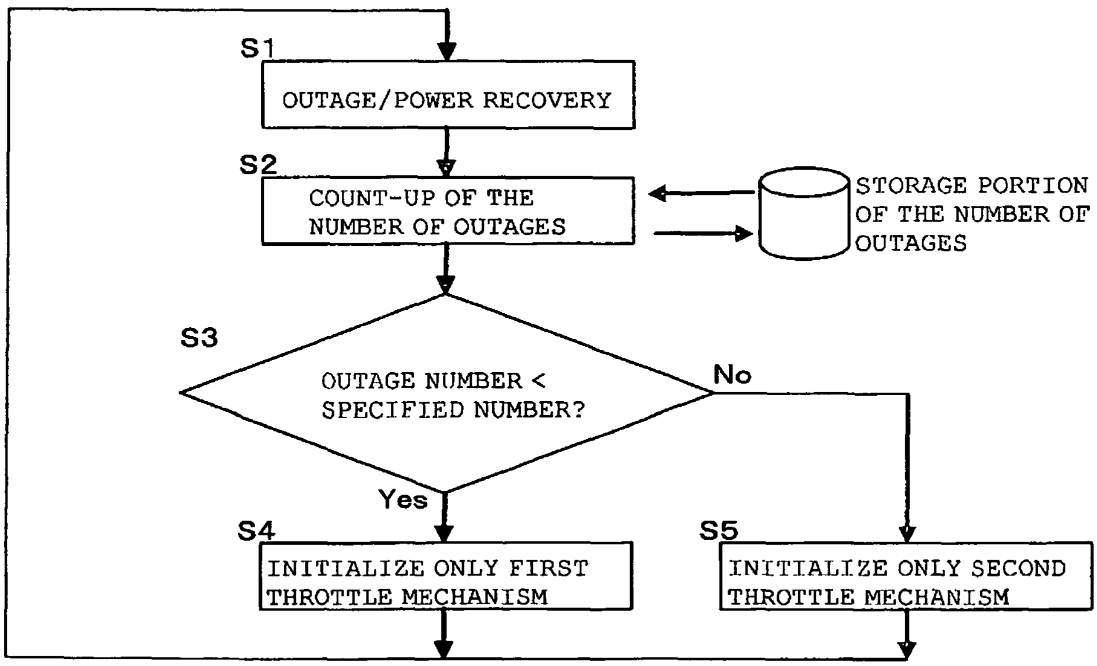

S1
OUTAGE/POWER RECOVERY
S2
COUNT-UP OF THE
NUMBER OF OUTAGES
STORAGE PORTION
OF THE NUMBER OF
OUTAGES
S3
OUTAGE NUMBER <
SPECIFIED NUMBER?
No
Yes
S4
INITIALIZE ONLY FIRST
THROTTLE MECHANISM
S5
INITIALIZE ONLY SECOND
THROTTLE MECHANISM

FIG. 5

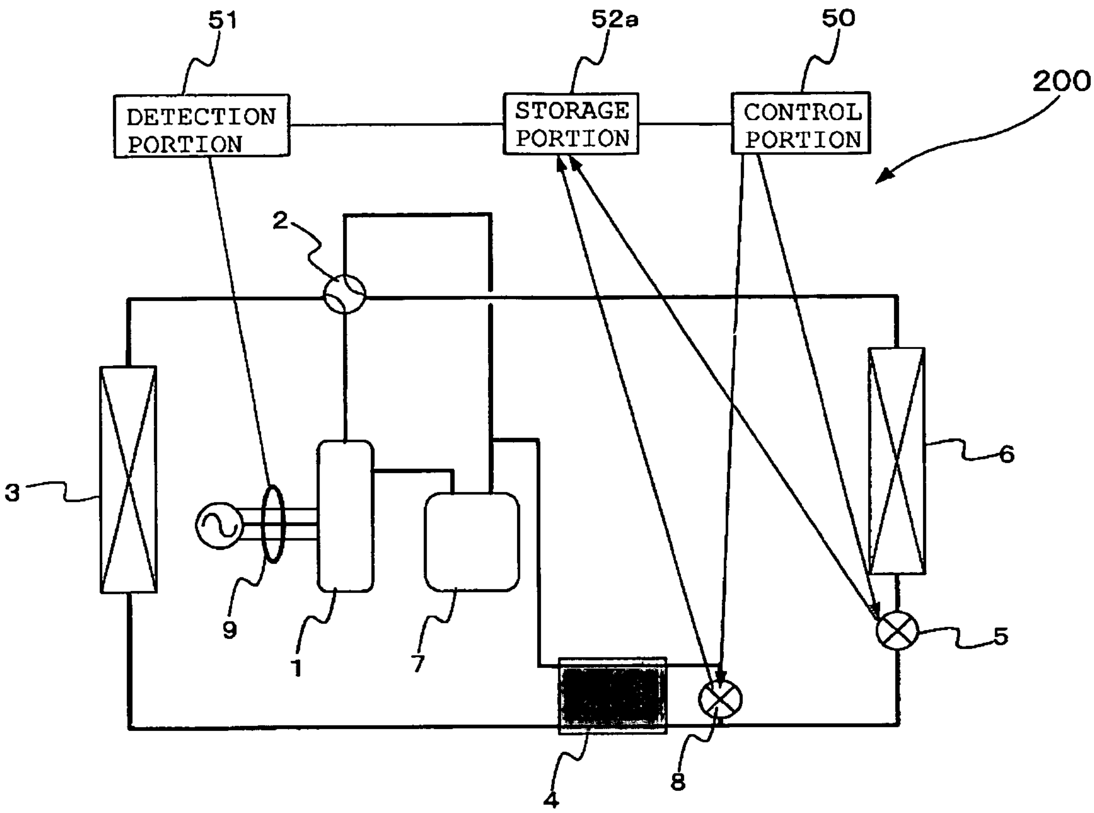
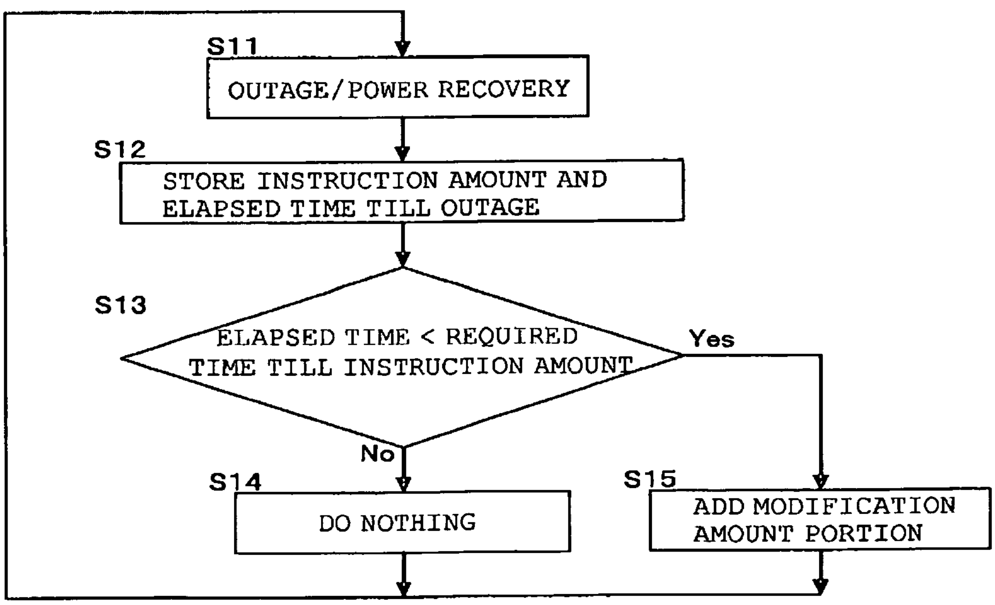
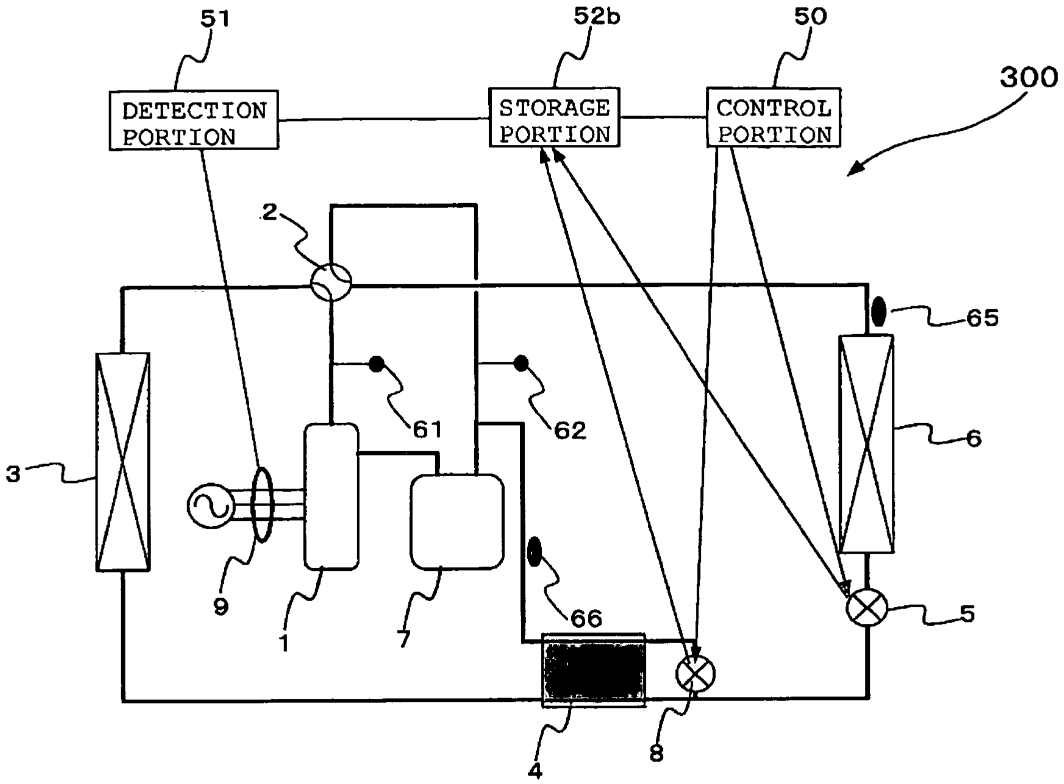

51
52a
50
200
DETECTION PORTION
STORAGE PORTION
CONTROL PORTION
2
3
6
9
1
7
5
4
8

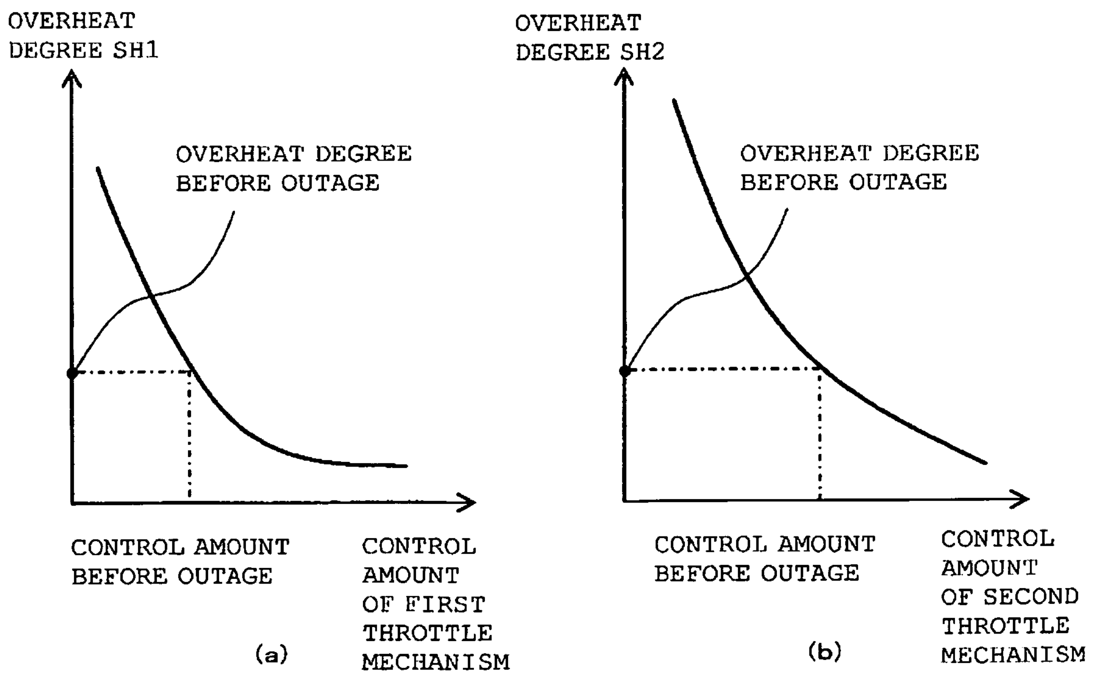
FIG. 6


S11
OUTAGE/POWER RECOVERY
S12
STORE INSTRUCTION AMOUNT AND ELAPSED TIME TILL OUTAGE
S13
ELAPSED TIME < REQUIRED TIME TILL INSTRUCTION AMOUNT
Yes
No
S14
DO NOTHING
S15
ADD MODIFICATION AMOUNT PORTION

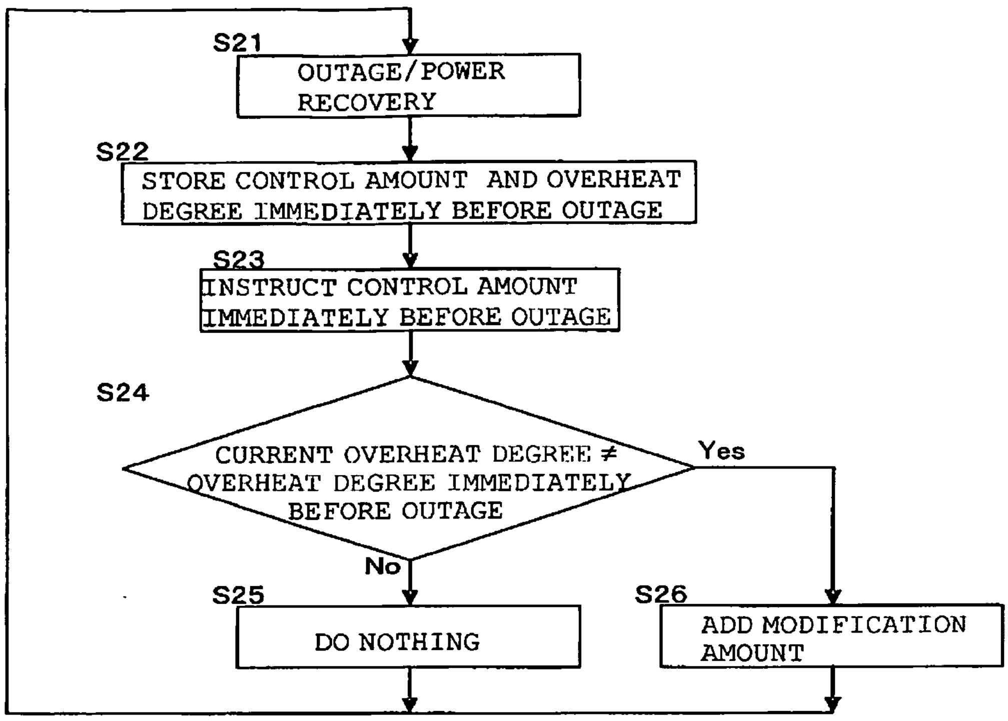
F I G. 7


51
52b
50
300
DETECTION PORTION
STORAGE PORTION
CONTROL PORTION
2
65
61
62
6
3
9
1
7
66
5
4
8

F I G. 8


OVERHEAT DEGREE SH1
OVERHEAT DEGREE BEFORE OUTAGE
CONTROL AMOUNT BEFORE OUTAGE
CONTROL AMOUNT OF FIRST THROTTLE MECHANISM
(a)
OVERHEAT DEGREE SH2
OVERHEAT DEGREE BEFORE OUTAGE
CONTROL AMOUNT BEFORE OUTAGE
CONTROL AMOUNT OF SECOND THROTTLE MECHANISM
(b)

F I G. 9


S21
OUTAGE/POWER RECOVERY
S22
STORE CONTROL AMOUNT AND OVERHEAT DEGREE IMMEDIATELY BEFORE OUTAGE
S23
INSTRUCT CONTROL AMOUNT IMMEDIATELY BEFORE OUTAGE
S24
CURRENT OVERHEAT DEGREE ≠ OVERHEAT DEGREE IMMEDIATELY BEFORE OUTAGE
Yes
No
S25
DO NOTHING
S26
ADD MODIFICATION AMOUNT

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2009/053811

A. CLASSIFICATION OF SUBJECT MATTER
F24F11/02(2006.01)i, *F25B1/00*(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, F25B1/00

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	1996-2009
Kokai Jitsuyo Shinan Koho	1971-2009	Toroku Jitsuyo Shinan Koho	1994-2009

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 5-256526 A (Daikin Industries, Ltd.), 05 October, 1993 (05.10.93), Par. Nos. [0007] to [0040]; Figs. 1 to 7 (Family: none)	1-5
Y	JP 2008-138921 A (Mitsubishi Electric Corp.), 19 June, 2008 (19.06.08), Par. Nos. [0012] to [0023]; Fig. 1 (Family: none)	1-5
Y	JP 9-189456 A (Sharp Corp.), 22 July, 1997 (22.07.97), Claim 1; Fig. 1 (Family: none)	4

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

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

Date of the actual completion of the international search	Date of mailing of the international search report
21 May, 2009 (21.05.09)	02 June, 2009 (02.06.09)
Name and mailing address of the ISA/ Japanese Patent Office	Authorized officer
Facsimile No.	Telephone No.

Form PCT/ISA/210 (second sheet) (April 2007)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2009/053811

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2007-255759 A (Mitsubishi Electric Corp.), 04 October, 2007 (04.10.07), Par. Nos. [0014], [0015]; Fig. 2 (Family: none)	4

Form PCT/ISA/210 (continuation of second sheet) (April 2007)

REFERENCES CITED IN THE DESCRIPTION

Patent documents cited in the description

- JP 2007255759 A **[0004]**