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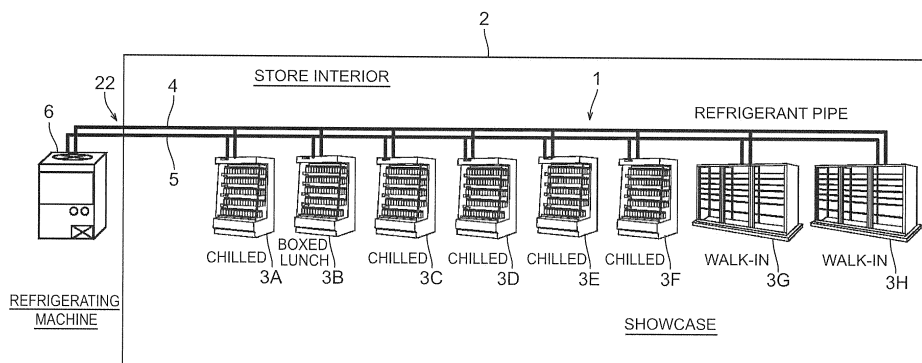
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(54) **SHOWCASE COOLING DEVICE**

(57) There is disclosed a showcase cooling device which is capable of cooling all of a plurality of showcases with no difficulty, while suppressing a power consumption of a compressor. A showcase cooling device 1 distributes and supplies a refrigerant discharged from a compressor to evaporators disposed in a plurality of showcases 3A to 3H, and comprises chamber inside temperature sen-

sors which detect chamber inside temperatures of the showcases 3A to 3H, respectively, and control means for controlling an operation of the compressor, and this control means controls the operation of the compressor on the basis of the chamber inside temperature of the showcase that is hardest to cool among the respective showcases 3A to 3H.

FIG. 1



Description

Technical Field

[0001] The present invention relates to a showcase cooling device in which a refrigerant discharged from a compressor is distributed and supplied to evaporators of a plurality of showcases and each of the showcases is cooled.

Background Art

[0002] Heretofore, a plurality of showcases have been installed in an interior of a store such as a convenience store, and a refrigerant has been distributed and supplied to evaporators of the respective showcases from a compressor of a refrigerating machine installed in an exterior of the store, or the like. In this case, the refrigerant compressed in the compressor radiates heat in a condenser similarly disposed in the refrigerating machine, and is condensed and then supplied to each of the showcases through a refrigerant pipe constituting a refrigerant circuit. In the showcase, an expansion valve and the evaporator are disposed, and the refrigerant is throttled in the expansion valve and then flows into the evaporator in which the refrigerant evaporates, thereby cooling cold air to be circulated in a chamber of the showcase (e.g., see Patent Document 1).

[0003] In addition, a throttle degree of the expansion valve is regulated so that a superheat degree of the refrigerant flowing out from the evaporator has the most suitably predetermined value, and realizes efficient cooling of the showcase and prevention of liquid back to the compressor, but as this expansion valve, a mechanical type and an electronic type (an electric expansion valve) are present. In the case of the mechanical expansion valve, the valve self-sustainably operates to obtain the predetermined superheat degree set to itself (the predetermined value), and in the case of the electronic expansion valve, a valve open degree is controlled by a control device so that a target superheat degree is obtained. Additionally, in a previous stage of each expansion valve, a liquid solenoid valve is disposed, and in a state where an inside of the chamber of the showcase is sufficiently cooled, this liquid solenoid valve is closed (in the case of the electronic expansion valve, the valve itself can fully be closed, and hence, the liquid solenoid valve is not disposed in a certain case).

[0004] In addition, for example, an operation frequency of the compressor is usually controlled on the basis of a low pressure of the refrigerant circuit. In this case, a target low pressure is set to such a value that each of the showcases can sufficiently be cooled, on the basis of, e.g., enthalpy in the store by the control device, and the operation frequency of the compressor is controlled so that the low pressure becomes this target low pressure. It is to be noted that such ability control of the compressor is not limited to the operation frequency, and a plurality of

compressors are disposed to change the number of the compressors to be operated in a certain case.

Citation List

Patent Documents

[0005] Patent Document 1: Publication of Japanese Patent No. 5053527

Summary of the Invention

Problems to be solved by the Invention

[0006] Here, loads (ambient temperature or humidity, influence of wind, chamber inside temperature control or defrosting control to cool commodities on display, etc.) in a plurality of showcases vary, respectively, and hence, opening/closing of a liquid solenoid valve (a valve open degree in the case of an electronic expansion valve) depends on these loads. On the other hand, heretofore, an operation frequency of a compressor has been controlled on the basis of a low pressure of a refrigerant circuit, and hence, in a situation where the opening/closing of liquid solenoid valves of the plurality of showcases is simultaneously or substantially simultaneously performed (i.e., a situation where the opening/closing is synchronously performed) or in a situation where, in the case of the electronic expansion valve, regulating directions of valve open degrees have the same tendency in the plurality of electronic expansion valves (the same tendency is a tendency that the valves close at the same time, and the valves fully close in the most remarkable case, or the same tendency is a tendency that the valves open at the same time, and the valves fully open in the most remarkable case) and regulation is simultaneously or substantially simultaneously performed, a fluctuation of the low pressure enlarges, and due to an influence of the fluctuation, the operation frequency of the compressor also fluctuates. That is, when the cooling load fluctuates due to the opening and closing of the liquid solenoid valve of the showcase, the low pressure fluctuates, and hence, ease of cooling in the other showcases changes, so that operations are chained. Further, the operation frequency of the compressor noticeably fluctuates to inhibit this low pressure fluctuation.

[0007] In consequence, heretofore, the operation frequency of the compressor has excessively been concerned with the low pressure and therefore noticeably fluctuated, with the result that a power consumption has increased. In addition, as described above, the load varies with the respective showcases, whereas the target low pressure is set to such a value that all the showcases can sufficiently be cooled, which causes a situation where the ability of the compressor is excessive for the showcase that is easy to cool (e.g., the showcase on which the load is light) and also causes an energy loss.

[0008] The present invention has been developed to

solve such a conventional technical problem, and an object thereof is to provide a showcase cooling device which is capable of cooling all showcases with no difficulty, while suppressing a power consumption of a compressor.

Means for solving the Problems

[0009] To solve the above problems, a showcase cooling device of the present invention distributes and supplies a refrigerant discharged from a compressor to evaporators disposed in a plurality of showcases, comprises chamber inside temperature sensors which detect chamber inside temperatures of the showcases, respectively, and control means for controlling an operation of the compressor, and is characterized in that this control means controls the operation of the compressor on the basis of the chamber inside temperature of the showcase that is hardest to cool among the respective showcases.

[0010] The showcase cooling device of the invention of claim 2 is characterized in that, in the above invention, each of the showcases comprises superheat degree regulating means for throttling the refrigerant flowing into the evaporator and regulating, into a predetermined value, the superheat degree of the refrigerant flowing out from the evaporator, and an opening/closing valve which controls the inflow of the refrigerant into the evaporator, and the control means controls the operation of the compressor on the basis of the chamber inside temperature of the showcase that is hardest to cool, sets a target superheat degree of the other showcase on the basis of the chamber inside temperatures of the other showcases, and opens and closes the opening/closing valve of the other showcases on the basis of this target superheat degree and the predetermined value of the superheat degree.

[0011] The showcase cooling device of the invention of claim 3 is characterized in that, in the invention of claim 1, each of the showcases comprises superheat degree regulating means for throttling the refrigerant flowing into the evaporator and regulating, into a predetermined value, the superheat degree of the refrigerant flowing out from the evaporator, and an opening/closing valve which controls the inflow of the refrigerant into the evaporator, and the control means controls the operation of the compressor on the basis of the chamber inside temperature of the showcase that is hardest to cool, opens and closes the opening/closing valve of the other showcases on the basis of the chamber inside temperatures of the other showcases, and executes the opening and closing of the respective opening/closing valves at different timings, when the opening/closing valves of the other showcases of the other showcases are opened and closed.

[0012] The showcase cooling device of the invention of claim 4 is characterized in that, in the invention of claim 1, each of the showcases comprises an expansion valve which throttles the refrigerant flowing into the evaporator and controls, into a target superheat degree, the super-

heat degree of the refrigerant flowing out from the evaporator, and the control means defines, as a predetermined value, the target superheat degree of the showcase that is hardest to cool to control a valve open degree of an expansion valve of the showcase, controls the operation of the compressor on the basis of the chamber inside temperature of the showcase, sets the target superheat degree of the other showcases on the basis of the chamber inside temperatures of the other showcases, and controls the valve open degree of the expansion valve of the other showcases.

[0013] The showcase cooling device of the invention of claim 5 is characterized in that, in the above respective inventions, the control means distinguishes the showcase that is hardest to cool among the respective showcases, and in a case where there is present the other showcase that is harder to cool than the showcase in which the operation of the compressor is controlled on the basis of the chamber inside temperature, the control means switches to a state to control the operation of the compressor on the basis of the chamber inside temperature of the other showcase.

[0014] The showcase cooling device of the invention of claim 6 is characterized in that, in the above invention, the control means distinguishes the showcase that is hardest to cool among the respective showcases, in a state where the chamber inside temperature is stabilized.

[0015] The showcase cooling device of the invention of claim 7 is characterized in that, in the above respective inventions, the control means controls an operation frequency of the compressor on the basis of the chamber inside temperature of the showcase that is hardest to cool.

[0016] The showcase cooling device of the invention of claim 8 is characterized in that the above invention comprises a blowout temperature sensor disposed in a cold air blowout portion of each of the showcases to detect a blowout temperature of the cold air to each of the showcases, and the control means determines a target blowout temperature of the cold air to the showcase by a PID calculation based on a deviation between the chamber inside temperature of the showcase and a set value of the chamber inside temperature, and determines a target operation frequency of the compressor and/or the target superheat degree by a PID calculation based on a deviation between the blowout temperature detected by the blowout temperature sensor and the target blowout temperature.

[0017] The showcase cooling device of the invention of claim 9 is characterized in that the invention of claim 7 comprises evaporator temperature sensors to detect temperatures of the evaporators of the showcases, respectively, and the control means determines a target evaporator temperature of each of the showcases by a PID calculation based on a deviation between the chamber inside temperature of the showcase and a set value of the chamber inside temperature, and determines a target operation frequency of the compressor and/or the

target superheat degree by a PID calculation based on a deviation between the temperature of each of the evaporators which is detected by the evaporator sensor and the target evaporator temperature.

Advantageous Effect of the Invention

[0018] According to the present invention, a showcase cooling device, which distributes and supplies a refrigerant discharged from a compressor to evaporators disposed in a plurality of showcases, comprises chamber inside temperature sensors which detect chamber inside temperatures of the showcases, respectively, and control means for controlling an operation of the compressor, and this control means controls the operation of the compressor on the basis of the chamber inside temperature of the showcase that is hardest to cool among the respective showcases. Therefore, as compared with a case where the operation is controlled in accordance with a low pressure, the control is hard to be affected by an operation of an opening/closing valve, an expansion valve or the like of each showcase.

[0019] In consequence, a fluctuation of an operation state of the compressor is inhibited, and a power consumption is decreased. On the other hand, the cooling of the showcase that is hardest to cool among the respective showcases is securely performed, and hence, an energy loss due to an excessive ability of the compressor to the other showcases is also eliminated. Consequently, according to the present invention, all of the plurality of showcases can be cooled with no difficulty, while suppressing the power consumption in the compressor.

[0020] In this case, as in the invention of claim 2, when each of the showcases comprises superheat degree regulating means for throttling the refrigerant flowing into the evaporator and regulating, into a predetermined value, the superheat degree of the refrigerant flowing out from the evaporator, and an opening/closing valve which controls the inflow of the refrigerant into the evaporator, i.e., when a so-called mechanical expansion valve is employed as the superheat degree regulating means, the control means controls the operation of the compressor on the basis of the chamber inside temperature of the showcase that is hardest to cool, sets a target superheat degree of the other showcase on the basis of the chamber inside temperatures of the other showcases, and opens and closes the opening/closing valve on the basis of this target superheat degree and the predetermined value of the superheat degree. In consequence, it is possible to smoothly execute chamber inside temperature control of all the showcases by the control of the compressor in accordance with the showcase that is hardest to cool and by the control of the opening/closing valves of the other showcases.

[0021] In addition, as in the invention of claim 3, when each of the showcases comprises superheat degree regulating means for throttling the refrigerant flowing into the

evaporator and regulating, into a predetermined value, the superheat degree of the refrigerant flowing out from the evaporator, and an opening/closing valve which controls the inflow of the refrigerant into the evaporator, i.e., when the so-called mechanical expansion valve is employed as the superheat degree regulating means, the control means controls the operation of the compressor on the basis of the chamber inside temperature of the showcase that is hardest to cool, opens and closes the opening/closing valve of the other showcases on the basis of the chamber inside temperatures of the other showcases, and executes the opening and closing of the respective opening/closing valves at different timings, when the opening/closing valves of the other showcases are opened and closed. In consequence, while smoothing executing the chamber inside temperature control of all the showcases by the control of the compressor in accordance with the showcase that is hardest to cool and the control of the opening/closing valves of the other showcases, a disadvantage that the opening/closing valves of the plurality of showcases are synchronously opened and closed is eliminated, and a fluctuation of an operation state of the compressor is accordingly inhibited.

[0022] In addition, as in the invention of claim 4, when each of the showcases comprises an expansion valve which throttles the refrigerant flowing into the evaporator and controls, into a target superheat degree, the superheat degree of the refrigerant flowing out from the evaporator, i.e., when a so-called electronic expansion valve is employed as the expansion valve, the control means defines, as a predetermined value, the target superheat degree of the showcase that is hardest to cool to control a valve open degree of an expansion valve of the showcase, controls the operation of the compressor on the basis of the chamber inside temperature of the showcase, sets the target superheat degree of the other showcases on the basis of the chamber inside temperatures of the other showcases, and controls the valve open degree of the expansion valve of the other showcases. In consequence, it is possible to smoothly execute the chamber inside temperature control of all the showcases by the control of the compressor in accordance with the showcase that is hardest to cool and by the control of the opening/closing valves of the other showcases.

[0023] Furthermore, as in the invention of claim 5, the control means distinguishes the showcase that is hardest to cool among the respective showcases, and in a case where there is present the other showcase that is harder to cool than the showcase in which the operation of the compressor is controlled on the basis of the chamber inside temperature, the control means switches to a state to control the operation of the compressor on the basis of the chamber inside temperature of the other showcases. In consequence, even when the showcase that is hardest to cool is replaced due to a change of a load of each showcase, or the like, it is possible to switch the operation state with no difficulty.

[0024] In this case, as in the invention of claim 6, the control means distinguishes the showcase that is hardest to cool among the respective showcases, in a state where the chamber inside temperature is stabilized, so that it is possible to effectively prevent occurrence of wrong judgment due to the distinguishing during defrosting or during pull-down.

[0025] Further, when the control means controls an operation frequency of the compressor on the basis of the chamber inside temperature of the showcase that is hardest to cool as in the invention of claim 7, the above invention is especially effective.

[0026] Furthermore, as in the invention of claim 8, when the showcase cooling device comprises a blowout temperature sensor disposed in a cold air blowout portion of each of the showcases to detect a blowout temperature of the cold air to each of the showcases, the control means determines a target blowout temperature of the cold air to the showcase by a PID calculation based on a deviation between the chamber inside temperature of the showcase and a set value of the chamber inside temperature, and determines a target operation frequency of the compressor and/or the target superheat degree by a PID calculation based on a deviation between the blowout temperature detected by the blowout temperature sensor and the target blowout temperature. In this case, the chamber inside temperature which moderately changes and the blowout temperature which steeply changes are classified to perform the respective PID calculations, the compressor and the opening/closing valve or the expansion valve can be controlled, and it is possible to exactly realize cooling control by eliminating a time lag of the refrigerant supply to the evaporator of each showcase as much as possible.

[0027] Additionally, as in the invention of claim 9, when the showcase cooling device comprises evaporator temperature sensors to detect temperatures of the evaporators of the showcases, respectively, the control means determines a target evaporator temperature of each of the showcases by a PID calculation based on a deviation between the chamber inside temperature of the showcase and a set value of the chamber inside temperature, and determines a target operation frequency of the compressor and/or the target superheat degree by a PID calculation based on a deviation between the temperature of each of the evaporators which is detected by the evaporator sensor and the target evaporator temperature. Also in this case, the chamber inside temperature which moderately changes and the temperature of the evaporator which steeply changes are classified to perform the respective PID calculations, the compressor and the opening/closing valve or the expansion valve can be controlled, and it is possible to exactly realize cooling control by eliminating a time lag of the refrigerant supply to the evaporator of each showcase as much as possible.

Brief Description of the Drawings

[0028]

- 5 FIG. 1 is a pipe constitutional view of a showcase cooling device of an embodiment to which the present invention is applied;
 FIG. 2 is a pipe constitutional view in a refrigerating machine of the showcase cooling device of FIG. 1;
 10 FIG. 3 is a pipe constitutional view in a showcase of the showcase cooling device of FIG. 1 (Embodiment 1);
 FIG. 4 is a control constitutional view of the showcase cooling device of FIG. 1;
 15 FIG. 5 is a view showing data communication of the showcase cooling device of FIG. 4;
 FIG. 6 is a timing chart explaining another liquid solenoid valve control by a main control device of FIG. 4 in the case of the showcase of FIG. 3 (Embodiment 2);
 20 FIG. 7 is another pipe constitutional view in the showcase of the showcase cooling device of FIG. 1 (Embodiment 3);
 FIG. 8 is a control constitutional view of the showcase cooling device of FIG. 7; and
 25 FIG. 9 is a control block diagram of a compressor operation frequency, a liquid solenoid valve, and an electronic expansion valve by a main control device of each of FIG. 4 and FIG. 8.

Mode for carrying out the Invention

[0029] Hereinafter, embodiments of the present invention will be described in detail with reference to the drawings.

Embodiment 1

[0030] In a pipe constitutional view of FIG. 1, a showcase cooling device 1 of an embodiment cools a plurality of showcases 3A to 3H installed in a store interior 2 of a convenience store (a store). In an exterior of the store, a refrigerating machine 6 connected to the respective showcases 3A to 3H via refrigerant pipes 4 and 5, and the showcases 3A to 3H and the refrigerating machine 6 constitute the showcase cooling device 1 of the embodiment.

[0031] It is to be noted that the showcases 3A to 3F are open showcases, and in the showcases 3A and 3C to 3F among these showcases, chilled foods (commodities) are displayed and sold chamber insides (the display chambers), and insides of the chambers are cooled in a comparatively low refrigeration temperature zone (0°C to +5°C) which is suitable for the cooling of the chilled foods. In the showcase 3B, boxed lunches (the commodities) are displayed and sold in a chamber (the display chamber), and the inside of the chamber is cooled in a refrigeration temperature zone of comparatively high

temperatures (+15°C to +20°C) which is suitable for the cooling of the boxed lunches. In addition, although not shown in the drawing, a refrigeration showcase is also installed to display frozen foods or ice creams in a refrigerating state (-20°C to -25°C).

[0032] On the other hand, the showcases 3G and 3H are closed type showcases referred to as walk-in showcases comprising transparent glass doors and installed on a wall surface of the store, beverages or the like (the commodities) are displayed and sold chamber insides (display chambers), and an inside of each chamber is cooled in a refrigeration temperature zone (0°C to +5°C) which is suitable for the cooling of the beverages. Further, the respective showcases 3A to 3H are connected in parallel to the refrigerating machine 6 by the refrigerant pipes 4 and 5.

[0033] FIG. 2 shows a pipe constitution in the refrigerating machine 6 of FIG. 1. In the refrigerating machine 6, there are disposed a compressor 7 to be driven by a motor 7M, a condenser 8, a blower 9 for the condenser, various sensors including a low pressure sensor 11, and the like. Further, a discharge pipe 7D (a high pressure side) of the compressor 7 is connected to an inlet pipe 8A of the condenser 8, and an outlet pipe 8B of the condenser 8 is connected to the refrigerant pipe 4 toward the store interior 2. In addition, a suction pipe 7S (a low pressure side) of the compressor 7 is connected to the refrigerant pipe 5 from the store interior 2. Further, the blower 9 for the condenser is operated to air-cool the condenser 8. In addition, the low pressure sensor 11 is disposed to detect a refrigerant pressure of the suction pipe 7S of the compressor 7.

[0034] On the other hand, FIG. 3 shows a pipe constitution in each of the showcases 3A to 3H of FIG. 1. In each of the showcases 3A to 3H of this embodiment, there are disposed a liquid solenoid valve 12 as an opening/closing valve, a mechanical expansion valve 13 as superheat degree regulating means, an evaporator 14, a blower 16 for cold air circulation, respective main sensors including an chamber inside temperature sensor 17, a blowout temperature sensor 18, and a suction temperature sensor 19, and the like. Further, an outlet of the liquid solenoid valve 12 is connected to the expansion valve 13, an outlet of the expansion valve 13 is connected to the evaporator 14, an inlet pipe 12A of the liquid solenoid valve 12 is connected to the refrigerant pipe 4, and an outlet pipe 14A of the evaporator 14 is connected to the refrigerant pipe 5. As described above, series circuits of the liquid solenoid valves 12, the expansion valves 13 and the evaporators 14 in the respective showcases 3A to 3H are connected in parallel between the refrigerant pipes 4 and 5.

[0035] The blower 16 for cold air circulation sucks cold air of a chamber inside 21, thereby allowing the evaporator 14 to perform heat exchange between the cold air and the evaporator, and the blower blows the cold air outwardly to the chamber inside 21, thereby cooling the chamber inside 21 in the abovementioned refrigeration

temperature zone. In addition, the chamber inside temperature sensor 17 is disposed to detect a temperature (an chamber inside temperature) of the chamber inside 21, the blowout temperature sensor 18 is disposed to detect a temperature (a blowout temperature) of the cold air to be blown out to the chamber inside 21, and the suction temperature sensor 19 is disposed to detect a temperature (a suction temperature) of the cold air to be sucked from the chamber inside 21 to the blower 16 for cold air circulation.

[0036] According to such a pipe constitution, the compressor 7 and the condenser 8 of the refrigerating machine 6 and the expansion valves 13 and the evaporators 14 of the showcases 3A to 3H constitute a well-known refrigerant circuit 22. An operation frequency of the motor 7M of the compressor 7 of the refrigerating machine 6 of the embodiment is controlled. When the compressor 7 is operated, a gas refrigerant compressed to have a high temperature and high pressure flows into the condenser 8 in which the refrigerant is then air-cooled by the blower 9 for the condenser to condense. The refrigerant (a liquid refrigerant) allowed to condense in the condenser 8 reaches the store interior 2 through the refrigerant pipe 4, and is distributed and supplied from the store interior to each of the showcases 3A to 3H.

[0037] The liquid refrigerant flowing into each of the showcases 3A to 3H reaches the expansion valve 13 through the liquid solenoid valve 12, is throttled and decompressed in the expansion valve, and flows into the evaporator 14. The refrigerant flowing into the evaporator 14 evaporates, and exerts a cooling effect by a heat absorbing operation generated at this time. Further, the refrigerant flowing out from the evaporator 14 returns to the refrigerating machine 6 through the refrigerant pipe 5, and is sucked by the compressor 7, thereby repeating this circulation.

[0038] The mechanical expansion valve 13 of this embodiment self-sustainably controls a throttle degree of the expansion valve by an operation of bellows (not shown) which expand and contract in accordance with a temperature of the outlet pipe 14A of the evaporator 14, and a superheat degree of the refrigerant flowing out from the evaporator 14 is regulated into a predetermined value set in advance (e.g., a fixed superheat degree of 3K). In consequence, the refrigerant supply to the evaporator 14 is regulated, and liquid back to the compressor 7 is prevented.

[0039] Next, FIG. 4 and FIG. 5 show a control constitution of the showcase cooling device 1. In each drawing, 23 is a main control device referred to as a store master. This main control device 23 is installed in a management room of the store, or the like to centrally control operations of the refrigerating machine 6 and the respective showcases 3A to 3H. Also in the refrigerating machine 6 and the respective showcases 3A to 3H, a refrigerating machine control device 24 and showcase control devices 26 are disposed, respectively, and connected to the main control device 23 by a communication line 27. Each of

the main control device 23, the refrigerating machine control device 24 and the showcase control devices 26 is constituted of a microcomputer, and these microcomputers constitute control means of the showcase cooling device 1.

[0040] Separate ID numbers of, e.g., 101 to 108 are given to the respective showcase control devices 26, and an ID number of 301 is given to the refrigerating machine control device 24. The main control device 23 identifies the respective showcase control devices 26 and the refrigerating machine control device 24 by these ID numbers, and receives, from each of the showcase control devices 26, data or the like concerning the chamber inside temperature, the blowout temperature and the suction temperature of each of the showcases 3A to 3H as shown in FIG. 5. Further, the main control device 23 transmits data or the like concerning an opening/closing instruction of the liquid solenoid valve 12 to the showcase control device 26 of each of the showcases 3A to 3H, and transmits data or the like concerning a target value instruction of a target low pressure or a target operation frequency or the like of the compressor 7 to the refrigerating machine control device 24 of the refrigerating machine 6.

[0041] In addition, the main control device 23 is connected to a temperature/humidity sensor 28. The temperature/humidity sensor 28 detects a temperature/humidity of the store interior 2. The main control device 23 calculates an enthalpy of the store interior 2 on the basis of temperature/humidity data of the store interior 2 which is detected by the temperature/humidity sensor 28, and sets the target low pressure of the refrigerant circuit 22. It is to be noted that this target low pressure is set to such a value that all the showcases 3A to 3H can sufficiently be cooled. Additionally, in the main control device 23, a set value of the chamber inside temperature of each of the showcases 3A to 3H can be input, and data such as the chamber inside temperature of each of the showcases 3A to 3H can be confirmed, thereby realizing central management of the showcases 3A to 3H in the store by use of the main control device 23.

[0042] Next, an operation of the showcase cooling device 1 of this embodiment having the above constitution will be described. First, the main control device 23 always monitors the chamber inside temperature (detected by the chamber inside temperature sensor 17) received from each of the showcase control devices 26, and compares the temperature with the set value of the chamber inside temperature of each of the showcases 3A to 3H, to monitor cooling degrees of these showcases. Further, among the respective showcases 3A to 3H, the showcase that is hardest to cool is distinguished. For example, in a case where, as compared with the other showcases, the liquid solenoid valve 12 of each of the showcases 3G and 3H continues to be opened but a long time is required until the chamber inside temperature reaches the set value or a state that the chamber inside temperature is the set value or more lasts long, or the like, the main control

device 23 determines each of the showcases 3G and 3H as the showcase that is hardest to cool. It is to be noted that the number of the showcases is not limited to two in this manner, and the number of the showcases is one in a certain case.

[0043] When each of the showcases 3G and 3H is determined as the showcase that is hardest to cool in this manner, the main control device 23 transmits an instruction to the showcase control device 26 of each of the showcases 3G and 3H to set the liquid solenoid valve 12 to a 100% open state. In consequence, the liquid refrigerant throttled by the expansion valve 13 is always supplied to the evaporator 14 of each of the showcases 3G and 3H (an operation ratio of 100%). In addition, the main control device 23 controls the operation frequency of the compressor 7 (the motor 7M) of the refrigerating machine 6 on the basis of the chamber inside temperature of each of the showcases 3G and 3H, and controls the chamber inside temperature of each of the showcases 3G and 3H into the set value.

[0044] A specific control system in this case will be described with reference to FIG. 9. First, the main control device 23 compares the chamber inside temperature detected by the chamber inside temperature sensor 17 of each of the showcases 3G and 3H with the set value (a target value), and a PID calculating section 31 performs a PID calculation of a deviation e1 between the temperature to determine a target blowout temperature (a control amount). Next, the main control device compares the blowout temperature detected by the blowout temperature sensor 18 of each of the showcases 3G and 3H with the target blowout temperature, and a PID calculating section 32 performs a PID calculation of a deviation e2 between the temperatures to determine the target operation frequency (a control amount) of the compressor 7.

[0045] The determined target operation frequency is instructed from the main control device 23 to the refrigerating machine control device 24 of the refrigerating machine 6. The refrigerating machine control device 24 controls the operation frequency of the compressor 7 (the motor 7M) to match the received target operation frequency. Here, when the cooling effect in the evaporator 14 varies due to the change of the operation frequency of the compressor 7, the chamber inside temperature of each of the showcases 3G and 3H moderately changes, but the blowout temperature steeply changes. Therefore, as in the embodiment, when the chamber inside temperature which moderately changes and the blowout temperature which steeply changes are classified to perform the PID calculations by the PID calculating sections 31 and 32, respectively, a time lag of the refrigerant supply from the compressor 7 to the evaporator of each of the showcases 3G and 3H decreases.

[0046] On the other hand, as to the other showcases 3A to 3F that more easily cool than the showcases 3G and 3H, the main control device 23 determines the target superheat degree on the basis of the chamber inside temperature detected by the chamber inside temperature

sensor 17 of each of the showcases 3A to 3F and the set value. Also in the determination of this target superheat degree, the main control device 23 similarly performs the PID calculation of FIG. 9. However, an operation amount of the PID calculating section 32 in this case is the target superheat degree of the showcases 3A to 3F. That is, when the chamber inside temperature is higher than the set value, the target superheat degree becomes smaller, and when the chamber inside temperature is lower, the target superheat degree becomes larger.

[0047] The main control device 23 calculates an opening/closing ratio of the liquid solenoid valve 12 of each of the showcases 3A to 3F on the basis of the determined target superheat degree and the predetermined value (the fixed superheat degree of 3K) of the superheat degree of the expansion valve 13. For example, when the target superheat degree of the showcase 3D is 5K, the opening/closing ratio (i.e., the operation ratio) of the liquid solenoid valve 12 is 60%. The main control device 23 transmits the instruction concerning the opening and closing of the liquid solenoid valve 12 to each of the showcase control devices 26 on the basis of the determined opening/closing ratio concerning each of the showcases 3A to 3F. The showcase control device 26 opens and closes (turns on and off) the liquid solenoid valve 12 on the basis of the received opening/closing instruction, thereby controlling the chamber inside temperature of each of the showcases 3A to 3F into the set value.

[0048] Thus, the main control device 23 controls the operation of the compressor 7 on the basis of the chamber inside temperature of the showcase that is hardest to cool among the respective showcases 3A to 3H, and hence, the compressor is hard to be influenced by the operation of the liquid solenoid valve 12 of each of the showcases 3A to 3H as compared with the operation of the compressor is controlled in accordance with the low pressure. In consequence, a fluctuation of an operation state of the compressor 7 is inhibited, and a power consumption is reduced. On the other hand, the cooling of the showcase that is hardest to cool (each of 3G and 3H in the embodiment) among the respective showcases 3A to 3H is securely performed, and hence, an energy loss due to an excessive ability of the compressor 7 to the other showcases (3A to 3F in the embodiment) is also eliminated. Consequently, all of the plurality of showcases 3A to 3H can be cooled with no difficulty, while suppressing the power consumption in the compressor 7.

[0049] In particular, when the mechanical expansion valve is employed as the expansion valve 13 as in this embodiment, the main control device 23 controls the operation of the compressor 7 on the basis of the chamber inside temperature of the showcase that is hardest to cool (each of 3G and 3H in the embodiment), sets the target superheat degree of the showcase on the basis of the chamber inside temperatures of the other showcases (3A to 3F in the embodiment), and calculates the opening/closing ratio of the liquid solenoid valve 12 on the basis of this target superheat degree and the predeter-

mined value (the fixed superheat degree) to open and close the valve, so that it is possible to smoothly execute chamber inside temperature control of all the showcases 3A to 3H by the control of the compressor 7 in accordance with the showcase that is hardest to cool and by the control of the liquid solenoid valves 12 of the other showcases. In consequence, there is also the effect that the abovementioned setting control of the target low pressure on the basis of the store interior enthalpy by the temperature/humidity sensor 28 is not required.

[0050] It is to be noted that, as described above, the main control device 23 always monitors a cooling state of each of the showcases 3A to 3H, and distinguishes the showcase that is hardest to cool among the showcases. Further, in a case where there is present the other showcase that is harder to cool than the showcases 3G and 3H in which the operation frequency of the compressor 7 is controlled on the basis of the chamber inside temperatures at present, the control means determines the other showcase as the showcase that is hardest to cool, and switches to such a state to control the operation of the compressor 7 on the basis of the chamber inside temperature of the showcase. In consequence, even when the showcase that is hardest to cool is replaced due to a change of an amount of the commodities on display (loads) of each of the showcases 3A to 3H, a change of environment, or the like, it is possible to switch the operation state with no difficulty.

[0051] However, the main control device 23 executes the distinguishing of the showcase that is hardest to cool as described above only when the chamber inside temperature of each of the showcases 3A to 3H is stabilized. That is, such distinguishing of the showcase that is hardest to cool is not performed during defrosting (to be executed four times a day) of each of the showcases 3A to 3H or during pull-down, but a control state prior to the defrosting is maintained. In consequence, occurrence of wrong judgment is avoided.

Embodiment 2

[0052] Here, in the above embodiment, as to the other showcases 3A to 3F, the target superheat degree is determined to calculate the opening/closing ratio of the liquid solenoid valve 12, thereby controlling the chamber inside cooling of these showcases, but the present invention is not limited to this embodiment, and the opening and closing of each liquid solenoid valve 12 may be controlled on the basis of a chamber inside temperature of each of the showcases 3A to 3F and a set value of the chamber inside temperature. In this case, the liquid solenoid valve 12 is opened/closed on the basis of an ON-temperature (an upper limit value) and an OFF-temperature (a lower limit value) that are set above and below the set value of the chamber inside temperature by use of predetermined differentials (the set value becomes an average temperature). However, when the values are used as they are and loads of the respective showcases

3A to 3F are similar, the liquid solenoid valves 12 disadvantageously synchronously open and close, and there is the risk that, due to an influence of the valves, an operation frequency of a compressor 7 noticeably fluctuates.

[0053] To solve the problem, FIG. 6 shows a control example by a main control device 23 to eliminate such a disadvantage. A top stage of FIG. 6 shows a case that the liquid solenoid valve 12 is opened at the ON-temperature and closed at the OFF-temperature as described above. When the respective showcases 3A to 3F have the same ease of cooling, there enlarges the risk that the liquid solenoid valves 12 of all the showcases 3A to 3F synchronously open and close. Therefore, control processes of a second stage from the top, a third stage from the top and a bottom stage including the top stage of FIG. 6 are combined and executed in the showcases 3A to 3F, respectively. That is, for example, the showcase 3A is controlled as shown in the top stage, the showcases 3C and 3D are controlled as shown in the second stage from the top, the showcase 3F is controlled as shown in the third stage from the top, and the showcase 3B is controlled as shown in the bottom stage.

[0054] The control of the second stage from the top of FIG. 6 is control to open the liquid solenoid valve 12 when the chamber inside temperature is the ON-temperature or more and to close the valve when the chamber inside temperature is lower than the set value. In this case, as compared with the case of the top stage, the liquid solenoid valve 12 is more frequently opened and closed, and the average temperature (a bold broken line) is slightly higher than the set value. In addition, the control of the third stage from the top of FIG. 6 is control to open the liquid solenoid valve 12 when the chamber inside temperature is the ON-temperature or more and to close the valve when the chamber inside temperature is lower than the ON-temperature. In this case, the liquid solenoid valve 12 is further frequently opened and closed, and the average temperature (a bold broken line) is further higher than the set value. In addition, the control of the bottom stage of FIG. 6 is control to open the liquid solenoid valve 12 when the chamber inside temperature is the ON-temperature or more and to close the valve when the temperature turns to drop. In this case, the liquid solenoid valve 12 is further frequently opened and closed, and the average temperature (a bold broken line) is further higher than the set value. Therefore, the set value is beforehand shifted to be lower as much as the average temperature heightens.

[0055] In this case, the control of the upper stage of FIG. 6 may be assigned to the showcase that is harder to cool and harder to warm (a temperature change is larger), and the control of the lower stage of FIG. 6 may be assigned to the showcase that is easier to cool and easier to warm (the temperature change is smaller). The showcases that are hard to cool (hard to warm) or easy to cool (easy to warm) are ranked in accordance with the change of the chamber inside temperature after the

opening/closing of the liquid solenoid valve 12 in a state where the chamber inside temperature is stabilized of a fluctuation width of the temperature.

[0056] Thus, the opening/closing control processes of the liquid solenoid valves 12 are combined and executed in the respective showcases 3A to 3F, and hence, operation timings of the respective liquid solenoid valves 12 shift from one another and opening/closing operations of the valves are performed at different timings. In consequence, while smoothly executing the chamber inside temperature control of all the showcases 3A to 3H by the operation control of the compressor 7 in accordance with the showcases 3G and 3H that are hardest to cool and by the control of the liquid solenoid valve 12 of each of the other showcases 3A to 3F, there is eliminated the disadvantage that the opening/closing valves of the plurality of showcases 3A to 3F are synchronously opened and closed, and a fluctuation of an operation state of the compressor 7 due to the disadvantage is also inhibited.

[0057] It is to be noted that, in the above embodiment, a temperature to open and close the liquid solenoid valve 12 is switched to shift the opening/closing timing, but the present invention is not limited to the embodiment, and the differentials of the ON-temperature and the OFF-temperature are used as they are, and the set value may be shifted to a different value for each of the showcases 3A to 3F.

Embodiment 3

[0058] Next, there will be described control in a case where, for example, an electronic expansion valve (an electric expansion valve) operated by a stepping motor is used as an expansion valve of each of the showcases 3A to 3H. FIG. 7 is a pipe constitutional view in each of the showcases 3A to 3H in this case, and FIG. 8 is a control constitutional view. It is to be noted that, in the respective drawings, parts denoted with the same symbols as in FIG. 3 to FIG. 5 produce the same or similar functions.

[0059] In this case, an electronic expansion valve (an electric expansion valve) 33 is employed in place of a mechanical expansion valve in each of the showcases 3A to 3H. In addition, an evaporator inlet temperature sensor 36 and an evaporator outlet temperature sensor 37 are disposed in an inlet pipe 14B and an outlet pipe 14A of an evaporator, respectively, and the sensors detect a temperature of a refrigerant flowing into an evaporator 14 and a temperature of the refrigerant flowing out from the evaporator 14. Further, outputs of the sensors are transmitted to a main control device 23 via a showcase control device 26, and the main control device 23 calculates a superheat degree of the evaporator 14 from a difference between the temperatures. In addition, a valve open degree of the expansion valve 33 is controlled by the main control device 23 via the showcase control device 26.

[0060] Next, an operation in this case will be described.

Also in this case, the main control device 23 always monitors an chamber inside temperature (detected by an chamber inside temperature sensor 17) received from each of the showcase control devices 26, compares the chamber inside temperature with a set value of the chamber inside temperature of each of the showcases 3A to 3H, and monitors cooling degrees of the showcases. Further, among the respective showcases 3A to 3H, the showcase that is hardest to cool is distinguished. For example, in a case where, as compared with the other showcases, the valve open degree of the expansion valve 33 of each of the showcases 3G and 3H continues to be large but a long time is required until the chamber inside temperature reaches the set value or a state that the chamber inside temperature is the set value or more lasts long, or the like, the main control device 23 determines each of the showcases 3G and 3H as the showcase that is hardest to cool. It is to be noted that the number of the showcases is not limited to two in this manner, and the number of the showcases is one in a certain case.

[0061] When each of the showcases 3G and 3H is determined as the showcase that is hardest to cool in this manner, the main control device 23 transmits an instruction to the showcase control device 26 of each of the showcases 3G and 3H to control the valve open degree of the expansion valve 33 so that a superheat degree of the evaporator 14 becomes a predetermined value (e.g., 5K). In addition, the main control device 23 controls an operation frequency of a compressor 7 (a motor 7M) of a refrigerating machine 6 on the basis of the chamber inside temperature of each of the showcases 3G and 3H. A specific control system in this case is similar to FIG. 9. In consequence, the chamber inside temperature of each of the showcases 3G and 3H is controlled into the set value.

[0062] On the other hand, as to the other showcases 3A to 3F that are easier to cool than the showcases 3G and 3H, the main control device 23 determines a target superheat degree on the basis of the chamber inside temperature of each of the showcases 3A to 3F which is detected by the chamber inside temperature sensor 17 and the set value. Also in the determination of this target superheat degree, the main control device 23 similarly performs a PID calculation of FIG. 9. Additionally, an operation amount of a PID calculating section 32 in this case is the target superheat degree of each of the showcases 3A to 3F. That is, when the chamber inside temperature is higher than the set value, the target superheat degree becomes smaller, and when the temperature is lower, the degree becomes larger.

[0063] The main control device 23 determines a target valve open degree of the expansion valve 33 so that the superheat degree of the evaporator 14 of each of the showcases 13A to 13F becomes the determined target superheat degree. The main control device 23 transmits, to each of the showcase control devices 26, an instruction concerning the valve open degree of the expansion valve

33 on the basis of the determined target valve open degree concerning each of the showcases 3A to 3F. The showcase control device 26 controls the valve open degree of the expansion valve 33 on the basis of the received target valve open degree. It is to be noted that the liquid solenoid valve 12 is set to an open state. In consequence, the chamber inside temperature of each of the showcases 3A to 3F is controlled into the set value. Additionally, in the embodiment, a liquid solenoid valve 12 is disposed in a previous stage of the expansion valve 33, but the expansion valve 33 which is the electronic expansion valve can fully be closed, and hence, the liquid solenoid valve 12 may be omitted depending on a control followability. Furthermore, when the plurality of fully closed expansion valves 33 are opened, the valves are controlled so that timings of the opening vary, and hence, a fluctuation of an operation state of the compressor 7 can be inhibited in the same manner as described above.

[0064] In consequence, when the electronic expansion valves 33 are employed as expansion valves in the showcases 3A to 3H as in this embodiment, the main control device 23 defines the target superheat degree of each of showcases 3G and 3H that are hardest to cool as a predetermined value to control the valve open degrees of the expansion valves 33 of the showcases 3G and 3H, controls the operation of the compressor 7 on the basis of the chamber inside temperatures of the showcases 3G and 3H, sets the target superheat degree of each of the showcases 3A to 3F on the basis of the chamber inside temperatures of the other showcases 3A to 3F, and controls the valve open degrees of the expansion valves 33 of the showcases 3A to 3F, so that it is possible to smoothly execute the chamber inside temperature control of all the showcases 3A to 3H by the control of the compressor 7 in accordance with the showcases 3G and 3H that are hardest to cool and by the control of the expansion valves 33 of the other showcases 3A to 3F.

[0065] It is to be noted that, in the above embodiments, there has been described the system where the main control device 23 transmits the control instruction of each of the liquid solenoid valves 12 or the expansion valves 33 to each of the showcases 3A to 3H to control the valve, but the present invention is not limited to the embodiments. Specifically, the main control device 23 may determine the showcase that is hardest to cool, give, to the determined showcase, the instruction that the showcase is the showcase that is hardest to cool, control the operation frequency of the compressor 7 on the basis of the chamber inside temperature of the showcase, and transmit the target superheat degree to each showcase, and the actual control of the liquid solenoid valve 12 or the expansion valve 33 in each showcase may be executed by the showcase control device 26 of each showcase.

[0066] Additionally, in the embodiments, there have been described the case where the mechanical expansion valves 13 are used in all the showcases 3A to 3H and the case where the electronic expansion valves 33 are used therein, but the present invention is also effective

tive for a case where the valves are mixed. In this case, as to the showcase in which the mechanical expansion valve 13 is used and which is hardest to cool, an instruction to open the liquid solenoid valve 12 is transmitted to the showcase control device 26 of the showcase, and as to the showcase in which the electronic expansion valve 33 is used and which is hardest to cool, an instruction to define the target superheat degree as the predetermined value and control the valve open degree of the expansion valve 33 is transmitted to the showcase control device of the showcase. In addition, the compressor 7 of the refrigerating machine 6 is controlled on the basis of the chamber inside temperatures of these showcases. Furthermore, as to the other showcase in which the mechanical expansion valve 13 is used and which is easy to cool, the opening/closing ratio of the liquid solenoid valve 12 is calculated by the main control device 23, and as to the other showcase in which the electronic expansion valve 33 is used and which is easy to cool, the target superheat degree is calculated by the main control device. Additionally, the main control device gives the instruction to each of the showcase control devices 26.

[0067] Furthermore, in the above embodiments, the target blowout temperature is determined by the PID calculation based on the deviation between the chamber inside temperature and the set value of the chamber inside temperature, and the target operation frequency of the compressor 7 and the target superheat degree of the refrigerant flowing out from the evaporator 14 are determined by the PID calculation based on the deviation between the blowout temperature detected by the blowout temperature sensor 18 and the target blowout temperature, but the temperature of the evaporator 14 can be employed because the temperature steeply changes. Therefore, the present invention is not limited to this blowout temperature, and a temperature sensor which detects the temperature of the evaporator 14 may be disposed, a target evaporator temperature may be determined in accordance with the chamber inside temperature and the set value, and a PID calculation may be performed on the basis of the temperature of the evaporator 14 which is detected by the temperature sensor of the evaporator 14 and the target evaporator temperature, to determine the target operation frequency or the target superheat degree.

[0068] Furthermore, in the embodiment, both of the target operation frequency of the compressor 7 and the target superheat degree of the refrigerant flowing out from the evaporator 14 are determined by the control of FIG. 9, but the present invention is not limited to the embodiment, and one of the target superheat degree and the target operation frequency may be determined by the control of FIG. 9, and the other may be determined by a usual PID calculation based on the chamber inside temperature and the set value.

[0069] Additionally, in the embodiment, the present invention is applied to the refrigerant circuit in which the mechanical expansion valves or the electronic expansion

valves are used, but the invention of claim 1 is not limited to the embodiment, and the invention is also effective for a case where the refrigerant flowing into the evaporator is throttled by a capillary tube.

Description of Reference Numerals

[0070]

10	1	showcase cooling device
	3A to 3H	showcase
	4 and 5	refrigerant pipe
	6	refrigerating machine
	7	compressor
15	8	condenser
	12	liquid solenoid valve (opening/closing valve)
	13 and 33	expansion valve
	14	evaporator
20	17	chamber inside temperature sensor
	17	blowout temperature sensor
	23	main control device (control means)
	24	refrigerating machine control device (control means)
25	26	showcase control device (control means)
	31 and 32 PID	calculating section

Claims

1. A showcase cooling device, which distributes and supplies a refrigerant discharged from a compressor to evaporators disposed in a plurality of showcases, comprising:

chamber inside temperature sensors which detect chamber inside temperatures of the showcases, respectively; and
control means for controlling an operation of the compressor,
wherein the control means controls the operation of the compressor on the basis of the chamber inside temperature of the showcase that is hardest to cool among the respective showcases.

2. The showcase cooling device according to claim 1, wherein each of the showcases comprises superheat degree regulating means for throttling the refrigerant flowing into the evaporator and regulating, into a predetermined value, the superheat degree of the refrigerant flowing out from the evaporator, and an opening/closing valve which controls the inflow of the refrigerant into the evaporator, and the control means controls the operation of the compressor on the basis of the chamber inside temperature of the showcase that is hardest to cool, sets a

target superheat degree of the other showcases on the basis of the chamber inside temperatures of the other showcases, and opens and closes the opening/closing valve of the other showcases on the basis of the target superheat degree and the predetermined value of the superheat degree.

3. The showcase cooling device according to claim 1, wherein each of the showcases comprises superheat degree regulating means for throttling the refrigerant flowing into the evaporator and regulating, into a predetermined value, the superheat degree of the refrigerant flowing out from the evaporator, and an opening/closing valve which controls the inflow of the refrigerant into the evaporator, and the control means controls the operation of the compressor on the basis of the chamber inside temperature of the showcase that is hardest to cool, opens and closes the opening/closing valve of the other showcases on the basis of the chamber inside temperatures of the other showcases, and executes the opening and closing of the respective opening/closing valves at different timings, when the opening/closing valves of the other showcases are opened and closed.
4. The showcase cooling device according to claim 1, wherein each of the showcases comprises an expansion valve which throttles the refrigerant flowing into the evaporator and controls, into a target superheat degree, the superheat degree of the refrigerant flowing out from the evaporator, and the control means defines, as a predetermined value, the target superheat degree of the showcase that is hardest to cool to control a valve open degree of an expansion valve of the showcase, controls the operation of the compressor on the basis of the chamber inside temperature of the showcase, sets the target superheat degree of the other showcases on the basis of the chamber inside temperatures of the other showcases, and controls the valve open degree of the expansion valves of the other showcases.
5. The showcase cooling device according to any one of claims 1 to 4, wherein the control means distinguishes the showcase that is hardest to cool among the respective showcases, and in a case where there is present the other showcase that is harder to cool than the showcase in which the operation of the compressor is controlled on the basis of the chamber inside temperature, the control means switches to a state to control the operation of the compressor on the basis of the chamber inside temperature of the other showcase.
6. The showcase cooling device according to claim 5,

wherein the control means distinguishes the showcase that is hardest to cool among the respective showcases, in a state where the chamber inside temperature is stabilized.

7. The showcase cooling device according to any one of claims 1 to 6, wherein the control means controls an operation frequency of the compressor on the basis of the chamber inside temperature of the showcase that is hardest to cool.
8. The showcase cooling device according to claim 7, which comprises a blowout temperature sensor disposed in a cold air blowout portion of each of the showcases to detect a blowout temperature of the cold air to each of the showcases, wherein the control means determines a target blowout temperature of the cold air to the showcase by a PID calculation based on a deviation between the chamber inside temperature of the showcase and a set value of the chamber inside temperature, and determines a target operation frequency of the compressor and/or the target superheat degree by a PID calculation based on a deviation between the blowout temperature detected by the blowout temperature sensor and the target blowout temperature.
9. The showcase cooling device according to claim 7, which comprises evaporator temperature sensors to detect temperatures of the evaporators of the showcases, respectively, wherein the control means determines a target evaporator temperature of each of the showcases by a PID calculation based on a deviation between the chamber inside temperature of the showcase and a set value of the chamber inside temperature, and determines a target operation frequency of the compressor and/or the target superheat degree by a PID calculation based on a deviation between the temperature of each of the evaporators which is detected by the evaporator sensor and the target evaporator temperature.

FIG. 1

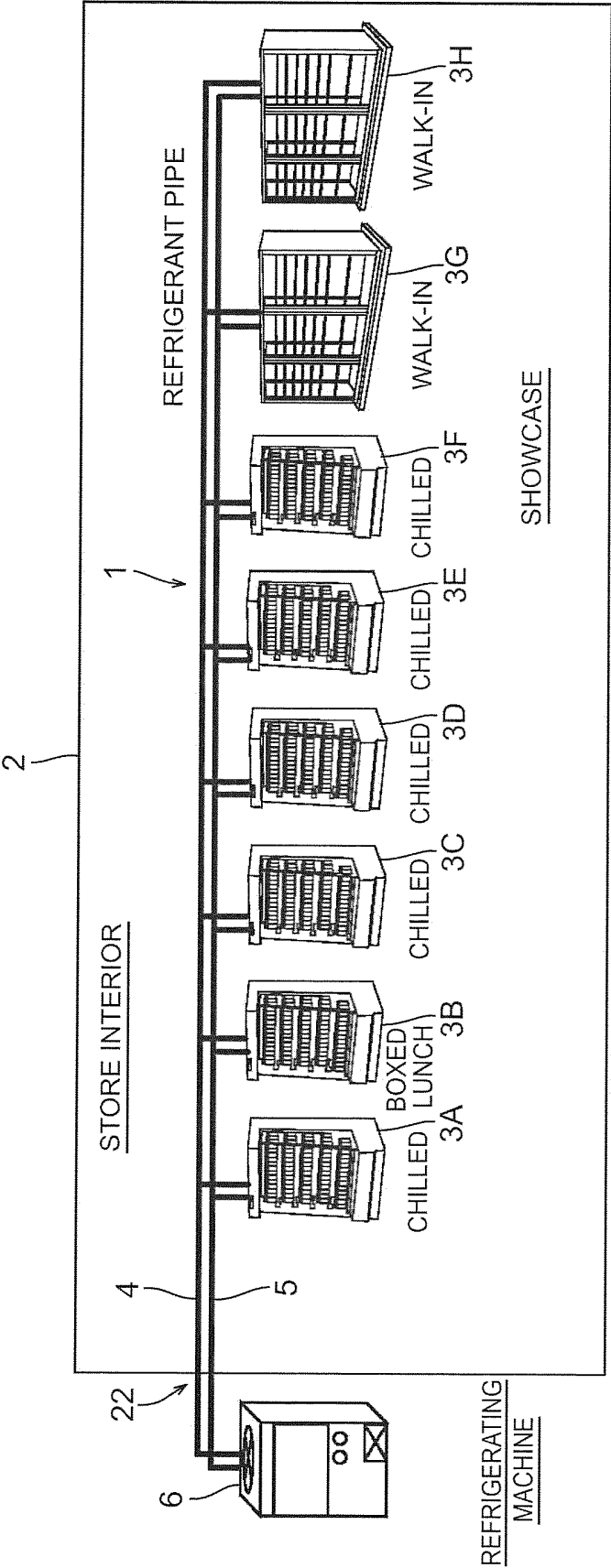


FIG. 2

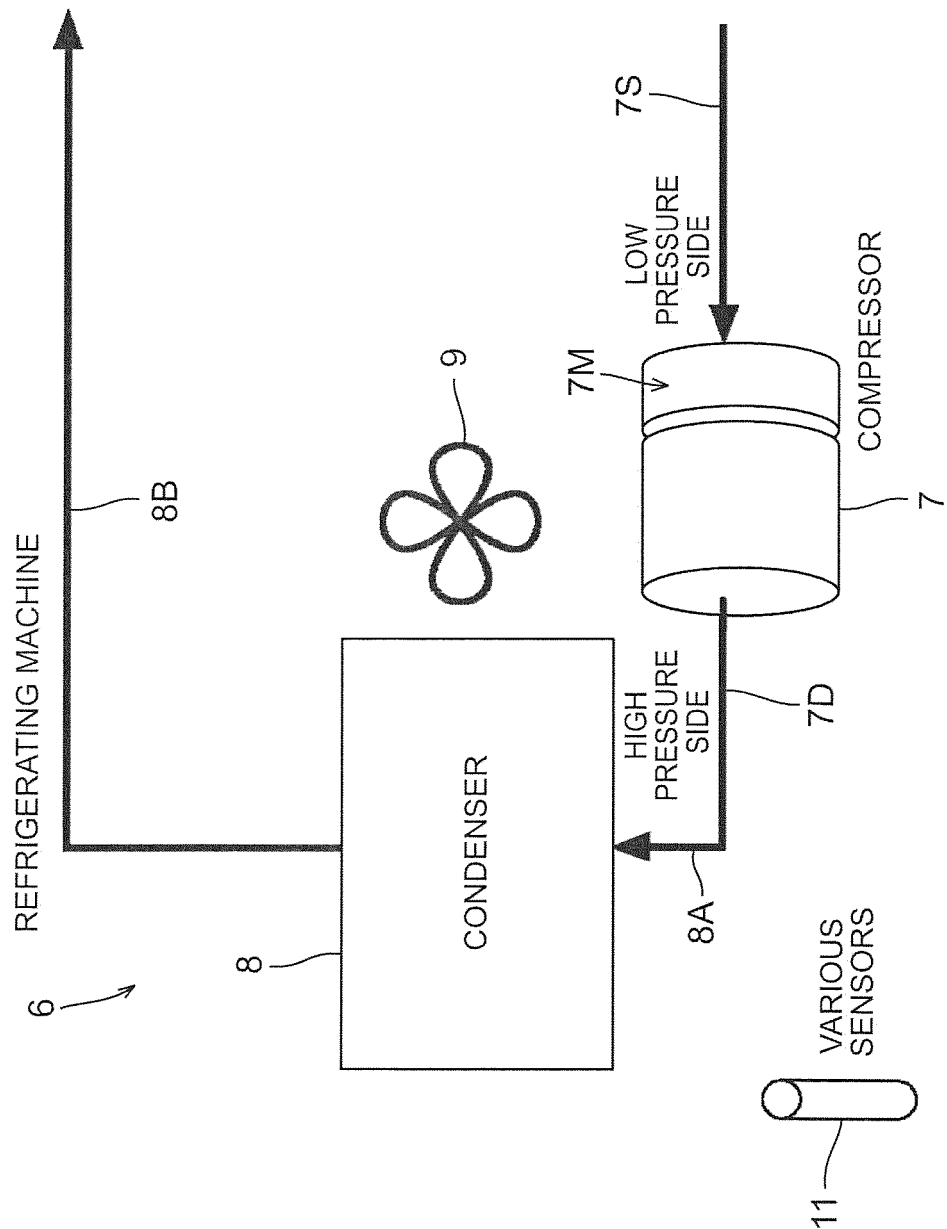


FIG. 3

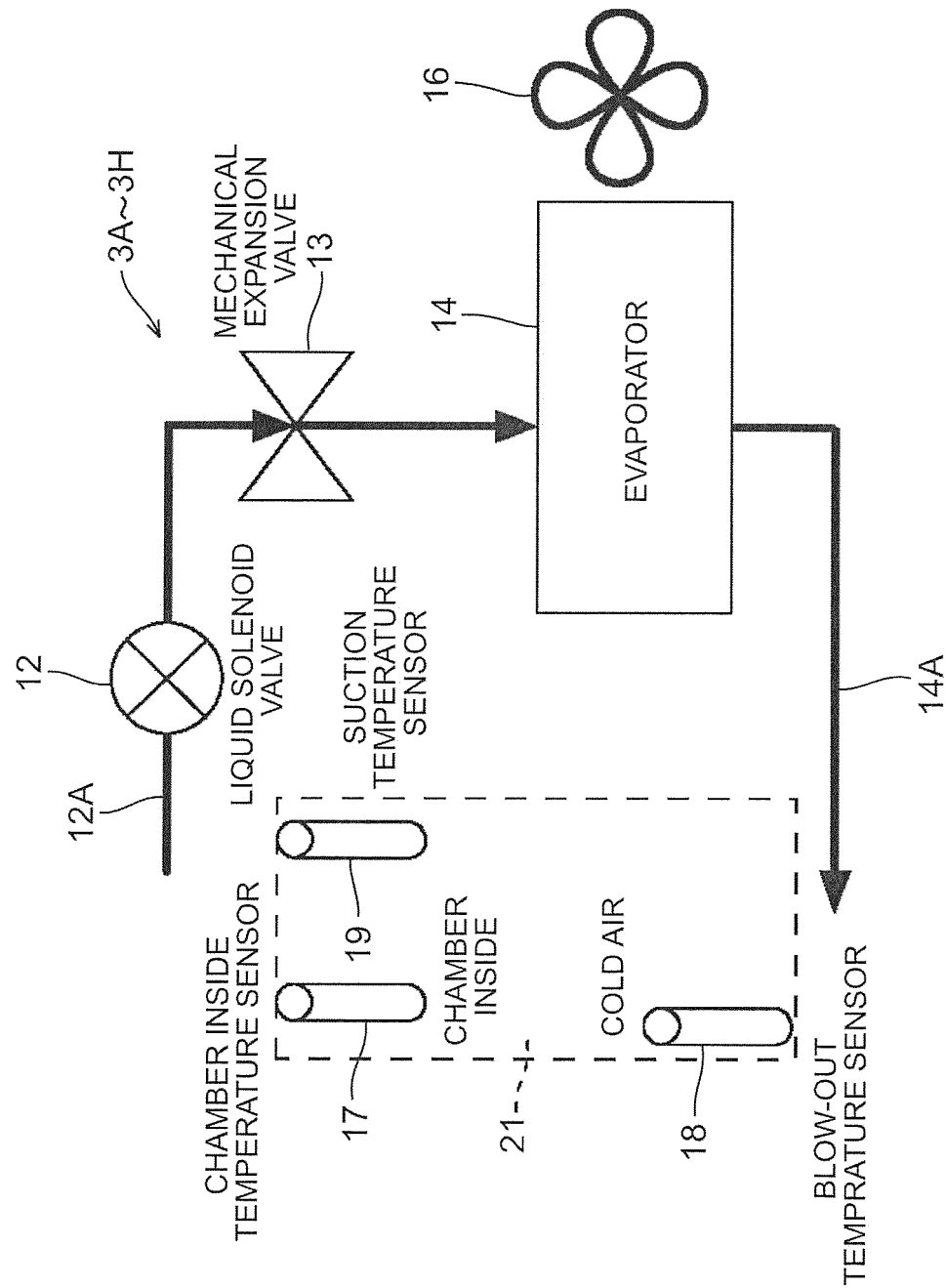


FIG. 4

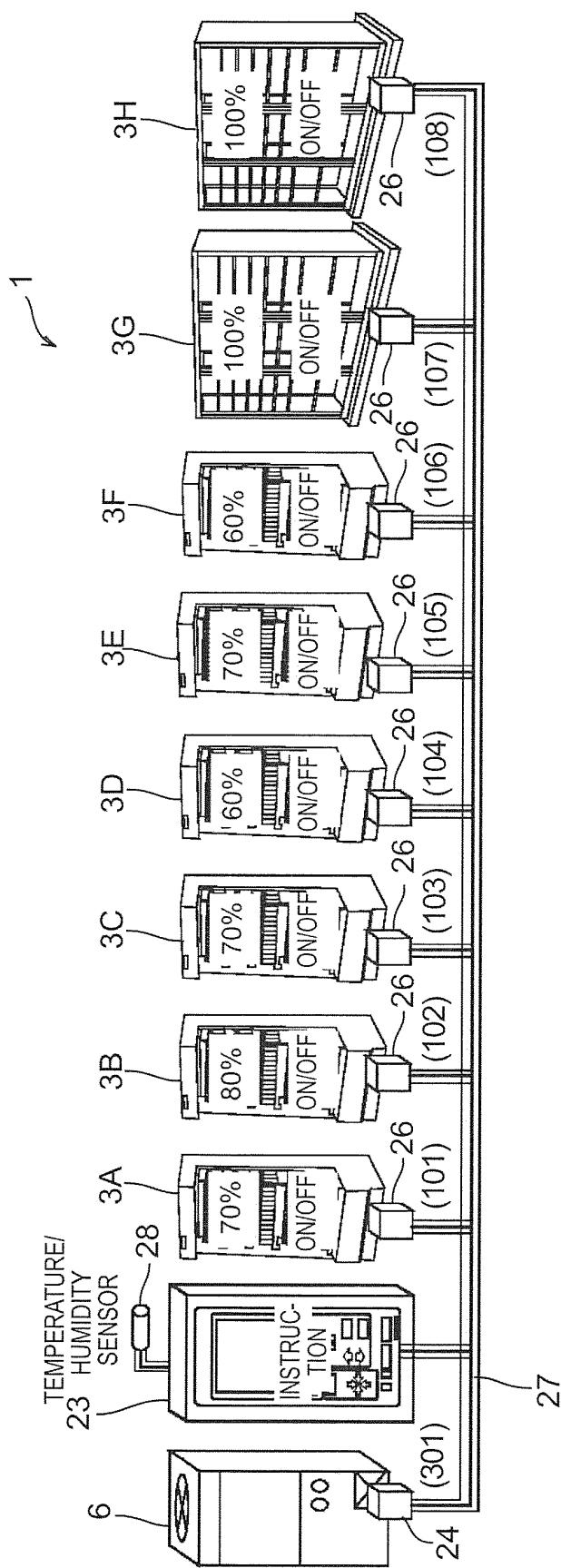


FIG. 5

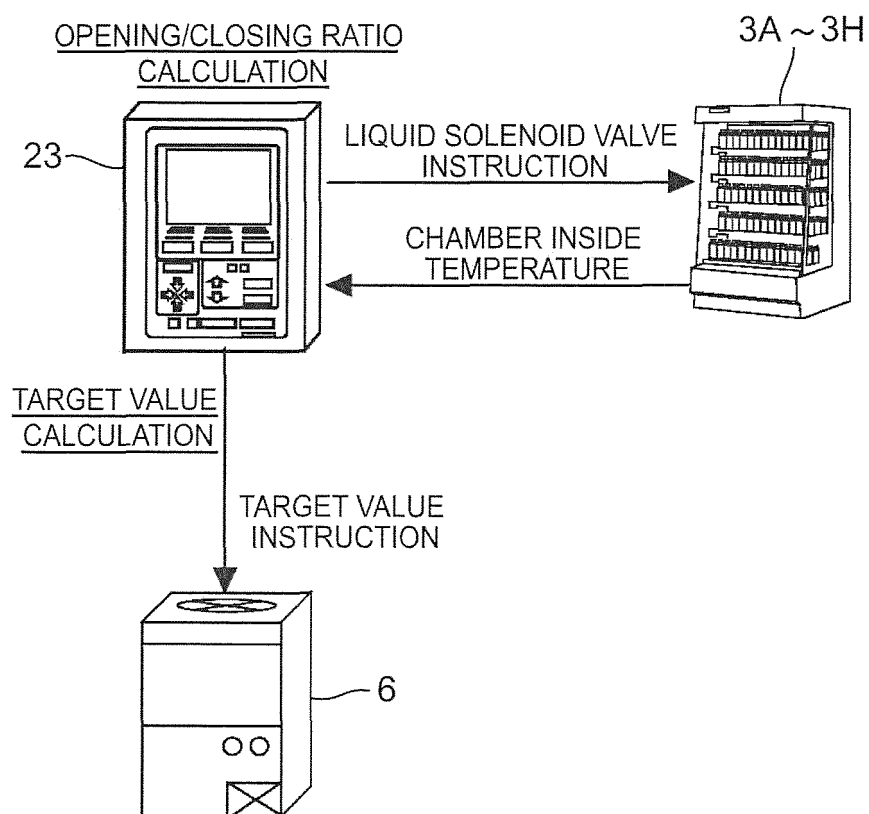


FIG. 6

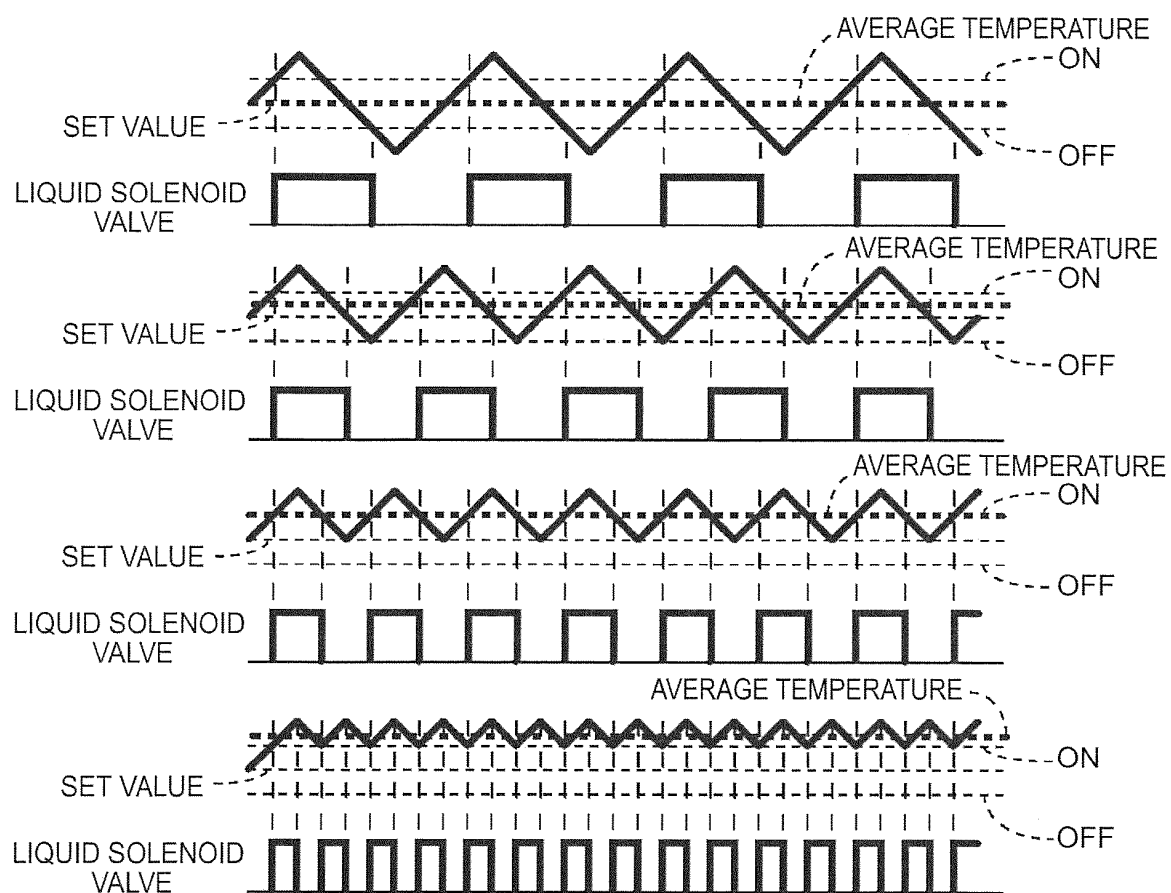


FIG. 7

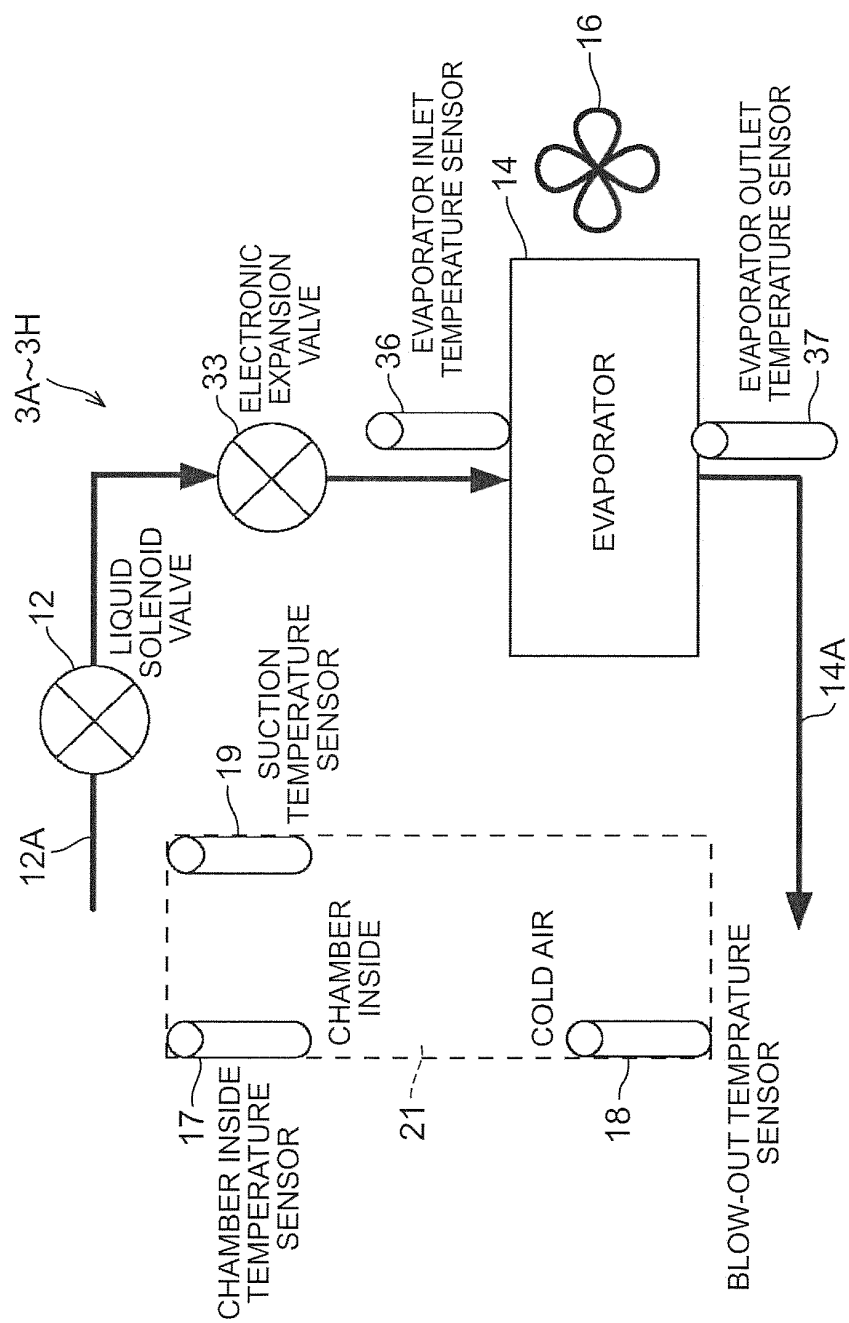


FIG. 8

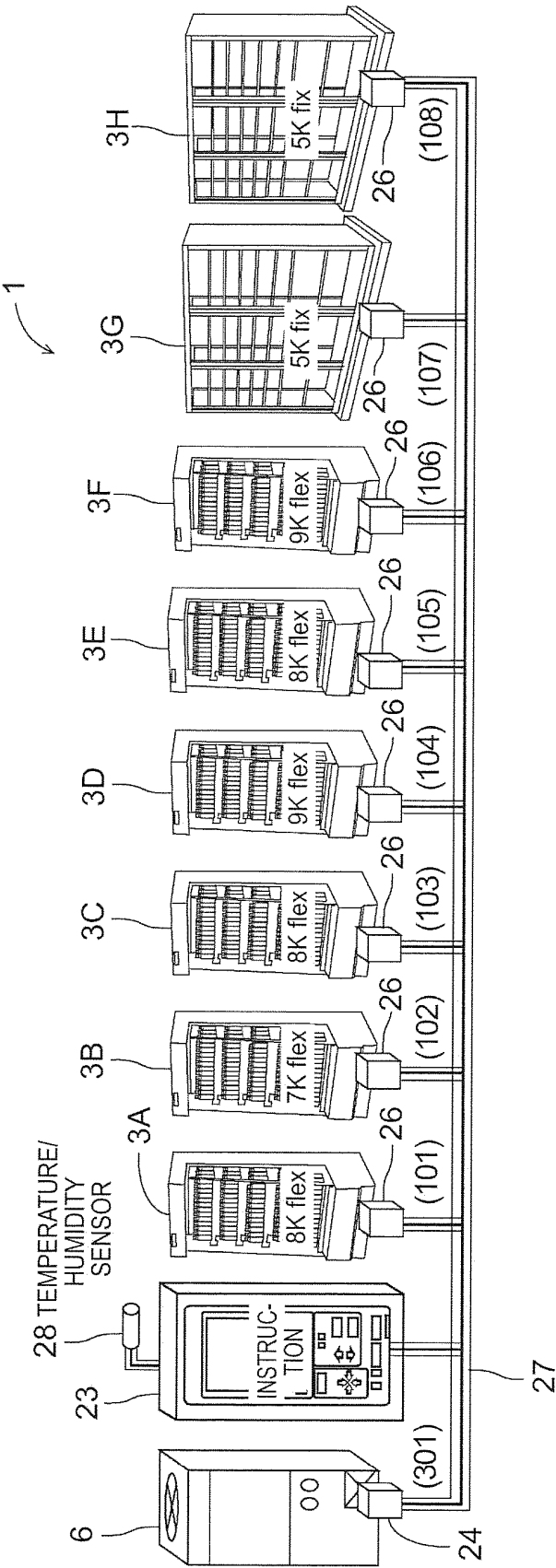
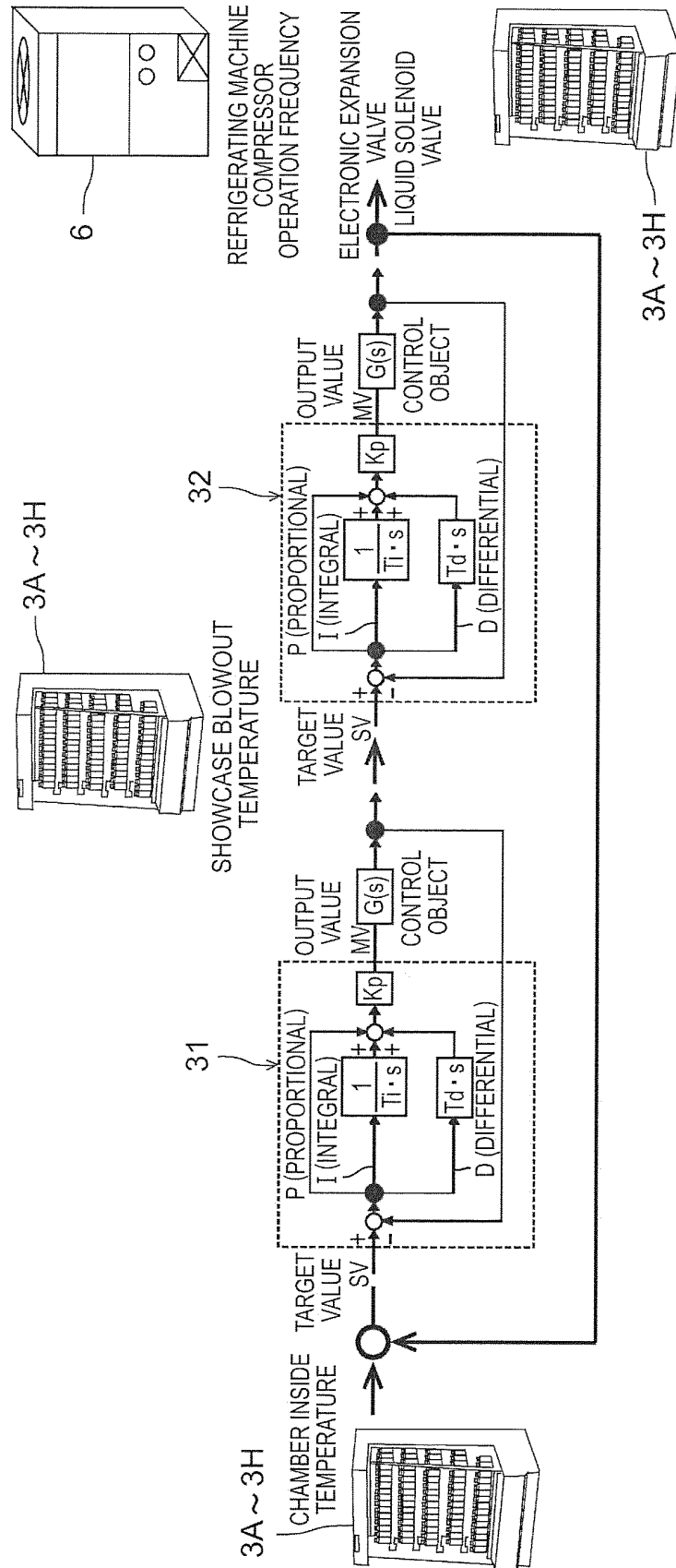


FIG. 9



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2014/052999

A. CLASSIFICATION OF SUBJECT MATTER

F25D11/00(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)

F25D11/00, F25B1/00, F24F11/00-11/08

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 1996-2014

Kokai Jitsuyo Shinan Koho 1971-2014 Toroku Jitsuyo Shinan Koho 1994-2014

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2005-30679 A (Mitsubishi Electric Corp.), 03 February 2005 (03.02.2005), entire text; all drawings (Family: none)	1-9
A	JP 2010-249346 A (Mitsubishi Electric Corp.), 04 November 2010 (04.11.2010), entire text; all drawings (Family: none)	1-9
A	JP 2007-33002 A (Sanden Corp.), 08 February 2007 (08.02.2007), entire text; all drawings (Family: none)	1-9

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

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"&" document member of the same patent family

Date of the actual completion of the international search
01 May, 2014 (01.05.14)Date of mailing of the international search report
13 May, 2014 (13.05.14)Name and mailing address of the ISA/
Japanese Patent Office

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2014/052999

C (Continuation).	DOCUMENTS CONSIDERED TO BE RELEVANT	
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2009-14272 A (Sanyo Electric Co., Ltd.), 22 January 2009 (22.01.2009), entire text; all drawings (Family: none)	1-9
A	JP 5053527 B2 (Sanden Corp.), 17 October 2012 (17.10.2012), entire text; all drawings (Family: none)	1-9
A	WO 2009/122706 A1 (Daikin Industries, Ltd.), 08 October 2009 (08.10.2009), entire text; all drawings & JP 2009-243810 A & US 2011/0023534 A1 & EP 2270405 A1 & CN 101981389 A	1-9

Form PCT/ISA/210 (continuation of second sheet) (July 2009)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 5053527 B [0005]