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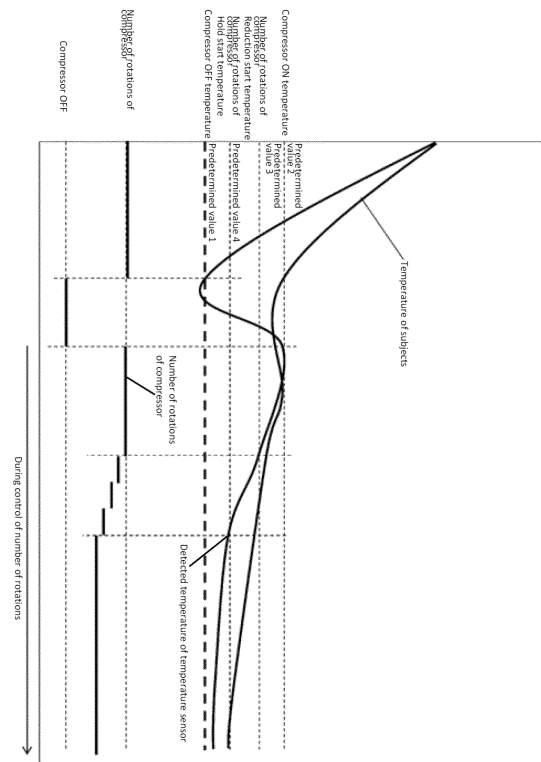
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(54) **REFRIGERATED SHOWCASE**

(57) A refrigerated showcase 30 including: a refrigeration circuit 20 annularly formed by connecting, to one another through a refrigerant pipe, a compressor 1, a condenser 2, a decompression device 3 and an evaporator 4; a fan 5 for blowing air to the evaporator 4 and circulating the air; a temperature sensor 6 for detecting temperature of the air; and a control device 8, wherein the control device 8 stops the operation of the compressor 1 when detected temperature of the temperature sensor 6 reaches the predetermined value 1 during high speed operation of the compressor 1 in which the number of operational rotations thereof is constant, and thereafter, when the detected temperature of the temperature sensor 6 reaches the predetermined value 2, the compressor 1 is made to execute the high speed operation and, when the detected temperature of the temperature sensor 6 reaches the predetermined value 3, the number of operational rotations of the compressor 1 is controlled, and the number of operational rotations of the compressor 1 is reduced stepwisely. According to this, a cooling effect and energy-saving operation of the refrigerated showcase 30 are realized.

[Fig. 4]



Description

[TECHNICAL FIELD]

[0001] The present invention relates to a refrigerated showcase.

[BACKGROUND TECHNIQUE]

[0002] A conventional refrigerated showcase of this kind is composed of: a refrigeration circuit annularly formed by connecting, to one another through a refrigerant pipe, a compressor, a radiator, a decompression device and an evaporator; a thermally insulated storage in which a subject to be refrigerated is placed; and a device for circulating air which passes through the evaporator in the storage, air temperature in the storage is adjusted by starting and stopping the compressor, and control is performed such that the subject has the same temperature as the air temperature (see patent document 1 for example).

[PRIOR ART DOCUMENT]

[Patent Document]

[0003] [Patent Document 1] Japanese Patent Application Laid-open No.2015-75310

[SUMMARY OF THE INVENTION]

[PROBLEM TO BE SOLVED BY THE INVENTION]

[0004] According to the conventional configuration, it is general to control the compressor by circulating air temperature in the storage instead of temperature of the subject to be refrigerated, and it is general to control based on a fact that circulating air temperature is equal to subject temperature without taking subject temperature into consideration.

[0005] Enhancement of efficiency of the compressor proceeds in recent years by an inverter for saving energy, but concerning control of the number of operational rotations of the compressor, it is only possible to control the same by circulating air temperature. When there is a large difference in thermal capacities between the subject and the circulating air, a difference between the circulating air temperature and the subject temperature is small in a state where the subject is sufficiently cooled, but when the subject is not cooled, the difference between the circulating air temperature and the subject temperature is large, and if the compressor is controlled based on the circulating air temperature, since the subject temperature is not involved, there is a problem that the subject is not cooled or it takes time to cool the subject.

[0006] The present invention has been accomplished to solve the conventional problem, and it is an object of

the invention to provide a refrigerated showcase which realizes enhancement of the refrigeration effect and energy-saving operation.

[MEANS FOR SOLVING THE PROBLEM]

[0007] To solve the conventional problem, the present invention provides a refrigerated showcase including: a refrigeration circuit annularly formed by connecting, to one another through a refrigerant pipe, a compressor, a condenser, a decompression device and an evaporator; a fan for blowing air to the evaporator and circulating the air; a temperature sensor for detecting temperature of the air; and a control device, wherein a predetermined value 1 for stopping operation of the compressor, a predetermined value 2 for starting the operation of the compressor and a predetermined value 3 for starting control of number of operational rotations of the compressor are stored in the control device, the control device stops operation of the compressor when detected temperature of the temperature sensor reaches the predetermined value 1 during high speed operation of the compressor in which the number of operational rotations thereof is constant, and thereafter, when the detected temperature of the temperature sensor reaches the predetermined value 2, the compressor is made to execute the high speed operation and then, when the detected temperature of the temperature sensor reaches the predetermined value 3, the number of operational rotations of the compressor is controlled, and the number of operational rotations of the compressor is reduced stepwisely.

[0008] According to this, it is possible to shorten the cooling time of a subject from a state where temperature of the subject is high, realize the enhancement of the refrigeration effect, and realize the energy-saving operation.

[EFFECT OF THE INVENTION]

[0009] According to the present invention, it is possible to provide a refrigerated showcase which realizes the enhancement of the refrigeration effect and the energy-saving operation.

[BRIEF DESCRIPTION OF THE DRAWINGS]

[0010]

Fig. 1 is a schematic diagram of a refrigerated showcase in an embodiment of the present invention;
Fig. 2 is a schematic diagram of a refrigeration cycle of the refrigerated showcase;
Fig. 3 is a block diagram of a control device of the refrigerated showcase in the embodiment;
Fig. 4 is a temperature correlation diagram between control of the number of operational rotations of a compressor, detected temperature of a temperature sensor in the embodiment;

Fig. 5 is an other temperature correlation diagram between control of the number of operational rotations of the compressor, detected temperature of the temperature sensor in the embodiment; and Fig. 6 is a control flow chart in the embodiment.

[MODE FOR CARRYING OUT THE INVENTION]

[0011] A first aspect of the present invention provides a refrigerated showcase including: a refrigeration circuit annularly formed by connecting, to one another through a refrigerant pipe, a compressor, a condenser, a decompression device and an evaporator; a fan for blowing air to the evaporator and circulating the air; a temperature sensor for detecting temperature of the air; and a control device, wherein a predetermined value 1 for stopping operation of the compressor, a predetermined value 2 for starting the operation of the compressor and a predetermined value 3 for starting control of number of operational rotations of the compressor are stored in the control device, the control device stops the operation of the compressor when detected temperature of the temperature sensor reaches the predetermined value 1 during high speed operation of the compressor in which the number of operational rotations thereof is constant, and thereafter, when the detected temperature of the temperature sensor reaches the predetermined value 2, the compressor is made to execute the high speed operation and then, when the detected temperature of the temperature sensor reaches the predetermined value 3, the number of operational rotations of the compressor is controlled, and the number of operational rotations of the compressor is reduced stepwisely.

[0012] According to this, since the number of operational rotations of the compressor is not reduced until the temperature of the circulating air reaches the cooling set temperature, the subject can be cooled early, and energy-saving operation after cooling can be realized.

[0013] According to a second aspect of the invention, in addition to the first aspect, the control device determines whether time elapsed after the detected temperature of the temperature sensor reaches the predetermined value 1 and until the detected temperature reaches the predetermined value 2 exceeds reference time, if the elapsed time exceeds the reference time, the number of operational rotations of the compressor is controlled when the detected temperature of the temperature sensor thereafter reaches the predetermined value 3, the number of operational rotations of the compressor is stepwisely reduced, and if the elapsed time does not exceed the reference time, the high speed operation of the compressor is continued until the detected temperature of the temperature sensor thereafter reaches the predetermined value 1.

[0014] According to this, it is possible to further shorten the cooling time of a high temperature subject as compared with the first aspect.

[0015] According to a third aspect of the invention, in

addition to the first or second aspect, the fan is not stopped while the operation of the compressor is stopped.

[0016] According to this, even if the compressor is brought into the stopped state, the cooling operation of the subject is not stopped by continuing circulation of cold air. Therefore, the effect of the first or second aspect can further be enhanced.

[0017] An embodiment of the present invention will be described below with reference to the drawings. The invention is not limited to the embodiment.

[0018] Fig. 1 is a schematic diagram of a refrigerated showcase in the embodiment of the invention.

[0019] Fig. 2 is a schematic diagram of a refrigeration cycle of the refrigerated showcase.

[0020] As shown in Fig. 2, the refrigeration cycle for cooling the refrigerated showcase of the embodiment is composed of a refrigeration circuit 20 formed by sequentially connecting, to one another through a refrigerant pipe, a compressor 1, a condenser 2, a decompression device 3 and an evaporator 4. As shown in Fig. 1, the evaporator 4 is placed in the refrigerated showcase 30 for cooling. A fan 5 is placed near the evaporator 4. Air in the refrigerated showcase 30 is circulated by the fan 5 and cools cooling subjects 7.

[0021] A temperature sensor 6 is provided in an air flow path upstream of the evaporator 4 for managing temperature of the cooling subjects 7. Operation of the compressor 1 and operation of the fan 5 are determined by circulating air temperature which is detected by the temperature sensor 6.

[0022] In this embodiment, the compressor 1 can be changed and controlled the number of rotations (ability) by driving an inverter, and the fan 5 can be controlled by starting and stopping using a constant speed fan. The refrigeration circuit 20 is stored in a lower portion of the refrigerated showcase 30.

[0023] The refrigeration circuit 20 may be placed outside the refrigerated showcase 30. It is preferable that the temperature sensor 6 in the refrigerated showcase 30 is located upstream of the evaporator 4 and downstream of the cooling subjects 7, but the position of the temperature sensor 6 is not limited to this position, and the temperature sensor 6 may not be placed near the evaporator 4 only if the fan 5 can circulates air in the refrigerated showcase 30.

[0024] Fig. 3 is a block diagram of a control device of the refrigerated showcase in the embodiment. An electric power source, the temperature sensor 6, the fan 5 and the compressor 1 are connected to the control device 8. The control device 8 has a function to determine the operations of the compressor 1 and the fan 5 based on temperature detected by the temperature sensor 6. An inverter driving circuit 9 of the compressor 1 is operated by instructions of the control device 8 and in this embodiment, the control device 8 includes the inverter driving circuit 9. The inverter driving circuit 9 may be provided separately from the control device 8.

[0025] Operation and behavior of the refrigerated showcase 30 having the above-described configuration will be described below.

[0026] Figs. 4 and 5 are temperature correlation diagrams between control of the number of operational rotations of the compressor and detected temperature of the temperature sensor in the embodiment, and Fig. 6 is a control flow chart in the embodiment.

[0027] In Figs. 4 and 5, a vertical axis shows temperature of circulating air in the refrigerated showcase 30 detected by the temperature sensor 6, temperature of the cooling subjects 7 and starting and stopping operations and variations in the number of rotations of the compressor 1, and a horizontal axis shows passage of time.

[0028] A predetermined value 1 is set temperature for stopping (OFF) the compressor 1, a predetermined value 2 is set temperature for starting up (ON) the compressor 1, a predetermined value 3 is set temperature for starting the control of the number of operational rotations of the compressor 1, a predetermined value 4 is set temperature for starting the operation of the compressor 1 to bring the number of operational rotations thereof into a low speed and constant operation, the set temperature of the predetermined value 4 is higher than that of the predetermined value 1, the set temperature of the predetermined value 3 is higher than that of the predetermined value 4, and the set temperature of the predetermined value 2 is higher than that of the predetermined value 3.

[0029] These predetermined values 1 to 4 are previously stored in the control device 8.

[0030] First, the control device 8 operates the compressor 1 at high speed, preferably, at the maximum ability (maximum number of rotations) (S1). In S1, operation of the fan 5 is started. After the control device 8 operates the compressor 1 at high speed, the control device 8 determines whether a detected value of the temperature sensor 6 reaches stop temperature (predetermined value 1) of the compressor 1 (S2). The compressor 1 continues the high speed operation until the detected value of the temperature sensor 6 reaches the stop temperature (predetermined value 1) of the compressor 1. If the detected value of the temperature sensor 6 reaches the stop temperature (predetermined value 1) of the compressor 1, the control device 8 stops the compressor 1 (S3). In S3, the fan 5 keeps operating without stopping. The control device 8 starts measuring of a timer from the stop of the compressor 1 in S3 (S4). After the compressor 1 is stopped in S3, it is determined whether the detected value of the temperature sensor 6 reaches startup temperature (predetermined value 2) of the compressor 1 (S5). The stop state of the compressor 1 is continued until the detected temperature of the temperature sensor 6 reaches the startup temperature (predetermined value 2) of the compressor 1.

[0031] If the detected value of the temperature sensor 6 reaches the startup temperature (predetermined value 2) of the compressor 1, the control device 8 again operates (ON) the compressor 1 at high speed, preferably,

at the maximum ability (maximum number of rotations) (S6). The control device 8 terminates the measurement of the timer by the operation of the compressor 1 in S6 (S7).

[0032] The control device 8 determines whether time elapsed from the start of the measurement of the timer in S4 to the end of the measurement of the timer in S7 exceeds reference time (S8).

[0033] If it is determined that the elapsed time exceeds the reference time in S8, control shown in Fig. 4 is performed.

[0034] That is, the control device 8 determines whether the detected value of the temperature sensor 6 reaches start temperature (predetermined value 3) of reducing operation of the number of rotations of the compressor 1 (S9). As the compressor 1 operates, circulating air temperature (detected value of temperature sensor 6) is lowered, and if the detected value of the temperature sensor 6 reaches the start temperature (predetermined value 3) of the reducing operation of the number of rotations of the compressor 1, the control is shifted to the control of the number of operational rotations of the compressor 1, i.e., inverter control, and the number of rotations is stepwisely reduced (S10). In S10, the fan 5 keeps operating without stopping. In S9, the compressor 1 keeps operating at high speed until the detected value of the temperature sensor 6 reaches the start temperature (predetermined value 3) of the control of the number of operational rotations of the compressor 1.

[0035] After S9, the control device 8 determines whether the detected value of the temperature sensor 6 reaches start temperature (predetermined value 4) of operation to bring the number of operational rotations of the compressor 1 into the low speed and constant operation (S11). The control device 8 reduces the number of operational rotations of the compressor 1 stepwisely until the detected value of the temperature sensor 6 is reduced to the predetermined value 4 (S10). In S11, if the detected value of the temperature sensor 6 reaches the predetermined value 4, the control device 8 brings the number of operational rotations of the compressor 1 into the low speed and constant speed operation (S12).

[0036] As described above, in this embodiment, the control of the number of operational rotations of the compressor 1 is not performed until the circulating air temperature (detected value of temperature sensor 6) reaches the predetermined value 1, and the circulating air temperature can be lowered in a short time by keeping the high speed operation, preferably, the maximum ability (maximum number of rotations) operation of the compressor 1.

[0037] After the temperature of the circulating air is restored to the predetermined value 2, the compressor 1 is operated at high speed until the circulating air temperature is lowered to the predetermined value 3. After the circulating air temperature is lowered to the predetermined value 3, the control is shifted to the control of the number of operational rotations. According to this, it is

possible to cool the cooling subjects 7 in a short time, and after the cooling subjects 7 are cooled, the number of the starting and stopping operations of the compressor 1 can be reduced. Therefore, energy can be saved and the cooling time can be shortened.

[0038] In the maximum ability (maximum number of rotations) operation, the number of rotations is controlled by protection in some cases. The control of the number of operational rotations is shifted to the constant number of rotations operation when temperature becomes equal to or higher than the predetermined temperature or when the electric power source is stopped, but this shift is not limited to these cases.

[0039] In S8, control when it is determined that the reference time is not elapsed is shown in Fig. 5.

[0040] In Fig. 5, it is determined whether time elapsed after the circulating air temperature (detected value of temperature sensor 6) reaches the predetermined value 1 and until the circulating air temperature reaches the predetermined value 2 exceeds the reference time.

[0041] If it is determined in S8 that the reference time is not elapsed, the compressor 1 is operated at high speed, and it is determined whether the circulating air temperature (detected value of temperature sensor 6) reaches the predetermined value 1 (S2).

[0042] As described above, constant reference time is provided within stopped time of the compressor 1, and it is determined whether the number of operational rotations of the compressor 1 is controlled in a next step by a rising width of the circulating air temperature (detected value of temperature sensor 6) within this reference time.

[0043] As shown in Fig. 5, if the circulating air temperature (detected value of temperature sensor 6) reaches the predetermined value 2, the compressor 1 is operated at high speed, preferably, the maximum ability (maximum number of rotations). Even if the circulating air temperature (detected value of temperature sensor 6) reaches the predetermined value 3, the number of operational rotations of the compressor 1 is not controlled.

[0044] If the circulating air temperature (detected value of temperature sensor 6) exceeds the reference time and reaches the predetermined value 2, the compressor 1 is operated at high speed, preferably, the maximum ability (maximum number of rotations), and if the circulating air temperature (detected value of temperature sensor 6) reaches the predetermined value 3, the control of the compressor 1 is shifted to the number of operational rotations control thereafter.

[0045] According to this, by operating the compressor 1 at high speed, preferably, the maximum ability (maximum number of rotations), it is possible to further shorten the cooling time of the cooling subjects 7.

[0046] Normally, when the compressor 1 is stopped, air circulation which places emphasis on cold storage is stopped, but before the control is shifted to the number of rotations control, heat exchange between circulating air and the cooling subjects 7 is promoted by not stopping the fan 5 while the compressor 1 is stopped, and detected

temperature of the temperature sensor 6 is made close to temperature of the cooling subjects 7. According to this, cooling time is shortened and excessive cooling is prevented.

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[INDUSTRIAL APPLICABILITY]

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[0047] As described above, according to the refrigerated showcase of the present invention, it is possible to enhance the cooling effect and realize the energy-saving operation. Therefore, the invention can be applied to a cooling device such as a refrigerator having an inverter compressor and a vending machine.

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[EXPLANATION OF SYMBOLS]

[0048]

1

compressor

20

condenser

decompression device

evaporator

fan

temperature sensor

25

cooling subject

control device

inverter driving circuit

refrigeration circuit

30

refrigerated showcase

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Claims

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1. A refrigerated showcase (30) comprising:

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a refrigeration circuit (20) annularly formed by connecting, to one another through a refrigerant pipe, a compressor (1), a condenser (2), a decompression device (3) and an evaporator (4); a fan (5) for blowing air to the evaporator (4) and circulating the air;

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a temperature sensor (6) for detecting temperature of the air; and

a control device (8), wherein

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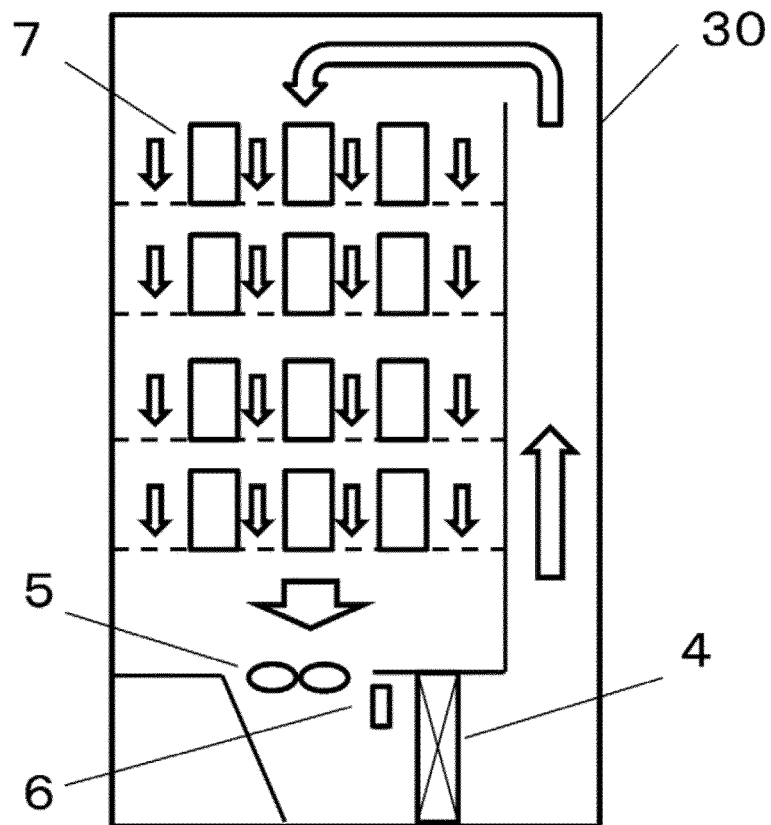
a predetermined value 1 for stopping operation of the compressor (1), a predetermined value 2 for starting the operation of the compressor (1) and a predetermined value 3 for starting control of number of operational rotations of the compressor (1) are stored in the control device (8), the control device (8) stops the operation of the compressor (1) when detected temperature of the temperature sensor (6) reaches the predetermined value 1 during high speed operation of the compressor (1) in which the number of operational rotations thereof is constant, and thereafter, when the detected temperature of the temperature sensor (6) reaches the predeter-

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mined value 2, the compressor (1) is made to execute the high speed operation and then, when the detected temperature of the temperature sensor (6) reaches the predetermined value 3, the number of operational rotations of the compressor (1) is controlled, and the number of operational rotations of the compressor (1) is reduced stepwisely. 5

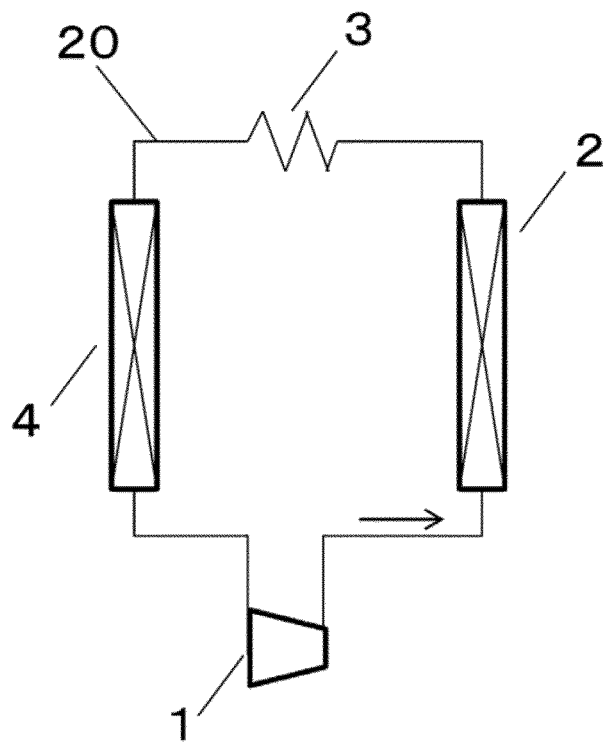
2. The refrigerated showcase (30) according to claim 1, wherein the control device (8) determines whether time elapsed after the detected temperature of the temperature sensor (6) reaches the predetermined value 1 and until the detected temperature reaches the predetermined value 2 exceeds reference time, 10
if the elapsed time exceeds the reference time, the number of operational rotations of the compressor (1) is controlled when the detected temperature of the temperature sensor (6) thereafter reaches the predetermined value 3, the number of operational rotations of the compressor (1) is stepwisely reduced, and 15
if the elapsed time does not exceed the reference time, the high speed operation of the compressor (1) is continued until the detected temperature of the temperature sensor (6) thereafter reaches the predetermined value 1. 20
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3. The refrigerated showcase (30) according to claim 1 or 2, wherein 30
the fan (5) is not stopped while the operation of the compressor (1) is stopped. 35
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[Fig. 1]



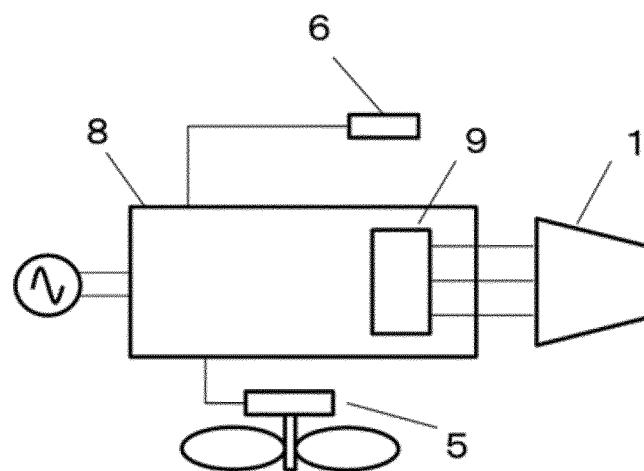
- 1 Compressor
- 5 Fan
- 6 Temperature sensor
- 20 Refrigeration circuit

[Fig. 2]



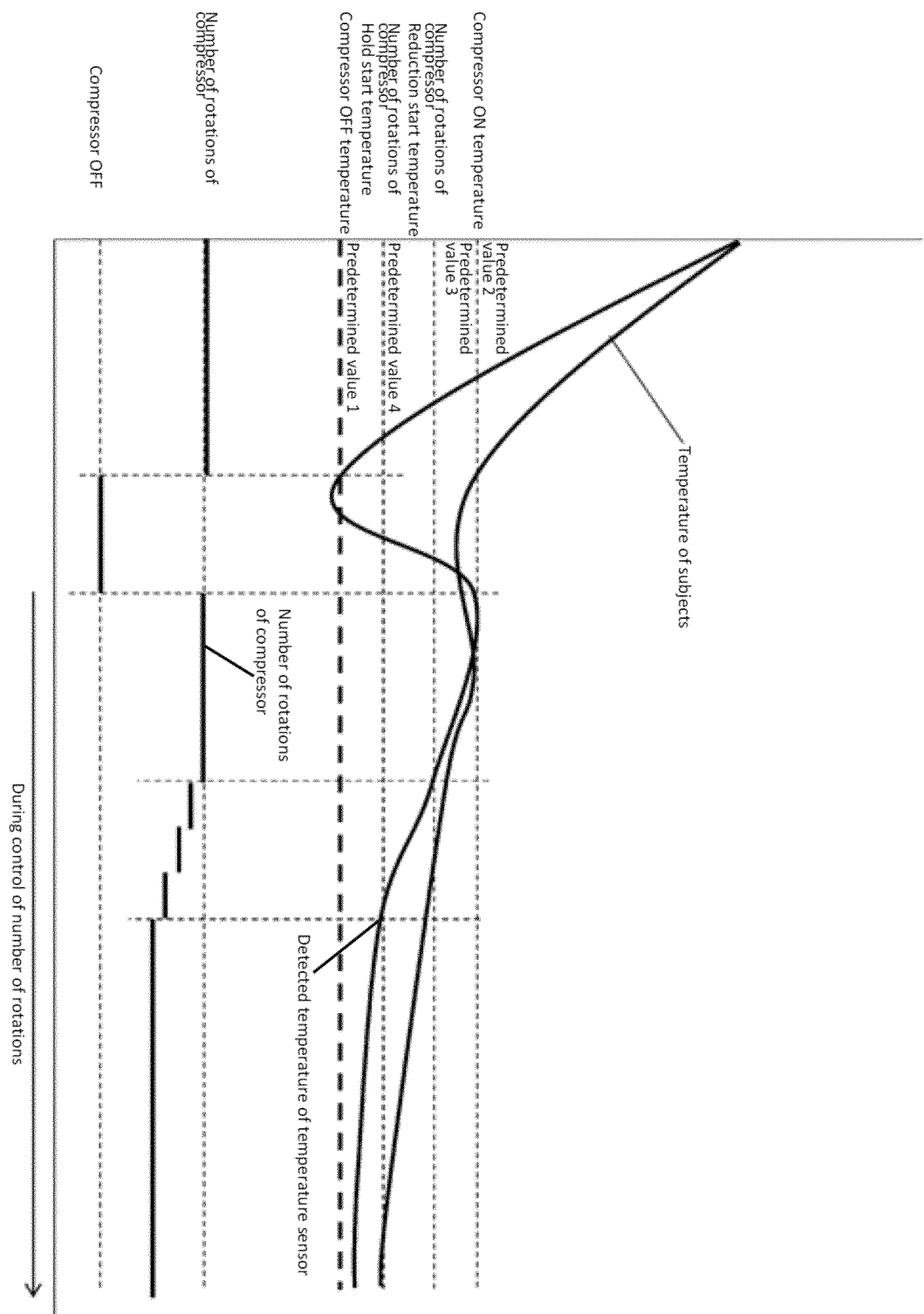
- | | |
|---|------------|
| 1 | Compressor |
| 2 | Condenser |
| 4 | Evaporator |

[Fig. 3]

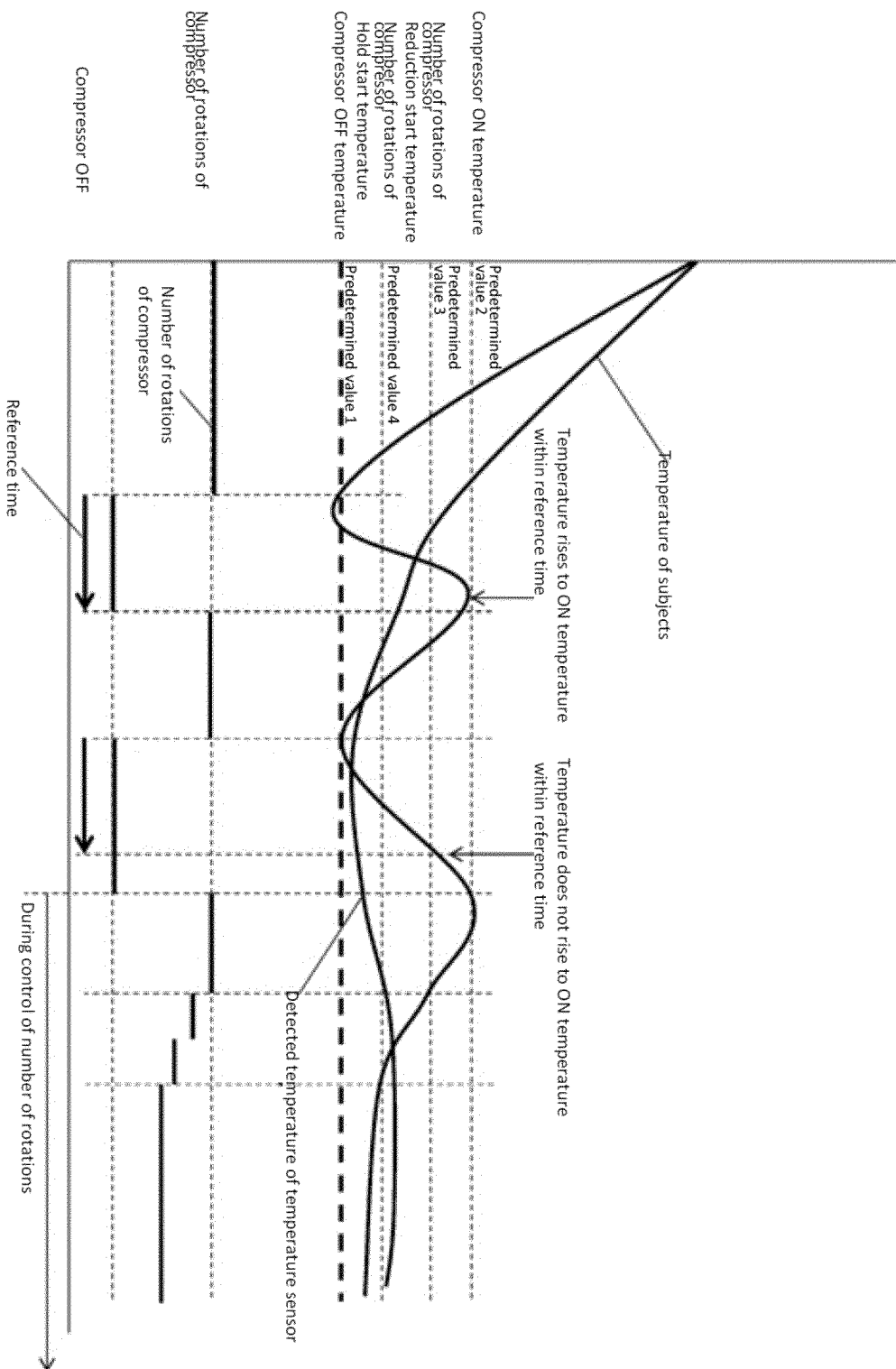


- | | |
|---|--------------------------|
| 1 | Compressor |
| 6 | Temperature sensor |
| 8 | Control device |
| 9 | Inverter driving circuit |

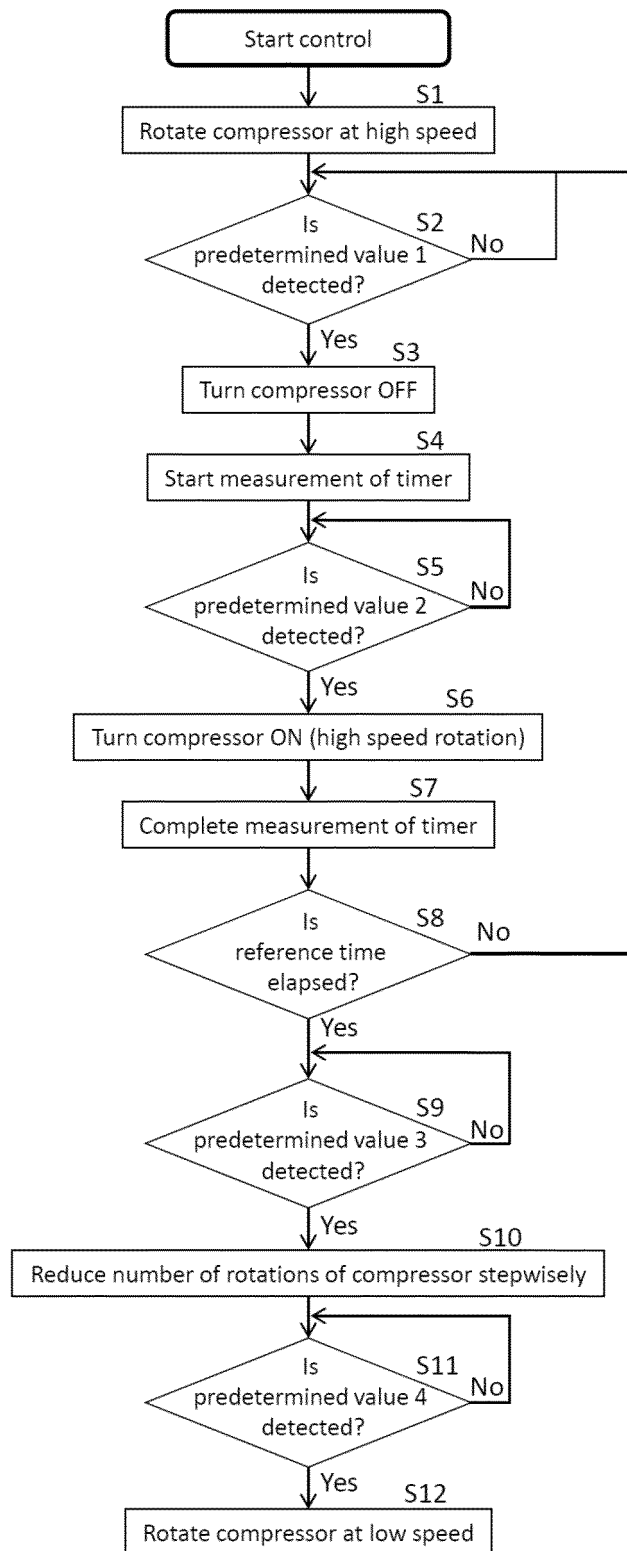
[Fig. 4]



[Fig. 5]



[Fig. 6]



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2018/006251

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl. 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)

Int. Cl. F25D1/00-31/00, F25B1/00-7/00

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

Published examined utility model applications of Japan 1922-1996

Published unexamined utility model applications of Japan 1971-2018

Registered utility model specifications of Japan 1996-2018

Published registered utility model applications of Japan 1994-2018

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

DWPI (Derwent Innovation), Japio-GPG/FX

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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Y	28 April 2005, paragraphs [0028], [0029], [0040],	3
A	[0064], [0065], fig. 3, 4, 6, 18 & US 2007/0144188 A1, paragraphs [0078], [0079], [0103], [0158]-[0160], fig. 3, 4, 6, 18 & EP 1681524 A1 & AU 2004282449 A & KR 10-2006-0060740 A & CN 1871482 A	2
Y	JP 7-282344 A (KUBOTA CORP.) 27 October 1995, paragraph [0006] (Family: none)	3
Y	CN 102287982 B (HEFEI MIDEA REFRIGERATOR CO., LTD.) 06 November 2013, paragraphs [0049]-[0056], fig. 4 & CN 102287982 A	3



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

16.04.2018

Date of mailing of the international search report

01.05.2018

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2018/006251

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	JP 7-35456 A (MATSUSHITA REFRIGERATION CO.) 07 February 1995, paragraphs [0023], [0025], [0029], [0033]-[0038] (Family: none)	2
A	JP 2014-190661 A (PANASONIC CORP.) 06 October 2014, paragraph [0018] (Family: none)	2
A	JP 2011-169590 A (MITSUBISHI ELECTRIC CORP.) 01 September 2011, abstract (Family: none)	1-3
A	JP 2011-208850 A (HOSHIZAKI ELECTRIC CO., LTD.) 20 October 2011, fig. 5 (Family: none)	3
A	JP 2007-315716 A (FUKUSHIMA INDUSTRIES CORP.) 06 December 2007, abstract, fig. 6 (Family: none)	3

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

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2015075310 A [0003]