(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 3 992 552 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
04.05.2022 Bulletin 2022/18

(21) Application number: **21191420.5**

(22) Date of filing: **16.08.2021**

(51) International Patent Classification (IPC):
F25B 49/02 *(2006.01)*

(52) Cooperative Patent Classification (CPC):
F25B 49/02; F25B 2400/13; F25B 2500/07; F25B 2500/08; F25B 2600/2509; F25B 2600/2513; F25B 2700/1931; F25B 2700/21152

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
KH MA MD TN

(30) Priority: **30.10.2020 JP 2020182013**

(71) Applicant: **Panasonic Intellectual Property Management Co., Ltd.**
Osaka-shi, Osaka 540-6207 (JP)

(72) Inventors:
- **IMAGAWA, Tsuneko**
  Osaka, 540-6207 (JP)
- **YAMAOKA, Yuki**
  Osaka, 540-6207 (JP)

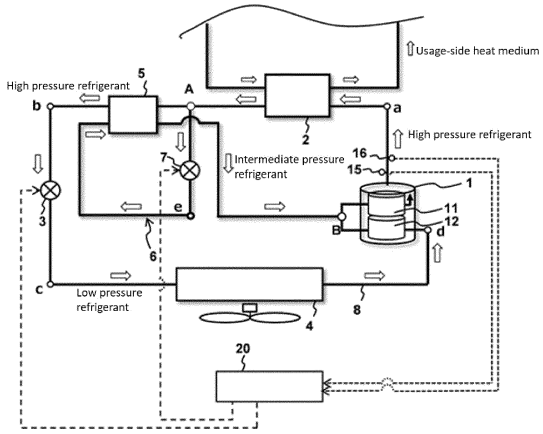
(74) Representative: **Eisenführ Speiser**
Patentanwälte Rechtsanwälte PartGmbB
Postfach 31 02 60
80102 München (DE)

(54) REFRIGERATION CYCLE DEVICE

(57) [Object] The present disclosure provides a refrigeration cycle device capable of suppressing rise in discharge temperature and rise of discharge pressure even when the discharge temperature and the discharge pressure reach upper limits of operating range.

[Solving Means] The refrigeration cycle device includes: a main refrigerant circuit 8 formed from a compressing mechanism 1, a usage-side heat exchanger 2, an intermediate heat exchanger 5, a first expanding device 3 and a heat source-side heat exchanger 4; a bypass refrigerant circuit 6 in which after refrigerant which branches off from between the usage-side heat exchanger 2 and the first expanding device 3 is decompressed by a second expanding device 7, heat of the refrigerant is exchanged with that of the refrigerant which flows through the main refrigerant circuit 8, and the refrigerant joins up with the refrigerant which is in middle of a compression operation of a compression rotating element; discharge temperature detecting means 15 for detecting discharge temperature, discharge pressure detecting means 16 for detecting discharge pressure; and a control device 20, wherein when the discharge pressure is higher than predetermined pressure and the discharge temperature is higher than predetermined temperature, opening degrees of both the first expanding device 3 and the second expanding device 7 are increased.

[Fig. 1]



EP 3 992 552 A1

Description

[TECHNICAL FIELD]

[0001] The present disclosure relates to a refrigeration cycle device.

[BACKGROUND TECHNIQUE]

[0002] Patent document 1 discloses a refrigeration device including a plurality of compressors placed in multiple stages in series for compressing refrigerant, and a bypass refrigerant circuit which bypasses a portion of circulating refrigerant of a main refrigerant circuit to a location between the plurality of compressors.

[0003] The portion of the refrigerant of the main refrigerant circuit is expanded by an electronic expansion valve placed in the bypass refrigerant circuit, the portion of the refrigerant exchanges heat with refrigerant which flows through the main refrigerant circuit and thereafter, the portion of the refrigerant bypasses to the location between the plurality of compressors, it joins up with refrigerant discharged from low stage one of the plurality of compressors, and it is sucked into high stage one of the compressors.

[0004] Discharge temperature of the high stage compressor is always detected, and when it is expected that the discharge temperature of the high stage compressor exceeds an upper limit, and control is performed such that an opening degree of the electronic expansion valve in the bypass refrigerant circuit is temporarily increased to lower the discharge temperature.

[PRIOR ART DOCUMENT]

[PATENT DOCUMENT]

[0005] [Patent Document 1] Japanese Patent Application Laid-open No.2009-192164

[SUMMARY OF THE INVENTION]

[PROBLEM TO BE SOLVED BY THE INVENTION]

[0006] The present disclosure provides a refrigeration cycle device having high reliability in which even if discharge temperature and discharge pressure increase and their values reach upper limits of an operating range, it is possible to suppress increase in discharge temperature and discharge pressure without exceeding the upper limits.

[MEANS FOR SOLVING THE PROBLEM]

[0007] A refrigeration cycle device in the present disclosure includes: a main refrigerant circuit formed by sequentially connecting, to one another through a pipe, a compressing mechanism composed of a compression rotating element, a usage-side heat exchanger for heating usage-side heat medium by refrigerant which is discharged from the compression rotating element, an intermediate heat exchanger, a first expanding device and a heat source-side heat exchanger; a bypass refrigerant circuit in which refrigerant which branches off from the pipe between the usage-side heat exchanger and the first expanding device is decompressed by the second expanding device and thereafter, heat of the refrigerant is exchanged with that of the refrigerant which flows through the main refrigerant circuit by the intermediate heat exchanger, and the refrigerant joins up with the refrigerant which is in middle of a compression operation of the compression rotating element; discharge temperature detecting means for detecting discharge temperature of the compression rotating element; discharge pressure detecting means for detecting discharge pressure of the compression rotating element; and a control device, wherein when the discharge pressure of the compression rotating element is higher than predetermined pressure and the discharge temperature of the compression rotating element is higher than predetermined temperature, the control device increases opening degrees of both the first expanding device and the second expanding device.

[EFFECT OF THE INVENTION]

[0008] The present disclosure can provide a refrigeration cycle device having high reliability in which even if discharge temperature and discharge pressure increase and their values reach upper limits of an operating range, it is possible to suppress increase in discharge temperature and discharge pressure without exceeding the upper limits.

[BRIEF DESCRIPTION OF THE DRAWINGS]

[0009]

Fig. 1 is a block diagram of a refrigeration cycle in an embodiment of the present disclosure;
Fig. 2 is a pressure-enthalpy diagram (P-h diagram) when an opening degree of only a second expanding device is increased in a refrigeration cycle device of the embodiment;
Fig. 3 is a pressure-enthalpy diagram (P-h diagram) when an opening degree of only a first expanding device is increased in the refrigeration cycle device of the embodiment; and
Fig. 4 is a pressure-enthalpy diagram (P-h diagram) when the opening degrees of the first and second expanding devices are increased in the refrigeration cycle device of the embodiment.

[MODE FOR CARRYING OUT THE INVENTION]

[0010] An embodiment will be described below in detail

with reference to the drawings. However, excessively detailed description more than necessary will be omitted in some cases. For example, detailed description of already well known matters, or redundant description of substantially the same configuration will be omitted in some cases.

[0011] The accompanying drawing and the following description are provided so that a person skilled in the art can sufficiently understand the present disclosure, and it is not intended that they limit the subject matter described in claims.

(Embodiment)

[0012] An embodiment of the present disclosure will be described below using Figs. 1 to 3.

[1-1. Configuration]

[0013] In Fig. 1, a refrigeration cycle device includes a main refrigerant circuit 8 and a bypass refrigerant circuit 6.

[0014] The main refrigerant circuit 8 is formed by sequentially connecting, to one another through a pipe, a compressing mechanism 1 which is composed of a compression rotating element, a usage-side heat exchanger 2 which is a radiator, an intermediate heat exchanger 5, a first expanding device 3 and a heat source-side heat exchanger 4 which is an evaporator. Carbon dioxide (CO_2) is used as refrigerant.

[0015] The compressing mechanism 1 is composed of a high stage compressing portion 11 and a low stage compressing portion 12. In the usage-side heat exchanger 2, usage-side heat medium is heated by refrigerant discharged from the compressing mechanism 1.

[0016] In Fig. 1, the compression rotating element is illustrated as a two-stage compressing mechanism composed of the low stage compressing portion 12 and the high stage compressing portion 11, but the compression rotating element can be applied to a single compressing mechanism. When the single compressing mechanism is employed, a position where refrigerant from the bypass refrigerant circuit 6 is sucked is defined as a compression midstream of the compression rotating element. A portion of the compression rotating element extending up to a position where refrigerant from the main refrigerant circuit 8 and refrigerant from the bypass refrigerant circuit 6 merge with each other is defined as the low stage compressing portion 12. A portion of the compression rotating element extending after the position where the refrigerant from the bypass refrigerant circuit 6 merge is defined as the high stage compressing portion 11.

[0017] The bypass refrigerant circuit 6 branches off from the main refrigerant circuit 8 through a pipe between the usage-side heat exchanger 2 and the intermediate heat exchanger 5, and the bypass refrigerant circuit 6 is connected to a location between the low stage compressing portion 12 and the high stage compressing portion 11.

[0018] The bypass refrigerant circuit 6 is provided with a second expanding device 7. A partial high pressure refrigerant which passes through the usage-side heat exchanger 2 is decompressed by the second expanding device 7, and becomes intermediate pressure refrigerant. The intermediate pressure refrigerant exchanges heat in the intermediate heat exchanger 5 with high pressure refrigerant which flows through the main refrigerant circuit 8, and the intermediate pressure refrigerant joins up with refrigerant which flows through the main refrigerant circuit 8 between the low stage compressing portion 12 and the high stage compressing portion 11 and which is in the compression midstream state.

[0019] Usage-side heat medium heated by the usage-side heat exchanger 2 is utilized for heating a room by a usage-side terminal (not shown). Water or antifreeze liquid is used as the usage-side heat medium.

[0020] In the main refrigerant circuit 8, a discharge pipe of the compressing mechanism 1 is provided with a discharge temperature sensor 15 which is discharge temperature detecting means and a discharge pressure sensor 16 which is discharge pressure detecting means. Discharge temperature detected by the discharge temperature sensor 15 and discharge pressure detected by the discharge pressure sensor 16 are taken into a control device 20 as data.

[0021] Here, predetermined temperature is a value which is lower, by a first predetermined value, than a value of discharge temperature that is the upper limit of the operating range of the refrigeration cycle device, and predetermined pressure is a value which is lower, by a second predetermined value, than a value of discharge pressure that is the upper limit of the operating range of the refrigeration cycle device. The predetermined temperature and the predetermined pressure are preset in the control device 20 as threshold values.

[0022] The value of the discharge temperature which is the upper limit of the operating range of the refrigeration cycle device and the value of the discharge pressure which is the upper limit of the operating range of the refrigeration cycle device are values in which the control device 20 stops the operation of the refrigeration cycle device.

[0023] When the discharge temperature detected by the discharge temperature sensor 15 and the discharge pressure detected by the discharge pressure sensor 16 respectively exceeds the threshold values, the control device 20 controls such that the opening degree of the first expanding device 3 and the opening degree of the second expanding device 7 are increased.

[0024] The discharge pressure sensor 16 detects pressure of high pressure refrigerant of the main refrigerant circuit 8. The discharge pressure sensor 16 is provided in a discharge-side pipe of the compressing mechanism 1, or is provided in an upstream-side pipe of the first expanding device 3. The discharge-side pipe of the compressing mechanism 1 and the upstream-side pipe of the first expanding device 3 are pipes of the main refrigerant

circuit 8.

[0025] Figs. 2 to 4 are pressure-enthalpy diagrams (P-h diagrams) when the opening degrees of the first and second expanding devices are increased in the refrigeration cycle device of the embodiment.

[0026] Fig. 2 shows variation of the refrigeration cycle when the opening degree of only the second expanding device 7 is increased. Solid lines show a state before the opening degree is increased, and broken lines show a state after the opening degree is increased.

[0027] Fig. 3 shows variation of the refrigeration cycle when the opening degree of only the first expanding device 3 is increased. Solid lines show a state before the opening degree is increased, and broken lines show a state after the opening degree is increased.

[0028] Fig. 4 shows variation of the refrigeration cycle when the opening degrees of the first and second expanding devices 3 and 7 are increased. Solid lines show a state before the opening degree is increased, and broken lines show a state after the opening degree is increased.

[0029] In Figs. 2 to 4, values of both the discharge temperature and the discharge pressure which become the upper limits of the operating range of the refrigeration cycle device are shown with broken lines. Points a to e and points A and B correspond to points in the brock diagram of the refrigeration cycle device shown in Fig. 1.

[1-2. Action]

[0030] Action and operation of the refrigeration cycle device configured as described above will be described below.

[0031] First, the action of the refrigeration cycle device will be described based on Figs. 1 and 2.

[0032] In the refrigeration cycle device before (solid lines) the opening degree of the second expanding device 7 is increased, high pressure refrigerant (point a) compressed by the high stage compressing portion 11 and discharged from the compressing mechanism 1 radiates heat in the usage-side heat exchanger 2 and thereafter, the high pressure refrigerant branches from the main refrigerant circuit 8 at a refrigerant branch point A, and the high pressure refrigerant is decompressed to the intermediate pressure by the second expanding device 7, and becomes the intermediate pressure refrigerant (point e). The intermediate pressure refrigerant exchanges heat in the intermediate heat exchanger 5, and joins up with refrigerant of the main refrigerant circuit 8 compressed by the low stage compressing portion 12 (point B).

[0033] The high pressure refrigerant flowing through the main refrigerant circuit 8 after it radiates heat in the usage-side heat exchanger 2 exchanges heat with the intermediate pressure refrigerant (point e) which flows through the bypass refrigerant circuit 6, and the high pressure refrigerant is cooled. The cooled high pressure refrigerant is decompressed by the first expanding device 3 in a state where its enthalpy is reduced (point b).

[0034] Refrigerant of the main refrigerant circuit 8 which is decompressed by the first expanding device 3 and becomes gas-liquid two-phase state evaporates by endotherm from the outside air in the evaporator 4, and becomes gas phase. The refrigerant which becomes the gas phase returns to a suction side (point d) of the compressing mechanism 1, and is compressed by the low stage compressing portion 12 of the compressing mechanism 1.

[0035] When an outside air temperature is low and heating ability is required, under such an operation condition that it is required to discharge high temperature water, it is necessary to increase the rotation frequency of the compressing mechanism 1. At that time, the discharge temperature of the compressing mechanism 1 exceeds the threshold value and not only that, the discharge pressure of the compressing mechanism 1 is also close to almost the threshold value.

[0036] Here, broken lines show variation of the refrigeration cycle when the opening degree of the second expanding device 7 is increased.

[0037] If the opening degree of the second expanding device 7 is increased, an amount of low temperature refrigerant which flows through the bypass refrigerant circuit 6 is increased, and temperature of refrigerant which is in the process of compression with which refrigerant flowing through the bypass refrigerant circuit 6 and refrigerant flowing through the main refrigerant circuit 8 merge with each other is reduced.

[0038] The merged refrigerant whose temperature was lowered is compressed by the high stage compressing portion 11 and discharged from the compressing mechanism 1. The discharge temperature (point a) of the discharged refrigerant can be equal to or lower than the threshold value, and it is possible to suppress a rise in the discharge temperature.

[0039] However, since the amount of refrigerant flowing through the bypass refrigerant circuit 6 increases, the amount of refrigerant which flows into the compressing mechanism 1 increases, and discharge pressure rises. Therefore, discharge pressure adversely exceeds the threshold value.

[0040] Next, action of the refrigeration cycle device will be described based on Figs. 1 and 3.

[0041] Action of the refrigeration cycle device before (solid lines) the opening degree of the first expanding device 3 is increased is the same as action before the opening degree of the second expanding device 7 in Fig. 2 is increased and therefore, its description will be omitted.

[0042] When the outside air temperature is low and heating ability is required, under such an operation condition that it is required to discharge high temperature water, it is necessary to increase the rotation frequency of the compressing mechanism 1. At that time, the discharge pressure of the compressing mechanism 1 exceeds the threshold value and not only that, the discharge

temperature of the compressing mechanism 1 is also close to almost the threshold value.

[0043] Here, broken lines show variation of the refrigeration cycle when the opening degree of the first expanding device 3 is increased.

[0044] If the opening degree of the first expanding device 3 is increased, the amount of refrigerant flowing through the main refrigerant circuit 8 is increased, and the amount of refrigerant flowing through the bypass refrigerant circuit 6 is reduced. Therefore, discharge pressure of the compressing mechanism 1 is reduced and it can be equal to or lower than the threshold value.

[0045] However, since the amount of refrigerant flowing through the bypass refrigerant circuit 6 is reduced, temperature of refrigerant which is the process of compression (point B) where refrigerant flowing through the bypass refrigerant circuit 6 and refrigerant flowing through the main refrigerant circuit 8 merge with each other increases.

[0046] Therefore, discharge temperature (point a) of refrigerant which is compressed by the high stage compressing portion 11 and which is discharged from the compressing mechanism 1 rises and exceeds the threshold value.

[0047] In this manner, if the opening degree of only the second expanding device 7 is increased, although the discharge temperature reduces, the discharge pressure increases. If the opening degree of only the first expanding device 3 is increased, although the discharge pressure reduces, the discharge temperature increases.

[0048] When the outside air temperature is low and heating ability is required, under such an operation condition that it is required to discharge high temperature water, the discharge temperature and the discharge pressure are close to the upper limits of the operating range of the refrigeration cycle device. That is, the refrigeration cycle device is operated in a state where both the discharge temperature and the discharge pressure exceed the respective threshold values.

[0049] However, when ambient environment of the refrigeration cycle device is varied and the discharge temperature exceeds the threshold value, the discharge pressure adversely exceeds the threshold value only by increasing the opening degree of the second expanding device 7, and operation with an appropriate refrigeration cycle cannot be realized.

[0050] When the ambient environment of the refrigeration cycle device is varied and the discharge pressure exceeds the threshold value, the discharge temperature adversely exceeds the threshold value only by increasing the opening degree of the first expanding device 3, and operation with an appropriate refrigeration cycle cannot be realized.

[0051] Hence, the control device 20 controls to increase the opening degrees of both the first expanding device 3 and the second expanding device 7. According to this, a state of the refrigeration cycle shown with solid lines is changed to that shown with broken lines.

[0052] That is, it is possible to provide a refrigeration cycle device having high reliability in which the discharge pressure and the discharge temperature are equal to or lower than the threshold values, respectively, i.e., it is possible to suppress the rise in the discharge temperature and the discharge pressure without exceeding the upper limit value of the operating range as showing Fig. 4.

[0053] Here, the predetermined temperature is a value which is lower, by the first predetermined value, than the discharge temperature value which is the upper limit of the operating range of the refrigeration cycle device, and the predetermined pressure is a value which is lower, by the second predetermined value, than the discharge pressure value which is the upper limit of the operating range of the refrigeration cycle device. The predetermined temperature and the predetermined pressure are preset in the control device 20 as respective threshold values.

[0054] If the discharge temperature detected by the discharge temperature sensor 15 and the discharge pressure detected by the discharge pressure sensor 16 respectively exceed the threshold values, the control device 20 controls to increase the opening degrees of the first expanding device 3 and the second expanding device 7.

[0055] According to this, to reduce the discharge temperature, an opening degree of the second expansion device 7 is increased, and a merging amount of refrigerant having low temperature is increased. At that time, even if a flow rate of refrigerant which flows into the compressing mechanism 1 increases and the discharge pressure increases, an opening degree of the first expansion device 3 is increased, and an amount of refrigerant which flows through the main refrigerant circuit 8 is increased. According to this, the increased discharge pressure can be reduced.

[0056] After the opening degree of the second expanding device 7 is increased, the control device 20 controls to increase the opening degree of the first expanding device 3.

[0057] According to this, the amount of low temperature refrigerant which joins up from the bypass refrigerant circuit 6 is increased and thereafter, the pressure reduction amount of the main refrigerant circuit 8 is reduced. Hence, it is possible to control the pressure reduction amount of the main refrigerant circuit 8 while detecting, by the discharge temperature sensor 15, a rise in discharge temperature caused by reduction in the flow rate of refrigerant of the bypass refrigerant circuit 6 caused by reduction in the pressure reduction amount of the main refrigerant circuit 8.

[0058] As the discharge temperature of the compressing mechanism 1 is higher, the control device 20 controls to increase the variation amount of the opening degree of the second expanding device 7.

[0059] According to this, as the discharge temperature of the compressing mechanism 1 is higher, it is possible to more swiftly increase the flow rate of low temperature

refrigerant which joins up from the bypass refrigerant circuit 6.

[0060] More specifically, as a temperature difference between the threshold value and the discharge temperature of the compressing mechanism 1 is greater, the control device 20 controls to increase the variation amount of the opening degree of the second expanding device 7.

[0061] According to this, since the discharge temperature of the compressing mechanism 1 is continuously detected, it is possible to more swiftly and reliably detect the excessive rise in the discharge temperature, and the opening degree of the second expanding device 7 can be controlled.

[1-3. Effect and the like]

[0062] In the embodiment, as described above, a refrigeration cycle device includes: a main refrigerant circuit 8 formed by sequentially connecting, to one another through a pipe, a compressing mechanism 1 composed of a compression rotating element, a usage-side heat exchanger 2 for heating usage-side heat medium by refrigerant which is discharged from the compression rotating element, an intermediate heat exchanger 5, a first expanding device 3 and a heat source-side heat exchanger 4; a bypass refrigerant circuit 6 in which refrigerant which branches off from the pipe between the usage-side heat exchanger 2 and the first expanding device 3 is decompressed by the second expanding device 7 and thereafter, heat of the refrigerant is exchanged with that of the refrigerant which flows through the main refrigerant circuit 8 by the intermediate heat exchanger 5, and the refrigerant joins up with the refrigerant which is in middle of a compression operation of the compression rotating element; discharge temperature detecting means 15 for detecting discharge temperature of the compression rotating element; discharge pressure detecting means 16 for detecting discharge pressure of the compression rotating element; and a control device 20, wherein when the discharge pressure of the compression rotating element is higher than predetermined pressure and the discharge temperature of the compression rotating element is higher than predetermined temperature, the control device 20 increases opening degrees of both the first expanding device 3 and the second expanding device 7.

[0063] According to this, even if the discharge temperature and the discharge pressure increase and their values reach the upper limit values of the operating range, it is possible to suppress the increase in the discharge temperature and the discharge pressure without exceeding the upper limits. Hence, it is possible to provide a refrigeration cycle device having high reliability.

[0064] In the refrigeration cycle device of the embodiment, after the control device 20 increases the opening degree of the second expanding device 7, the control device 20 increases the opening degree of the first expanding device 3.

[0065] According to this, the amount of the low temperature refrigerant which joins up from the bypass refrigerant circuit 6 is increased and thereafter, the pressure reduction amount of the main refrigerant circuit 8 is reduced.

[0066] Hence, it is possible to control the pressure reduction amount of the main refrigerant circuit 8 while detecting a rise in the discharge temperature caused by reduction of the flow rate of refrigerant of the bypass refrigerant circuit 6 which is caused by reduction of the pressure reduction amount of the main refrigerant circuit 8.

[0067] Therefore, even when the rising speed of the discharge temperature is fast, it is possible to suppress the rise in the discharge temperature in a shorter time and more effectively. Hence, it is possible to provide a refrigeration cycle device having high reliability.

[0068] In the refrigeration cycle device of the embodiment, the higher the discharge temperature of the compression rotating element is, the greater the control device 20 increases a variation amount of the opening degree of the second expanding device 7.

[0069] According to this, as the discharge temperature is higher, it is possible to more swiftly increase the flow rate of low temperature refrigerant which joins up from the bypass refrigerant circuit 6, and to more swiftly lower the discharge temperature.

[0070] Therefore, even when the discharge temperature largely exceeds the predetermined temperature, it is possible to swiftly lower the discharge temperature. Hence, it is possible to provide a refrigeration cycle device having higher reliability.

[0071] In the refrigeration cycle device of the embodiment, the control device 20 determines a variation amount of the opening degree of the second expanding device 7 based on a temperature difference between the discharge temperature of the compression rotating element and the predetermined temperature.

[0072] According to this, since the temperature of discharged refrigerant of the compressing mechanism 1 is continuously detected, it is possible to more swiftly and reliably detect the excessive rise in the discharge temperature, and to control the second expanding device 7.

[0073] Therefore, it is possible to decrease the discharge temperature more swiftly. Hence, it is possible to provide a refrigeration cycle device having higher reliability.

[INDUSTRIAL APPLICABILITY]

[0074] According to the present disclosure, even when the discharge temperature and discharge pressure rise and their values reach the upper limits of the operating range, it is possible to suppress the rise of the discharge temperature and discharge pressure without exceeding the upper limits. Therefore, since it is possible to provide the refrigeration cycle device having high reliability, the

present invention can be applied to an air conditioner, a hot water supply system and the like.

[EXPLANATION OF SYMBOLS]

[0075]

1 compressing mechanism
2 radiator (usage-side heat exchanger)
3 first expanding device
4 evaporator (heat source-side heat exchanger)
5 intermediate heat exchanger
6 bypass refrigerant circuit
7 second expanding device
8 main refrigerant circuit
11 high stage compressing portion
12 low stage compressing portion
15 discharge temperature sensor (discharge temperature detecting means)
16 discharge pressure sensor (discharge pressure detecting means)
20 control device

Claims

1. A refrigeration cycle device comprising:

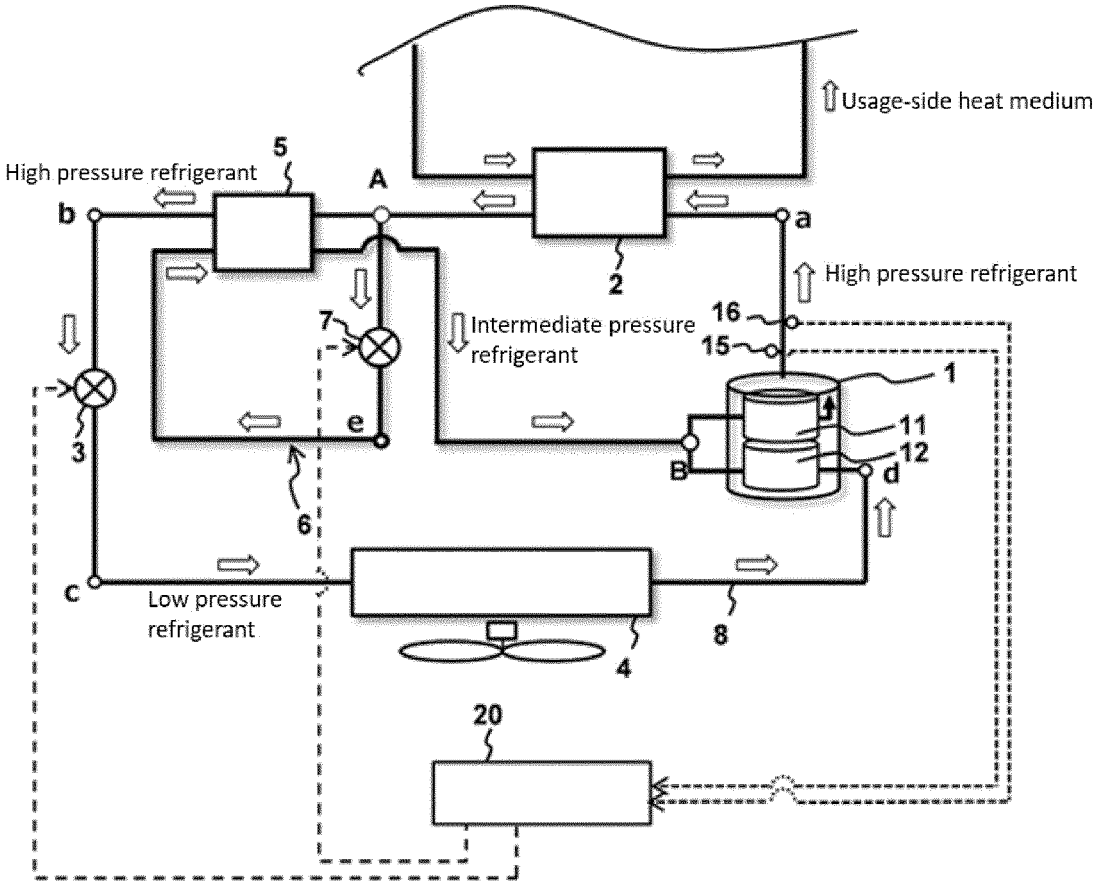
a main refrigerant circuit (8) formed by sequentially connecting, to one another through a pipe, a compressing mechanism (1) composed of a compression rotating element, a usage-side heat exchanger (2) for heating usage-side heat medium by refrigerant which is discharged from the compression rotating element, an intermediate heat exchanger (5), a first expanding device (3) and a heat source-side heat exchanger (4);
a bypass refrigerant circuit (6) in which refrigerant which branches off from the pipe between the usage-side heat exchanger (2) and the first expanding device (3) is decompressed by the second expanding device (7) and thereafter, heat of the refrigerant is exchanged with that of the refrigerant which flows through the main refrigerant circuit (8) by the intermediate heat exchanger (5), and the refrigerant joins up with the refrigerant which is in middle of a compression operation of the compression rotating element;
discharge temperature detecting means (15) for detecting discharge temperature of the compression rotating element;
discharge pressure detecting means (16) for detecting discharge pressure of the compression rotating element; and
a control device (20), wherein
when the discharge pressure of the compression rotating element is higher than predetermined pressure and the discharge temperature of the compression rotating element is higher than predetermined temperature, the control device (20) increases opening degrees of both the first expanding device (3) and the second expanding device (7) .

2. The refrigeration cycle device according to claim 1, wherein after the control device (20) increases the opening degree of the second expanding device (7), the control device (20) increases the opening degree of the first expanding device (3).

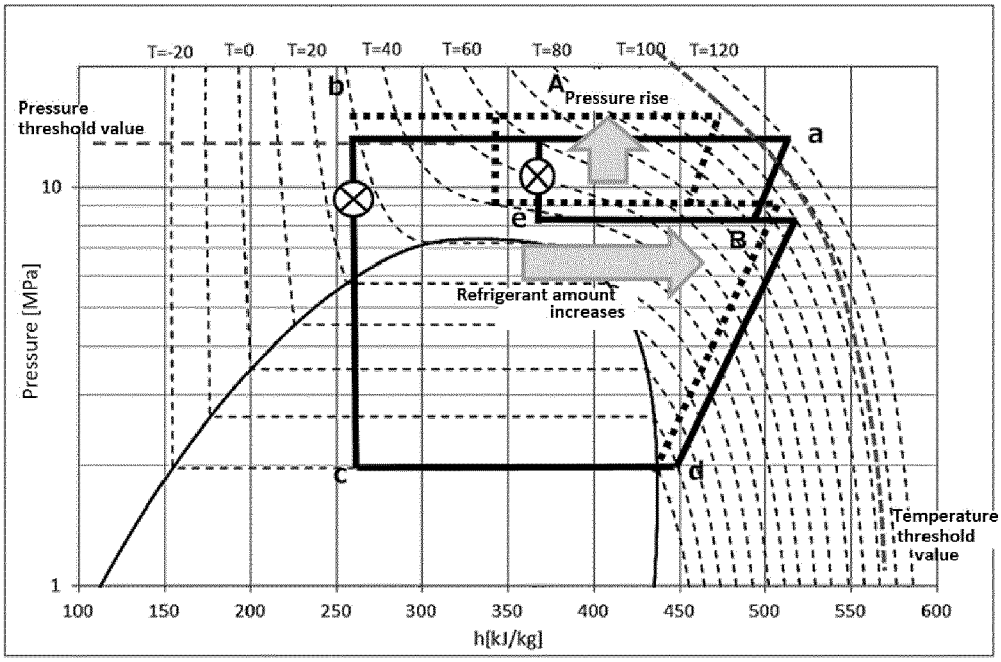
3. The refrigeration cycle device according to claim 1 or 2, wherein the higher the discharge temperature of the compression rotating element is, the greater the control device (20) increases a variation amount of the opening degree of the second expanding device (7).

4. The refrigeration cycle device according to any one of claims 1 to 3, wherein the control device (20) determines a variation amount of the opening degree of the second expanding device (7) based on a temperature difference between the discharge temperature of the compression rotating element and the predetermined temperature.

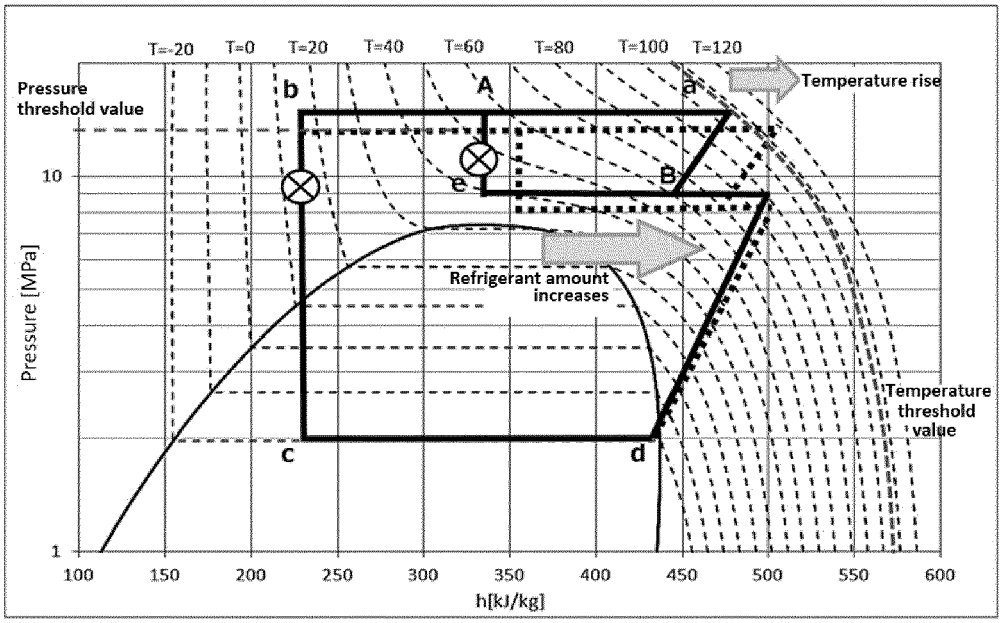
[Fig. 1]


Usage-side heat medium
High pressure refrigerant
5
A
b
a
2
High pressure refrigerant
7
Intermediate pressure refrigerant
16
15
1
3
e
11
12
B
d
6
c
Low pressure refrigerant
8
4
20

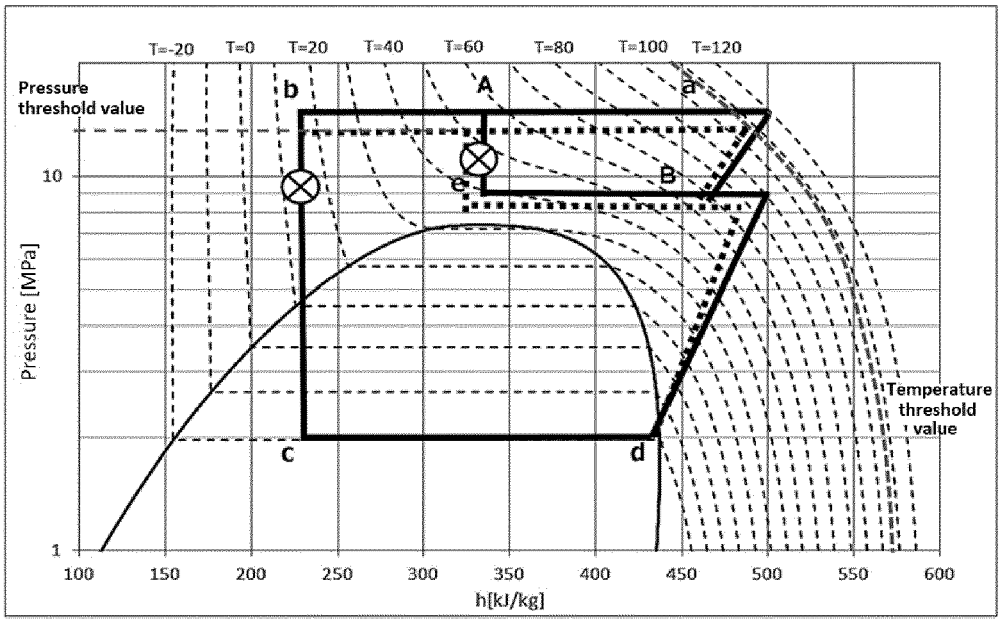
[Fig. 2]


T=-20
T=0
T=20
T=40
T=60
T=80
T=100
T=120
Pressure threshold value
Pressure rise
A
a
b
e
B
Refrigerant amount increases
c
d
Temperature threshold value
10
1
Pressure [MPa]
100
150
200
250
300
350
400
450
500
550
600
h[kJ/kg]

[Fig. 3]


T=-20
T=0
T=20
T=40
T=60
T=80
T=100
T=120
Pressure threshold value
Temperature rise
b
A
a
e
B
10
Refrigerant amount increases
Pressure [MPa]
Temperature threshold value
c
d
1
100
150
200
250
300
350
400
450
500
550
600
h[kJ/kg]

[Fig. 4]


T=-20
T=0
T=20
T=40
T=60
T=80
T=100
T=120
Pressure threshold value
10
1
Pressure [MPa]
a
b
c
d
A
B
e
Temperature threshold value
100
150
200
250
300
350
400
450
500
550
600
h[kJ/kg]

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 21 19 1420

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 2015/362235 A1 (YAMASHITA KOJI [JP]) 17 December 2015 (2015-12-17) * and associated description; paragraphs [0125], [0049]; figure 1 *	1-4	INV. F25B49/02
A	WO 2020/071299 A1 (DAIKIN IND LTD [JP]) 9 April 2020 (2020-04-09) * paragraphs [0068], [0118]; figure 1 *	1-4	
A	GB 2 533 041 A (MITSUBISHI ELECTRIC CORP [JP]) 8 June 2016 (2016-06-08) * paragraph [0096] - paragraph [0099]; figure 2 *	1-4	
A	EP 2 088 390 A2 (MITSUBISHI ELECTRIC CORP [JP]) 12 August 2009 (2009-08-12) * paragraphs [0018], [0021], [0037]; figure 1 *	1-4	
A	US 2015/020535 A1 (HATOMURA TAKESHI [JP] ET AL) 22 January 2015 (2015-01-22) * paragraph [0038] - paragraphs [0047], [0049]; figure 1 *	1-4	TECHNICAL FIELDS SEARCHED (IPC) F25B

1 The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	17 January 2022	Gasper, Ralf

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 21 19 1420

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

17-01-2022

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2015362235 A1	17-12-2015	CN 105008820 A	28-10-2015
		EP 2975335 A1	20-01-2016
		JP 6005255 B2	12-10-2016
		JP WO2014141374 A1	16-02-2017
		US 2015362235 A1	17-12-2015
		WO 2014141374 A1	18-09-2014
WO 2020071299 A1	09-04-2020	EP 3862655 A1	11-08-2021
		JP WO2020071299 A1	02-09-2021
		US 2021356177 A1	18-11-2021
		WO 2020071299 A1	09-04-2020
GB 2533041 A	08-06-2016	GB 2533041 A	08-06-2016
		JP 6017049 B2	26-10-2016
		JP WO2015029223 A1	02-03-2017
		WO 2015029223 A1	05-03-2015
EP 2088390 A2	12-08-2009	EP 2088390 A2	12-08-2009
		JP 5042058 B2	03-10-2012
		JP 2009186121 A	20-08-2009
		US 2009199581 A1	13-08-2009
US 2015020535 A1	22-01-2015	CN 104254743 A	31-12-2014
		EP 2843323 A1	04-03-2015
		JP 5774211 B2	09-09-2015
		JP WO2013160967 A1	21-12-2015
		US 2015020535 A1	22-01-2015
		WO 2013160967 A1	31-10-2013

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- JP 2009192164 A **[0005]**