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(71) Applicant: **Panasonic Intellectual Property Management Co., Ltd.**
Kadoma-shi, Osaka 571-0057 (JP)

(72) Inventors:

- **Imagawa, Tsuneko**
Osaka, 571-0057 (JP)
- **Yamaoka, Yuki**
Osaka, 571-0057 (JP)

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

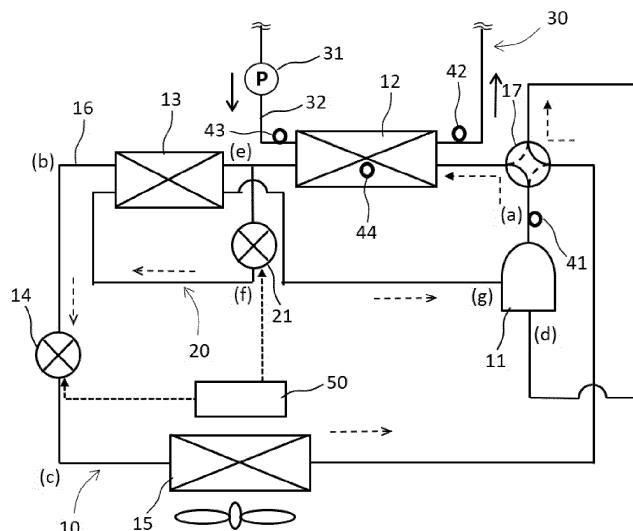
(54) **VAPOR COMPRESSION REFRIGERATION CYCLE DEVICE**

(57) [Object] It is an object of the present invention to provide a vapor compression refrigeration cycle device capable of reducing a dissolved amount of refrigerant into compressor oil by securing predetermined discharge superheat.

[Solving Means] According to the vapor compression refrigeration cycle device of the invention, a control de-

vice 50 controls a valve opening degree of a second expansion device 21 such that a temperature difference between use-side heat medium temperature T2 detected by a use-side heat medium after-heating temperature sensor 42 and refrigerant discharge temperature T1 detected by a refrigerant discharge temperature sensor 41 becomes equal to or greater than a predetermined value.

[Fig. 1]



Description

[0001] The present invention relates to a vapor compression refrigeration cycle device.

[BACKGROUND TECHNIQUE]

[0002] There is a vapor compression refrigeration cycle device including: a main refrigerant circuit formed by sequentially connecting a compressor, a use-side heat exchanger, an intermediate heat exchanger, a first expansion device and a heat source-side heat exchanger through refrigerant pipes; and a bypass refrigerant circuit which branches off from the refrigerant pipe between the use-side heat exchanger and the first expansion device, and which is formed by sequentially connecting a second expansion device, the intermediate heat exchanger and a compression midstream of the compressor; and refrigerant which branches off from the main refrigerant circuit cools main refrigerant which flows through the intermediate heat exchanger, and the vapor compression refrigeration cycle device injects at midstream of compression of the compressor.

[0003] Such a vapor compression refrigeration cycle device including an injection circuit can enhance cooling ability by increasing a degree of supercooling of refrigerant which flows into the heat source-side heat exchanger.

[0004] According to patent document 1, when discharge temperature exceeds a predetermined value, an injection amount is adjusted to suppress discharging temperature rise, thereby securing reliability of the compressor.

[0005] According to patent document 2, when oil temperature in a gas-liquid separation device exceeds a predetermined value, an opening degree of an expansion valve is changed to increase an injection amount, thereby suppressing rise of discharge temperature.

[PRIOR ART DOCUMENTS]

[PATENT DOCUMENTS]

[0006]

[Patent Document 1] Japanese Patent Application Laid-open No.H8-54148

[Patent Document 2] Japanese Patent Application Laid-open No.2011-149565

[SUMMARY OF THE INVENTION]

[PROBLEM TO BE SOLVED BY THE INVENTION]

[0007] However, to secure the reliability of the compressor, it is necessary not only to suppress the rise of the discharge temperature, but also to suppress reduction of the discharge temperature. That is, if a degree of

superheat in which discharge temperature is equal to or greater than a predetermined value cannot be secured, a dissolved amount of refrigerant into compressor oil is increased, and viscosity of oil is lowered and therefore, sliding property of the compressor is deteriorated and mechanical parts in the compressor become worn.

[0008] It is an object of the present invention to provide a vapor compression refrigeration cycle device capable of reducing a dissolved amount of refrigerant into compressor oil by securing predetermined discharge superheat.

[MEANS FOR SOLVING THE PROBLEM]

[0009] A vapor compression refrigeration cycle device of the present invention including: a main refrigerant circuit formed by sequentially connecting a compressor, a use-side heat exchanger, an intermediate heat exchanger, a first expansion device and a heat source-side heat exchanger to one another through a refrigerant pipe; a bypass refrigerant circuit which branches off from the refrigerant pipe located between the use-side heat exchanger and the first expansion device and which is formed by sequentially connecting a second expansion device, the intermediate heat exchanger and a compression midstream of the compressor to one another; a control device for controlling valve opening degrees of the first expansion device and the second expansion device; a use-side heat medium after-heating temperature sensor for detecting use-side heat medium temperature at an exit of the use-side heat exchanger through which a use-side heat medium circulates; and a refrigerant discharge temperature sensor for detecting refrigerant discharge temperature of refrigerant which is discharged from the compressor; wherein the control device controls the valve opening degree of the second expansion device such that a temperature difference between the use-side heat medium temperature detected by the use-side heat medium after-heating temperature sensor and the refrigerant discharge temperature detected by the refrigerant discharge temperature sensor becomes equal to or greater than a predetermined value.

[0010] Further, a vapor compression refrigeration cycle device of the invention including: a main refrigerant circuit formed by sequentially connecting a compressor, a use-side heat exchanger, an intermediate heat exchanger, a first expansion device and a heat source-side heat exchanger to one another through a refrigerant pipe; a bypass refrigerant circuit which branches off from the refrigerant pipe located between the use-side heat exchanger and the first expansion device and which is formed by sequentially connecting a second expansion device, the intermediate heat exchanger and a compression midstream of the compressor to one another; a control device for controlling valve opening degrees of the first expansion device and the second expansion device; a use-side heat medium before-heating temperature sensor for detecting use-side heat medium temperature

at an entrance of the use-side heat exchanger through which a use-side heat medium circulates; and a refrigerant discharge temperature sensor for detecting refrigerant discharge temperature of refrigerant which is discharged from the compressor; wherein the control device controls the valve opening degree of the second expansion device such that a temperature difference between the use-side heat medium temperature detected by the use-side heat medium before-heating temperature sensor and the refrigerant discharge temperature detected by the refrigerant discharge temperature sensor becomes equal to or greater than a predetermined value.

[0011] Further, a vapor compression refrigeration cycle device of the invention including: a main refrigerant circuit formed by sequentially connecting a compressor, a use-side heat exchanger, an intermediate heat exchanger, a first expansion device and a heat source-side heat exchanger to one another through a refrigerant pipe; a bypass refrigerant circuit which branches off from the refrigerant pipe located between the use-side heat exchanger and the first expansion device and which is formed by sequentially connecting a second expansion device, the intermediate heat exchanger and a compression midstream of the compressor to one another; a control device for controlling valve opening degrees of the first expansion device and the second expansion device; a refrigerant condensation temperature sensor for detecting refrigerant condensation temperature of refrigerant at the use-side heat exchanger; and a refrigerant discharge temperature sensor for detecting refrigerant discharge temperature of the refrigerant which is discharged from the compressor; wherein the control device controls the valve opening degree of the second expansion device such that a temperature difference between the refrigerant condensation temperature detected by the refrigerant condensation temperature sensor and the refrigerant discharge temperature detected by the refrigerant discharge temperature sensor becomes equal to or greater than a predetermined value.

[0012] According to this, it is possible to secure predetermined discharge superheat.

[EFFECT OF THE INVENTION]

[0013] According to the present invention, a dissolved amount of refrigerant into the compressor oil can be reduced by securing the predetermined discharge superheat, viscosity of the compressor oil is not lowered and therefore, it is possible to suppress wear of a machine in the compressor, and it is possible to secure the reliability of the compressor.

[BRIEF DESCRIPTION OF THE DRAWINGS]

[0014]

Fig. 1 is a diagram showing a configuration of a vapor compression refrigeration cycle device in an embod-

iment of the present invention;

Fig. 2 is a pressure-enthalpy diagram (P-h diagram) at the vapor compression refrigeration cycle device; Figs. 3 are graphs showing a relation between an injection amount of refrigerant and refrigerant discharge temperature of refrigerant which is discharged from a compressor;

Fig. 4 is a graph showing a relation between temperature and pressure of oil and solubility of refrigerant; and

Fig. 5 is a control flowchart of the vapor compression refrigeration cycle device of the embodiment.

[MODE FOR CARRYING OUT THE INVENTION]

[0015] In the vapor compression refrigeration cycle device of the first embodiment of the invention, the control device controls the valve opening degree of the second expansion device such that a temperature difference between the use-side heat medium temperature detected by the use-side heat medium after-heating temperature sensor and the refrigerant discharge temperature detected by the refrigerant discharge temperature sensor becomes equal to or greater than a predetermined value.

According to the first embodiment, it is possible to reduce the dissolved amount of refrigerant into the compressor oil by securing the predetermined discharge superheat, and viscosity of compressor oil is not lowered. Therefore, it is possible to suppress wear of a machine in the compressor.

[0016] In the vapor compression refrigeration cycle device of the second embodiment of the invention, the control device controls the valve opening degree of the second expansion device such that a temperature difference between the use-side heat medium temperature detected by the use-side heat medium before-heating temperature sensor and the refrigerant discharge temperature detected by the refrigerant discharge temperature sensor becomes equal to or greater than a predetermined value.

According to the second embodiment, it is possible to reduce the dissolved amount of refrigerant into the compressor oil by securing the predetermined discharge superheat, and viscosity of compressor oil is not lowered. Therefore, it is possible to suppress wear of a machine in the compressor.

[0017] In the vapor compression refrigeration cycle device of the third embodiment of the invention, the control device controls the valve opening degree of the second expansion device such that a temperature difference between the refrigerant condensation temperature detected by the refrigerant condensation temperature sensor and the refrigerant discharge temperature detected by the refrigerant discharge temperature sensor becomes equal to or greater than a predetermined value. According to the third embodiment, it is possible to reduce the dissolved amount of refrigerant into the compressor oil by securing the predetermined discharge superheat, and viscosity of compressor oil is not lowered. Therefore, it

is possible to suppress wear of a machine in the compressor.

[0018] In the fourth embodiment of the invention, according to the vapor compression refrigeration cycle device of any one of the first to third embodiments, when the temperature difference becomes smaller than the predetermined value, the control device reduces the valve opening degree of the second expansion device. According to the fourth embodiment, discharge temperature can be increased by reducing the valve opening degree, and predetermined discharge superheat can be secured.

[0019] In the fifth embodiment of the invention, according to the vapor compression refrigeration cycle device of any one of the first to third embodiments, the use-side heat medium is water or antifreeze liquid. According to the fifth embodiment, heated water can be utilized for hot-water supply of a bath, antifreeze liquid is circulated and it can be utilized for heating equipment.

[EMBODIMENT]

[0020] An embodiment of the present invention will be described below with reference to the drawings.

[0021] Fig. 1 is a diagram showing a configuration of a vapor compression refrigeration cycle device in an embodiment. The vapor compression refrigeration cycle device is composed of a main refrigerant circuit 10 and a bypass refrigerant circuit 20.

[0022] The main refrigerant circuit 10 is formed by sequentially connecting, to one another through a refrigerant pipe 16, a compressor 11 which compresses refrigerant, a use-side heat exchanger 12 which functions as a radiator, an intermediate heat exchanger 13 which functions as an economizer, a first expansion device 14 which is a main expansion valve, and a heat source-side heat exchanger 15 which functions as an evaporator.

[0023] As shown in the drawing, the vapor compression refrigeration cycle device may include a four-way valve 17 between the compressor 11 and the use-side heat exchanger 12. The four-way valve 17 can change a direction of refrigerant which flows through the main refrigerant circuit 10. That is, by switching the four-way valve 17, refrigerant which is discharged from the compressor 11 flows through the heat source-side heat exchanger 15, the first expansion device 14, the intermediate heat exchanger 13 and the use-side heat exchanger 12 in this order, and the refrigerant is sucked into the compressor 11. In this case, the heat source-side heat exchanger 15 functions as the radiator, and the use-side heat exchanger 12 functions as the evaporator.

[0024] The bypass refrigerant circuit 20 branches off from the refrigerant pipe 16 located between the use-side heat exchanger 12 and the first expansion device 14, and the bypass refrigerant circuit 20 is connected to a compression midstream of the compressor 11.

[0025] The bypass refrigerant circuit 20 is provided with a second expansion device 21. A portion of high-

pressure refrigerant after it passes through the use-side heat exchanger 12, or a portion of high-pressure refrigerant after it passes through the intermediate heat exchanger 13 is decompressed by the second expansion device 21 and becomes intermediate pressure refrigerant. Thereafter, intermediate pressure refrigerant is heat-exchanged with high-pressure refrigerant which flows through the main refrigerant circuit 10 by the intermediate heat exchanger 13, and injected into the compressor 11. The refrigerant which is injected into the compressor 11 joins up with refrigerant located at the compression midstream of the compressor 11.

[0026] In the compressor 11, injected refrigerant and refrigerant located at the compression midstream join up with each other and they are again compressed.

[0027] A use-side heat medium circuit 30 is formed by connecting the use-side heat exchanger 12, a transfer pump 31, a heating terminal (not shown) and a hot water tank (not shown) to one another through a heat medium pipe 32. Water or antifreeze liquid can be used as the use-side heat medium which flows through the use-side heat medium circuit 30.

[0028] The use-side heat exchanger 12 heats use-side heat medium by refrigerant which is discharged from the compressor 11.

[0029] The use-side heat medium which is heated by the use-side heat exchanger 12 radiates heat at a heating terminal and is utilized for heating a room. The use-side heat medium which radiates heat at the heating terminal and which is lowered in temperature is again heated by the use-side heat exchanger 12.

[0030] The use-side heat medium which is heated by the use-side heat exchanger 12 is introduced into the hot water tank from an upper portion of the hot water tank, low-temperature use-side heat medium comes out from a lower portion of the hot water tank, and is heated by the use-side heat exchanger 12.

[0031] The refrigerant pipe 16 on a discharge side of the compressor 11 is provided with a refrigerant discharge temperature sensor 41. The refrigerant discharge temperature sensor 41 detects refrigerant discharge temperature of refrigerant which is discharged from the compressor 11.

[0032] The heat medium pipe 32 on an exit-side of the use-side heat exchanger 12 is provided with a use-side heat medium after-heating temperature sensor 42. The use-side heat medium after-heating temperature sensor 42 detects use-side heat medium temperature of the use-side heat medium at the exit of the use-side heat exchanger 12.

[0033] The heat medium pipe 32 on an entrance side of the use-side heat exchanger 12 is provided with a use-side heat medium before-heating temperature sensor 43. The use-side heat medium before-heating temperature sensor 43 detects the use-side heat medium temperature of the use-side heat medium at the entrance of the use-side heat exchanger 12.

[0034] The use-side heat exchanger 12 is provided

with a refrigerant condensation temperature sensor 44. The refrigerant condensation temperature sensor 44 detects refrigerant condensation temperature at the use-side heat exchanger 12 of refrigerant.

[0035] At least one use-side heat medium after-heating temperature sensor 42, one use-side heat medium before-heating temperature sensor 43 and one refrigerant condensation temperature sensor 44 may be provided.

[0036] The vapor compression refrigeration cycle device of the embodiment includes a control device 50 which controls valve opening degrees of the first expansion device 14 and the second expansion device 21.

[0037] The control device 50 controls the valve opening degree of the second expansion device 21 such that a temperature difference between the use-side heat medium temperature detected by the use-side heat medium after-heating temperature sensor 42 and refrigerant discharge temperature detected by the refrigerant discharge temperature sensor 41 becomes equal to or greater than a predetermined value.

[0038] The control device 50 controls the valve opening degree of the second expansion device 21 such that a temperature difference between the use-side heat medium temperature detected by the use-side heat medium before-heating temperature sensor 43 and refrigerant discharge temperature detected by the refrigerant discharge temperature sensor 41 becomes equal to or greater than a predetermined value.

[0039] Further, the control device 50 controls the valve opening degree of the second expansion device 21 such that a temperature difference between the refrigerant condensation temperature detected by the refrigerant condensation temperature sensor 44 and refrigerant discharge temperature detected by the refrigerant discharge temperature sensor 41 becomes equal to or greater than a predetermined value.

[0040] An operation of the vapor compression refrigeration cycle device will be described using Figs. 1 and 2. Fig. 2 is a pressure-enthalpy diagram (P-h diagram) at the vapor compression refrigeration cycle device, and points (a) to (g) in Fig. 2 correspond to points (a) to (g) in Fig. 1.

[0041] First, high-pressure refrigerant (a) discharged from the compressor 11 radiates heat at the use-side heat exchanger 12 and then the high-pressure refrigerant (a) branches off from the main refrigerant circuit 10 (e), and is decompressed to intermediate pressure by the second expansion device 21 and becomes intermediate pressure refrigerant (f), and the intermediate pressure refrigerant heat-exchanges in the intermediate heat exchanger 13.

[0042] High-pressure refrigerant which flows through the main refrigerant circuit 10 after it radiates heat in the use-side heat exchanger 12 is cooled by the intermediate pressure refrigerant (f) which flows through the bypass refrigerant circuit 20, and the refrigerant is decompressed (c) by the first expansion device 14 in a state (b) where

enthalpy is reduced.

[0043] Dryness (weight ratio occupied by gas phase composition in entire refrigerant) of the refrigerant (c) decompressed by the first expansion device 14 when the refrigerant flows into the heat source-side heat exchanger 15 is lowered, liquid component of the refrigerant is increased, the refrigerant evaporates in the heat source-side heat exchanger 15 and the refrigerant returns to a suction side (d) of the compressor 11.

[0044] On the other hand, the intermediate pressure refrigerant (f) which is decompressed to the intermediate pressure by the second expansion device 21 is heated by high-pressure refrigerant which flows through the main refrigerant circuit 10 in the intermediate heat exchanger 13, and the intermediate pressure refrigerant (f) joins up with refrigerant located at the compression mid-stream of the compressor 11 (g) in a state where refrigerant enthalpy is increased.

[0045] Figs. 3 are graphs showing a relation between an injection amount of refrigerant and refrigerant discharge temperature of refrigerant which is discharged from the compressor.

[0046] As shown in Fig. 3(a), if an injection amount of refrigerant from the bypass refrigerant circuit 20 is increased, wetness fraction of injection is increased, and injection temperature is reduced as a heat-exchanging amount at the intermediate heat exchanger 13 is increased.

[0047] On the other hand, refrigerant discharge temperature of refrigerant discharged from the compressor 11 is increased during a period when the injection amount is small, but if the injection amount is increased, the injection temperature is reduced and the refrigerant discharge temperature is reduced.

[0048] As shown in Fig. 3(b), if the refrigerant discharge temperature of refrigerant discharged from the compressor 11 is increased, discharge superheat is increased, and if the refrigerant discharge temperature of refrigerant discharged from the compressor 11 is reduced, the discharge superheat is reduced. Since variation of discharge pressure is small, the discharge pressure is ignored in Figs. 3. If the injection amount is increased, a degree of supercooling can be increased and heating ability can be enhanced, but if the discharge superheat cannot be secured, a dissolved amount of refrigerant is increased and viscosity of oil is lowered. Therefore, reliability of the compressor cannot be secured.

[0049] Fig. 4 is a graph showing a relation between temperature and pressure of oil and solubility of refrigerant. Fig. 4 shows a relation between temperature and pressure of oil when the solubility of refrigerant is 10%, 20%, 30% and 100%.

[0050] When solubility is 100%, refrigerant is in its saturated state, and as shown in Fig. 4, when oil temperature becomes low, the dissolved amount of refrigerant into oil is increased. Therefore, if the oil temperature is increased, solubility of refrigerant into the oil is reduced. That is, if the discharge superheat is increased, the dis-

solved amount of refrigerant into the oil can be reduced.

[0051] Fig. 5 is a control flowchart of the vapor compression refrigeration cycle device of the embodiment.

[0052] The control device 50 obtains refrigerant discharge temperature T1 detected by the refrigerant discharge temperature sensor 41 (S1), and obtains use-side heat medium temperature T2 detected by the use-side heat medium after-heating temperature sensor 42, use-side heat medium temperature T2 detected by the use-side heat medium before-heating temperature sensor 43, or refrigerant condensation temperature T2 detected by the refrigerant condensation temperature sensor 44 (S2).

[0053] If a temperature difference between the refrigerant discharge temperature T1 and the use-side heat medium temperature T2 or the refrigerant condensation temperature T2 becomes smaller than the predetermined value (YES in S3), the control device 50 reduces the valve opening degree of the second expansion device 21 (S4). If the temperature difference between the refrigerant discharge temperature T1 and the use-side heat medium temperature T2 or the refrigerant condensation temperature T2 is equal to or greater than the predetermined value (NO in S3), the control device 50 maintains or increases the valve opening degree of the second expansion device 21 (S5).

[0054] As described above, if the temperature difference between the refrigerant discharge temperature T1 and the use-side heat medium temperature T2 or the refrigerant condensation temperature T2 becomes smaller than the predetermined value, the control device 50 reduces the valve opening degree of the second expansion device 21. According to this, the discharge temperature can be increased, and the predetermined discharge superheat can be secured. By securing the predetermined discharge superheat, the dissolved amount of refrigerant into the compressor oil can be reduced, and the viscosity of the compressor oil is not reduced. Therefore, wear of the machine in the compressor 11 can be suppressed.

[0055] The vapor compression refrigeration cycle device of the embodiment is especially effective when R290 is used as the refrigerant. When the R290 is used as the refrigerant, since discharge temperature is less prone to rise, sufficient discharge superheat is less prone to be secured.

[0056] When a plate type heat exchanger is used as the use-side heat exchanger 12, it is difficult to detect the refrigerant condensation temperature T2, and the use-side heat medium temperature T2 detected by the use-side heat medium after-heating temperature sensor 42 can be regarded as the refrigerant condensation temperature T2. Therefore, it is preferable to use the use-side heat medium temperature T2 which is detected by the use-side heat medium after-heating temperature sensor 42.

[INDUSTRIAL APPLICABILITY]

[0057] As described above, according to the vapor compression refrigeration cycle device of the present invention, it is possible to secure predetermined discharge superheat.

[EXPLANATION OF SYMBOLS]

[0058]

10	main refrigerant circuit
11	compressor
12	use-side heat exchanger
13	intermediate heat exchanger
14	first expansion device
15	heat source-side heat exchanger
16	refrigerant pipe
17	four-way valve
20	bypass refrigerant circuit
21	second expansion device
30	use-side heat medium circuit
31	transfer pump
41	refrigerant discharge temperature sensor
42	use-side heat medium after-heating temperature sensor
43	use-side heat medium before-heating temperature sensor
44	refrigerant condensation temperature sensor
50	control device

Claims

1. A vapor compression refrigeration cycle device comprising:

a main refrigerant circuit (10) formed by sequentially connecting a compressor (11), a use-side heat exchanger (12), an intermediate heat exchanger (13), a first expansion device (14) and a heat source-side heat exchanger (15) to one another through a refrigerant pipe (16);

a bypass refrigerant circuit (20) which branches off from the refrigerant pipe (16) located between the use-side heat exchanger (12) and the first expansion device (14) and which is formed by sequentially connecting a second expansion device (21), the intermediate heat exchanger (13) and a compression midstream of the compressor (11) to one another;

a control device (50) for controlling valve opening degrees of the first expansion device (14) and the second expansion device (21);

a use-side heat medium after-heating temperature sensor (42) for detecting use-side heat medium temperature (T2) at an exit of the use-side heat exchanger (12) through which a use-side

heat medium circulates; and
 a refrigerant discharge temperature sensor (41)
 for detecting refrigerant discharge temperature
 (T1) of refrigerant which is discharged from the
 compressor (11);

wherein

the control device (50) controls the valve opening
 degree of the second expansion device (21) such
 that a temperature difference between the use-side
 heat medium temperature (T2) detected by the use-
 side heat medium after-heating temperature sensor
 (42) and the refrigerant discharge temperature (T1)
 detected by the refrigerant discharge temperature
 sensor (41) becomes equal to or greater than a pre-
 determined value.

2. A vapor compression refrigeration cycle device comprising:

a main refrigerant circuit (10) formed by sequentially connecting a compressor (11), a use-side heat exchanger (12), an intermediate heat exchanger (13), a first expansion device (14) and a heat source-side heat exchanger (15) to one another through a refrigerant pipe (16);
 a bypass refrigerant circuit (20) which branches off from the refrigerant pipe (16) located between the use-side heat exchanger (12) and the first expansion device (14) and which is formed by sequentially connecting a second expansion device (21), the intermediate heat exchanger (13) and a compression midstream of the compressor (11) to one another;
 a control device (50) for controlling valve opening degrees of the first expansion device (14) and the second expansion device (21);
 a use-side heat medium before-heating temperature sensor (43) for detecting use-side heat medium temperature (T2) at an entrance of the use-side heat exchanger (12) through which a use-side heat medium circulates; and
 a refrigerant discharge temperature sensor (41) for detecting refrigerant discharge temperature (T1) of refrigerant which is discharged from the compressor (11);

wherein

the control device (50) controls the valve opening
 degree of the second expansion device (21) such
 that a temperature difference between the use-side
 heat medium temperature (T2) detected by the use-
 side heat medium before-heating temperature sensor
 (43) and the refrigerant discharge temperature (T1)
 detected by the refrigerant discharge temperature
 sensor (41) becomes equal to or greater than a
 predetermined value.

3. A vapor compression refrigeration cycle device comprising:

a main refrigerant circuit (10) formed by sequentially connecting a compressor (11), a use-side heat exchanger (12), an intermediate heat exchanger (13), a first expansion device (14) and a heat source-side heat exchanger (15) to one another through a refrigerant pipe (16);
 a bypass refrigerant circuit (20) which branches off from the refrigerant pipe (16) located between the use-side heat exchanger (12) and the first expansion device (14) and which is formed by sequentially connecting a second expansion device (21), the intermediate heat exchanger (13) and a compression midstream of the compressor (11) to one another;
 a control device (50) for controlling valve opening degrees of the first expansion device (14) and the second expansion device (21);
 a refrigerant condensation temperature sensor (44) for detecting refrigerant condensation temperature (T2) of refrigerant at the use-side heat exchanger (12); and
 a refrigerant discharge temperature sensor (41) for detecting refrigerant discharge temperature (T1) of the refrigerant which is discharged from the compressor (11);

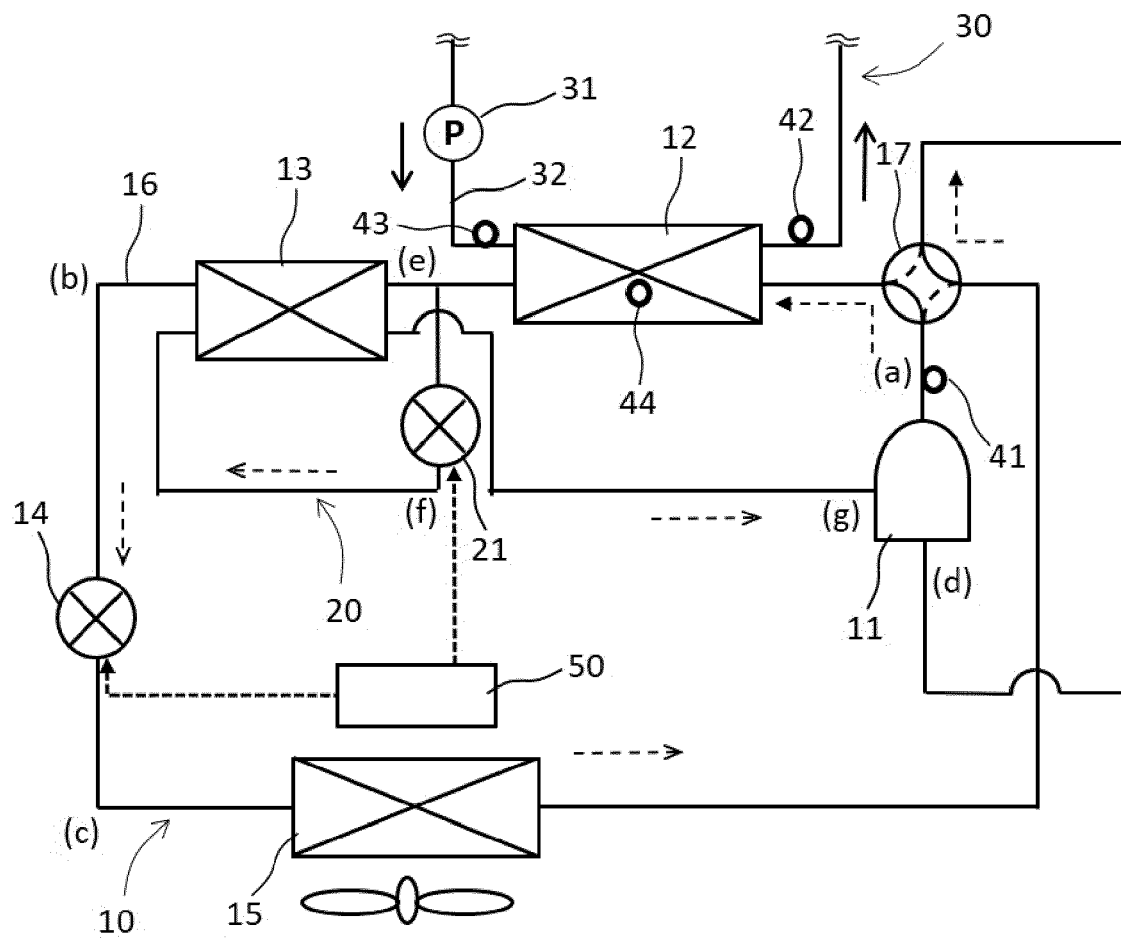
wherein

the control device (50) controls the valve opening
 degree of the second expansion device (21) such
 that a temperature difference between the refrigerant
 condensation temperature (T2) detected by the
 refrigerant condensation temperature sensor (44)
 and the refrigerant discharge temperature (T1) detected by the refrigerant discharge temperature sensor (41) becomes equal to or greater than a predetermined value.

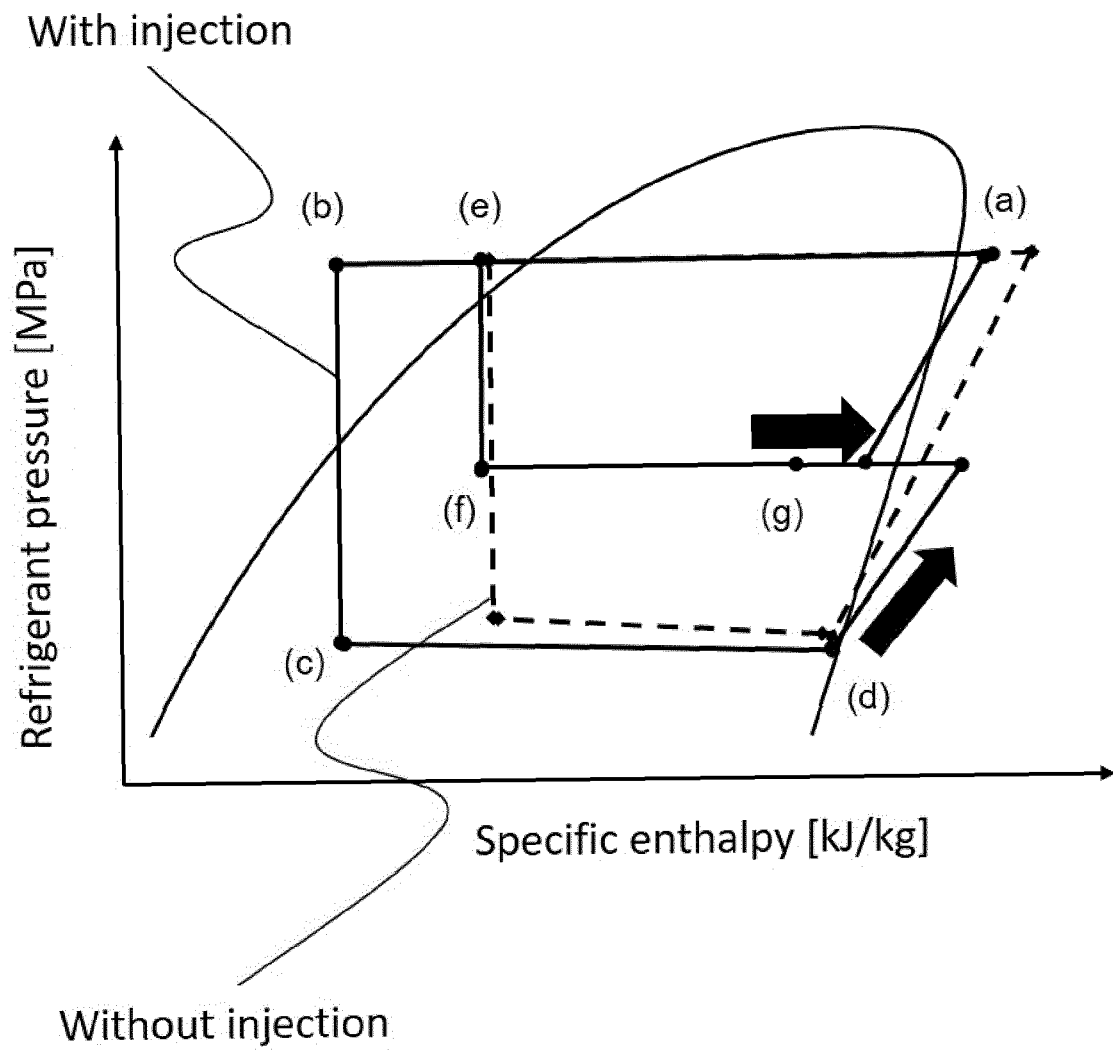
4. The vapor compression refrigeration cycle device according to any one of claims 1 to 3, wherein when the temperature difference becomes smaller than the predetermined value, the control device (50) reduces the valve opening degree of the second expansion device (21).

5. The vapor compression refrigeration cycle device according to any one of claims 1 to 3, wherein the use-side heat medium is water or antifreeze liquid.

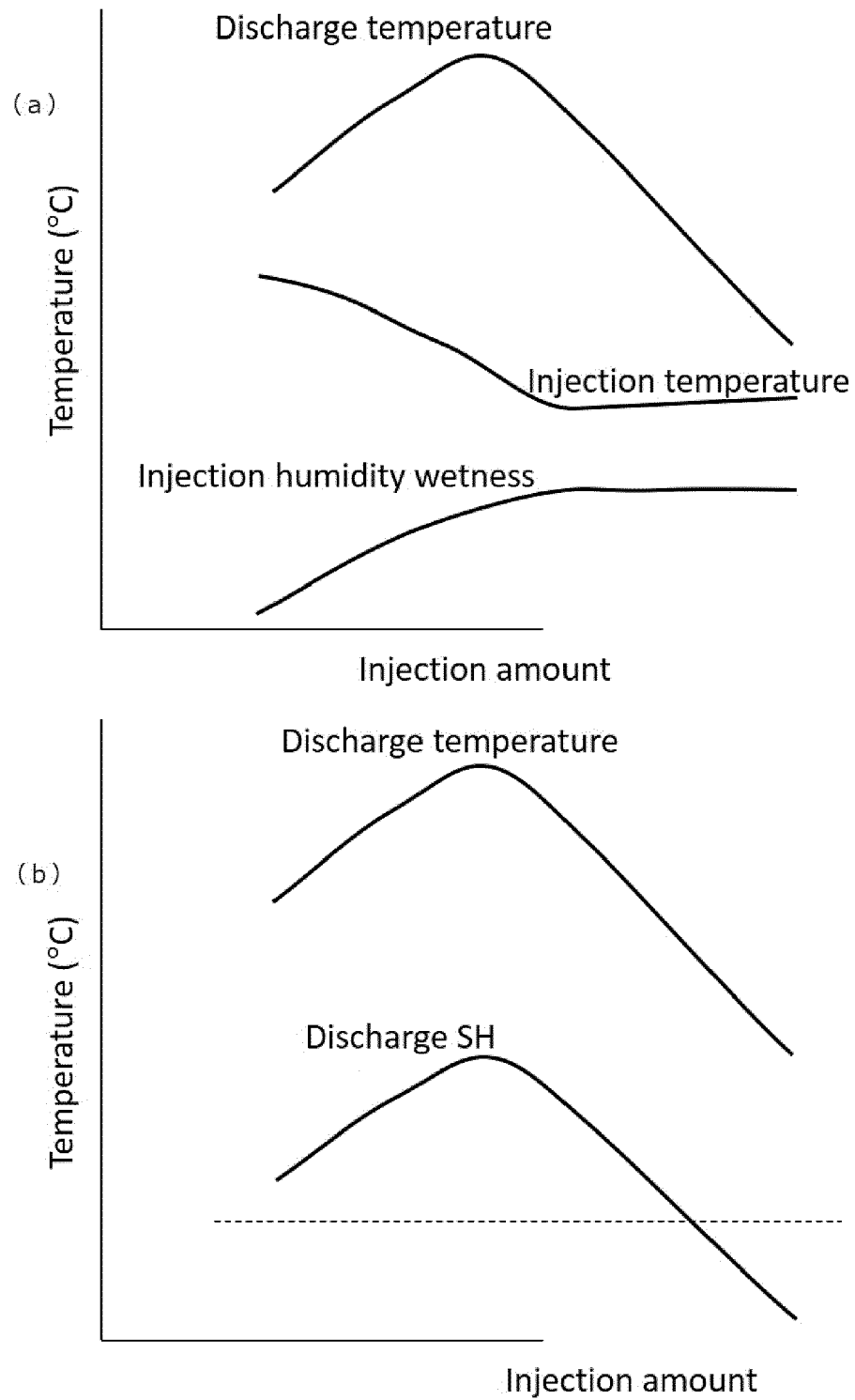
[Fig. 1]



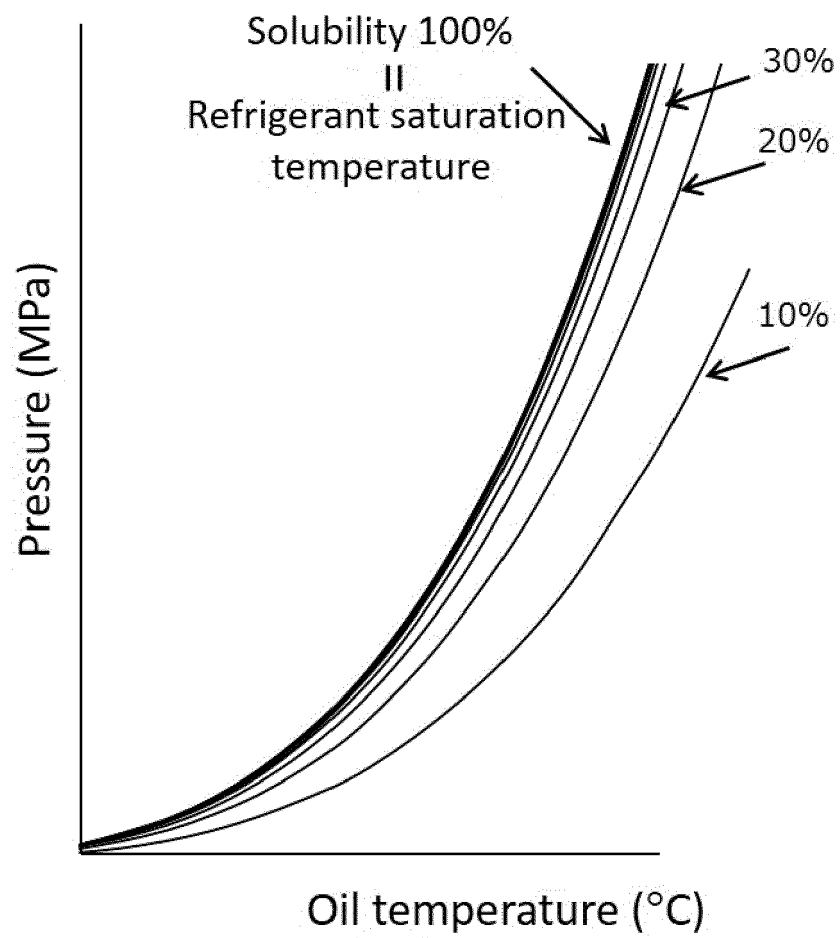
[Fig. 2]



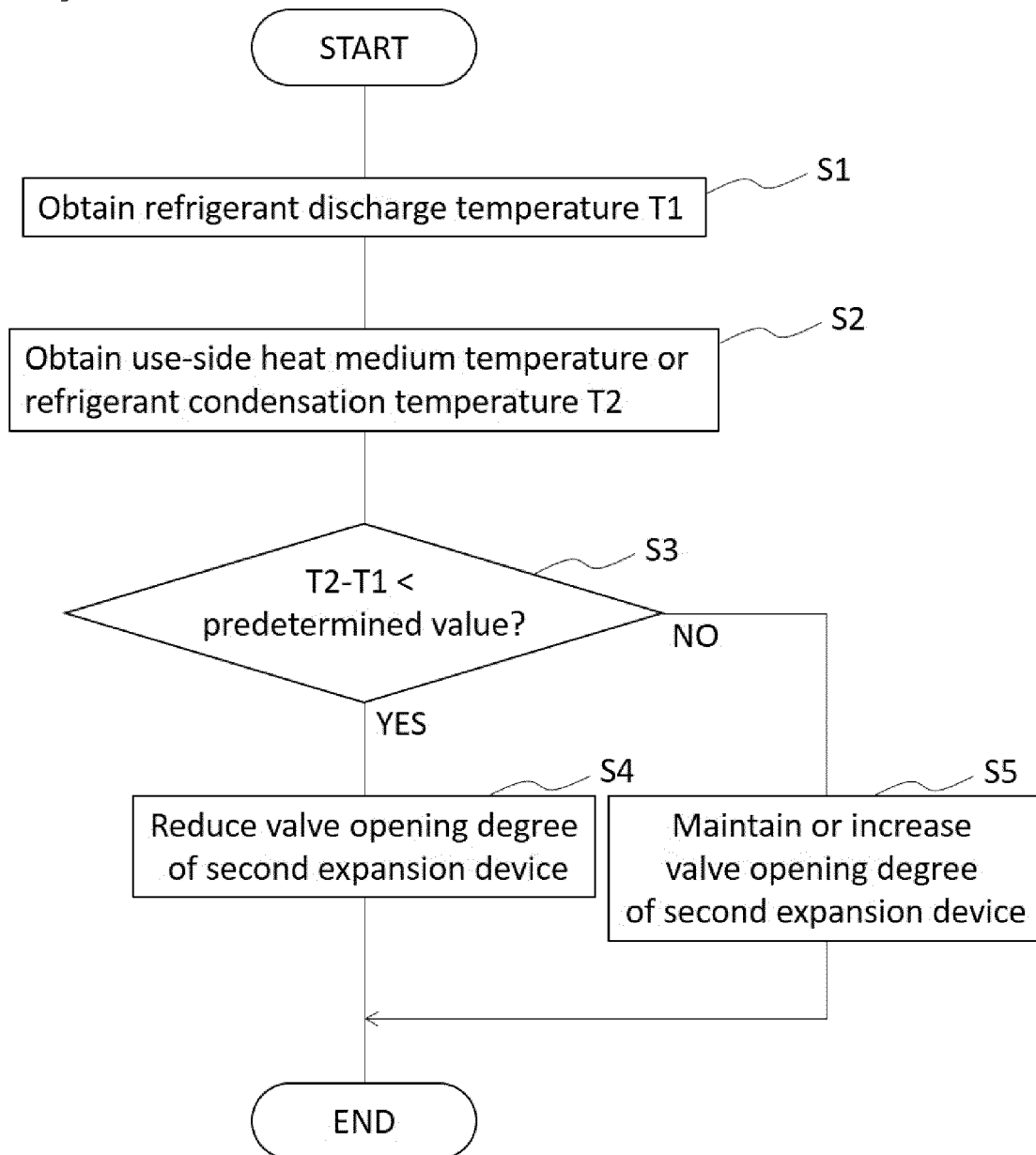
[Figs. 3]



[Fig. 4]



[Fig. 5]





EUROPEAN SEARCH REPORT

Application Number

EP 23 18 8928

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EPO FORM 1503 03.82 (P04C01)

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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			TECHNICAL FIELDS SEARCHED (IPC)
			F25B
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 29 November 2023	Examiner Weisser, Meinrad
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	

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 23 18 8928

5 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
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29-11-2023

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