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

(11) EP 4 455 576 A1

(12) # EUROPEAN PATENT APPLICATION
published in accordance with Art. 153(4) EPC

(43) Date of publication:
30.10.2024 Bulletin 2024/44

(21) Application number: **21968919.7**

(22) Date of filing: **22.12.2021**

(51) International Patent Classification (IPC):
F25B 1/00 *(2006.01)*

(52) Cooperative Patent Classification (CPC):
F25B 1/00

(86) International application number:
PCT/JP2021/047569

(87) International publication number:
WO 2023/119482 (29.06.2023 Gazette 2023/26)

(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

(71) Applicant: **MITSUBISHI ELECTRIC CORPORATION**
Chiyoda-ku
Tokyo 100-8310 (JP)

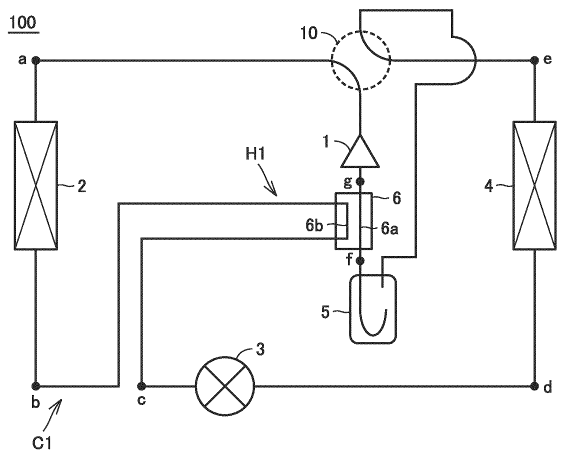
(72) Inventor: **ISHIYAMA, Hiroki**
Tokyo 100-8310 (JP)

(74) Representative: **Pfenning, Meinig & Partner mbB**
Patent- und Rechtsanwälte
Theresienhöhe 11a
80339 München (DE)

(54) **REFRIGERATION CYCLE DEVICE**

(57) A refrigeration cycle apparatus (100) includes: a refrigerant circuit (C1) including a compressor (1), a first heat exchanger (2), a first decompressing apparatus (3), a second heat exchanger (4), and an accumulator (5); and a heating unit (H1). In the refrigerant circuit (C1), refrigerant circulates in order of the compressor (1), the first heat exchanger (2), the first decompressing apparatus (3), the second heat exchanger (4), and the accumulator (5). The heating unit (H1) is configured to heat the refrigerant that returns from the accumulator (5) to the compressor (1), using the refrigerant that has passed through the first heat exchanger (2). Preferably, the heating unit (H1) includes a third heat exchanger (6) configured to perform heat exchange between the refrigerant running toward the first decompressing apparatus (3) after having passed through the first heat exchanger (2) and the refrigerant running toward the compressor (1) after having passed through the accumulator (5).

FIG.1



EP 4 455 576 A1

Description

TECHNICAL FIELD

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

BACKGROUND ART

[0002] Japanese Patent Laying-Open No. 2009-222348 (PTL 1) discloses a refrigeration apparatus that can reduce the possibility that liquid compression may occur in a compressor. The refrigeration apparatus includes an internal heat exchanger as a mechanism for heating refrigerant fed from an evaporator to the compressor.

CITATION LIST

PATENT LITERATURE

[0003] PTL 1: Japanese Patent Laying-Open No. 2009-222348

SUMMARY OF INVENTION

TECHNICAL PROBLEM

[0004] Within a compressor of a refrigeration cycle apparatus, there is a refrigerating machine oil in order to secure the lubricating property of the compressor. When the operation of the compressor is started, gas refrigerant is outputted from the compressor to a refrigerant circuit. With the flow of this gas refrigerant, a mixed liquid of liquid refrigerant and the refrigerating machine oil is taken out to the refrigerant circuit.

[0005] Japanese Patent Laying-Open No. 2009-222348 described above describes that an accumulator may be provided in a refrigerant circuit in order to prevent the refrigerant to be suctioned into the compressor from becoming wet, and reduce the possibility that liquid compression may occur in the compressor, in the refrigeration apparatus.

[0006] However, when an accumulator is provided, liquid compression is suppressed, but oil return property from the accumulator is deteriorated, and the reliability of the compressor is reduced. Further, since surplus refrigerant stays in the accumulator, the degree of suction dryness of the compressor is decreased, and the performance of the compressor is deteriorated.

[0007] An object of the present disclosure is to provide a refrigeration cycle apparatus that can avoid liquid compression using an accumulator and eliminate a shortage of a refrigerating machine oil in a compressor.

SOLUTION TO PROBLEM

[0008] The present disclosure relates to a refrigeration cycle apparatus. The refrigeration cycle apparatus includes: a refrigerant circuit including a compressor, a first heat exchanger, a first decompressing apparatus, a second heat exchanger, and an accumulator; and a heating unit. In the refrigerant circuit, refrigerant circulates in order of the compressor, the first heat exchanger, the first decompressing apparatus, the second heat exchanger, and the accumulator. The heating unit is configured to heat the refrigerant that returns from the accumulator to the compressor, using the refrigerant that has passed through the first heat exchanger.

ADVANTAGEOUS EFFECTS OF INVENTION

[0009] According to the refrigeration cycle apparatus in the present disclosure, it is possible to avoid liquid compression in the compressor and eliminate a shortage of a refrigerating machine oil in the compressor.

BRIEF DESCRIPTION OF DRAWINGS

[0010]

Fig. 1 shows a configuration of a refrigeration cycle apparatus in a first embodiment.
Fig. 2 shows the relation between each of an oil return ratio and the degree of dryness, and pressure loss.
Fig. 3 is a p-h diagram for describing operation of the refrigeration cycle apparatus in the first embodiment.
Fig. 4 shows a configuration of a refrigeration cycle apparatus in a second embodiment.
Fig. 5 is a p-h diagram for describing operation of the refrigeration cycle apparatus in the second embodiment.
Fig. 6 shows a configuration of a refrigeration cycle apparatus in a third embodiment.
Fig. 7 is a p-h diagram for describing operation of the refrigeration cycle apparatus in the third embodiment.
Fig. 8 shows a configuration of a refrigeration cycle apparatus in a fourth embodiment.
Fig. 9 is a flowchart for describing control performed by a controller 60.
Fig. 10 shows a configuration of a refrigeration cycle apparatus in a fifth embodiment.
Fig. 11 is a p-h diagram for describing operation of the refrigeration cycle apparatus in the fifth embodiment.

DESCRIPTION OF EMBODIMENTS

[0011] Hereinafter, embodiments of the present disclosure will be described in detail with reference to the drawings. In the following, a plurality of embodiments will be described, and it is originally intended from the time of filing the present application to combine configurations described in the embodiments as appropriate. It should be noted that identical or corresponding parts in the drawings will be designated by the same reference characters, and the description thereof will not be repeated.

First Embodiment

[0012] Fig. 1 shows a configuration of a refrigeration cycle apparatus in a first embodiment. A refrigeration cycle apparatus 100 shown in Fig. 1 includes a refrigerant circuit C1 and a heating unit H1. Refrigerant circuit C1 includes, at least, a compressor 1, a first heat exchanger 2, a first decompressing apparatus 3, a second heat exchanger 4, and an accumulator 5. It should be noted that refrigerant circuit C1 may further include a four-way valve 10, although it is not essential. Further, in Figs. 4, 6, 8, and 10 described later, refrigerant circuit C1 may also further include four-way valve 10, although it is not shown. Heating unit H1 includes a third heat exchanger 6.

[0013] First heat exchanger 2 is configured to perform heat exchange between high-pressure refrigerant after having been compressed by compressor 1 and a heat medium such as the air. Second heat exchanger 4 is configured to perform heat exchange between low-pressure refrigerant decompressed by the first decompressing apparatus and the heat medium such as the air. Third heat exchanger 6 has a first flow path 6a and a second flow path 6b, and is configured to perform heat exchange between the refrigerant passing through first flow path 6a and the refrigerant passing through second flow path 6b.

[0014] Compressor 1 is configured to change its operating frequency, in accordance with a control signal received from a controller not shown. Specifically, compressor 1 includes therein a drive motor variable in rotational speed under inverter control and, when the operating frequency is changed, the rotational speed of the drive motor is changed. By changing the operating frequency of compressor 1, an output of compressor 1 is adjusted. Compressor 1 of any of various types such as rotary type, reciprocating type, scroll type, and screw type, for example, may be employed.

[0015] Accumulator 5 is connected between compressor 1 and second heat exchanger 4 by pipes. First flow path 6a, which is a low-pressure side flow path of third heat exchanger 6, is connected between compressor 1 and accumulator 5 by pipes. Second flow path 6b, which is a high-pressure side flow path of third heat exchanger 6, is connected between first heat exchanger 2 and first decompressing apparatus 3 by pipes.

[0016] The refrigeration cycle apparatus in the first embodiment is characterized in that heat is exchanged between the refrigerant passing through low-pressure side first flow path 6a and the refrigerant passing through high-pressure side second flow path 6b. In refrigerant circuit C1, the refrigerant circulates in order of compressor 1, first heat exchanger 2, first decompressing apparatus 3, second heat exchanger 4, and accumulator 5. Heating unit H1 is configured to heat the refrigerant that returns from accumulator 5 to compressor 1, using the refrigerant that has passed through first heat exchanger 2. Heating unit H1 includes third heat exchanger 6 configured to perform heat exchange between the refrigerant running toward first decompressing apparatus 3 after having passed through first heat exchanger 2 and the refrigerant running toward compressor 1 after having passed through accumulator 5.

[0017] Here, before describing operation of refrigeration cycle apparatus 100 in the first embodiment, definitions of several terms will be provided.

[0018] An "oil return ratio" refers to a ratio of the flow rate of an oil flowing from accumulator 5 to compressor 1, to the flow rate of the entire refrigerant. The lower the pressure loss in an oil return path due to an oil return hole in accumulator 5 or the like is, the higher the oil return ratio is, and reliability can be improved.

[0019] The "degree of dryness" refers to a ratio of the flow rate of gas refrigerant flowing from the accumulator to the compressor, to the flow rate of the entire refrigerant flowing from the accumulator to the compressor (gas/(gas+liquid)). The higher the pressure loss in the oil return path due to the oil return hole or the like is, the lower the degree of dryness is, and liquid compression in compressor 1 can be suppressed and reliability can be improved.

[0020] Fig. 2 shows the relation between each of the oil return ratio and the degree of dryness, and the pressure loss. As shown in Fig. 2, the lower the pressure loss in the oil return path is, the higher the oil return ratio is, and the lower the pressure loss in the oil return path is, the higher the degree of dryness is. Thus, the oil return ratio and the degree of dryness have a trade-off relation.

[0021] Fig. 3 is a p-h diagram for describing operation of the refrigeration cycle apparatus in the first embodiment. Points a to g in Fig. 3 correspond to states of the refrigerant at points a to g in Fig. 1, respectively. The refrigerant discharged from compressor 1 (point a) passes through first heat exchanger 2 (point b), further passes through high-pressure side second flow path 6b of third heat exchanger 6 (point c), and is decompressed by first decompressing apparatus 3 (point d).

[0022] Then, the refrigerant thereafter passes through second heat exchanger 4 (point e), passes through accumulator 5 (point f), and then passes through low-pressure side first flow path 6a of third heat exchanger 6 (point g), and returns to compressor 1. Heat exchange is performed in low-pressure side first flow path 6a (points b to c) and high-pressure side second flow path 6b (points f to g) of third heat exchanger 6.

[0023] As described above, in the refrigeration cycle apparatus in the first embodiment, third heat exchanger 6 is installed, which is configured to perform heat exchange between the high-temperature, high-pressure refrigerant and the low-temperature, low-pressure refrigerant between accumulator 5 and compressor 1.

[0024] Thereby, the following effects are obtained.

That is, even when the pressure loss in the oil return path due to the oil return hole in accumulator 5 or the like is reduced to increase the oil return ratio and decrease the degree of dryness, only liquid compression can be suppressed by third heat exchanger 6, and thus the reliability of compressor 1 can be improved while maintaining the performance of the refrigeration cycle apparatus. Further, heat transfer performance can be improved by decreasing the degree of dryness at an inlet and an outlet of second heat exchanger 4.

Second Embodiment

[0025] In a second embodiment, a branch flow path F1 configured to branch a part of the refrigerant having flowed out of high-pressure side first heat exchanger 2 and cause it to bypass first decompressing apparatus 3 is provided, and the third heat exchanger is arranged in branch flow path F1.

[0026] Fig. 4 shows a configuration of a refrigeration cycle apparatus in the second embodiment. A refrigeration cycle apparatus 200 in the second embodiment includes refrigerant circuit C1 and a heating unit H2. Refrigerant circuit C1 includes, at least, compressor 1, first heat exchanger 2, first decompressing apparatus 3, second heat exchanger 4, and accumulator 5.

[0027] Refrigeration cycle apparatus 200 further includes branch flow path F1 configured to branch from a branch portion 7 in a flow path running toward first decompressing apparatus 3 after having passed through first heat exchanger 2, and merge into refrigerant circuit C1 at a merge portion 8 downstream of branch portion 7 of refrigerant circuit C1, in refrigerant circuit C1. Heating unit H2 includes a second decompressing apparatus 9 configured to decompress the refrigerant flowing through branch flow path F1, and third heat exchanger 6 configured to perform heat exchange between the refrigerant flowing through branch flow path F1 and running from branch portion 7 toward second decompressing apparatus 9 and the refrigerant running toward compressor 1 after having passed through accumulator 5 in refrigerant circuit C1.

[0028] Since first heat exchanger 2, second heat exchanger 4, first decompressing apparatus 3, and accumulator 5 are the same as those in the first embodiment, the description will not be repeated herein.

[0029] Branch portion 7 is installed between first heat exchanger 2 and first decompressing apparatus 3 in refrigerant circuit C1. Merge portion 8 is arranged in a flow path running from second heat exchanger 4 toward accumulator 5 in refrigerant circuit C1. Second decompressing apparatus 9 is connected between branch portion 7 and merge portion 8 in branch flow path F1 by pipes.

[0030] Low-pressure side first flow path 6a of third heat exchanger 6 is connected between accumulator 5 and compressor 1 in refrigerant circuit C1 by pipes. High-pressure side second flow path 6b of third heat exchanger 6 is connected between branch portion 7 and second decompressing apparatus 9 in branch flow path F1 by pipes.

[0031] In the second embodiment, the refrigeration cycle apparatus is characterized in that heat is exchanged between the refrigerants in low-pressure side first flow path 6a and high-pressure side second flow path 6b.

[0032] Fig. 5 is a p-h diagram for describing operation of the refrigeration cycle apparatus in the second embodiment. Points a to k in Fig. 5 correspond to states of the refrigerant at points a to k in Fig. 4, respectively.

[0033] The refrigerant discharged from compressor 1 (point a) flows in order of first heat exchanger 2 (point b) and branch portion 7. Of the refrigerant having flowed out of branch portion 7, one branched part passes through first decompressing apparatus 3 (point d), and the other branched part flows into high-pressure side second flow path 6b of third heat exchanger 6 and is subjected to heat exchange (points i to j). The refrigerant having flowed out of first decompressing apparatus 3 (point d) flows in order of second heat exchanger 4 (point e) and merge portion 8, and the refrigerant having flowed out of high-pressure side second flow path 6b of third heat exchanger 6 (point j) passes through second decompressing apparatus 9 (point k). These refrigerants are merged at merge portion 8 (point f). Thereafter, the merged refrigerant passes through accumulator 5 (point g), and further passes through low-pressure side first flow path 6a of third heat exchanger 6 (point h).

[0034] On this occasion, heat is exchanged between the refrigerant passing through low-pressure side first flow path 6a (points g to h) and the refrigerant passing through high-pressure side second flow path 6b (points i to j) of third heat exchanger 6.

[0035] As described above, in the second embodiment, third heat exchanger 6 and second decompressing apparatus 9 are provided, third heat exchanger 6 being configured to perform heat exchange between the refrigerant flowing between accumulator 5 and compressor 1, and the refrigerant that is partially branched from the refrigerant having flowed out of high-pressure side first heat exchanger 2 and flows into branch flow path F1. The refrigerant in second flow path 6b subjected to heat exchange in third heat exchanger 6 is merged at merge portion 8 at an inlet of accumulator 5.

[0036] With such a configuration, the following effects are obtained. First, under a condition where the temperature of the refrigerant discharged from compressor 1 increases, the temperature of the discharged refrigerant can be suppressed. Next, by reducing the flow rate of the refrigerant in low-pressure side second heat exchanger 4, the pressure loss in refrigerant circuit C1 can be reduced, and the performance of the refrigeration cycle apparatus can be improved.

Third Embodiment

[0037] Although a branch flow path is also provided in a third embodiment, the position of merge portion 8 at which the refrigerant is merged is changed. In the third embodiment, the refrigerant having passed through the branch flow path is merged at an inlet part of low-pressure side second heat exchanger 4.

[0038] Fig. 6 shows a configuration of a refrigeration cycle apparatus in the third embodiment. A refrigeration cycle apparatus 300 in the third embodiment includes refrigerant circuit C1 and a heating unit H3. Refrigerant circuit C1 includes, at least, compressor 1, first heat exchanger 2, first decompressing apparatus 3, second heat exchanger 4, and accumulator 5.

[0039] Refrigeration cycle apparatus 300 further includes a branch flow path F2 configured to branch from branch portion 7 in the flow path running toward first decompressing apparatus 3 after having passed through first heat exchanger 2, and merge into refrigerant circuit C1 at a merge portion 82 downstream of branch portion 7 of refrigerant circuit C1, in refrigerant circuit C1. Merge portion 82 is arranged in a flow path running from first decompressing apparatus 3 toward second heat exchanger 4 in refrigerant circuit C1. Heating unit H3 includes second decompressing apparatus 9 configured to decompress the refrigerant flowing through branch flow path F2, and third heat exchanger 6. Third heat exchanger 6 is configured to perform heat exchange between the refrigerant flowing through branch flow path F2 and running from branch portion 7 toward second decompressing apparatus 9 and the refrigerant running toward compressor 1 after having passed through accumulator 5 in refrigerant circuit C1.

[0040] Since first heat exchanger 2, second heat exchanger 4, first decompressing apparatus 3, and accumulator 5 are the same as those in the first embodiment, the description will not be repeated herein.

[0041] Branch portion 7 is installed between first heat exchanger 2 and first decompressing apparatus 3 in refrigerant circuit C1. Merge portion 82 is installed between first decompressing apparatus 3 and second heat exchanger 4 in refrigerant circuit C1. Second decompressing apparatus 9 is connected between branch portion 7 and merge portion 82 in branch flow path F2 by pipes.

[0042] Low-pressure side first flow path 6a of third heat exchanger 6 is connected between accumulator 5 and compressor 1 in refrigerant circuit C1 by pipes. High-pressure side second flow path 6b of third heat exchanger 6 is connected between branch portion 7 and second decompressing apparatus 9 in branch flow path F2 by pipes.

[0043] In the third embodiment, the refrigeration cycle apparatus is characterized in that heat is exchanged between the refrigerants in low-pressure side first flow path 6a and high-pressure side second flow path 6b, as in the second embodiment.

[0044] Fig. 7 is a p-h diagram for describing operation of the refrigeration cycle apparatus in the third embodiment. Points a to k in Fig. 7 correspond to states of the refrigerant at points a to k in Fig. 6, respectively.

[0045] The refrigerant discharged from compressor 1 (point a) flows in order of first heat exchanger 2 (point b) and branch portion 7. Of the refrigerant having flowed out of branch portion 7, one branched part passes through first decompressing apparatus 3 (point d), and the other branched part flows into high-pressure side second flow path 6b of third heat exchanger 6 and is subjected to heat exchange (points i to j). The refrigerant having flowed out of first decompressing apparatus 3 (point d) reaches merge portion 82. Further, the refrigerant having flowed out of high-pressure side second flow path 6b of third heat exchanger 6 passes through second decompressing apparatus 9 (point k) and reaches merge portion 82. The refrigerant merged at merge portion 82 (point e) passes through second heat exchanger 4 and accumulator 5 (points f, g), is subjected to heat exchange in low-pressure side first flow path 6a of third heat exchanger 6 (points g to h), and returns to compressor 1.

[0046] On this occasion, heat is exchanged between the refrigerant passing through low-pressure side first flow path 6a (points g to h) and the refrigerant passing through high-pressure side second flow path 6b (points i to j) of third heat exchanger 6.

[0047] As described above, also in the third embodiment, third heat exchanger 6 is provided as in the second embodiment. However, in the third embodiment, the refrigerant having passed through the branch flow path subjected to heat exchange is merged at the inlet of second heat exchanger 4.

[0048] With such a configuration, the following effects are obtained in addition to the effects in the second embodiment. That is, by decreasing the degree of dryness at the inlet of low-pressure side second heat exchanger 4, distribution performance can be improved, and the heat transfer performance of the refrigerant passing through second heat exchanger 4 can be improved.

Fourth Embodiment

[0049] In a fourth embodiment, a controller configured to control second decompressing apparatus 9 to have an appropriate opening degree is provided.

[0050] Fig. 8 shows a configuration of a refrigeration cycle apparatus in the fourth embodiment. A refrigeration cycle apparatus 400 shown in Fig. 8 includes a sensor 50 and a controller 60, in addition to the components of refrigeration cycle apparatus 300 shown in Fig. 6. Since other components are the same as those described in Fig. 6, the description will not be repeated. It should be noted that sensor 50 and controller 60 may further be provided to refrigeration cycle apparatus 200 in Fig. 4.

[0051] Sensor 50 is a temperature sensor configured to sense the temperature of the refrigerant discharged from compressor 1, for example. It should be noted that sensor 50 may be any other sensor that can predict a suction state of compressor 1. Sensor 50 may be arranged on a suction side of compressor 1.

[0052] Controller 60 has a configuration including a CPU (Central Processing Unit) 61, a memory 62 (a ROM (Read Only Memory) and a RAM (Random Access Memory)), input/output buffers (not shown), and the like. CPU 61 expands programs stored in the ROM onto the RAM or the like and executes the programs. The programs stored in the ROM are programs describing processing procedures of controller 60. In accordance with these programs, controller 60 performs control of devices in refrigeration cycle apparatus 400. This control can be processed not only by software but also by dedicated hardware (electronic circuitry). In particular, controller 60 is configured to control second decompressing apparatus 9 in accordance with a value sensed by sensor 50.

[0053] Fig. 9 is a flowchart for describing control performed by controller 60. First, in step S1, controller 60 confirms an operation state of the refrigeration cycle apparatus. When the refrigeration cycle apparatus is not operating (NO in S1), the processing of this flowchart ends.

[0054] On the other hand, when the refrigeration cycle apparatus is operating (YES in S1), in step S2, controller 60 obtains a sensed value from sensor 50. The sensed value is the temperature of the refrigerant discharged from compressor 1, for example. Then, in step S3, controller 60 compares the sensed value obtained from sensor 50 with a reference value.

[0055] In the case of the reference value < the sensed value (YES in S3), controller 60 decreases the opening degree of second decompressing apparatus 9 in step S4. On the other hand, in the case of the reference value > the sensed value (NO in S3), controller 60 increases the opening degree of second decompressing apparatus 9 in step S5.

[0056] After the processing in step S4 or step S5, the processing from step S1 is performed again.

[0057] As described above, in the fourth embodiment, second decompressing apparatus 9 is controlled to have an appropriate opening degree. Since the amount of heat exchange of third heat exchanger 6 is thereby controlled to an appropriate amount of heat exchange, the refrigeration cycle apparatus can be operated at a point excellent in performance, while suppressing an increase in the temperature of the refrigerant discharged from compressor 1.

Fifth Embodiment

[0058] In a fifth embodiment, the refrigerant decompressed in a branch flow path is caused to exchange heat with the refrigerant running from an outlet of first heat exchanger 2 toward first decompressing apparatus 3, and merge into the refrigerant flowing through the refrigerant circuit at a merge point between compressor 1 and accumulator 5.

[0059] Fig. 10 shows a configuration of a refrigeration cycle apparatus in the fifth embodiment. A refrigeration cycle apparatus 500 in the fifth embodiment includes refrigerant circuit C1 and a heating unit H4. Refrigerant circuit C1 includes, at least, compressor 1, first heat exchanger 2, first decompressing apparatus 3, second heat exchanger 4, and accumulator 5.

[0060] Since first heat exchanger 2, second heat exchanger 4, first decompressing apparatus 3, and accumulator 5 are the same as those in the first to fourth embodiments, the description will not be repeated herein.

[0061] Refrigeration cycle apparatus 500 further includes a branch flow path F3 configured to branch from branch portion 7 on the flow path running toward first decompressing apparatus 3 after having passed through first heat exchanger 2, and merge into refrigerant circuit C1 at a merge portion 83 on a flow path running toward compressor 1 after having passed through accumulator 5, in refrigerant circuit C1. Branch portion 7 is installed between first heat exchanger 2 and first decompressing apparatus 3 in refrigerant circuit C1. Merge portion 83 is installed between accumulator 5 and compressor 1 in refrigerant circuit C1.

[0062] Heating unit H4 includes second decompressing apparatus 9 configured to decompress the refrigerant flowing through branch flow path F3, and third heat exchanger 6 configured to perform heat exchange between the refrigerant flowing through branch flow path F3 and running from second decompressing apparatus 9 toward merge portion 83 and the refrigerant running from branch portion 7 toward first decompressing apparatus 3 in refrigerant circuit C1. Second decompressing apparatus 9 is connected between branch portion 7 and merge portion 83 in branch flow path F3 by pipes. In this case, heating unit H4 heats the refrigerant to be suctioned by compressor 1, by causing the heated refrigerant to merge at the merge portion.

[0063] Low-pressure side first flow path 6a of third heat exchanger 6 is connected between second decompressing apparatus 9 and merge portion 83 in branch flow path F3 by pipes. High-pressure side second flow path 6b of third heat exchanger 6 is connected between branch portion 7 and first decompressing apparatus 3 in refrigerant circuit C1 by pipes.

[0064] In the fifth embodiment, the refrigeration cycle apparatus is characterized in that heat is exchanged between the refrigerants in low-pressure side first flow path 6a and high-pressure side second flow path 6b.

[0065] Fig. 11 is a p-h diagram for describing operation of the refrigeration cycle apparatus in the fifth embodiment. Points a to k in Fig. 11 correspond to states of the refrigerant at points a to k in Fig. 10, respectively.

[0066] In Fig. 10, the refrigerant discharged from compressor 1 (point a) flows in order of first heat exchanger 2 and branch portion 7 (point b). Of the refrigerant branched at branch portion 7, one branched part runs toward high-pressure side second flow path 6b of third heat exchanger 6 (point c), and the other branched part flows into second decompressing apparatus 9 (point i). The refrigerant having passed through high-pressure side second flow path 6b of third heat exchanger 6 (point d) flows in order of first decompressing apparatus 3 (point e), second heat exchanger 4 (point f), accumulator 5 (point g), and merge portion 83. The refrigerant having passed through second decompressing apparatus 9 (point j) flows in order of low-pressure side first flow path 6a of third heat exchanger 6 (point k) and merge portion 83. The refrigerant merged at merge portion 83 (point h) is suctioned from a suction port of compressor 1.

[0067] The refrigerant flows as described above, and heat exchange is performed between the refrigerant flowing through low-pressure side first flow path 6a and the refrigerant flowing through high-pressure side second flow path 6b of third heat exchanger 6.

[0068] Thus, in the fifth embodiment, the refrigerant decompressed after having been branched into branch flow path F3 is caused to exchange heat with the refrigerant running from an outlet part of first heat exchanger 2 toward first decompressing apparatus 3, and then merge between compressor 1 and accumulator 5. Thereby, the following effects are obtained.

(1) Under the condition where the temperature of the refrigerant discharged from compressor 1 increases, the temperature of the discharged refrigerant can be suppressed.
(2) By reducing the flow rate of the refrigerant in low-pressure side second heat exchanger 4, pressure loss can be reduced, and the performance of the refrigeration cycle apparatus can be improved.
(3) By decreasing the degree of dryness of the refrigerant at the inlet of low-pressure side second heat exchanger 4, distribution performance can be improved, and heat transfer performance can be improved.

(Conclusion)

[0069] Finally, the present embodiment will be summarized with reference to the drawings again.

[0070] As shown in Fig. 1 and the like, the present disclosure relates to refrigeration cycle apparatus 100. Refrigeration cycle apparatus 100 includes: refrigerant circuit C1 including compressor 1, first heat exchanger 2, first decompressing apparatus 3, second heat exchanger 4, and accumulator 5; and heating unit H1. In refrigerant circuit C1, refrigerant circulates in order of compressor 1, first heat exchanger 2, first decompressing apparatus 3, second heat exchanger 4, and accumulator 5. Heating unit H1 is configured to heat the refrigerant that returns from accumulator 5 to compressor 1, using the refrigerant that has passed through first heat exchanger 2.

[0071] Preferably, heating unit H1 includes third heat exchanger 6 configured to perform heat exchange between the refrigerant running toward first decompressing apparatus 3 after having passed through first heat exchanger 2 and the refrigerant running toward compressor 1 after having passed through accumulator 5.

[0072] Preferably, as shown in Fig. 4 or Fig. 6, refrigeration cycle apparatus 200 or 300 further includes branch flow path F1 or F2 configured to branch from branch portion 7 in a flow path running toward first decompressing apparatus 3 after having passed through first heat exchanger 2, and merge into refrigerant circuit C1 at merge portion 8 or 82 downstream of branch portion 7 of refrigerant circuit C1, in refrigerant circuit C1. Heating unit H2 or H3 includes second decompressing apparatus 9 configured to decompress the refrigerant flowing through branch flow path F1 or F2, and third heat exchanger 6 configured to perform heat exchange between the refrigerant flowing through branch flow path F1 or F2 and running from branch portion 7 toward second decompressing apparatus 9 and the refrigerant running toward compressor 1 after having passed through accumulator 5 in refrigerant circuit C1.

[0073] More preferably, as shown in Fig. 4, merge portion 8 is arranged in a flow path running from second heat exchanger 4 toward accumulator 5 in refrigerant circuit C1.

[0074] More preferably, as shown in Fig. 6, merge portion 82 is arranged in a flow path running from first decompressing apparatus 3 toward second heat exchanger 4 in refrigerant circuit C 1.

[0075] More preferably, as shown in Fig. 8, second decompressing apparatus 9 is an expansion valve configured to have a variable opening degree. Refrigeration cycle apparatus 400 further includes sensor 50 arranged on a suction side or a discharge side of compressor 1 and configured to sense a state of the refrigerant to be suctioned into compressor 1, and controller 60 configured to control the opening degree of second decompressing apparatus 9 in accordance with an output of sensor 50. It should be noted that, since the temperature of the refrigerant to be suctioned into compressor 1 and the temperature of the refrigerant discharged from the compressor have a certain relation, sensor 50 is arranged on the discharge side of the compressor as shown in Fig. 8 in the present embodiment. However, the sensor may be arranged on the suction side of compressor 1.

[0076] Preferably, as shown in Fig. 10, refrigeration cycle apparatus 500 further includes branch flow path F3 configured to branch from branch portion 7 on a flow path running toward first decompressing apparatus 3 after having passed through first heat exchanger 2, and merge into refrigerant circuit C1 at merge portion 83 on a flow path running toward compressor 1 after having passed through accumulator 5, in refrigerant circuit C1. Heating unit H4 includes second decompressing apparatus 9 configured to decompress the refrigerant flowing through branch flow path F3, and third heat exchanger 6 configured to perform heat exchange between the refrigerant flowing through branch flow path F3 and running from second decompressing apparatus 9 toward merge portion 83 and the refrigerant running from branch portion 7 toward first decompressing apparatus 3 in refrigerant circuit C1. In this case, heating unit H4 heats the refrigerant to be suctioned by compressor 1, by causing the heated refrigerant to merge at the merge portion.

[0077] It should be understood that the embodiments disclosed herein are illustrative and non-restrictive in every respect. The scope of the present disclosure is defined by the scope of the claims, rather than the description of the embodiments described above, and is intended to include any modifications within the scope and meaning equivalent to the scope of the claims.

REFERENCE SIGNS LIST

[0078] 1: compressor; 2: first heat exchanger; 3: first decompressing apparatus; 4: second heat exchanger; 5: accumulator; 6: third heat exchanger; 6a: first flow path; 6b: second flow path; 7: branch portion; 10: four-way valve; 8, 82, 83: merge portion; 9: second decompressing apparatus; 50: sensor; 60: controller; 61: CPU; 62: memory; 100, 200, 300, 400, 500: refrigeration cycle apparatus; C1: refrigerant circuit; F1, F2, F3: flow path.

Claims

1. A refrigeration cycle apparatus, comprising:

a refrigerant circuit including a compressor, a first heat exchanger, a first decompressing apparatus, a second heat exchanger, and an accumulator; and
a heating unit, wherein
in the refrigerant circuit, refrigerant circulates in order of the compressor, the first heat exchanger, the first decompressing apparatus, the second heat exchanger, and the accumulator, and
the heating unit is configured to heat the refrigerant that returns from the accumulator to the compressor, using the refrigerant that has passed through the first heat exchanger.

2. The refrigeration cycle apparatus according to claim 1, wherein the heating unit includes a third heat exchanger configured to perform heat exchange between the refrigerant running toward the first decompressing apparatus after having passed through the first heat exchanger and the refrigerant running toward the compressor after having passed through the accumulator.

3. The refrigeration cycle apparatus according to claim 1, further comprising a branch flow path configured to branch from a branch portion in a flow path running toward the first decompressing apparatus after having passed through the first heat exchanger, and merge into the refrigerant circuit at a merge portion downstream of the branch portion, in the refrigerant circuit, wherein
the heating unit includes

a second decompressing apparatus configured to decompress the refrigerant flowing through the branch flow path, and
a third heat exchanger configured to perform heat exchange between the refrigerant flowing through the branch flow path and running from the branch portion toward the second decompressing apparatus and the refrigerant running toward the compressor after having passed through the accumulator in the refrigerant circuit.

4. The refrigeration cycle apparatus according to claim 3, wherein the merge portion is arranged in a flow path running from the second heat exchanger toward the accumulator in the refrigerant circuit.

5. The refrigeration cycle apparatus according to claim 3, wherein the merge portion is arranged in a flow path running from the first decompressing apparatus toward the second heat exchanger in the refrigerant circuit.

6. The refrigeration cycle apparatus according to any one of claims 3 to 5, wherein

the second decompressing apparatus is an expansion valve configured to have a variable opening degree, and
the refrigeration cycle apparatus further comprises

a sensor arranged on a suction side or a discharge side of the compressor and configured to sense a state of the refrigerant, and
a controller configured to control the opening degree of the second decompressing apparatus in accordance with an output of the sensor.

7. The refrigeration cycle apparatus according to claim 1, further comprising a branch flow path configured to branch from a branch portion on a flow path running toward the first decompressing apparatus after having passed through the first heat exchanger, and merge into the refrigerant circuit at a merge portion on a flow path running toward the compressor after having passed through the accumulator, in the refrigerant circuit, wherein
the heating unit includes

a second decompressing apparatus configured to decompress the refrigerant flowing through the branch flow path, and a third heat exchanger configured to perform heat exchange between the refrigerant flowing through the branch flow path and running from the second decompressing apparatus toward the merge portion and the refrigerant running from the branch portion toward the first decompressing apparatus in the refrigerant circuit.

FIG.1

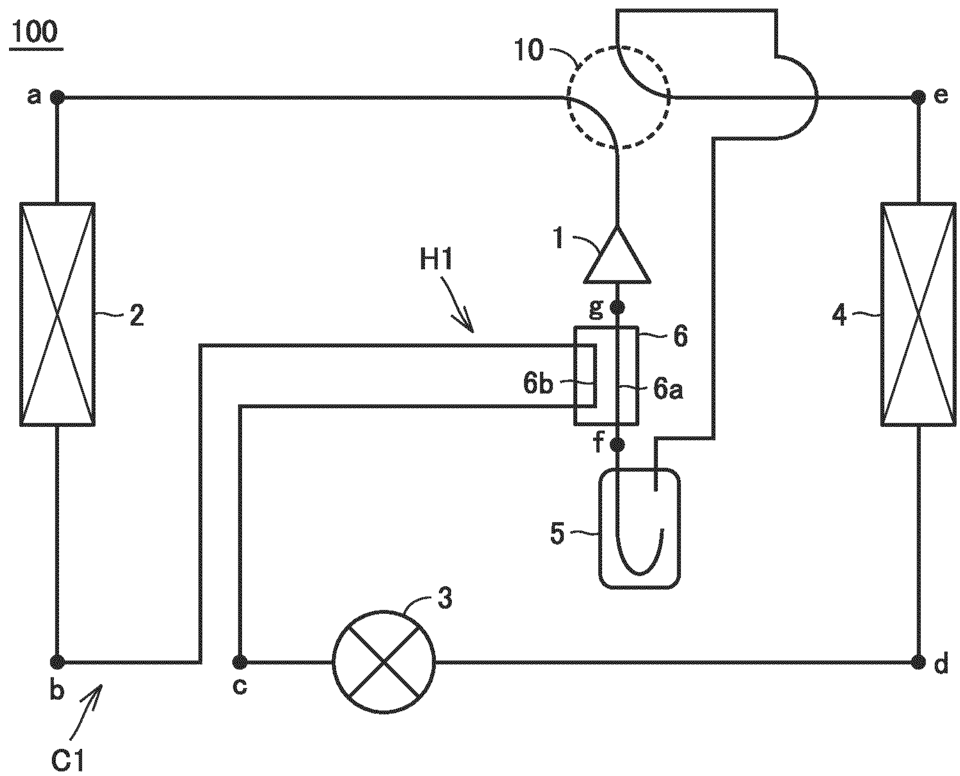

100
10
a
e
1
H1
2
g
6
4
6b
6a
f
5
3
b
c
d
C1

FIG.2

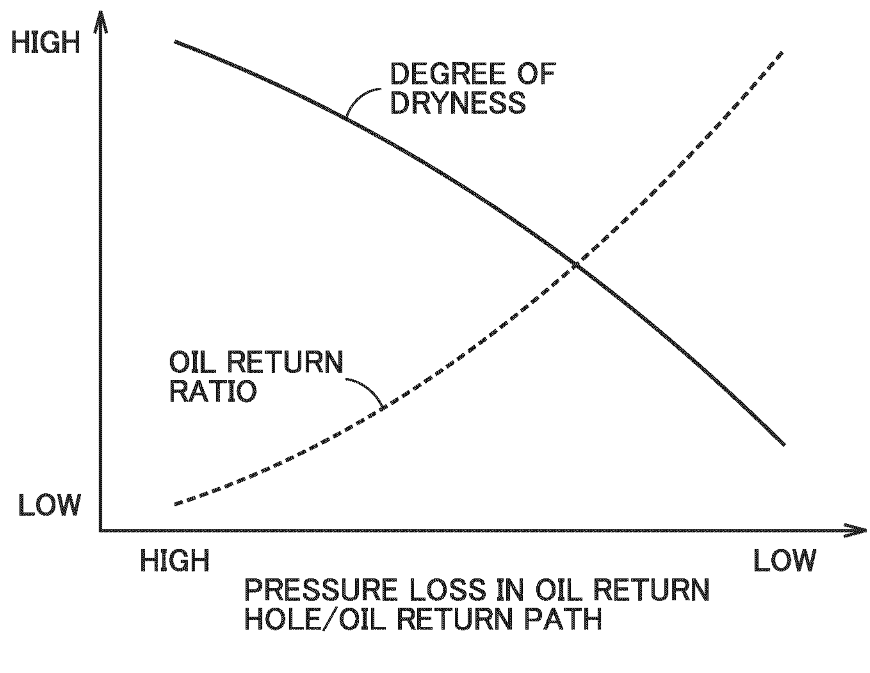

HIGH
DEGREE OF
DRYNESS
OIL RETURN
RATIO
LOW
HIGH
LOW
PRESSURE LOSS IN OIL RETURN
HOLE/OIL RETURN PATH

FIG.3

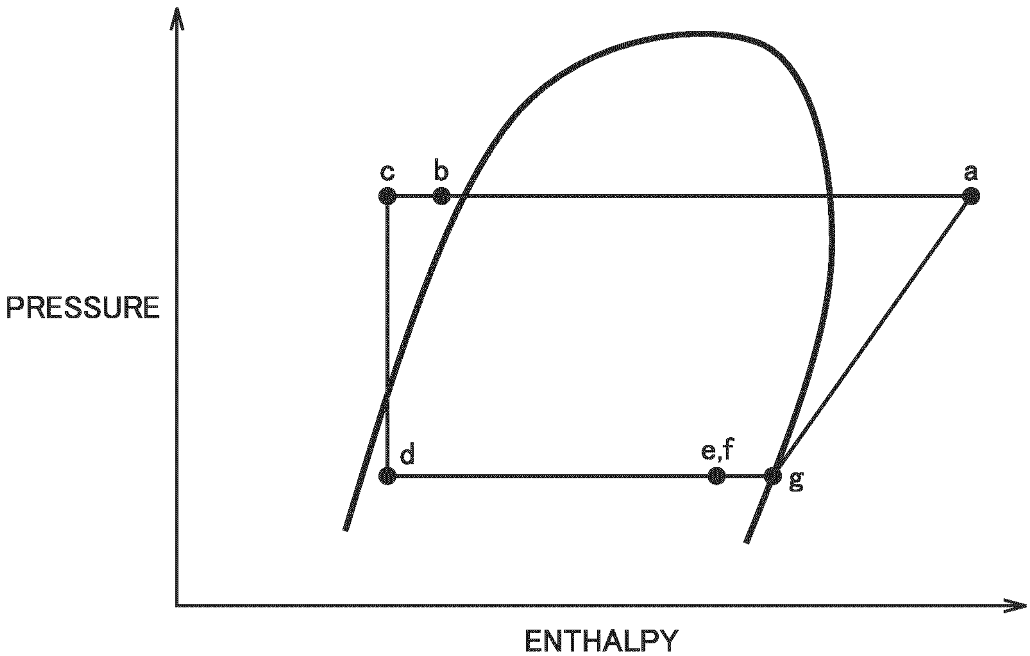

PRESSURE
ENTHALPY
a
b
c
d
e,f
g

FIG.4

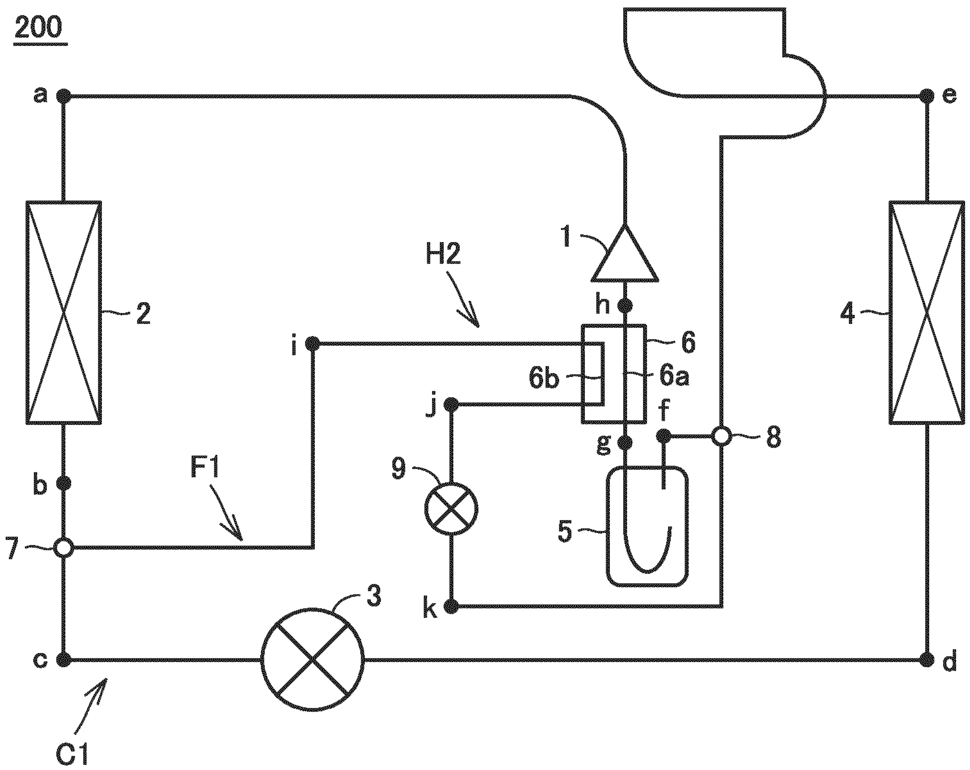

200
a
e
1
H2
h
2
6
4
i
6b
6a
j
f
8
g
9
b
F1
5
7
3
k
c
d
C1

FIG.5

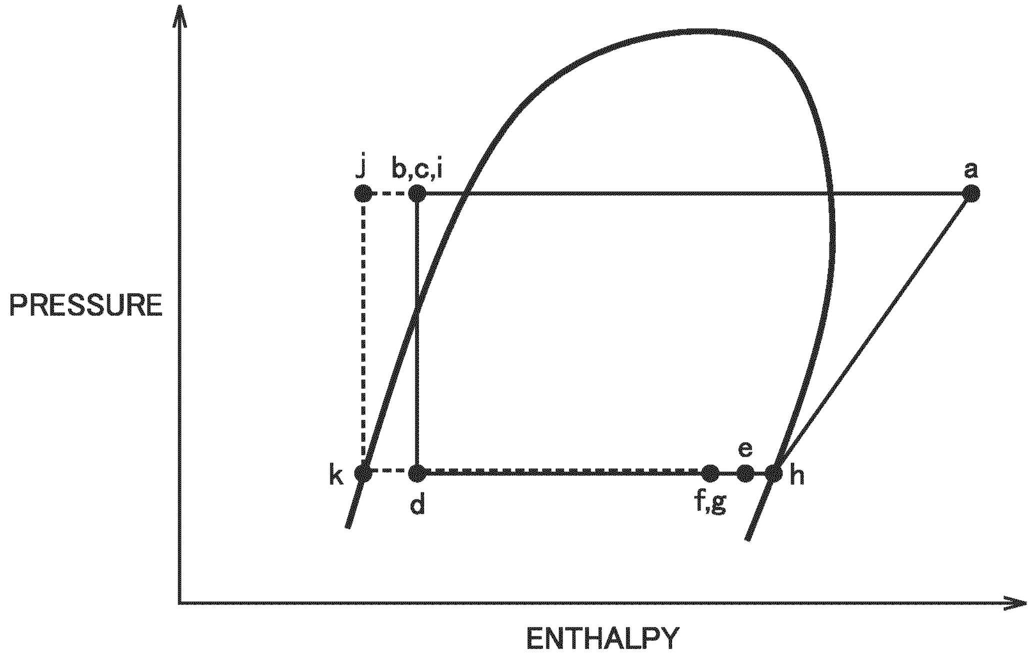

PRESSURE
ENTHALPY
j
b,c,i
a
e
k
h
d
f,g

FIG.6

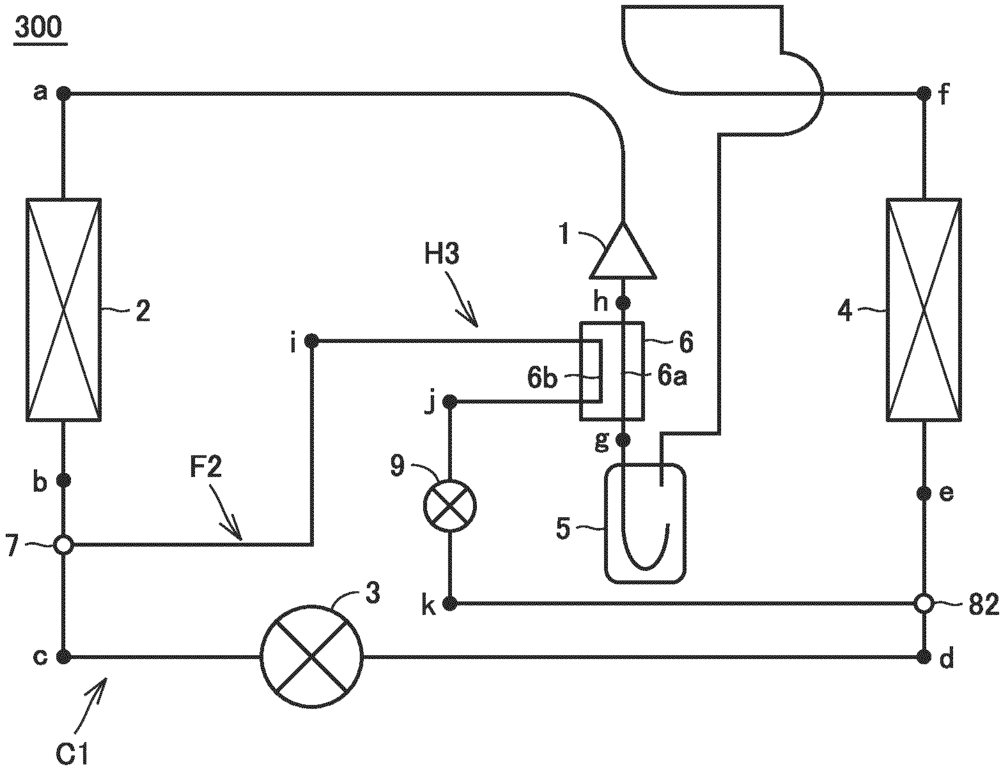
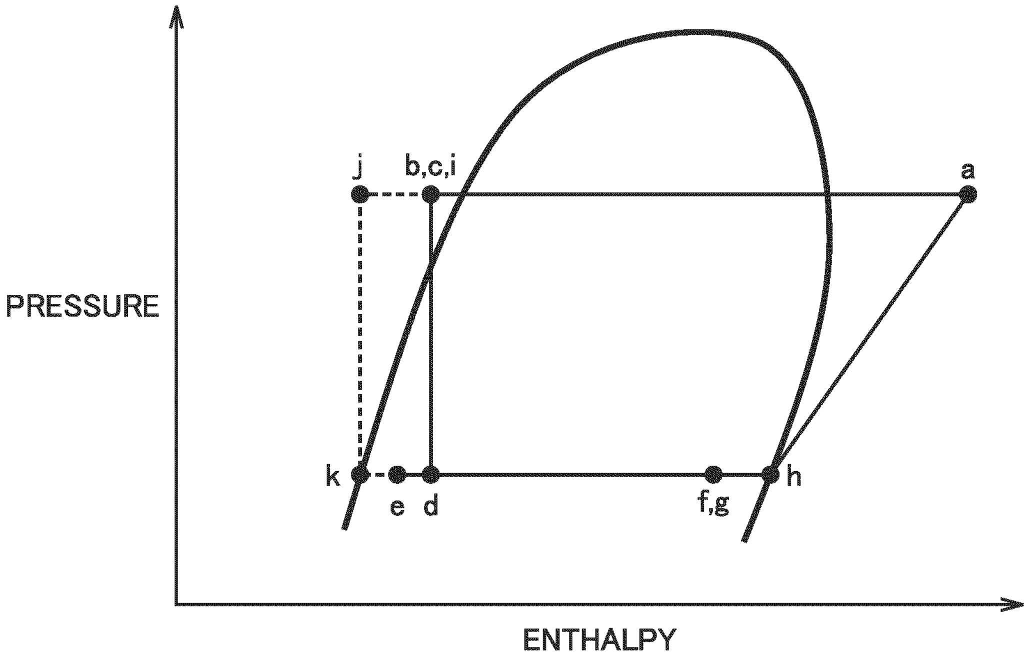
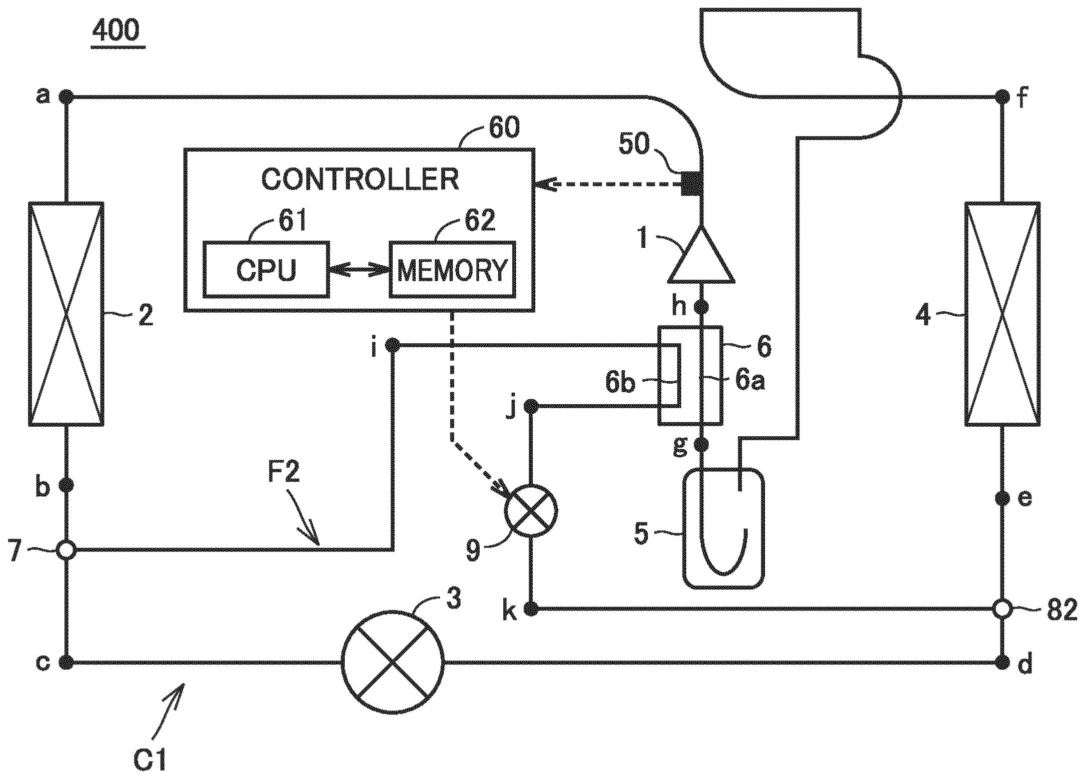

300
a
f
1
H3
h
2
4
i
6
6b
6a
j
g
9
b
F2
e
5
7
3
k
82
c
d
C1

FIG.7



PRESSURE
ENTHALPY
j
b,c,i
a
k
e
d
f,g
h

FIG.8



400
a
f
60
CONTROLLER
50
61
62
CPU
MEMORY
1
h
2
4
i
6
6b
6a
j
g
b
e
F2
7
9
5
3
k
82
c
d
C1

FIG.9

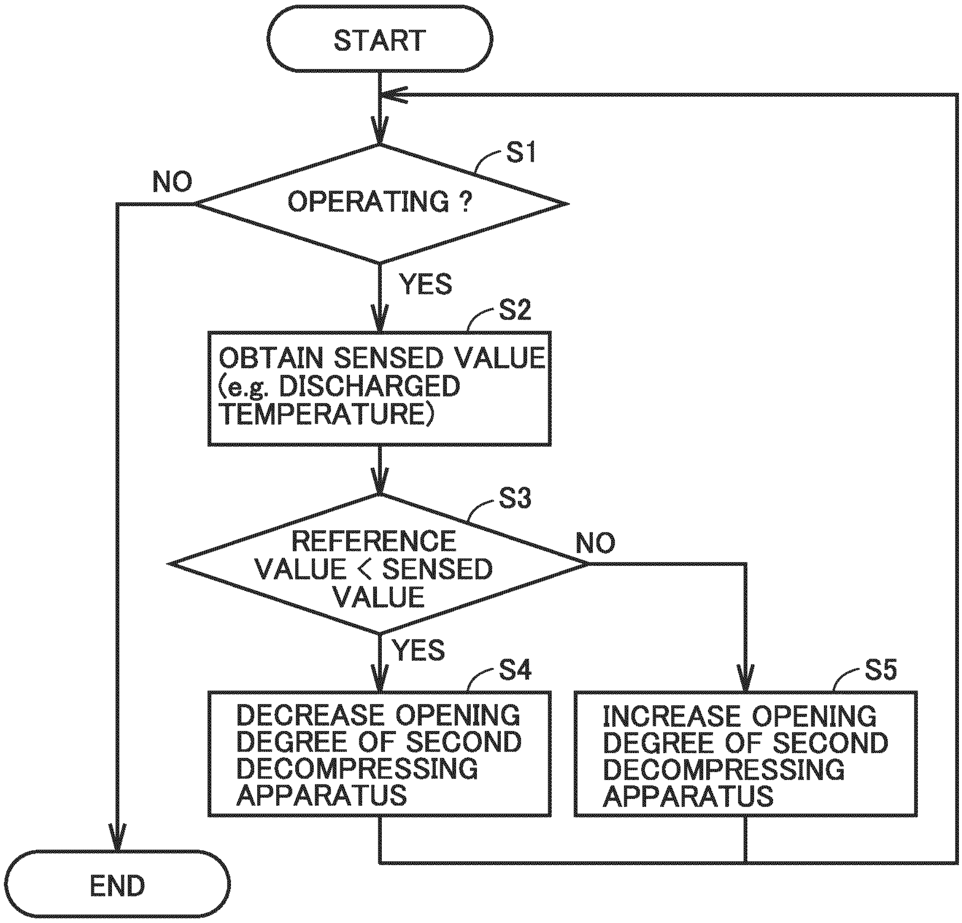

START
S1
OPERATING ?
NO
YES
S2
OBTAIN SENSED VALUE (e.g. DISCHARGED TEMPERATURE)
S3
REFERENCE VALUE < SENSED VALUE
NO
YES
S4
DECREASE OPENING DEGREE OF SECOND DECOMPRESSING APPARATUS
S5
INCREASE OPENING DEGREE OF SECOND DECOMPRESSING APPARATUS
END

FIG.10

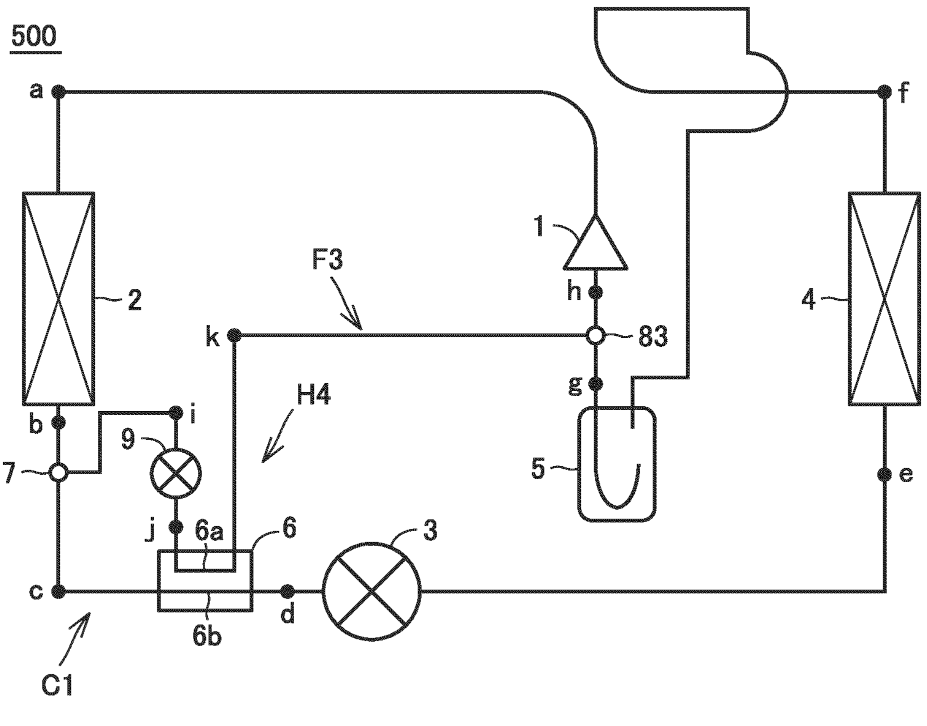
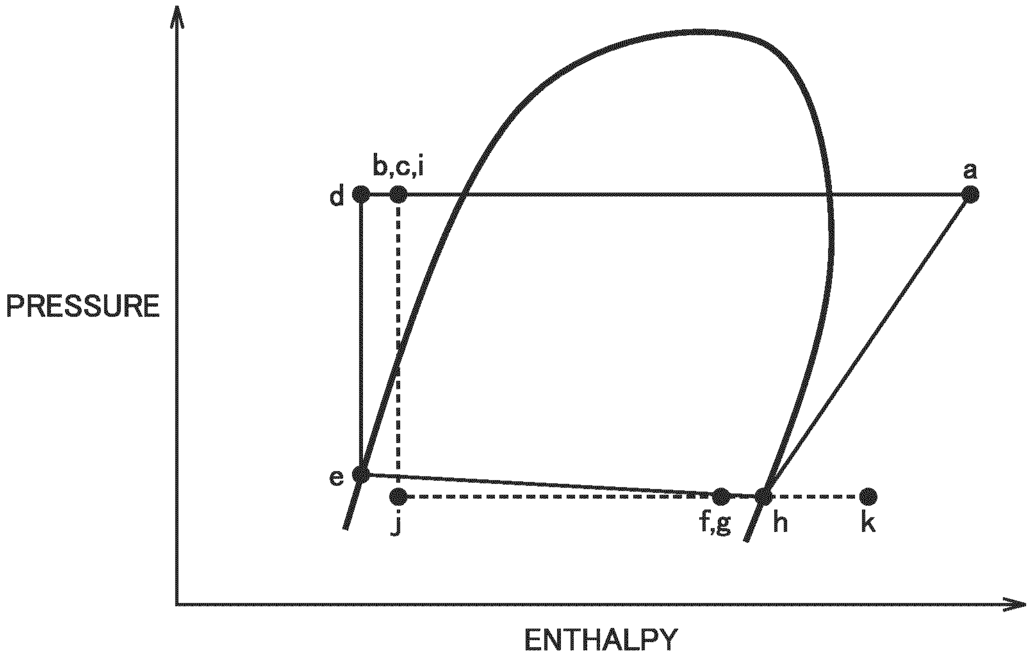

500
a
f
1
2
4
F3
h
k
83
g
H4
b
i
9
7
5
e
j
6a
6
3
c
d
6b
C1

FIG.11



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2021/047569

A. CLASSIFICATION OF SUBJECT MATTER

F25B 1/00(2006.01)i
FI: F25B1/00 331Z; F25B1/00 331D; F25B1/00 331E

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)

F25B1/00; F25B41/02;F25B41/06

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 1971-2022
Registered utility model specifications of Japan 1996-2022
Published registered utility model applications of Japan 1994-2022

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 2008-209059 A (DENSO CORP.) 11 September 2008 (2008-09-11) paragraphs [0016]-[0018], fig. 1	1-2
X	JP 2008-51474 A (DENSO CORP.) 06 March 2008 (2008-03-06) paragraphs [0026]-[0048], fig. 1	1-4, 6
X	JP 2003-130481 A (MITSUBISHI HEAVY INDUSTRIES, LTD.) 08 May 2003 (2003-05-08) paragraphs [0010]-[0012], fig. 2	1, 3, 5-6
X	JP 2002-106985 A (MATSUSHITA ELECTRIC INDUSTRIAL CO., LTD.) 10 April 2002 (2002-04-10) paragraphs [0024]-[0028], fig. 4	1, 7

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

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

Date of the actual completion of the international search	Date of mailing of the international search report
19 January 2022	**01 February 2022**

Name and mailing address of the ISA/JP	Authorized officer
Japan Patent Office (ISA/JP) **3-4-3 Kasumigaseki, Chiyoda-ku, Tokyo 100-8915** **Japan**	Telephone No.

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

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2021/047569

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
JP	2008-209059	A	11 September 2008	(Family: none)	
JP	2008-51474	A	06 March 2008	(Family: none)	
JP	2003-130481	A	08 May 2003	(Family: none)	
JP	2002-106985	A	10 April 2002	(Family: none)	

Form PCT/ISA/210 (patent family annex) (January 2015)

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 2009222348 A **[0002] [0003] [0005]**