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

(11) **EP 4 060 250 B1**

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
**28.02.2024 Bulletin 2024/09**

(21) Application number: **19952629.4**

(22) Date of filing: **15.11.2019**

(51) International Patent Classification (IPC):
***F04B 49/02*** *(2006.01)* ***F04B 49/06*** *(2006.01)*
***F24F 140/50*** *(2018.01)* ***F25B 49/00*** *(2006.01)*
***F25B 49/02*** *(2006.01)* ***F24F 11/37*** *(2018.01)*
***F04C 28/06*** *(2006.01)* ***F04C 28/28*** *(2006.01)*

(52) Cooperative Patent Classification (CPC):
**F25B 49/005; F04B 49/02; F04B 49/065; F24F 11/37; F25B 49/02;** F04C 28/06; F04C 28/28; F24F 2140/50; F25B 2500/26; F25B 2500/28; F25B 2600/01; F25B 2600/02; F25B 2600/23; F25B 2700/2106; F25B 2700/2117

(86) International application number:
**PCT/JP2019/044891**

(87) International publication number:
**WO 2021/095237 (20.05.2021 Gazette 2021/20)**

(54) **COLD HEAT SOURCE UNIT AND REFRIGERATION CIRCUIT DEVICE**

KÄLTE-WÄRMEQUELLENEINHEIT UND KÜHLKREISLAUFVORRICHTUNG

UNITÉ DE SOURCE DE CHALEUR FROIDE ET DISPOSITIF À CIRCUIT DE RÉFRIGÉRATION

(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**

(43) Date of publication of application:
**21.09.2022 Bulletin 2022/38**

(73) Proprietor: **MITSUBISHI ELECTRIC CORPORATION**
**Chiyoda-ku**
**Tokyo 100-8310 (JP)**

(72) Inventors:
- **TSURUSHIMA, Seiya**
  **Tokyo 100-8310 (JP)**
- **MORITA, Hisato**
  **Tokyo 100-8310 (JP)**
- **SATA, Hiroshi**
  **Tokyo 100-8310 (JP)**

(74) Representative: **Witte, Weller & Partner Patentanwälte mbB**
**Postfach 10 54 62**
**70047 Stuttgart (DE)**

(56) References cited:
**JP-A- H0 493 558**
**JP-A- H0 634 224**
**JP-A- H08 261 571**
**JP-A- 2000 105 011**
**JP-B2- 5 342 528**
**JP-A- H0 493 558**
**JP-A- H0 634 224**
**JP-A- H09 149 547**
**JP-A- 2009 216 000**
**US-B1- 6 578 373**



EP 4 060 250 B1

## Description

### TECHNICAL FIELD

**[0001]** The present invention relates to a cold source unit.

### BACKGROUND ART

**[0002]** In a conventional refrigerator or the like, for example, a large amount of liquid refrigerant in the unit may return into the accumulator upon start of operation after defrosting. At this time, a large amount of liquid refrigerant flows in an oil return circuit located in a lower portion of the accumulator, and an excessive amount of this liquid refrigerant may flow from the oil return circuit into the compressor, i.e., a liquid return phenomenon (hereinafter "liquid back") may occur. The liquid back during operation causes a pressure surge in the compressor, resulting a problem that the operating current for the compressor becomes overcurrent.

**[0003]** Japanese Patent Laying-Open No. H06-034224 (PTL 1) discloses an air conditioner intended to prevent failure of a compressor due to overcurrent, by temporarily stopping the compressor when a current value comparator detects that the value of compressor current has been kept at a certain value or more for a certain period of time, restarting the compressor after a certain period of time from the stoppage of the compressor and, after this is repeated certain number of times, completely stopping operation.

**[0004]** Document JP 5342528 B2 discloses a cold source unit according to the preamble of claim 1.

### CITATION LIST

### PATENT LITERATURE

**[0005]**

PTL 1: JP H06 34224 A
PTL 2: JP 5 342528 B2

### SUMMARY OF INVENTION

### TECHNICAL PROBLEM

**[0006]** If the compressor is restarted with liquid refrigerant accumulated in the compressor due to the liquid back, increase of the load on a motor of the compressor for compressing the liquid may cause overcurrent to cause the compressor to be stopped temporarily. A technique disclosed in Japanese Patent Laying-Open No. H06-034224 (PTL 1) attempts to restart the compressor when a certain period of time has elapsed from the stoppage of the compressor. This attempt to restart the compressor is hereinafter referred to as "start retry." The start retry under the condition that a large amount of liquid refrigerant remains in the compressor, however, may result in stoppage of the compressor due to overcurrent, which leads to a problem of a high possibility of complete stoppage of operation after repeated start retry.

**[0007]** The present invention is made to solve the problem as described above, and an object of the present invention is to provide a cold source unit and a refrigeration cycle apparatus that improve the probability of success of restart of the compressor when the compressor is stopped due to overcurrent.

### SOLUTION TO PROBLEM

**[0008]** According to the present invention, a cold source unit as defined in the independent claim 1 is provided. Further embodiments of the invention are defined in the dependent claims. The present invention relates to a cold source unit connected to a load apparatus and serving as a component of a refrigeration cycle apparatus. The cold source unit includes a compressor, and a controller to control the compressor. When the controller detects overload on the compressor, the controller performs first start retry control of restarting the compressor after pausing the compressor for a first time period. When the number of times of performing of the first start retry control exceeds a first criterion value, the controller performs second start retry control of restarting the compressor after pausing the compressor for a second time period longer than the first time period.

### ADVANTAGEOUS EFFECTS OF INVENTION

**[0009]** According to the present invention, when the compressor is not started successfully, the compressor is restarted after an increased waiting time, and therefore, liquid refrigerant in the compressor is discharged to improve the probability of success of the restart.

### BRIEF DESCRIPTION OF DRAWINGS

**[0010]**

Fig. 1 shows a refrigerant circuit of a refrigeration cycle apparatus 200 according to an embodiment of the present invention.
Fig. 2 shows a relation between the pause time period of a compressor and the rate of change of the liquid amount in the compressor.
Fig. 3 is a flowchart for illustrating control for performing compressor start retry.
Fig. 4 is a flowchart for illustrating energization control for a heater when liquid discharge promotion control is started.

### DESCRIPTION OF EMBODIMENTS

**[0011]** Embodiments of the present invention are hereinafter described in detail with reference to the drawings.

In the following, a plurality of embodiments are described, and it is originally intended that characteristics described in connection with the embodiments each are combined as appropriate. In the drawings, the same or corresponding parts are denoted by the same reference characters, and a description thereof is not herein repeated. In the following drawings, the relation between components in terms of the size may be different from the actual one.

**[0012]** Fig. 1 shows a refrigerant circuit of a refrigeration cycle apparatus 200 according to the present embodiment. As shown in Fig. 1, refrigeration cycle apparatus 200 includes a cold source unit 100 and a load apparatus 110. "Cold source unit" may also be called "heat source unit."

**[0013]** Load apparatus 110 includes an expansion valve 3 and a first heat exchanger (hereinafter referred to as evaporator 4). Cold source unit 100 is connected to load apparatus 110 and serves as a part of refrigeration cycle apparatus 200. Cold source unit 100 includes a compressor 1, a second heat exchanger (hereinafter referred to as condenser 2), a heater 40, and a controller 30 to control compressor 1 and heater 40.

**[0014]** Controller 30 includes a CPU (Central Processing Unit) 31, a memory 32 (ROM (Read Only Memory) and RAM (Random Access Memory)), and an input/output device (not shown) for allowing various signals to be input, for example. CPU 31 deploys a program stored in the ROM on the RAM for example and executes the program. The program stored in the ROM is a program in which a process procedure for controller 30 is specified. In accordance with the program, controller 30 controls each component of cold source unit 100. This control is not limited to processing by software, but may be processing by dedicated hardware (electronic circuit).

**[0015]** Compressor 1 is equipped with a thermistor 5 that detects the suction temperature, a thermistor 6 that detects the temperature of a lower portion of a housing shell of compressor 1 or the temperature of refrigeration oil remaining in the housing of compressor 1 (hereinafter referred to as "shell-bottom temperature"), and a current sensor 7 that detects overcurrent.

**[0016]** In refrigeration cycle apparatus 200, compressor 1 compresses refrigerant gas into high-pressure gas, and the high-pressure gas refrigerant flows into condenser 2. In condenser 2, heat is released from the refrigerant and the high-pressure gas refrigerant is condensed into high-pressure liquid refrigerant. The high-pressure liquid refrigerant flows into expansion valve 3. In expansion valve 3, the pressure of the high-pressure liquid refrigerant is reduced and the resultant low-pressure liquid refrigerant flows into evaporator 4. In evaporator 4, the liquid refrigerant is evaporated to absorb heat from the environment, i.e., cooling is done. The evaporated gas refrigerant returns into compressor 1. Thus, a refrigerant circuit is completed.

**[0017]** According to the present embodiment, compressor 1 is paused when overload is detected, and a sufficient pause time period is ensured to reduce the amount of liquid in compressor 1 and thereby suppress unsuccessful start when the start retry is made. For example, when overcurrent is detected by current sensor 7, controller 30 detects that load on compressor 1 is overload.

**[0018]** Specifically, when controller 30 detects overload on compressor 1, controller 30 performs first start retry control, i.e., restarts compressor 1 after pausing compressor 1 for a first time period. When the number of times the first start retry control is performed exceeds a criterion value, controller 30 performs second start retry control, i.e., restarts compressor 1 after pausing compressor 1 for a second time period longer than the first time period. The first time period can be 3 minutes and the second time period can be 30 minutes. The pause time period, however, is not limited to the above-specified ones.

**[0019]** Fig. 2 shows a relation between the pause time period of the compressor and the rate of change of the liquid amount in the compressor. In consideration of the relation shown in Fig. 2 and increase of the internal temperature of a refrigerator compartment resultant from pause of the compressor, the compressor pause time period per liquid discharge promotion control is determined.

**[0020]** If the compressor is paused with the inside of the refrigerator compartment cooled by normal operation, the time for which increase of the internal temperature of the refrigerator compartment is permissible is approximately 60 minutes. If, however, the liquid amount has been reduced enough, before 60 minutes elapse, to cause no overcurrent when compressor 1 is started, the pause time period should be as short as possible. According to the present embodiment, therefore, the liquid discharge promotion control is performed up to twice, and the compressor pause time period per liquid discharge promotion control is set to 30 minutes.

**[0021]** Fig. 3 is a flowchart for illustrating control for performing compressor start retry. Based on this flowchart, improvement to avoid unsuccessful start due to overcurrent abnormality is described.

**[0022]** In step S1, initially controller 30 determines whether or not the start retry control in response to overcurrent has been performed five times.

**[0023]** When the start retry control has been performed five times in total (YES in S 1), controller proceeds to step S10 to give a notification of stoppage due to abnormality, so as not to perform the start retry control any more. For example, a light-emitting diode is lit to enable users to identify stoppage due to abnormality.

**[0024]** When the start retry control has not been performed five times in total (NO in S1), controller 30 proceeds to step S2 to determine whether or not the start retry control has been performed three times in total.

**[0025]** When the start retry control has not been performed three times in total (NO in S2), controller 30 proceeds to step S11 to perform normal start retry control for the compressor. In this case, for example, compressor

restart is attempted by energizing compressor 1 after keeping the compressor paused for three minutes. The period of three minutes is a time period determined for preventing repeated start and pause of compressor 1 in which the amount of liquid refrigerant is small.

**[0026]** In contrast, when the start retry control has been performed three times in total (YES in S2), controller 30 proceeds to step S3.

**[0027]** As a rule, when the answer is YES in step S2, control is performed from step S5 in which start of compressor 1 is delayed more than before. It should be noted that, in order to prevent malfunction due to failure to cool resultant from long-time pause of compressor 1, or in order to perform another control of higher priority, start of compressor 1 may be repeated up to five times as before, without performing the process from step S5, in some cases. This situation may occur in the following cases, for example.

- Priority has to be given to cooling, because the internal temperature of the refrigerator compartment is a certain threshold or more due to defrosting, or because the refrigeration capacity of the cold source unit is insufficient, for example.
- No liquid back occurs.
- Oil-return control is started due to shortage of refrigeration oil in compressor 1.
- The pressure at the discharge side and the pressure at the suction side of compressor 1 may be reversed to each other.
- Malfunction occurs due to open- or short-circuit detected by a low-pressure sensor.

**[0028]** For each of all these cases, a determination may be made as to whether or not such a condition occurs. According to the present embodiment, however, the determination in each of steps S3 and S4 is made before proceeding to step S5.

**[0029]** In step S3, controller 30 determines whether or not any one of the superheat of the sucked refrigerant (suction SH), the shell-bottom temperature, and the superheat of refrigeration oil remaining in the shell of compressor 1 (hereinafter "shell-bottom SH"), measured by thermistor 5 and thermistor 6, is kept lower than a reference value associated to each for a certain period of time (three minutes, for example). In this way, controller 30 determines whether or not the liquid back occurs.

**[0030]** The superheat (SH) is a temperature difference between the actually measured refrigerant temperature and the saturated gas temperature at a measured pressure.

**[0031]** When the suction SH is kept lower by 10 K than a target value for three minutes, for example, controller 30 detects occurrence of the liquid back.

**[0032]** When all the suction SH, the shell-bottom temperature, and the shell-bottom SH are not kept lower than the reference value for a certain period of time (NO in S3), controller 30 performs the normal start retry control for the compressor in step S12. In this case, for example, compressor restart is attempted by energizing compressor 1 after keeping the compressor paused for three minutes.

**[0033]** In contrast, when any of the suction SH, the shell-bottom temperature, and the shell-bottom SH is kept lower than the reference value for a certain period of time (YES in S3), controller 30 proceeds to step S4.

**[0034]** In step S4, controller 30 determines whether or not an evaporation temperature ET is lower than a target evaporation temperature ETm+10K (kelvin). When the difference between evaporation temperature ET and target evaporation temperature ETm is less than or equal to 10K, it is determined that the inside of the refrigerator compartment can be kept cooled even when the compressor is paused for some time. While evaporation temperature ET may be measured with a temperature sensor provided for evaporator 4, the temperature detected by thermistor 5 which detects the suction temperature may be used instead.

**[0035]** When ET < ETm+10K is not satisfied (NO in S4), controller 30 performs the normal start retry control for the compressor in step S13. In this case, for example, compressor restart is attempted by energizing compressor 1 after keeping the compressor paused for three minutes. This is for the following reason. If the internal temperature of the refrigerator compartment after defrosting is high, or if the internal temperature of the refrigerator compartment is high due to insufficient refrigeration capacity of the cold source unit to which a plurality of load units are connected, the pause time period of 30 minutes is too long.

**[0036]** When ET < ETm+10K is satisfied (YES in S4), controller 30 starts, in step S5, the liquid discharge promotion control for delaying start of compressor 1. Then, measurement of the time from stoppage of compressor 1 is started. Such a measured time from the stoppage of compressor 1 to restart thereof is herein referred to as "delay time." In order to sufficiently reduce liquid refrigerant in compressor 1, controller 30 keeps stopping compressor 1 until the delay time reaches a second time period (30 minutes, for example). The second time period is set longer than the first time period (3 minutes, for example) that is the pause time period in steps S11, S12, and S13. At this time, the situation in which the liquid discharge promotion control is performed is determined by a user, and therefore, it is preferable to show "Lout" or the like on a liquid crystal display of a control panel mounted on the refrigeration apparatus.

**[0037]** In step S6, initially it is determined whether or not the delay time has reached the set time (30 minutes, for example). When the delay time has reached the set time (YES in S6), start retry for compressor 1 is performed in step S14.

**[0038]** In contrast, when the delay time has not reached the set time (NO in S6), the process proceeds to step S7. In step S7, it is determined whether or not a request to start oil return control is made. The oil return

control is requested when shortage of the refrigeration oil in compressor 1 occurs, in order to prevent burning of compressor 1.

**[0039]** When a request to start the oil return control is made (YES in S7), start retry for compressor 1 is performed in step S15.

**[0040]** In contrast, when the request to start the oil return control is not made (NO in S7), the process proceeds to step S8. In step S8, it is determined whether or not a request to start high-low pressure reverse prevention control is made. The high-low pressure reverse prevention control is requested when it is detected that the pressure at the suction port side of compressor 1 is higher than the pressure at the discharge port side.

**[0041]** When the request to start the high-low pressure reverse prevention control is made (YES in S8), start retry for compressor 1 is performed in step S16.

**[0042]** In contrast, when the request to start the high-low pressure reverse prevention control is not made (NO in S8), the process proceeds to step S9. In step S9, it is determined whether or not evaporation temperature ET is kept higher than or equal to target evaporation temperature ETm+10K (kelvin) for three minutes.

**[0043]** When the relation: Et ≥ ETm+10K is kept satisfied for three minutes (YES in S9), start retry for compressor 1 is performed in step S17, since increase of the internal temperature of the refrigerator compartment is not permissible. Because evaporation temperature Et may momentarily exceed the threshold, the fact that the above relation is kept satisfied for three minutes is used as a condition for stopping delay of start.

**[0044]** When Et ≥ target evaporation temperature ETm+10K (kelvin) is kept satisfied for less than three minutes (NO in S9), the process returns to step S6 and measurement of the delay time to the start of the compressor start retry is continued.

**[0045]** When the start retry for compressor 1 is performed in any of steps S11 to S17, controller 30 determines in step S18 whether or not the start of compressor 1 has normally been completed.

**[0046]** For example, when overcurrent is detected again, it is determined that the start of compressor 1 is not in success (NO in S18), energization of the motor of compressor 1 is stopped, and compressor 1 is thus stopped. In this case, in step S19, controller 30 increments, by one, the number of times the start retry is performed, and performs the process again from step S1.

**[0047]** When the start retry fails to start the compressor after the liquid refrigerant discharge promotion control is performed twice, operation is stopped in step S10. At this time, it is determined that the cause of detection of overcurrent abnormality is not liquid back.

**[0048]** When overcurrent is not detected, it is determined that compressor 1 is started successfully (YES in S18), and the count of the start retry is initialized in step S20, and the process returns to the control routine for the normal operating state of normal compressor 1 in step S21.

**[0049]** When the liquid discharge promotion control is started in step S5, heater 40 is additionally used for heating. When the outside air temperature is high, however, heater 40 may be stopped for saving energy.

**[0050]** Fig. 4 is a flowchart for illustrating energization control for the heater when the liquid discharge promotion control is started. Referring to Fig. 4, controller 30 obtains an outside air temperature Ta from an outside air temperature sensor 8 and determines whether or not outside air temperature Ta is lower than a first threshold temperature Tth in step S51.

**[0051]** When Ta < Tth is satisfied (YES in S51), controller 30 causes heater 40 to be energized to heat the liquid refrigerant in compressor 1 by heater 40 for a delay time of 30 minutes. In contrast, when Ta <Tth is not satisfied (NO in S51), controller 30 does not cause heater 40 to be energized, and waits until the liquid refrigerant in compressor 1 is warmed up by the outside air temperature while the heater is off in the delay time of 30 minutes.

**[0052]** In this way, whether to perform heating by the heater is determined depending on the outside air temperature so as not to heat the refrigerant more than necessary, and accordingly the power consumption can be reduced.

**[0053]** As seen from the foregoing, the refrigeration cycle apparatus according to the present embodiment sets the pause time period of compressor 1 for the fourth and subsequent start retries longer than the pause time period for the first start retry. Thus, even when the liquid amount in compressor 1 is increased due to the liquid back, the liquid refrigerant in compressor 1 can be heated by heater 40 or by the outside air temperature, and discharged sufficiently from compressor 1. In this way, the liquid amount in compressor 1 can be reduced to suppress unsuccessful start due to overcurrent abnormality at the time of the start retry.

**[0054]** Finally, the present embodiment is summarized with reference again to the drawings.

**[0055]** Referring to Fig. 1, the present embodiment relates to cold source unit 100 connected to load apparatus 110 and serving as a component of refrigeration cycle apparatus 200. Cold source unit 100 includes compressor 1 and controller 30 to control compressor 1. When controller 30 detects overload on compressor 1, controller 30 performs first start retry control of restarting compressor 1 after pausing compressor 1 for a first time period. When the number of times the first start retry control is performed exceeds a first criterion value, controller 30 performs second start retry control of restarting compressor 1 after pausing compressor 1 for a second time period longer than the first time period.

**[0056]** Preferably, the second time period is a time period required for the amount of liquid in compressor 1 to be reduced enough to enable compressor 1 to be restarted.

**[0057]** Accordingly, when the second start retry control is performed, the amount of liquid refrigerant in compres-

sor 1 is expected to be smaller than that when the first start retry control is performed, and therefore, overload on compressor 1 is removed to increase the possibility of success of restart of compressor 1.

**[0058]** Preferably, cold source unit 100 further includes heater 40 to heat liquid refrigerant in compressor 1. When controller 30 performs the second start retry control, controller 30 causes the liquid refrigerant to be heated by heater 40.

**[0059]** Thus, when the second retry control is performed, the amount of liquid in compressor 1 is expected to be reduced by further promotion of evaporation of the liquid refrigerant in compressor 1 by heater 40, and therefore, the overload on compressor 1 when started is removed to further increase the possibility of success of restart of compressor 1.

**[0060]** More preferably, as shown in Fig. 4, when outside air temperature Ta is less than or equal to first threshold temperature Tth, controller 30 performs the second start retry control while causing the liquid refrigerant to be heated by heater 40. When outside air temperature Ta is more than first threshold temperature Tth, controller 30 performs the second start retry control while stopping heating of the liquid refrigerant by heater 40.

**[0061]** Thus, when outside air temperature Ta is high and accordingly the amount of liquid refrigerant in compressor 1 is reduced within the waiting time corresponding to the second time period, without requiring heating by heater 40, heater 40 is not energized and the power consumption can therefore be reduced.

**[0062]** Preferably, as shown in step S4 in Fig. 3, when a difference between refrigerant evaporation temperature ET and target refrigerant evaporation temperature ETm is less than a second threshold temperature (10 K for example), controller 30 performs the first start retry control.

**[0063]** Thus, when the internal temperature of the refrigerator compartment is high after defrosting or the refrigeration capacity of the cold source unit is insufficient to cause evaporation temperature ET to be higher than target evaporation temperature ETm to some extent, further increase of the internal temperature of the refrigerator compartment resultant from the start time delay can be avoided.

**[0064]** Preferably, as shown in step S3 in Fig. 3, when liquid refrigerant is not sucked into compressor 1, controller 30 still performs the first start retry control regardless of that the number of times the first start retry control is performed exceeds the first criterion value (three, for example). Controller 30 determines whether or not the liquid refrigerant is sucked into compressor 1, based on at least one of superheat of refrigerant sucked into compressor 1, shell-bottom temperature of compressor 1, and superheat of refrigerant in compressor 1.

**[0065]** When no liquid back occurs, overload is not removed even when start of compressor 1 is delayed, and therefore, increase of the internal temperature of the refrigerator compartment due to delay of start of compressor 1 can thus be avoided.

**[0066]** Preferably, when controller 30 is unsuccessful in starting compressor 1 by the second start retry control, controller 30 repeats the second start retry control. When the number of times the second start retry control is performed exceeds a second criterion value, controller 30 sets compressor 1 in a paused state. The first criterion value is 60% to a sum of the first criterion value and the second criterion value.

**[0067]** Specifically, according to the flowchart in Fig. 3, the first retry control is performed three times, and then the retry control is performed twice. When start of compressor 1 is still unsuccessful regardless of this, controller 30 sets compressor 1 in the paused state. As seen from this, the first criterion value is 3, the second criterion value is 2, and the first criterion value is 60% to the sum of the first criterion value and the second criterion value. The maximum effect of liquid discharge is expected to be derived from a pause of 60 minutes (30 min $\times$ 2 times) in total, and therefore, liquid discharge is done when the start retry is done more than three times out of five times.

**[0068]** It should be construed that the embodiments disclosed herein are given by way of illustration in all respects, not by way of limitation. It is intended that the scope of the present invention is defined by claims, not by the above description of the embodiments.

REFERENCE SIGNS LIST

**[0069]** 1 compressor; 2 condenser; 3 expansion valve; 4 evaporator; 5, 6 thermistor; 7 current sensor; 8 outside air temperature sensor; 30 controller; 31 CPU; 32 memory; 40 heater; 100 cold source unit; 110 load apparatus; 200 refrigeration cycle apparatus

**Claims**

1. A cold source unit (100) connected to a load apparatus (110) and serving as a component of a refrigeration cycle apparatus (200), the cold source unit (100) comprising:

   a compressor (1); and
   a controller (30) to control the compressor (1), wherein
   when the controller (30) detects overload on the compressor (1), the controller (30) performs first start retry control of restarting the compressor (1) after pausing the compressor (1) for a first time period, wherein
   when the number of times of performing of the first start retry control exceeds a first criterion value, the controller (30) performs second start retry control of restarting the compressor (1) after pausing the compressor (1) for a second time period longer than the first time period,
   **characterized in that** the cold source unit (100)

further comprises a heating apparatus (40) to heat liquid refrigerant in the compressor (1), wherein
when the controller (30) performs the second start retry control, the controller (30) causes the liquid refrigerant to be heated by the heating apparatus (40).

**2.** The cold source unit (100) according to claim 1, wherein

when an outside air temperature is less than or equal to a first threshold temperature, the controller (30) performs the second start retry control while causing the liquid refrigerant to be heated by the heating apparatus (40), and
when the outside air temperature is more than the first threshold temperature, the controller (30) performs the second start retry control while stopping heating of the liquid refrigerant by the heating apparatus (40).

**3.** The cold source unit (100) according to any one of claims 1 to 2, wherein when a difference between a refrigerant evaporation temperature and a target refrigerant evaporation temperature is less than a second threshold temperature, the controller (30) performs the first start retry control.

**4.** The cold source unit (100) according to any one of claims 1 to 3, wherein the second time period is a time period required for a liquid amount in the compressor (1) to be reduced enough to enable the compressor (1) to be restarted.

**5.** The cold source unit (100) according to any one of claims 1 to 4, wherein

when the controller (30) is unsuccessful in starting the compressor (1) by the second start retry control, the controller (30) repeats the second start retry control,
when the number of times of performing of the second start retry control exceeds a second criterion value, the controller (30) sets the compressor (1) in a paused state, and
the first criterion value is 60% to a sum of the first criterion value and the second criterion value.

**6.** A refrigeration cycle apparatus (200) comprising the cold source unit (100) according to any one of claims 1 to 5, and the load apparatus (110).

**Patentansprüche**

**1.** Kältequelleneinheit (100), die mit einer Lastvorrichtung (110) verbunden ist und die als eine Komponente einer Kühlkreislaufvorrichtung (200) dient, wobei die Kältequelleneinheit (100) aufweist:

einen Kompressor (1); und
eine Steuereinrichtung (30) zum Steuern des Kompressors (1), wobei
wenn die Steuereinrichtung (30) eine Überlast bei dem Kompressor (1) erfasst, die Steuereinrichtung (30) eine Steuerung für einen ersten erneuten Startversuch zum erneuten Starten des Kompressors (1) durchführt, nachdem der Kompressor (1) für eine erste Zeitdauer pausiert hat, wobei
wenn die Anzahl von Durchführungen der Steuerung für einen ersten erneuten Startversuch einen ersten Kriteriumswert übersteigt, die Steuerung (30) eine Steuerung für einen zweiten erneuten Startversuch zum erneuten Starten des Kompressors (1) durchführt, nachdem der Kompressor für eine zweite Zeitdauer pausiert hat, die länger als die erste Zeitdauer ist,
**dadurch gekennzeichnet, dass** die Kältequelleneinheit (100) ferner eine Heizvorrichtung (40) zum Erwärmen eines flüssigen Kühlmittels im Kompressor (1) aufweist, wobei
wenn die Steuereinrichtung (30) die Steuerung für einen zweiten erneuten Startversuch durchführt, die Steuereinrichtung (30) veranlasst, dass das flüssige Kühlmittel durch die Heizvorrichtung (40) erwärmt wird.

**2.** Kältequelleneinheit (100) nach Anspruch 1, wobei

wenn eine Außenlufttemperatur kleiner oder gleich einer ersten Schwellentemperatur ist, die Steuereinrichtung (30) die Steuerung für einen zweiten erneuten Startversuch durchführt, während veranlasst wird, dass das flüssige Kühlmittel durch die Heizvorrichtung (40) erwärmt wird, und
wenn die Außenlufttemperatur größer als die erste Schwellentemperatur ist, die Steuereinrichtung die Steuerung für einen zweiten erneuten Startversuch durchführt, während ein Erwärmen des flüssigen Kühlmittels durch die Heizvorrichtung (40) gestoppt wird.

**3.** Kältequelleneinheit (100) nach einem der Ansprüche 1 bis 2, wobei, wenn eine Differenz zwischen einer Kühlmittelverdampfungstemperatur und einer Zielkühlmittelverdampfungstemperatur kleiner als eine zweite Schwellentemperatur ist, die Steuereinrichtung (30) die Steuerung für einen ersten erneuten Startversuch durchführt.

**4.** Kältequelleneinheit (100) nach einem der Ansprüche 1 bis 3, wobei die zweite Zeitdauer eine Zeitdau-

er ist, die benötigt wird, um eine Flüssigkeitsmenge im Kompressor ausreichend zu verringern, um es zu ermöglichen, dass der Kompressor (1) erneut gestartet wird.

**5.** Kältequelleneinheit (100) nach einem der Ansprüche 1 bis 4, wobei

wenn die Steuereinrichtung (30) beim Starten des Kompressors (1) durch die Steuerung für einen zweiten erneuten Startversuch nicht erfolgreich ist, die Steuereinrichtung (30) die Steuerung für einen zweiten erneuten Startversuch wiederholt,
wenn die Anzahl von Durchführungen der Steuerung für einen zweiten erneuten Startversuch einen zweiten Kriteriumswert übersteigt, die Steuereinrichtung (30) den Kompressor (1) in einen pausierten Zustand versetzt, und
der erste Kriteriumswert 60 % eine Summe aus dem ersten Kriteriumswert und dem zweiten Kriteriumswert beträgt.

**6.** Kühlkreislaufvorrichtung (200), die die Kältequelleneinheit (100) gemäß einem der Ansprüche 1 bis 5 und die Lastvorrichtung (110) aufweist.

**Revendications**

**1.** Unité de source froide (100) reliée à un appareil de charge (110) et servant de composant d'un appareil à cycle de réfrigération (200), l'unité de source froide (100) comprenant :

un compresseur (1) ; et
un dispositif de commande (30) pour commander le compresseur (1), dans laquelle
lorsque le dispositif de commande (30) détecte une surcharge sur le compresseur (1), le dispositif de commande (30) exécute une première commande de nouvel essai de démarrage pour redémarrer le compresseur (1) après la mise en pause du compresseur (1) pendant une première période, dans laquelle
lorsque le nombre d'exécutions de la première commande de nouvel essai de démarrage dépasse une première valeur critère, le dispositif de commande (30) exécute une seconde commande de nouvel essai de démarrage pour redémarrer le compresseur (1) après la mise en pause du compresseur (1) pendant une seconde période plus longue que la première période, **caractérisée en ce que** l'unité de source froide (100) comprend en outre un appareil de chauffage (40) pour chauffer un réfrigérant liquide dans le compresseur (1), dans laquelle
lorsque le dispositif de commande (30) exécute la seconde commande de nouvel essai de démarrage, le dispositif de commande (30) entraîne le chauffage du réfrigérant liquide par l'appareil de chauffage (40).

**2.** Unité de source froide (100) selon la revendication 1, dans laquelle

lorsqu'une température ambiante extérieure est inférieure ou égale à une première température seuil, le dispositif de commande (30) exécute la seconde commande de nouvel essai de démarrage tout en entraînant le chauffage du réfrigérant liquide par l'appareil de chauffage (40), et
lorsque la température ambiante extérieure est supérieure à la première température seuil, le dispositif de commande (30) exécute la seconde commande de nouvel essai de démarrage tout en stoppant le chauffage du réfrigérant liquide par l'appareil de chauffage (40).

**3.** Unité de source froide (100) selon l'une quelconque des revendications 1 et 2, dans laquelle lorsqu'une différence entre une température d'évaporation de réfrigérant et une température cible d'évaporation de réfrigérant est inférieure à une seconde température seuil, le dispositif de commande (30) exécute la première commande de nouvel essai de démarrage.

**4.** Unité de source froide (100) selon l'une quelconque des revendications 1 à 3, dans laquelle la seconde période est une période nécessaire pour qu'une quantité de liquide dans le compresseur (1) soit suffisamment réduite pour permettre le redémarrage du compresseur (1).

**5.** Unité de source froide (100) selon l'une quelconque des revendications 1 à 4, dans laquelle

lorsque le dispositif de commande (30) échoue à démarrer le compresseur (1) à l'aide de la seconde commande de nouvel essai de démarrage, le dispositif de commande (30) répète la seconde commande de nouvel essai de démarrage,
lorsque le nombre d'exécutions de la seconde commande de nouvel essai de démarrage dépasse une seconde valeur critère, le dispositif de commande (30) place le compresseur (1) dans un état de pause, et
la première valeur critère est égale à 60 % d'une somme de la première valeur critère et de la seconde valeur critère.

**6.** Appareil à cycle de réfrigération (200) comprenant l'unité de source froide (100) selon l'une quelconque des revendications 1 à 5, et l'appareil de charge (110).

FIG.1

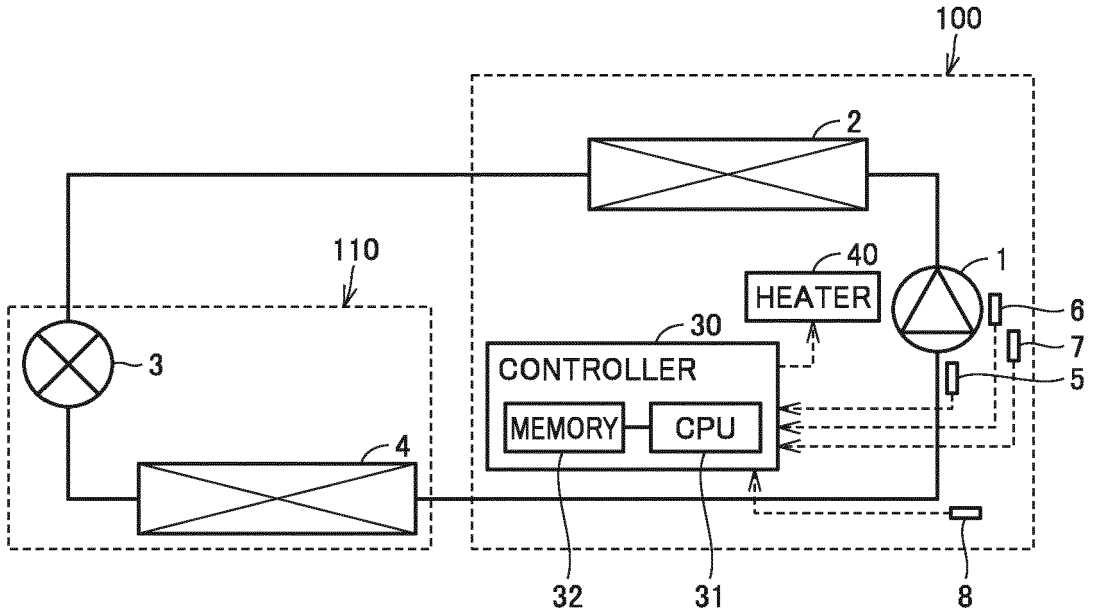

200
100
2
110
40
HEATER
1
6
7
5
30
CONTROLLER
MEMORY
CPU
3
4
32
31
8

FIG.2

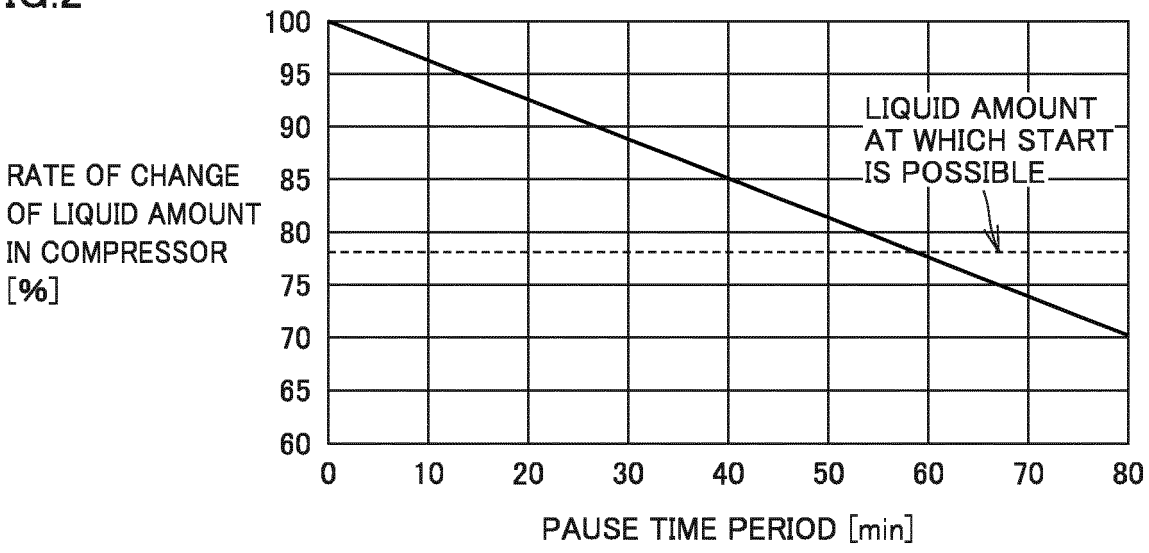

RATE OF CHANGE OF LIQUID AMOUNT IN COMPRESSOR [%]
100
95
90
85
80
75
70
65
60
LIQUID AMOUNT AT WHICH START IS POSSIBLE
0
10
20
30
40
50
60
70
80
PAUSE TIME PERIOD [min]

FIG.3

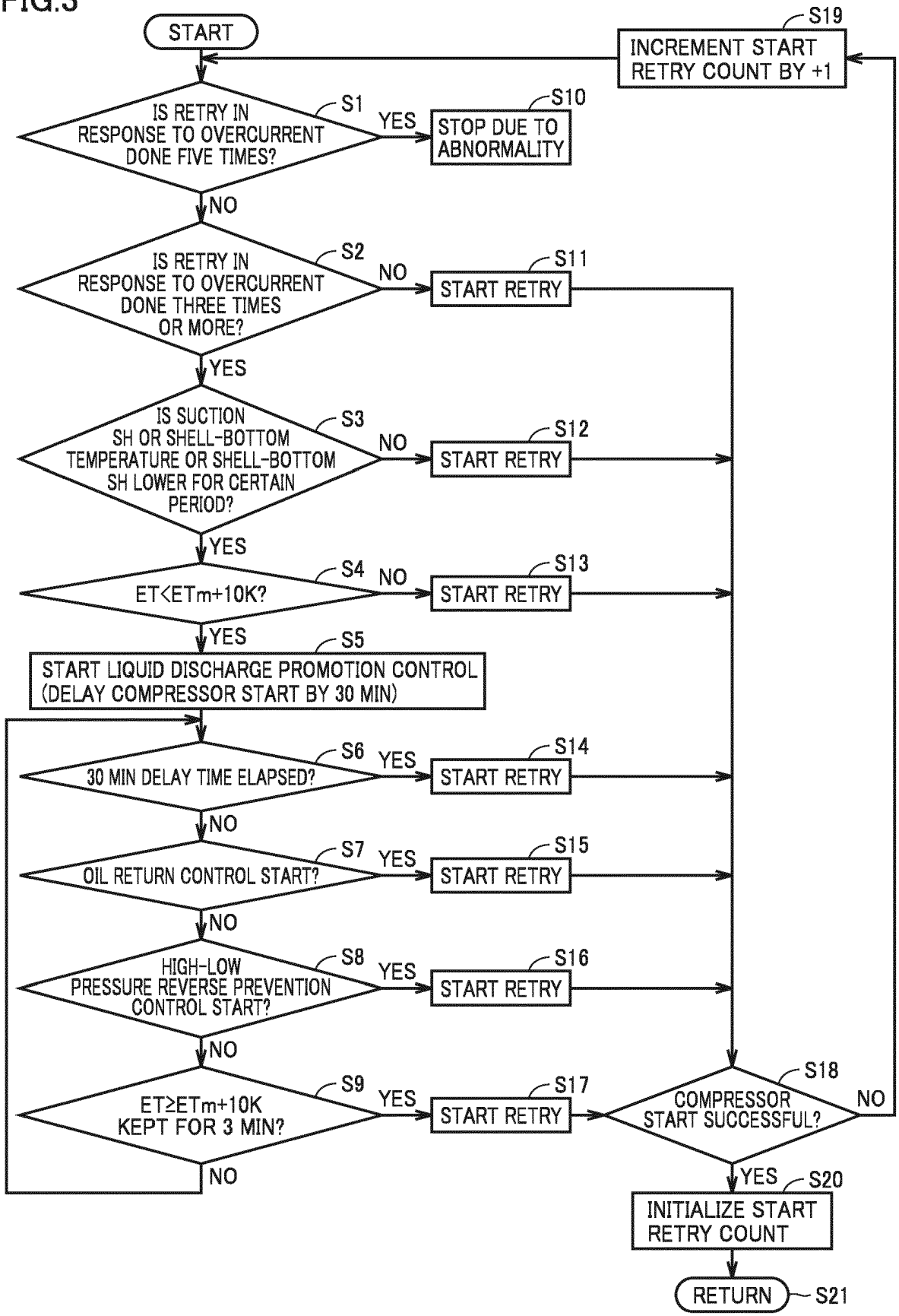
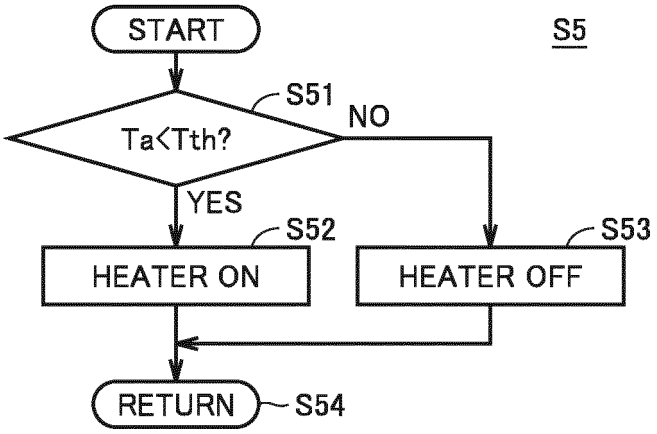

START
S1
IS RETRY IN RESPONSE TO OVERCURRENT DONE FIVE TIMES?
YES
S10
STOP DUE TO ABNORMALITY
NO
S2
IS RETRY IN RESPONSE TO OVERCURRENT DONE THREE TIMES OR MORE?
NO
S11
START RETRY
YES
S3
IS SUCTION SH OR SHELL-BOTTOM TEMPERATURE OR SHELL-BOTTOM SH LOWER FOR CERTAIN PERIOD?
NO
S12
START RETRY
YES
S4
ET<ETm+10K?
NO
S13
START RETRY
YES
S5
START LIQUID DISCHARGE PROMOTION CONTROL (DELAY COMPRESSOR START BY 30 MIN)
S6
30 MIN DELAY TIME ELAPSED?
YES
S14
START RETRY
NO
S7
OIL RETURN CONTROL START?
YES
S15
START RETRY
NO
S8
HIGH-LOW PRESSURE REVERSE PREVENTION CONTROL START?
YES
S16
START RETRY
NO
S9
ET≥ETm+10K KEPT FOR 3 MIN?
YES
S17
START RETRY
NO
S18
COMPRESSOR START SUCCESSFUL?
NO
S19
INCREMENT START RETRY COUNT BY +1
YES
S20
INITIALIZE START RETRY COUNT
RETURN
S21

FIG.4


START
S5
S51
Ta<Tth?
NO
YES
S52
HEATER ON
S53
HEATER OFF
RETURN
S54

## 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 H06034224 A **[0003] [0006]**
- JP 5342528 B **[0004] [0005]**
- JP H0634224 A **[0005]**