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

(72) Inventors:
- **TAKAYASU, Masahiro**
  Kadoma-shi, Osaka 571-0057 (JP)
- **ISEKI, Takayuki**
  Kadoma-shi, Osaka 571-0057 (JP)

(74) Representative: **Eisenführ Speiser**
Patentanwälte Rechtsanwälte PartGmbB
Gollierstraße 4
80339 München (DE)

(54) REFRIGERATION CYCLE APPARATUS

(57) The present disclosure provides a refrigeration cycle apparatus (1) that can restrain a load on a compressor from becoming excessive at the start of the compressor. The refrigeration cycle apparatus in the present disclosure includes: a bypass refrigerant circuit (20) branching off from a main refrigerant circuit (10) between a use side heat exchanger (12) and an expansion valve (14), the bypass refrigerant circuit communicating with an injection port (11a) through an economizer (13); a bypass valve (21) provided in the bypass refrigerant circuit, the bypass valve being configured to change an opening degree of the bypass refrigerant circuit; a discharge pressure sensor (40) configured to detect a pressure of a refrigerant discharged from a compressor (11); and a controller (50) configured to execute a high discharge pressure corresponding process for gradually increasing the opening degree of the bypass refrigerant circuit from a first predetermined opening degree to a second predetermined opening degree using the bypass valve when a pressure detected by the discharge pressure sensor is higher than a predetermined determination pressure at start of the compressor.

The refrigeration cycle apparatus (1) in the present disclosure includes: a bypass refrigerant circuit (20) branching off from a main refrigerant circuit (10) between a use side heat exchanger (12) and an expansion valve (14), the bypass refrigerant circuit communicating with an injection port (11a) through an economizer (13); a bypass valve (21) provided in the bypass refrigerant circuit, the bypass valve being configured to change an opening degree of the bypass refrigerant circuit; a discharge pressure sensor (40) configured to detect a pressure of a refrigerant discharged from a compressor (11); and a controller (50) configured to execute a high discharge pressure corresponding process for gradually increasing the opening degree of the bypass refrigerant circuit from a first predetermined opening degree to a second predetermined opening degree using the bypass valve when a pressure detected by the discharge pressure sensor is higher than a predetermined determination pressure at start of the compressor.

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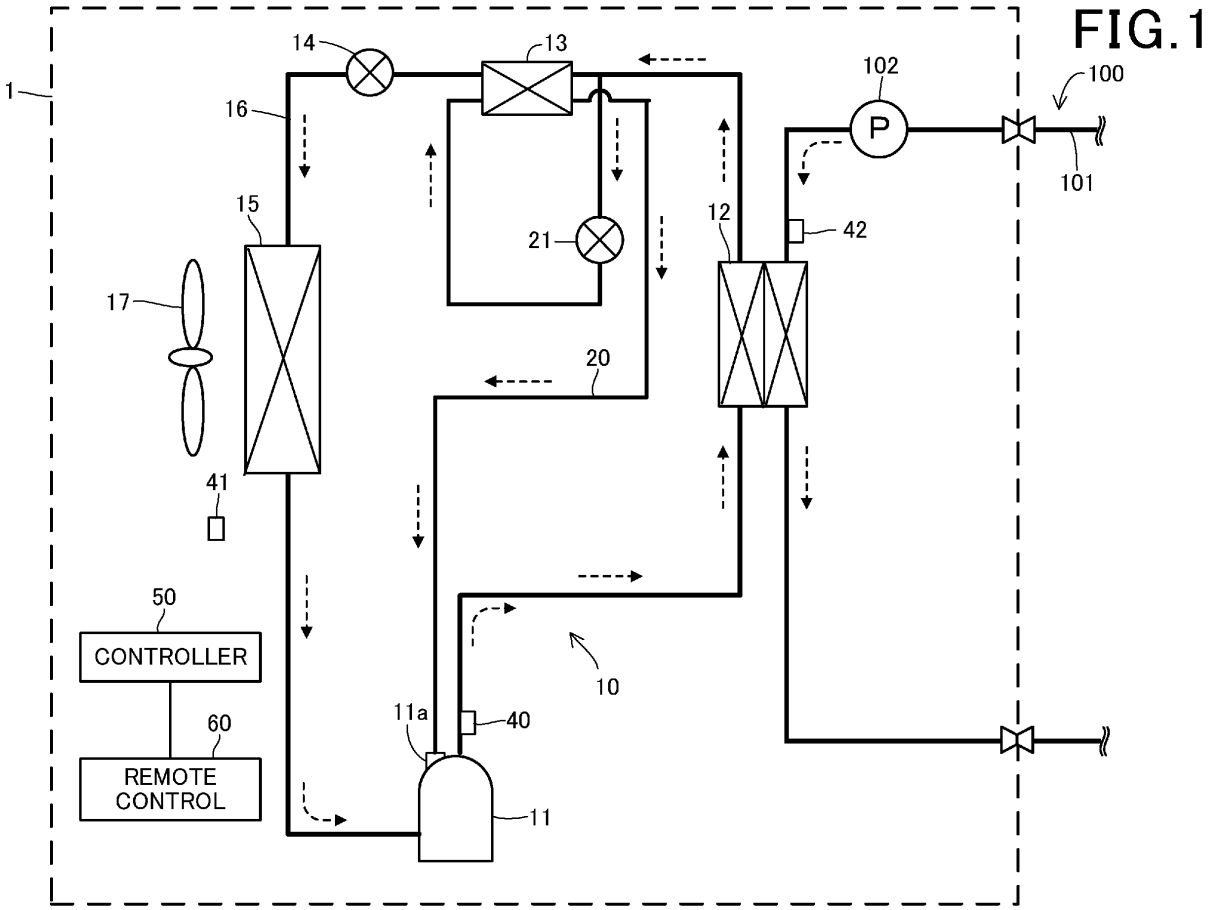
FIG.1


1
14
13
16
102
100
P
101
15
21
12
42
17
20
41
50
CONTROLLER
60
REMOTE CONTROL
10
11a
40
11

Description

BACKGROUND OF THE INVENTION

Field of the Invention

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

Description of the Related Art

[0002] European Patent Application Publication No. 3023711 discloses a configuration of a heat pump system including a main refrigerant circuit including a compressor, a condenser (use side heat exchanger), an expansion valve, and an evaporator (heat source side heat exchanger) that are connected in order, in which the heat pump system includes an economizer connected between the use side heat exchanger and the expansion valve, a bypass refrigerant circuit branching off from the refrigerant circuit between the use side heat exchanger and the economizer, the bypass refrigerant circuit communicating with the compressor through the economizer, and a bypass valve that changes the opening degree of the bypass refrigerant circuit.

[0003] The present disclosure provides a refrigeration cycle apparatus that can restrain a load on a compressor from becoming excessive at the start of the compressor.

SUMMARY OF THE INVENTION

[0004] A refrigeration cycle apparatus in the present disclosure includes: a main refrigerant circuit through which a refrigerant circulates, the main refrigerant circuit including a compressor having an injection port communicating with a compression chamber, a use side heat exchanger, an economizer, an expansion valve, and a heat source side heat exchanger connected in order; a bypass refrigerant circuit branching off from the main refrigerant circuit between the use side heat exchanger and the expansion valve, the bypass refrigerant circuit communicating with the injection port through the economizer; a bypass valve provided in the bypass refrigerant circuit, the bypass valve being configured to change an opening degree of the bypass refrigerant circuit; a discharge pressure sensor configured to detect a pressure of the refrigerant discharged from the compressor; and a controller configured to execute a high discharge pressure corresponding process for gradually increasing the opening degree of the bypass refrigerant circuit from a first predetermined opening degree to a second predetermined opening degree using the bypass valve when a pressure detected by the discharge pressure sensor is higher than a predetermined determination pressure at start of the compressor.

Advantageous Effect of Invention

[0005] The refrigeration cycle apparatus of the present disclosure can restrain the load on the compressor from becoming excessive at the start of the compressor.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006]

FIG. 1 is a configuration diagram of a refrigeration cycle apparatus in an embodiment;
FIG. 2 is a control block diagram of the refrigeration cycle apparatus in the embodiment;
FIG. 3 is a flowchart of a control process at the start of a compressor in the embodiment; and
FIG. 4 is a timing chart of opening degree control on a bypass valve in the embodiment.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

(Knowledge and the like Underlying Present Disclosure)

[0007] At the time when the inventors conceived of the present disclosure, there was a technique of a heat pump system including a main refrigerant circuit including a multi-stage compressor, a condenser (use side heat exchanger), an expansion valve, and an evaporator (heat source side heat exchanger) that are connected in order, in which the heat pump system includes an economizer connected between the use side heat exchanger and the expansion valve, a bypass refrigerant circuit branching off from the refrigerant circuit between the use side heat exchanger and the economizer, the bypass refrigerant circuit communicating with the compressor through the economizer, and a bypass valve that changes the opening degree of the bypass refrigerant circuit. This technique can achieve a higher refrigeration effect than in a case in which a single-stage compressor is used.

[0008] However, the inventors have found such a problem that the load on the compressor may become excessive depending on the conditions at the start of the compressor in the above technique, and have come to constitute the subject matter of the present disclosure to solve the problem.

[0009] Thus, the present disclosure provides a refrigeration cycle apparatus that can restrain the load on the compressor from becoming excessive at the start of the compressor.

[0010] Hereinbelow, embodiments will be described in detail with reference to the drawings. Note that more details than necessary may be omitted. For example, detailed description of already well-known matters or repetitive description for substantially identical configurations may be omitted. This is to avoid making the following description unnecessarily redundant and facilitate the understanding of those skilled in the art.

[0011] Note that the accompanying drawings and the following description are provided to enable those skilled in the art to fully understand the present disclosure and are not intended to limit the subject matter described in the claims.

(Embodiment)

[0012] Hereinbelow, an embodiment will be described with reference to FIGS. 1 to 4.

[1. Configuration]

[0013] FIG. 1 is a configuration diagram of a refrigeration cycle apparatus 1 according to the present embodiment. The refrigeration cycle apparatus 1 is a vapor compression refrigeration cycle apparatus, and includes a main refrigerant circuit 10 and a bypass refrigerant circuit 20, and a controller 50. The refrigeration cycle apparatus 1 is installed outdoors and connected to a heating terminal (not shown) by the use side heating medium circuit 100 to constitute a hot water heating system.

[0014] The main refrigerant circuit 10 includes a compressor 11 that compresses a refrigerant, a use side heat exchanger 12 that functions as a radiator, an economizer 13, an expansion valve 14, and a heat source side heat exchanger 15 that functions as an evaporator connected in order through a refrigerant pipe 16. The expansion valve 14 is an opening adjustable valve whose opening degree is changeable. The refrigerant is, for example, a propane refrigerant, such as R290. Note that a refrigerant other than a propane refrigerant may be used.

[0015] The bypass refrigerant circuit 20 branches off from the main refrigerant circuit 10 between the use side heat exchanger 12 and the expansion valve 14 and communicates with an injection port 11a provided in a compression chamber of the compressor 11. The compressor 11 is a scroll two-stage compressor. A bypass valve 21 and the economizer 13 are connected to the bypass refrigerant circuit 20 in this order from the upstream side. The bypass valve 21 is an opening adjustable valve whose opening degree is changeable.

[0016] Part of the high-pressure refrigerant passing through the use side heat exchanger 12 flows into the bypass refrigerant circuit 20 and is decompressed by the bypass valve 21 to become an intermediate-pressure refrigerant. The intermediate-pressure refrigerant exchanges heat with the high-pressure refrigerant flowing through the main refrigerant circuit 10 in the economizer 13 and is then injected into the compressor 11. The refrigerant injected into the compressor 11 merges with the refrigerant in the process of being compressed in the compression chamber of the compressor 11. The compressor 11 merges the injected refrigerant with the refrigerant in the process of being compressed and performs recompression.

[0017] A use side heating medium circuit 100 includes the use side heat exchanger 12, a feed pump 102, and the heating terminal (not shown) that are connected through a heating medium pipe 101. Water or an antifreeze solution can be used as a heating medium passed through the use side heating medium circuit 100. In the present embodiment, water is used as the heating medium, and the heating medium pipe 101 corresponds to the water pipe of the present disclosure. The use side heat exchanger 12 performs heat exchange between the water flowing through the use side heating medium circuit 100 and the refrigerant discharged from the compressor 11 to the main refrigerant circuit 10 to heat the water flowing through the use side heating medium circuit 100. The water heated in the use side heat exchanger 12 is used for heating by heat dissipation from the heating terminal, and the water that has become a low temperature due to the heat dissipation from the heating terminal is heated again in the use side heat exchanger 12.

[0018] In a case in which the refrigeration cycle apparatus 1 constitutes a hot water storage type hot water supply system, the heating medium pipe 101 is connected to an upper part and a lower part of a hot water storage tank, water heated in the use side heat exchanger 12 is fed from the upper part of the hot water storage tank into the hot water storage tank through the heating medium pipe 101 and stored in the hot water storage tank, and low-temperature water is fed from the lower part of the hot water storage tank into the heating medium pipe 101 and heated in the use side heat exchanger 12.

[0019] The refrigerant pipe 16 is provided with, on the discharge side of the compressor 11, a discharge pressure sensor 40 that detects the pressure of the refrigerant discharged from the compressor 11. The heating medium pipe 101 is provided with, on the inlet side of the use side heat exchanger 12, a water temperature sensor 42 that detects the temperature of the water flowing into the use side heat exchanger 12. An outside air temperature sensor 41 that detects the outside air temperature is provided near the heat source side heat exchanger 15.

[0020] FIG. 2 is a control block diagram of the refrigeration cycle apparatus 1. Referring to FIG. 2, the controller 50 is connected to the discharge pressure sensor 40, the outside air temperature sensor 41, and the water temperature sensor 42, and detection signals of these sensors are input to the controller 50. The controller 50 is also connected to the compressor 11, the expansion valve 14, a heat source fan 17, the bypass valve 21, and the feed pump 102, and the actuation of these objects to be controlled is controlled by control signals output from the controller 50.

[0021] A remote control 60 for performing operations such as start and stop of the operation of the refrigeration cycle apparatus 1 is connected to the controller 50. The remote control 60 includes a switch, and a display unit. An operation signal of the switch is input to the controller 50, and the actuation state of the refrigeration cycle apparatus 1 is displayed on the display unit of the remote control 60 in accordance with a display signal output from the

controller 50.

[0022] The controller 50 includes a processor 51, and a memory 52. A program 53 for controlling the refrigeration cycle apparatus 1 and control data 54 for determining control conditions for the refrigeration cycle apparatus 1 are stored in the memory 52. The processor 51 reads and executes the program 53, thereby controlling the actuation of the refrigeration cycle apparatus 1.

[2. Control Process at Start of Compressor]

[0023] A procedure of a control process executed by the controller 50 at the start of the compressor 11 will be described in accordance with a flowchart shown in FIG. 3. The controller 50, for example, executes the process of the flowchart shown in FIG. 3 when starting the circulation of the water in the use side heating medium circuit 100 using the feed pump 102 and the circulation of the refrigerant in the main refrigerant circuit 10 using the compressor 11 in response to an operation to start heating operation using the remote control 60.

[0024] The controller 50 starts the compressor 11 in step S1 of FIG. 3 and sets the opening degree of the expansion valve 14 to an initial opening degree in step S2. In the following step S3, the controller 50 recognizes the outside air temperature based on a detection signal of the outside air temperature sensor 41. In the next step S4, the controller 50 recognizes the temperature of the water flowing into the use side heat exchanger 12 based on a detection signal of the water temperature sensor 42.

[0025] In the following step S5, the controller 50 sets a determination pressure for determining the level of the pressure of the refrigerant discharged from the compressor 11 according to the rotation speed of the compressor 11, the outside air temperature, and the water temperature, using a data table included in the control data 54 (refer to FIG. 2). The data table includes the rotation speed of the compressor 11, the outside air temperature, and the temperature of the water flowing into the use side heat exchanger 12 as input parameters, and the corresponding determination pressure as an output parameter.

[0026] The data table is created based on results of experiments, computer simulations, and the like. With the data table, the determination pressure is set, for example, as in a setting example 1 and a setting example 2 below.

[0027] Setting Example 1 ... When the rotation speed of the compressor 11 is 80 Hz, the outside air temperature is from -3°C to 5°C, and the water temperature is from 33°C to 37°C, the determination pressure is set to 2.17 MPa.

[0028] Setting Example 2 ... When the rotation speed of the compressor 11 is 90 Hz, the outside air temperature is from -17°C to -10°C, and the water temperature is 32°C or less, the determination pressure is set to 1.61 MPa.

[0029] In this manner, the determination pressure is set according to the rotation speed of the compressor 11 and the outside air temperature. Basically, the determination pressure is set to be lower as the rotation speed of the compressor 11 increases and set to be higher as the outside air temperature increases.

[0030] The controller 50 applies the rotation speed of the compressor 11, and the outside air temperature and the water temperature recognized in steps S3 and S4 to the above data table to set the determination pressure. In the next step S6, the controller 50 recognizes the pressure of the refrigerant discharged from the compressor 11 (discharge pressure) based on a detection signal of the discharge pressure sensor 40. In the following step S7, the controller 50 determines whether the discharge pressure is higher than the determination pressure. Then, the controller 50 advances the process to step S20 when the discharge pressure is higher than the determination pressure and advances the process to step S8 when the discharge pressure is equal to or lower than the determination pressure.

[0031] In step S8, the controller 50 immediately (e.g., at the highest setting speed of the bypass valve 21) switches the opening degree of the bypass valve 21 from V1 (corresponding to the first predetermined opening degree of the present disclosure) to V2 (corresponding to the second predetermined opening degree of the present disclosure) and advances the process to step S9.

[0032] On the other hand, in step S20, the controller 50 executes a process for gradually increasing the opening degree of the bypass valve 21 from V1 to V2 (high discharge pressure corresponding process) and advances the process to step S9. In step S9, the controller 50 starts feedback control for the bypass valve 21. In the next step S10, the controller 50 starts feedback control for the expansion valve 14. The controller 50 feedback-controls the rotation speed of the compressor 11, the opening degree of the expansion valve 14, and the opening degree of the bypass valve 21 so that the temperature of the water flowing into the heating medium pipe 101 from the use side heat exchanger 12 becomes a target temperature, thereby adjusting the heating capacity of the use side heat exchanger 12.

[0033] FIG. 4 shows a change in the opening degree of the bypass valve 21 caused by the process of step S8 by A and a change in the opening degree of the bypass valve 21 caused by the process of step S20 by B, with the vertical axis set to the opening degree pls of the bypass valve 21 and the horizontal axis set to time t.

[0034] In FIG. 4, t1 is a point in time when the process for opening the bypass valve 21 from V1 to V2 is started in step S8 or step S20, and t2 is a point in time when the opening degree of the bypass valve 21 becomes V2 by the process of step S20. In a pattern of A caused by the control of step S8, at t1, the opening degree of the bypass valve 21 is immediately switched from V1 to V2, and the feedback control for the bypass valve 21 is started.

[0035] On the other hand, in a pattern of B caused by the process of step S20, the opening degree of the bypass valve 21 is increased in a stepwise manner from t1 to t2. Here, t1 to t2 is, for example, 15 seconds, and V2

is the opening degree increased by 30 pulses from V1. Although, in FIG. 4, the opening degree of the bypass valve 21 is increased in a stepwise manner, the opening degree of the bypass valve 21 may be increased linearly and steplessly. In this manner, by gradually increasing the opening degree of the bypass valve 21 when the discharge pressure of the compressor 11 is higher than the determination pressure, it is possible to avoid a rapid increase of the refrigerant injected into the bypass valve 21 and restrain the load on the compressor 11 from becoming excessive.

[0036] In addition, since the feedback control for the opening degree of the expansion valve 14 is started in step S10, the feedback control for the opening degree of the expansion valve 14 is kept on standby (inhibited) while the opening degree of the bypass valve 21 is gradually increased by the control of step S20. This restrains the load on the compressor 11 from increasing due to fluctuations in the amount of refrigerant suctioned into the compressor 11.

[3. Effects and the like]

[0037] As above, in the present embodiment, the refrigeration cycle apparatus 1 includes the main refrigerant circuit 10 through which the refrigerant circulates, the main refrigerant circuit 10 including the compressor 11 having the injection port 11a communicating with the compression chamber, the use side heat exchanger 12, the economizer 13, the expansion valve 14, and the heat source side heat exchanger 15 connected in order, the bypass refrigerant circuit 20 that branches off from the main refrigerant circuit 10 between the use side heat exchanger 12 and the expansion valve 14 and communicates with the injection port 11a through the economizer 13, the bypass valve 21 that is provided in the bypass refrigerant circuit 20 and changes the opening degree of the bypass refrigerant circuit 20, the discharge pressure sensor 40 that detects the pressure of the refrigerant discharged from the compressor, and the controller 50 that executes the high discharge pressure corresponding process for gradually increasing the opening degree of the bypass refrigerant circuit 20 from the first predetermined opening degree to the second predetermined opening degree using the bypass valve 21 when the pressure detected by the discharge pressure sensor 40 is higher than the predetermined determination pressure at the start of the compressor 11.

[0038] In the refrigeration cycle apparatus 1, by the controller 50 executing the high discharge pressure corresponding process for gradually increasing the opening degree of the bypass refrigerant circuit 20 from the first predetermined opening degree to the second predetermined opening degree using the bypass valve 21 when the pressure detected by the discharge pressure sensor 40 is higher than the determination pressure at the start of the compressor 11, it is possible to avoid a rapid increase of the refrigerant injected into the injection port of the compressor 11 and restrain the load on the compressor 11 from becoming excessive.

(Other Embodiments)

[0039] As above, the embodiment has been described as an example of the technique disclosed in the present application. However, the technique in the present disclosure is not limited thereto and is also applicable to embodiments with changes, replacements, additions, omissions, and the like.

[0040] In the above embodiment, while the controller 50 executes the process (high discharge pressure corresponding process) for gradually increasing the opening degree of the bypass valve 21 in step S20 of FIG. 3, the feedback control for the expansion valve 14 is kept on standby until the process of step S20 is completed. As another embodiment, this standby does not need to be performed.

[0041] In the above embodiment, the controller 50 sets the determination pressure according to the rotation speed of the compressor 11, the outside air temperature, and the temperature of the water flowing into the use side heat exchanger 12 in step S5 of FIG. 3. As another embodiment, the determination pressure may be set according to another condition such as only the rotation speed of the compressor 11, or the determination pressure may be a fixed value.

[0042] It is only required that the controller in the present disclosure be one that can control the apparatus in the present disclosure. In describing the subject matter of the invention, one that controls the apparatus of the present disclosure may be described as control means or a control unit, or described with similar wording, in addition to the controller. The controller can be implemented in various modes. For example, a processor may be used as the controller. Using the processor as the controller makes it possible to execute various processes by the processor reading a program from a storage medium in which the program is stored and executing the program. Thus, processing details can be changed by changing the program stored in the storage medium, and flexibility of changing control details can thus be increased. Examples of the processor include a central processing unit (CPU) and a micro-processing unit (MPU). Examples of the storage medium include a hard disk, a flash memory, and an optical disk. Wired logic that cannot be reprogrammed may be used as the controller. Using the wired logic as the controller is effective in improving the processing speed. An application specific integrated circuit (ASIC) is an example of the wired logic. The controller may be implemented by a combination of the processor and the wired logic. Implementing the controller by the combination of the processor and the wired logic makes it possible to improve the processing speed while increasing the flexibility of software design. The controller and a circuit having a function different from the function of the controller may be configured as a

single semiconductor device. An A/D or D/A conversion circuit is an example of the circuit having the different function. The controller may be configured as a single semiconductor device or may include multiple semiconductor devices. When the controller includes multiple semiconductor devices, the control operations described in the claims may be achieved by semiconductor devices different from each other. Furthermore, the controller may have a configuration including a semiconductor device, and a passive component such as a resistor or a capacitor.

[0043] Since the embodiments described above are intended to exemplify the technique in the present disclosure, various changes, replacements, additions, omissions, and the like can be made within the scope of the claims or a scope equivalent thereto.

(Supplement)

[0044] The description of the above embodiments discloses the following techniques.

[0045] (Technique 1) A refrigeration cycle apparatus including: a main refrigerant circuit through which a refrigerant circulates, the main refrigerant circuit including a compressor having an injection port communicating with a compression chamber, a use side heat exchanger, an economizer, an expansion valve, and a heat source side heat exchanger connected in order; a bypass refrigerant circuit branching off from the main refrigerant circuit between the use side heat exchanger and the expansion valve, the bypass refrigerant circuit communicating with the injection port through the economizer; a bypass valve provided in the bypass refrigerant circuit, the bypass valve being configured to change an opening degree of the bypass refrigerant circuit; a discharge pressure sensor configured to detect a pressure of the refrigerant discharged from the compressor; and a controller configured to execute a high discharge pressure corresponding process for gradually increasing the opening degree of the bypass refrigerant circuit from a first predetermined opening degree to a second predetermined opening degree using the bypass valve when a pressure detected by the discharge pressure sensor is higher than a predetermined determination pressure at start of the compressor.

[0046] This configuration makes it possible to restrain the load on the compressor from becoming excessive at the start of the compressor.

[0047] (Technique 2) The refrigeration cycle apparatus according to technique 1, in which the expansion valve has an opening degree changing function, and the controller keeps execution of opening degree adjusting control for the expansion valve on standby during execution of the high discharge pressure corresponding process and starts the opening degree adjusting control for the expansion valve after completion of the high discharge pressure corresponding process.

[0048] This configuration makes it possible to avoid a decrease in the effect of restraining the load on the compressor due to the high discharge pressure corresponding process from becoming excessive due to fluctuations in the amount of refrigerant suctioned into the compressor caused by the opening degree adjusting control on the expansion valve.

[0049] (Technique 3) The refrigeration cycle apparatus according to technique 1 or 2, in which the refrigeration cycle apparatus is installed outdoors, the use side heat exchanger is connected to a water pipe and performs heat exchange between water flowing through the water pipe and the refrigerant flowing through the main refrigerant circuit, the refrigeration cycle apparatus further includes: an outside air temperature sensor configured to detect an outside air temperature; and a water temperature sensor configured to detect a temperature of the water flowing into the use side heat exchanger from the water pipe, and the controller sets the determination pressure based on a temperature detected by the outside air temperature sensor and a temperature detected by the water temperature sensor.

[0050] In this configuration, the load applied to the compressor when the refrigerant is discharged from the compressor fluctuates according to the temperature difference between the temperature of the water flowing into the use side heat exchanger from the water pipe and the outside air temperature. Thus, by changing the determination pressure based on the temperature detected by the outside air temperature sensor and the temperature detected by the water temperature sensor, the timing to execute the high discharge pressure corresponding process can be more appropriately set.

[0051] (Technique 4) The refrigeration cycle apparatus according to technique 1 or 2, in which the refrigerant is a propane refrigerant.

[0052] This configuration makes it possible to restrain the temperature of the compressor from excessively rising due to an excessive load on the compressor when a flammable propane refrigerant is used.

Industrial Applicability

[0053] The present disclosure is applicable to a use to restrain a load on a compressor from becoming excessive at the start of the compressor.

Reference Signs List

[0054]

1	refrigeration cycle apparatus
10	main refrigerant circuit
11	compressor
12	use side heat exchanger
13	economizer
14	expansion valve
15	heat source side heat exchanger
16	refrigerant pipe

17 heat source fan
20 bypass refrigerant circuit
21 bypass valve
40 discharge pressure sensor
41 outside air temperature sensor
42 water temperature sensor
50 controller
60 remote control
100 use side heating medium circuit
101 heating medium pipe
102 feed pump

Claims

1. A refrigeration cycle apparatus (1) **characterized by** comprising:

a main refrigerant circuit (10) through which a refrigerant circulates, the main refrigerant circuit including a compressor (11) having an injection port (11a) communicating with a compression chamber, a use side heat exchanger (12), an economizer (13), an expansion valve (14), and a heat source side heat exchanger (15) connected in order;
a bypass refrigerant circuit (20) branching off from the main refrigerant circuit between the use side heat exchanger and the expansion valve, the bypass refrigerant circuit communicating with the injection port through the economizer;
a bypass valve (21) provided in the bypass refrigerant circuit, the bypass valve being configured to change an opening degree of the bypass refrigerant circuit;
a discharge pressure sensor (40) configured to detect a pressure of the refrigerant discharged from the compressor; and
a controller (50) configured to execute a high discharge pressure corresponding process for gradually increasing the opening degree of the bypass refrigerant circuit from a first predetermined opening degree to a second predetermined opening degree using the bypass valve when a pressure detected by the discharge pressure sensor is higher than a predetermined determination pressure at start of the compressor.

2. The refrigeration cycle apparatus according to claim 1, wherein

the expansion valve has an opening degree changing function, and
the controller keeps execution of opening degree adjusting control for the expansion valve on standby during execution of the high discharge pressure corresponding process and starts the opening degree adjusting control for the expansion valve after completion of the high discharge pressure corresponding process.

3. The refrigeration cycle apparatus according to claim 1 or 2, wherein

the refrigeration cycle apparatus is installed outdoors,
the use side heat exchanger is connected to a water pipe and performs heat exchange between water flowing through the water pipe and the refrigerant flowing through the main refrigerant circuit,
the refrigeration cycle apparatus further comprises:

an outside air temperature sensor (41) configured to detect an outside air temperature; and
a water temperature sensor (42) configured to detect a temperature of the water flowing into the use side heat exchanger from the water pipe, and

the controller sets the determination pressure based on a temperature detected by the outside air temperature sensor and a temperature detected by the water temperature sensor.

4. The refrigeration cycle apparatus according to claim 1 or 2, wherein the refrigerant is a propane refrigerant.

FIG. 1

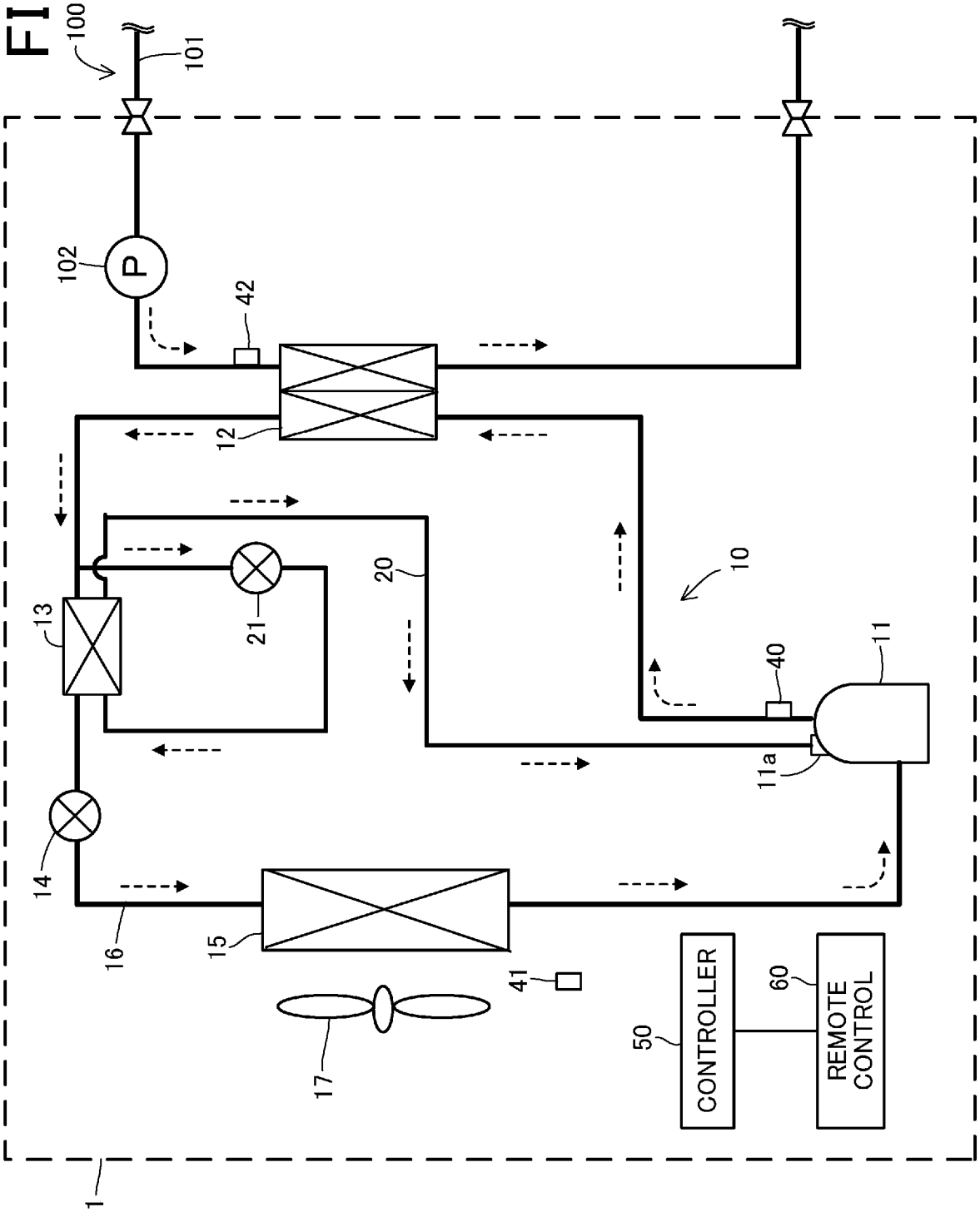

100
101
102
P
42
12
13
21
20
10
40
11
11a
14
16
15
41
17
50
CONTROLLER
60
REMOTE CONTROL
1

FIG.2

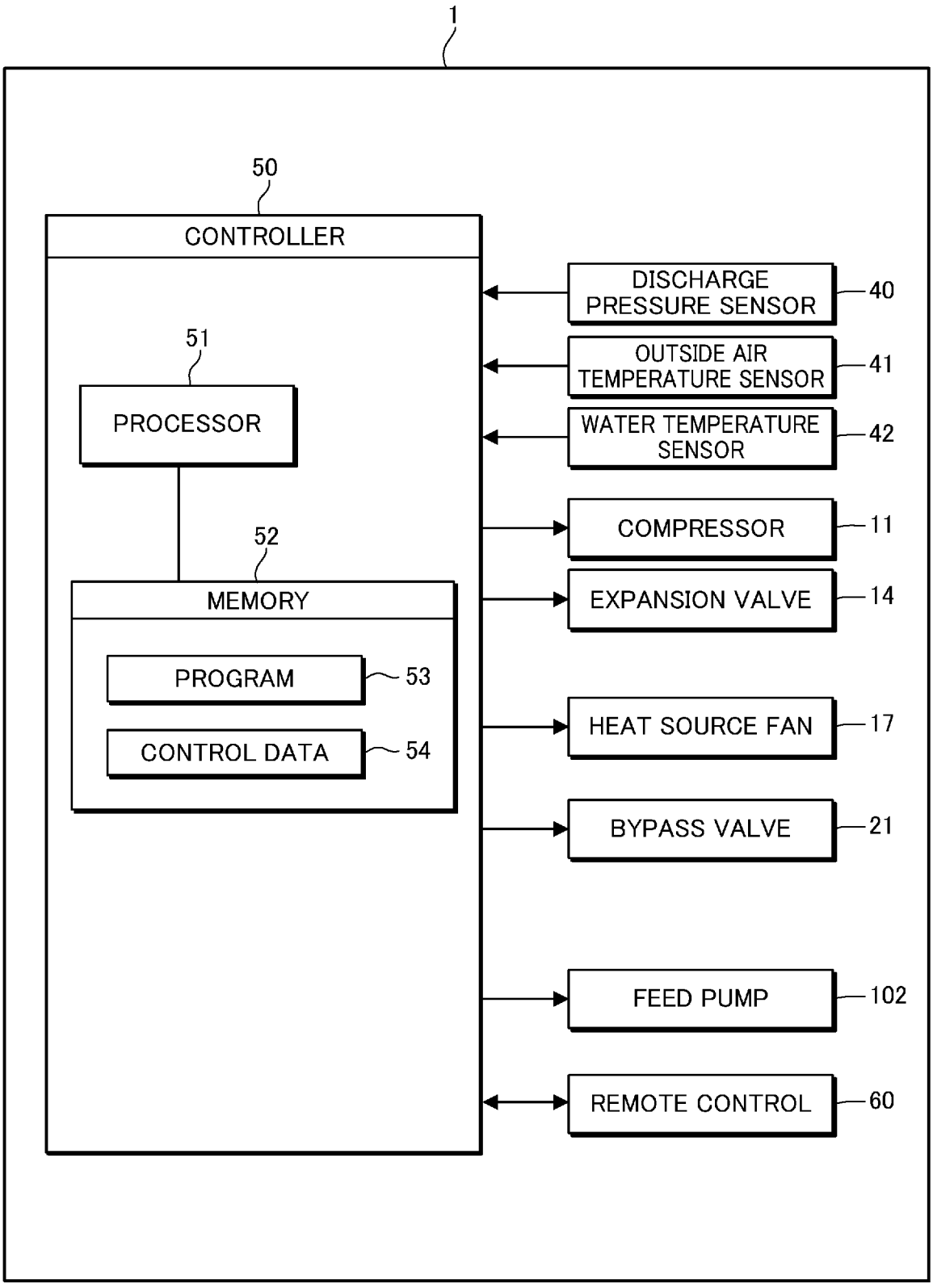

1
50
CONTROLLER
51
PROCESSOR
52
MEMORY
PROGRAM
53
CONTROL DATA
54
DISCHARGE PRESSURE SENSOR
40
OUTSIDE AIR TEMPERATURE SENSOR
41
WATER TEMPERATURE SENSOR
42
COMPRESSOR
11
EXPANSION VALVE
14
HEAT SOURCE FAN
17
BYPASS VALVE
21
FEED PUMP
102
REMOTE CONTROL
60

FIG.3

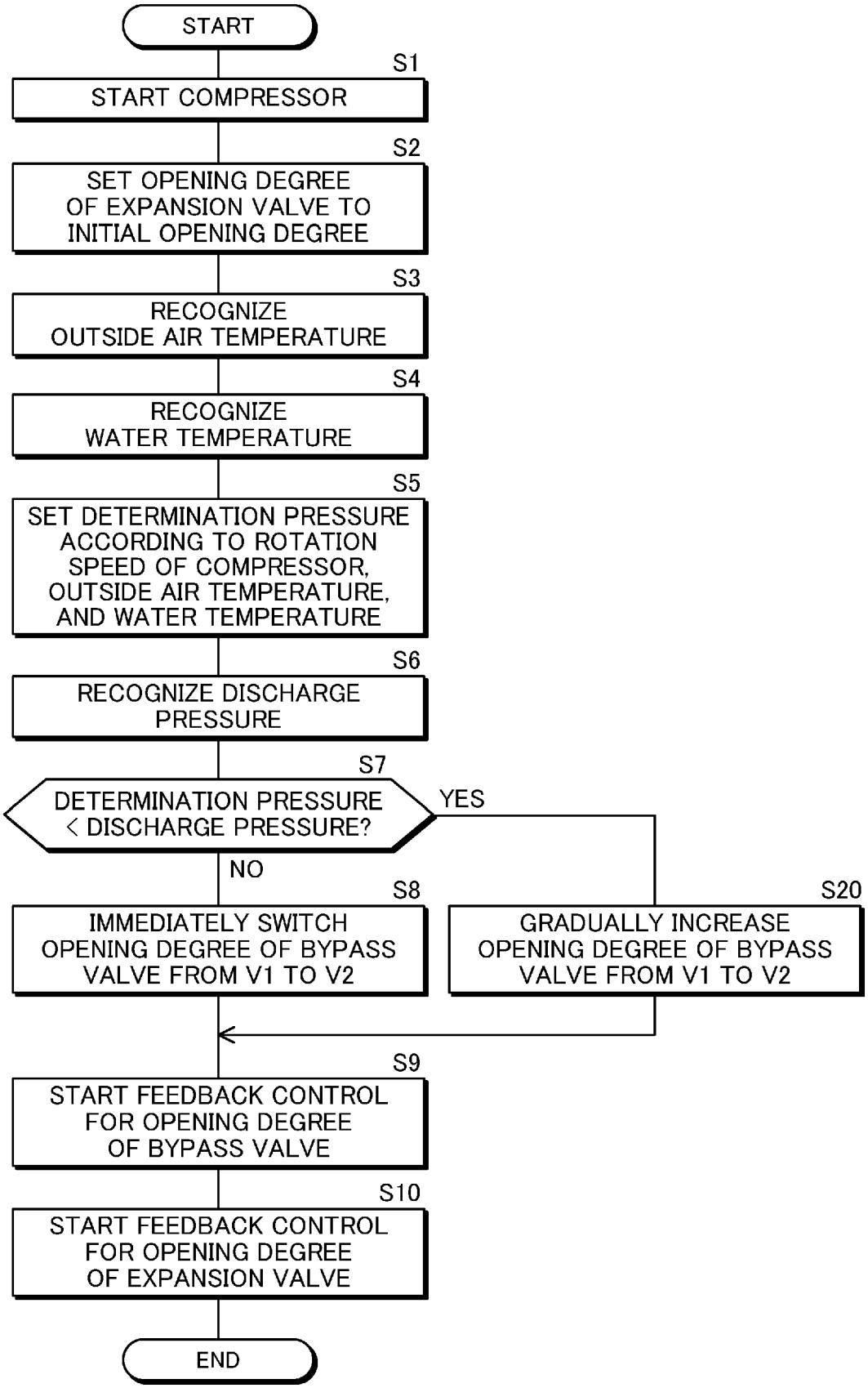
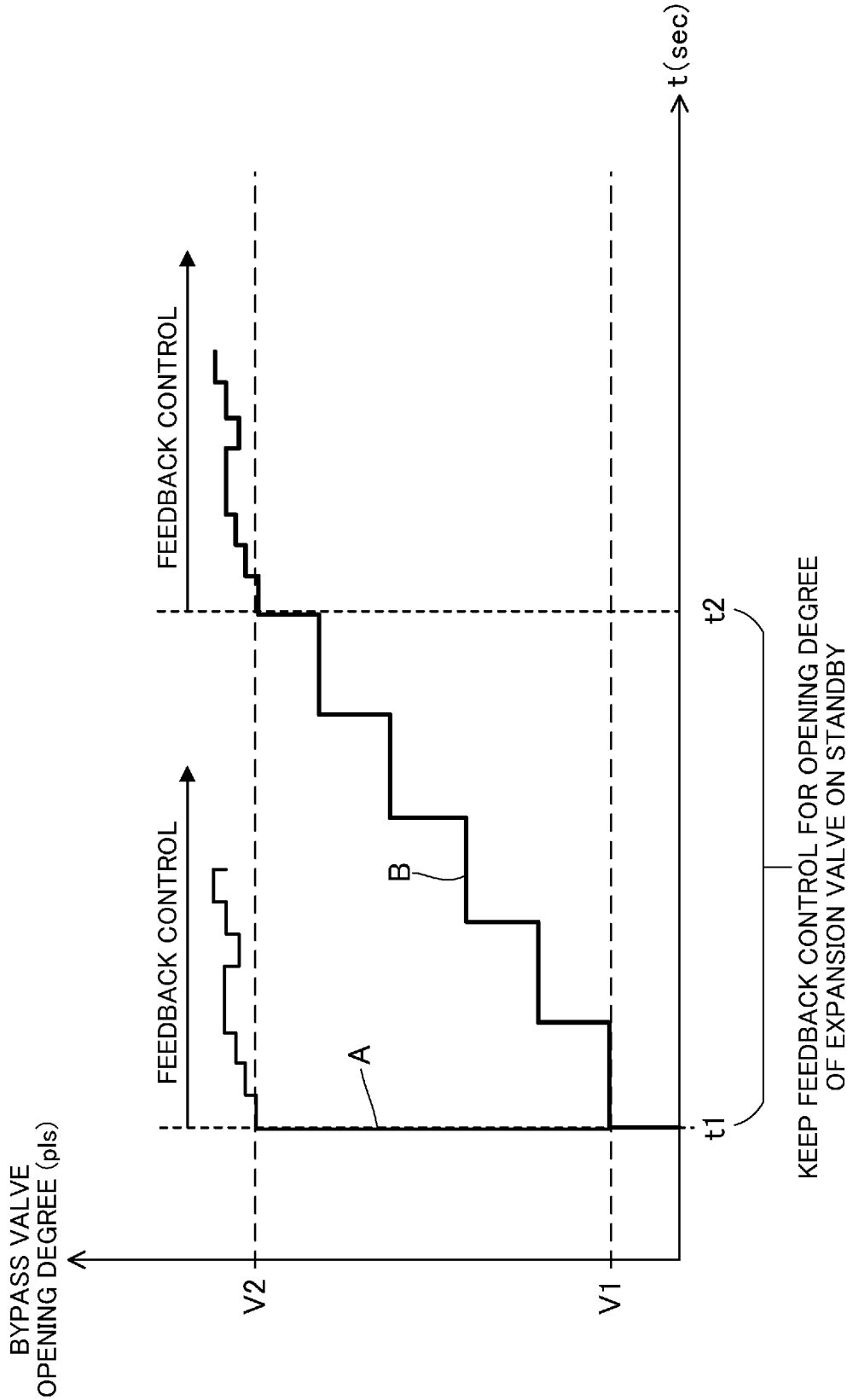

START
S1
START COMPRESSOR
S2
SET OPENING DEGREE OF EXPANSION VALVE TO INITIAL OPENING DEGREE
S3
RECOGNIZE OUTSIDE AIR TEMPERATURE
S4
RECOGNIZE WATER TEMPERATURE
S5
SET DETERMINATION PRESSURE ACCORDING TO ROTATION SPEED OF COMPRESSOR, OUTSIDE AIR TEMPERATURE, AND WATER TEMPERATURE
S6
RECOGNIZE DISCHARGE PRESSURE
S7
DETERMINATION PRESSURE < DISCHARGE PRESSURE?
YES
NO
S8
IMMEDIATELY SWITCH OPENING DEGREE OF BYPASS VALVE FROM V1 TO V2
S20
GRADUALLY INCREASE OPENING DEGREE OF BYPASS VALVE FROM V1 TO V2
S9
START FEEDBACK CONTROL FOR OPENING DEGREE OF BYPASS VALVE
S10
START FEEDBACK CONTROL FOR OPENING DEGREE OF EXPANSION VALVE
END

FIG.4


BYPASS VALVE
OPENING DEGREE (pls)
FEEDBACK CONTROL
FEEDBACK CONTROL
V2
V1
A
B
t1
t2
t (sec)
KEEP FEEDBACK CONTROL FOR OPENING DEGREE
OF EXPANSION VALVE ON STANDBY

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EUROPEAN SEARCH REPORT

Application Number
EP 24 21 7389

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 2017/074569 A1 (KURATA YUSUKE [JP] ET AL) 16 March 2017 (2017-03-16) * figures 1,8 * * paragraph [0028] - paragraph [0048] * * paragraph [0064] - paragraph [0081] *	1-4	INV. F25B31/00 F25B49/02 ADD. F25B1/10
A	US 2015/354878 A1 (YAMASHITA KOJI [JP]) 10 December 2015 (2015-12-10) * figure 5 * * paragraph [0037] - paragraph [0041] * * paragraph [0051] * * paragraph [0060] * * paragraph [0081] * * paragraph [0115] - paragraph [0117] * * paragraph [0125] * * paragraph [0135] *	1-4	
A	US 2015/143841 A1 (KAWANO SATOSHI [JP] ET AL) 28 May 2015 (2015-05-28) * column 7, line 29 - column 11, line 15; figures 1-3 *	1-4	TECHNICAL FIELDS SEARCHED (IPC)
A	US 9 182 161 B2 (MATSUKURA NORIYUKI [JP]; UEDA KENJI [JP] ET AL.) 10 November 2015 (2015-11-10) * figure 1 * * paragraph [0040] - paragraph [0067] * * paragraph [0082] - paragraph [0088] *	1-4	F25B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	6 May 2025	Karspeck, Sabine

CATEGORY OF CITED DOCUMENTS

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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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06-05-2025

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2017074569 A1	16-03-2017	CN 106524546 A	22-03-2017
		JP 6814974 B2	20-01-2021
		JP 2017053598 A	16-03-2017
		US 2017074569 A1	16-03-2017
US 2015354878 A1	10-12-2015	CN 105074351 A	18-11-2015
		EP 2975336 A1	20-01-2016
		JP 5968519 B2	10-08-2016
		JP WO2014141373 A1	16-02-2017
		US 2015354878 A1	10-12-2015
		WO 2014141373 A1	18-09-2014
US 2015143841 A1	28-05-2015	AU 2013268781 A1	22-01-2015
		BR 112014029461 A2	27-06-2017
		CN 104334980 A	04-02-2015
		CN 105526727 A	27-04-2016
		EP 2878900 A1	03-06-2015
		EP 3144602 A1	22-03-2017
		ES 2659431 T3	15-03-2018
		ES 2860462 T3	05-10-2021
		JP 5516712 B2	11-06-2014
		JP 2014006042 A	16-01-2014
		KR 20150020220 A	25-02-2015
		KR 20160045909 A	27-04-2016
		TR 201802234 T4	21-03-2018
		US 2015143841 A1	28-05-2015
		US 2016370039 A1	22-12-2016
		WO 2013179803 A1	05-12-2013
US 9182161 B2	10-11-2015	CN 103140726 A	05-06-2013
		EP 2623890 A1	07-08-2013
		JP 5881282 B2	09-03-2016
		JP 2012077971 A	19-04-2012
		KR 20130025388 A	11-03-2013
		US 2013025306 A1	31-01-2013
		WO 2012043283 A1	05-04-2012

EPO FORM P0459

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

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- EP 3023711 A **[0002]**