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

(11) **EP 2 672 204 A1**

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

(43) Date of publication:
11.12.2013 Bulletin 2013/50

(21) Application number: **12754509.3**

(22) Date of filing: **08.03.2012**

(51) Int Cl.:
F25B 7/00 *(2006.01)* ***F25B 1/00*** *(2006.01)*

(86) International application number:
PCT/JP2012/055951

(87) International publication number:
WO 2012/121326 (13.09.2012 Gazette 2012/37)

(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

(30) Priority: **09.03.2011 JP 2011051306**

(71) Applicant: **Toshiba Carrier Corporation**
Tokyo 108-0074 (JP)

(72) Inventor: **TAKAYAMA, Tsukasa**
Shizuoka-Ken 461-8521 (JP)

(74) Representative: **Kramer - Barske - Schmidtchen**
Landsberger Strasse 300
80687 München (DE)

(54) BINARY REFRIGERATION CYCLE DEVICE

(57) A binary refrigeration cycle system includes: a low temperature-side refrigeration cycle including a heat source-side heat exchanger that absorbs heat from an external heat source, and a low temperature-side compressor; a high temperature-side refrigeration cycle including a utilization-side heat exchanger that supplies heat to a utilization side, and a high temperature-side compressor; an intermediate heat exchanger that exchanges heat between a refrigerant in the low temperature-side refrigeration cycle and a refrigerant in the high temperature-side refrigeration cycle; a casing to which at least the utilization-side heat exchanger is mounted; a utilization-side pipe that is provided for the casing and connected to the utilization-side heat exchanger so as to exchange heat between a circulated utilization-side fluid and the refrigerant in the high temperature-side refrigeration cycle and supply the heat to the utilization side; a bypass passage that is connected to the utilization-side pipe in parallel with the utilization-side heat exchanger so as to feed the utilization-side fluid in the utilization-side pipe from a utilization-side heat exchanger outlet side to a utilization-side heat exchanger inlet side; and a fluid control unit that controls a flow of the utilization-side fluid circulated in the bypass passage.

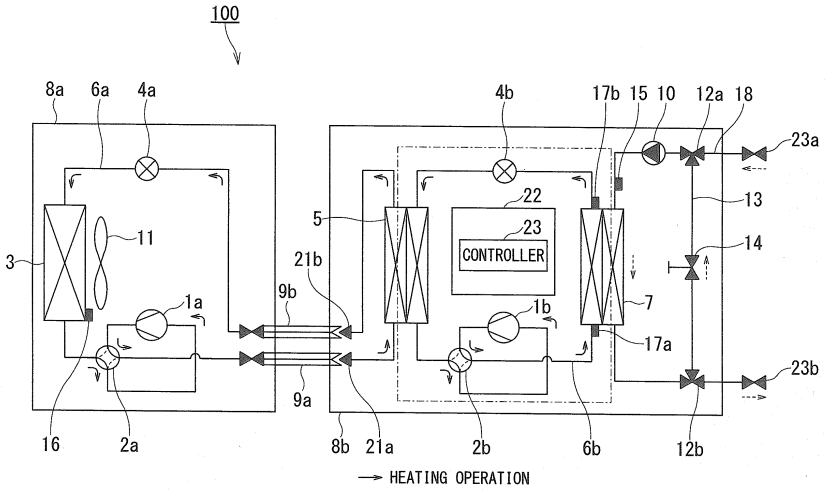

FIG. 1

EP 2 672 204 A1

Description

Technical Field

[0001] The present embodiment of this invention relates to a binary refrigeration cycle system.

Background Art

[0002] A binary refrigeration cycle system including a low temperature-side refrigeration cycle and a high temperature-side refrigeration cycle to supply high-temperature heat to a heat utilization device is sometimes employed as refrigeration cycle apparatus such as air conditioner and heat pump water heater.

[0003] Each of the low temperature-side refrigeration cycle and the high temperature-side refrigeration cycle of the binary refrigeration cycle system is provided with a compressor, an expansion unit, and the like. The low temperature-side refrigeration cycle and the high temperature-side refrigeration cycle are connected to be capable of exchanging heat via an intermediate heat exchanger. High-temperature heat extracted by a heat source-side heat exchanger as a low temperature-side evaporator provided in the low temperature-side refrigeration cycle is supplied to the heat utilization device via a utilization-side heat exchanger as a high temperature-side condenser provided in the high temperature-side refrigeration cycle.

Prior Art Documents

Patent Document

[0004]

Patent Document 1: Japanese Patent Laid-Open Publication No. 08-189714

Summary of The Invention

Problem to be solved by The Invention

[0005] However, in a case when a temperature of a (utilization-side) fluid flowing into the utilization-side heat exchanger from the heat utilization device is low, it is known that a compression ratio in the high temperature-side refrigeration cycle is decreased, and reliability of a compressor is hence reduced and reliability of the refrigeration cycle system is itself reduced.

[0006] The present invention has been made in view of the above mentioned problem, and an object of an embodiment thereof is to provide a binary refrigeration cycle system which solves the problem of a reduction in reliability of a compressor, and hence, solves the problem of a reduction in reliability of the refrigeration cycle system.

Means for solving The Problem

[0007] A binary refrigeration cycle system according to an embodiment of the present invention includes a low temperature-side refrigeration cycle that absorbs heat from an external heat source, a high temperature-side refrigeration cycle that supplies heat to a utilization side, and an intermediate heat exchanger that exchanges heat between refrigerants in the low temperature-side refrigeration cycle and the high temperature-side refrigeration cycle.

[0008] A utilization-side heat exchanger is provided with a utilization-side pipe that exchanges heat between a utilization-side fluid and the refrigerant in the high temperature-side refrigeration cycle and supplies the heat to the utilization side. A casing in which at least the utilization-side heat exchanger is mounted is also provided. A bypass passage that is connected to the utilization-side pipe in parallel with the utilization-side heat exchanger to circulate the utilization-side fluid in the utilization-side pipe from a utilization-side heat exchanger outlet side to a utilization-side heat exchanger inlet side is mounted in the casing. A fluid control unit that controls a flow of the utilization-side fluid circulated in the bypass passage is further provided.

Brief Description of The Drawings

[0009]

[Fig. 1] is a schematic view of a binary refrigeration cycle system according to an embodiment of the present invention.
[Fig. 2] is a block diagram of a controller and associated peripheral equipments according to the embodiment of the present invention.
[Fig. 3] is a flowchart of control according to the embodiment of the present invention.

Embodiment for carrying out The Invention

[0010] Hereunder, an embodiment of the present invention will be described with reference to the drawings.

(First Embodiment)

[0011] A first embodiment will be described with reference to Fig. 1.

[0012] As shown in Fig. 1, a binary refrigeration cycle system 100 according to the present embodiment includes a low temperature-side refrigeration cycle 6a and a high temperature-side refrigeration cycle 6b which are arranged to be capable of exchanging heat via an intermediate heat exchanger 5.

[0013] The binary refrigeration cycle system 100 includes a first casing 8a and a second casing 8b.

[0014] In the first casing 8a, a low temperature-side compressor 1a, a low temperature-side four-way valve

2a connected to the low temperature-side compressor 1a by a refrigerant pipe, a heat source-side heat exchanger 3 that exchanges heat with outside air (an external heat source), and a low temperature-side expansion unit 4a are provided so as to be sequentially connected by a refrigerant pipe.

Further, connection pipes 9a and 9b are also connected to the low temperature-side four-way valve 2a and the low temperature-side expansion unit 4a, respectively, and the connection pipes 9a and 9b are connected to the intermediate heat exchanger 5 provided in the second casing 8b.

[0015] The heat source-side heat exchanger 3 is provided with an air blower 11, which encourages heat exchange with outside air. The heat source-side heat exchanger 3 is also provided with an outside air temperature sensor 16 as an external heat source temperature detection unit, which detects a temperature of outside air supplied to the heat source-side heat exchanger 3 by the air blower 11.

[0016] On the other hand, in the second casing 8b, a high temperature-side compressor 1b, a high temperature-side four-way valve 2b connected to the high temperature-side compressor 1b, the intermediate heat exchanger 5, a high temperature-side expansion unit 4b, and a utilization-side heat exchanger 7 are sequentially connected by a refrigerant pipe to thereby constitute the high temperature-side refrigeration cycle 6b.

[0017] High temperature-side refrigerant temperature sensors 17a and 17b as refrigerant temperature detection units are provided in the refrigerant pipe on an inlet side and an outlet side of the utilization-side heat exchanger 7. The high temperature-side refrigerant temperature sensors 17a and 17b detect temperature of the refrigerant flowing into the utilization-side heat exchanger 7 and temperature of the refrigerant flowing out of the utilization-side heat exchanger 7.

[0018] Packed valves 21a and 21 b to be connected with the connection pipes 9a and 9b are connected to the intermediate heat exchanger 5. When the connection pipes 9a and 9b are connected to the packed valves 21a and 21 b, the low temperature-side refrigeration cycle 6a is constituted, thereby being capable of performing heat exchange between the low temperature-side refrigeration cycle 6a and the high temperature-side refrigeration cycle 6b through the intermediate heat exchanger 5.

[0019] In the low temperature-side refrigeration cycle 6a and the high temperature-side refrigeration cycle 6b, refrigerants having different characteristics are enclosed respectively.

[0020] The type of the enclosed refrigerant varies in accordance with an intended use of the binary refrigeration cycle system 100, and for example, when the binary refrigeration cycle system 100 uses a high-temperature heat pump water heater that generates hot water of almost 90°C by using the utilization-side heat exchanger 7 as a water heat exchanger, a working refrigerant, such as R410A, exhibiting good performance even at a low outside air temperature (about - 15°C) is preferably employed as a low temperature-side refrigerant used in the low temperature-side refrigeration cycle 6a, and a working refrigerant, such as R134a, exhibiting good performance at a high temperature (about 95°C) is preferably employed as a high temperature-side refrigerant used in the high temperature-side refrigeration cycle 6b.

[0021] A utilization-side fluid pipe 18 that supplies heat extracted by the binary refrigeration cycle system 100 to a heat utilization device that utilizes the heat is connected to the utilization-side heat exchanger 7.

[0022] The utilization-side pipe 18 includes connection port portions 23a and 23b to be connected to the heat utilization device, and a feed pump 10 that feeds a utilization-side fluid within the utilization-side fluid pipe 18. The connection port portion 23a, an inlet-side branch portion 12a, the feed pump 10, the utilization-side heat exchanger 7, an outlet-side branch portion 12b, and the connection port portion 23b are sequentially connected in this order by means of the utilization-side pipe 18.

Moreover, the inlet-side branch portion 12a and the outlet-side branch portion 12b are directly connected together by means of bypass passage 13, which is connected to the utilization-side pipe 18 in parallel with the utilization-side heat exchanger 7. A flow control valve 14 is provided in an intermediate portion of the bypass passage 13.

[0023] A fluid control unit in the present embodiment controls an opening degree of the flow control valve 14 to thereby control a flow rate of the utilization-side fluid circulated in the bypass passage 13.

[0024] In an actual fluid supply, when the feed pump 10 provided between the inlet-side branch portion 12a and the utilization-side heat exchanger 7 is operated to feed the utilization-side fluid, the utilization-side fluid is fed to the connection port portion 23b sequentially through the connection port portion 23a, the inlet-side branch portion 12a, the utilization-side heat exchanger 7, and the outlet-side branch portion 12b. The flowing direction of the utilization-side fluid is indicated by a dashed arrow in Fig. 1.

[0025] Since the feed pump 10 is located in an area between the inlet-side branch portion 12a and the utilization-side heat exchanger 7, the utilization-side fluid in the bypass passage 13 flows in a direction from the outlet-side branch portion 12b to the inlet-side branch portion 12a when the flow control valve 14 is opened.

Further, the inlet-side branch portion 12a, the outlet-side branch portion 12b, the feed pump 10, and the bypass passage 13 are mounted in the second casing 8b.

[0026] A water temperature sensor 15 as a utilization-side fluid temperature detection unit is provided for the utilization-side fluid pipe 18 between the feed pump 10 and the utilization-side heat exchanger 7. The water temperature sensor 15 detects a temperature of the utilization-side fluid flowing into the utilization-side heat exchanger 7.

[0027] Hot water or brine for supplying heat to the heat

utilization device is enclosed and circulated in the utilization-side fluid pipe 18.

[0028] The outside air temperature sensor 16, the high temperature-side refrigerant temperature sensors 17a and 17b, and the water temperature sensor 15 are connected to a controller 23 so as to detect the outside air temperature, the temperature of the refrigerant in the high temperature-side refrigeration cycle, and the temperature of the utilization-side fluid such as hot water and brine flowing into the utilization-side heat exchanger 7.

[0029] The second casing 8b is provided with an electric component box 22 for controlling operation of the binary refrigeration cycle system 100.

[0030] The electric component box 22 is therein provided with an inverter circuit, not shown, that drives the low temperature-side compressor 1a and the high temperature-side compressor 1b, and the controller 23 that controls opening degrees of the low temperature-side expansion unit 4a and the high temperature-side expansion unit 4b and also controls switching of the low temperature-side four-way valve 2a and the high temperature-side four-way valve 2b.

The low temperature-side refrigeration cycle 6a and the high temperature-side refrigeration cycle 6b are controlled by the inverter circuit and the controller 23 to be operated under optimum operating conditions.

[0031] The flow of the refrigerant during heating operation of the binary refrigeration cycle system 100 is indicated by a solid arrow in Fig. 1.

[0032] With reference to Fig. 1, first, in the low temperature-side refrigeration cycle 6a, the low temperature-side refrigerant sequentially passes through the low temperature-side compressor 1a, the low temperature-side four-way valve 2a, a low temperature-side flow passage of the intermediate heat exchanger 5, the low temperature-side expansion unit 4a, and the heat source-side heat exchanger 3, and returns to the low temperature-side compressor 1a through the low temperature-side four-way valve 2a.

In the like manner, in the high temperature-side refrigeration cycle 6b, the high temperature-side refrigerant compressed in the high temperature-side compressor 1b sequentially passes through the high temperature-side four-way valve 2b, the utilization-side heat exchanger 7, the high temperature-side expansion unit 4b, and a high temperature-side flow passage of the intermediate heat exchanger 5, and returns to the high temperature-side compressor 1b through the high temperature-side four-way valve 2b.

[0033] At this operation period, the low temperature-side refrigerant is evaporated in the heat source-side heat exchanger 3 and condensed in the low temperature side of the intermediate heat exchanger 5. The high temperature-side refrigerant is condensed in the utilization-side heat exchanger 7 to supply heat to the hot water or brine in the utilization-side pipe 18 on a utilization side. The refrigerant in form of liquid decompressed by the high temperature-side expansion unit 4b is evaporated in the high temperature-side flow passage of the intermediate heat exchanger 5 to thereby absorb the condensation heat of the low temperature-side refrigerant as evaporation heat.

[0034] The utilization-side fluid fed by the feed pump 10 is circulated in the utilization-side pipe 18.

[0035] At this time, in a case when the utilization-side fluid flowing into the utilization-side heat exchanger 7 is significantly low, the temperature of the high temperature-side refrigerant in the utilization-side heat exchanger 7 becomes lower than a predetermined temperature Tb1, and a compression ratio in the high temperature-side compressor 1b is reduced. If the compressor is operated with a reduced compression ratio, reliability of the compressor is lowered.

[0036] As shown in the block diagram of Fig. 2, the water temperature sensor 15, the outside air temperature sensor 16, the high temperature-side refrigerant temperature sensors 17a and 17b, and the flow control valve 14 are connected to the controller 23 located in the electric component box 22 of the binary refrigeration cycle system 100.

[0037] In a case when the temperature of the utilization-side fluid supplied to the utilization-side heat exchanger 7 from the heat utilization device is low, the flow control valve 14 in the bypass passage 13 is opened. The utilization-side fluid flowing out of the utilization-side heat exchanger 7 is thereby fed to the inlet-side branch portion 12a from the outlet-side branch portion 12b through the bypass passage 13, and mixed with a utilization-side fluid newly flowing into the utilization-side heat exchanger 7 from the connection port body 23a, thereby being flowed into the utilization-side heat exchanger 7 as a utilization-side fluid having an intermediate temperature.

[0038] The controlling operation of the flow control valve 14 by the controller 23 will be described hereunder by reference to the flowchart of Fig. 3.

[0039] First, during the operation of the binary refrigeration cycle system 100, the controller 23 determines whether or not a difference (Tw - T0) between an outside air temperature T0 detected by the outdoor temperature sensor 16 and a utilization-side fluid temperature Tw detected by the utilization-side fluid temperature sensor 15 mounted on the inlet side of the utilization-side heat exchanger 7 is equal to or smaller than a predetermined temperature Ta (step S201).

[0040] At such determination of the controller 23, when the difference between the detected outside air temperature T0 and the detected utilization-side fluid temperature Tw is greater than the predetermined temperature Ta (NO in step S201), the flow control valve 14 in the bypass passage 13 is closed (step S205) so as to entirely feed the utilization-side fluid flowing out of the utilization-side heat exchanger 7 to the heat utilization device.

[0041] Meanwhile, when the difference between the outside air temperature T0 and the utilization-side fluid

temperature Tw is equal to or smaller than the predetermined temperature Ta (YES in step S201), the flow control valve 14 in the bypass passage 13 is opened by a predetermined opening degree (step S202) so as to partially feed the utilization-side fluid flowing out of the utilization-side heat exchanger 7 to the utilization-side fluid inlet of the utilization-side heat exchanger 7 through the bypass passage 13. Accordingly, the high-temperature utilization-side fluid flowing out of the utilization-side heat exchanger 7 is mixed with the low-temperature utilization-side fluid supplied from the heat utilization device so as to provide an intermediate temperature, and is then flowed into the utilization-side heat exchanger 7.

[0042] Subsequently, an average temperature between the temperatures Ts1 and Ts2 of the high temperature-side refrigerant flowing into and flowing out of the utilization-side heat exchanger 7 detected by the two high temperature-side refrigerant temperature sensors 17a and 17b is calculated. The average temperature is used as an estimate of a condensation temperature Ts of the high temperature-side refrigerant. It is then determined whether or not the condensation temperature Ts is within a range of predetermined temperatures Tb1 to Tb2 (Tb1 < Tb2) (steps S203 and S204).

[0043] That is, it is determined whether or not the condensation temperature Ts of the high temperature-side refrigerant is equal to or higher than Tb1 (step S203), and in a case when the condensation temperature Ts of the high temperature-side refrigerant is lower than Tb1 (NO in step S203), the opening degree of the flow control valve 14 is increased (step S206). The process then returns to step S203.

[0044] Meanwhile, in a case when the condensation temperature Ts of the high temperature-side refrigerant is equal to or higher than Tb1 (YES in step S203), it is determined whether or not the condensation temperature Ts of the high temperature-side refrigerant is equal to or lower than Tb2 (step S204). While, in a case when the condensation temperature Ts of the high temperature-side refrigerant is higher than Tb2 (NO in step S204), the opening degree of the flow control valve 14 is decreased (step S207), and the process then returns to step S203.

[0045] Thereafter, when the condensation temperature Ts of the high temperature-side refrigerant in the utilization-side heat exchanger 7 is within the range of the predetermined temperatures Tb1 to Tb2 (YES in step S203 and YES in step S204), the opening degree of the flow control valve 14 is maintained, and the process returns to step S201.

[0046] As described above, when the temperature difference between the outdoor air temperature as an external heat source and the utilization-side fluid temperature flowing into the utilization-side heat exchanger satisfies the temperature conditions under which the compressor is operated with the reduced compression ratio, the flow control valve 14 is released, the heated utilization-side fluid is mixed with the utilization-side fluid to be supplied to the utilization-side heat exchanger 7, and the temperature of the utilization-side fluid flowing into the utilization-side heat exchanger is increased. Thus, according to such operations, the temperature conditions under which the compressor is operated with a reduced compression ratio can be avoided.

[0047] Furthermore, by detecting the temperature of the high temperature-side refrigerant in the utilization-side heat exchanger 7, it is determined whether or not the compressor is operated with a reduced compression ratio, and by controlling the opening degree of the flow control valve 14 provided in the bypass passage 13, the temperature of the utilization-side fluid to be supplied to the utilization-side heat exchanger 7 can be increased to an optimum temperature at which the compressor is not operated with a reduced compression ratio.

[0048] According to the structure as well as controlling manner mentioned above, the lowering in the condensation temperature of the utilization-side heat exchanger 7 can be suppressed, and then, the reduction in the compression ratio can be suppressed. Accordingly, it is possible to prevent a reduction in the reliability of the compressor occurring in a low compression ratio state, and eventually, to prevent a reduction in reliability of the binary refrigeration cycle system 100.

[0049] As described in the above embodiment, by constituting the binary refrigeration cycle system 100 with the first casing and the second casing independently from each other, the binary refrigeration cycle system 100 can be provided flexibly to a state of an installation place. For example, in a case of less outdoor installation space, the first casing accommodating the heat source-side heat exchanger 3 may be arranged on the outdoor side space, and the second casing accommodating the utilization-side heat exchanger may be arranged on the indoor side space.

[0050] It is to be noted that, in the described embodiment, although the low temperature-side casing 8a and the high temperature-side casing 8b are separately constituted, the present invention is not limited thereto, and the high temperature-side refrigeration cycle and the low temperature-side refrigeration cycle may be provided in one casing.

[0051] Furthermore, in the described embodiment, although the fluid control unit that controls the flow rate of the utilization-side fluid circulated in the bypass passage 13 is adapted to control the opening degree of the flow control valve 14, a different control unit may be used. For example, a three-way valve may be employed as at least one of the inlet-side branch portion 12a and the outlet-side branch portion 12b so that an opening degree of the three-way valve is controlled as the flow control valve.

[0052] It is further to be noted that the present invention is not limited to the embodiments described above, and a plurality of constitutional elements disclosed in the embodiments of the present invention may be combined appropriately to form various inventions. For example, some constitutional elements may be deleted from all the constitutional elements disclosed in the embodiments

of the present invention. Moreover, constitutional elements in different embodiments may be combined appropriately.

Reference Numeral

[0053] 1a --- low temperature-side compressor, 1b --- high temperature-side compressor, 2a --- low temperature-side four-way valve, 2b --- high temperature-side four-way valve, 3 --- heat source side heat exchanger, 4a --- low temperature-side expansion unit, 4b --- high temperature-side expansion unit, 5 --- intermediate heat exchanger, 6a--- low temperature-side refrigeration cycle, 6b --- high temperature-side refrigeration cycle, 7 --- utilization-side heat exchanger, 8a --- low temperature-side casing, 8b-high temperature-side casing, 9a, 9b --- connection pipe, 10 --- feed pump, 12a --- inlet-side branch portion, 12b-outlet-side branch portion, 13 --- bypass passage, 22-electric component box, 15 --- utilization-side fluid temperature detection unit, 16 --- outdoor air temperature sensor, 17a, 17b --- high temperature-side refrigerant temperature sensor, 18 --- utilization-side fluid pipe, 100-- binary refrigerant cycle system

Claims

1. A binary refrigeration cycle system comprising:

a low temperature-side refrigeration cycle including a heat source-side heat exchanger that absorbs heat from an external heat source, and a low temperature-side compressor;
a high temperature-side refrigeration cycle including a utilization-side heat exchanger that supplies heat to a utilization side, and a high temperature-side compressor;
an intermediate heat exchanger that exchanges heat between a refrigerant in the low temperature-side refrigeration cycle and a refrigerant in the high temperature-side refrigeration cycle;
a casing to which at least the utilization-side heat exchanger is mounted;
a utilization-side pipe that is provided for the casing and connected to the utilization-side heat exchanger so as to exchange heat between a circulated utilization-side fluid and the refrigerant in the high temperature-side refrigeration cycle and supply the heat to the utilization side;
a bypass passage that is connected to the utilization-side pipe in parallel with the utilization-side heat exchanger so as to feed the utilization-side fluid in the utilization-side pipe from a utilization-side heat exchanger outlet side to a utilization-side heat exchanger inlet side; and
a fluid control unit that controls a flow of the utilization-side fluid circulated in the bypass passage.

2. The binary refrigeration cycle apparatus according to claim 1, wherein the fluid control unit controls the flow of the utilization-side fluid circulated in the bypass passage so as not to decrease in a condensation temperature of the refrigerant in the high temperature-side refrigeration cycle and not to cause the high temperature-side compressor to be operated with a reduced compression ratio.

3. The binary refrigeration cycle apparatus according to claim 1, wherein the fluid control unit includes a utilization-side fluid temperature detection unit that detects a temperature of the utilization-side fluid flowing into the utilization-side heat exchanger, an external heat source temperature detection unit that is provided at the heat source-side heat exchanger to detect a temperature of the external heat source, and a flow control valve that changes a flow rate in the bypass passage, and the fluid control unit is controlled so as to open the flow control valve when a difference between the temperature of the utilization-side fluid detected by the utilization-side fluid temperature detection unit and the temperature of the external heat source detected by the external heat source temperature detection unit is equal to or smaller than a predetermined value.

4. The binary refrigeration cycle apparatus according to claim 1, wherein the fluid control unit includes a refrigerant temperature detection unit that detects a temperature of the refrigerant in the high temperature-side refrigeration cycle flowing into the utilization-side heat exchanger, and a flow control valve that changes a flow rate in the bypass passage, and the fluid control unit controls to increase an opening degree of the flow control valve in a case when a condensation temperature of the refrigerant in the high temperature-side refrigeration cycle detected by the refrigerant temperature detection unit is lower than a predetermined temperature.

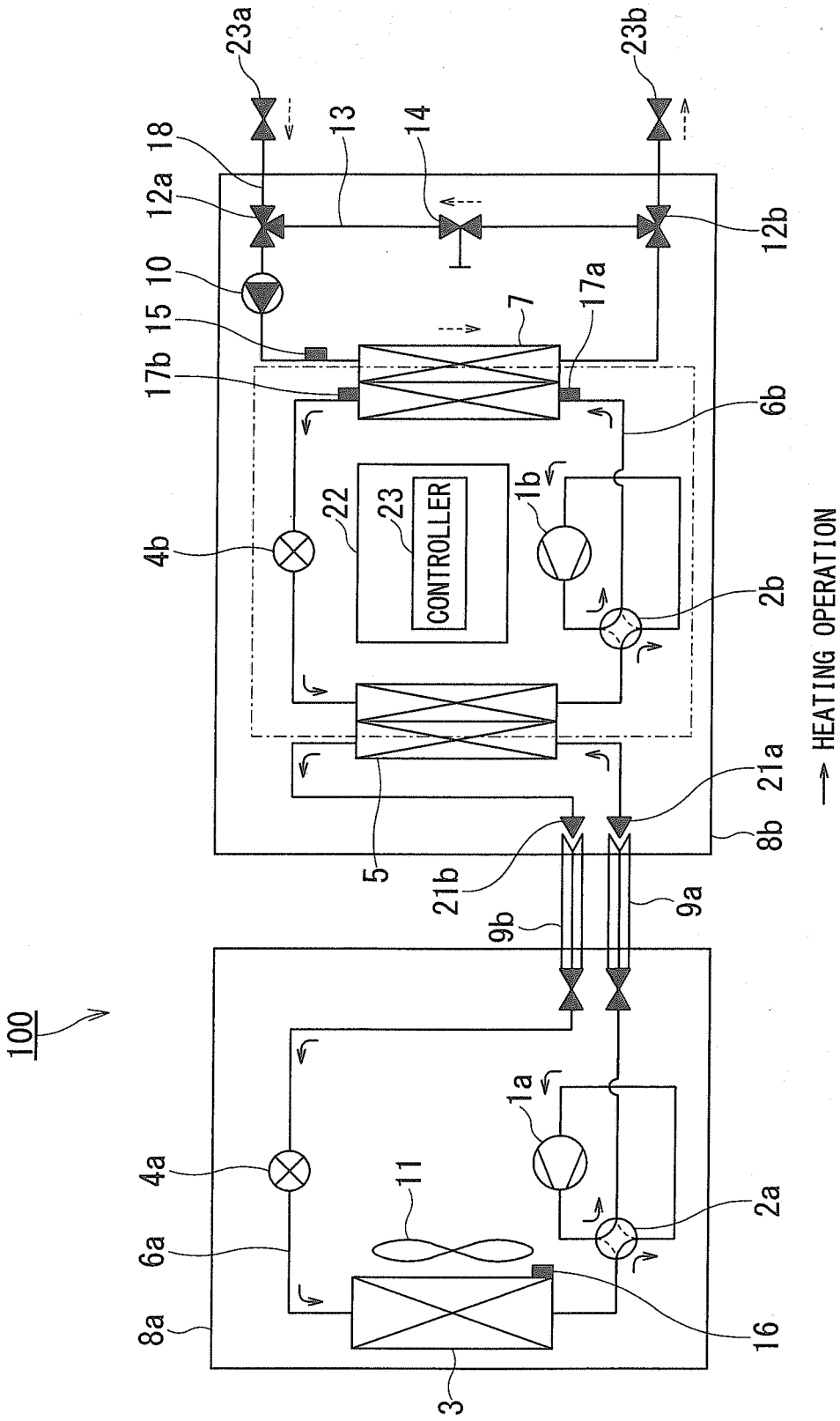
100
23a
23b
13
14
18
12a
12b
10
15
17b
17a
7
6b
4b
22
23
CONTROLLER
1b
2b
5
21b
21a
8b
9b
9a
1a
4a
11
2a
6a
8a
16
3
HEATING OPERATION

FIG. 1

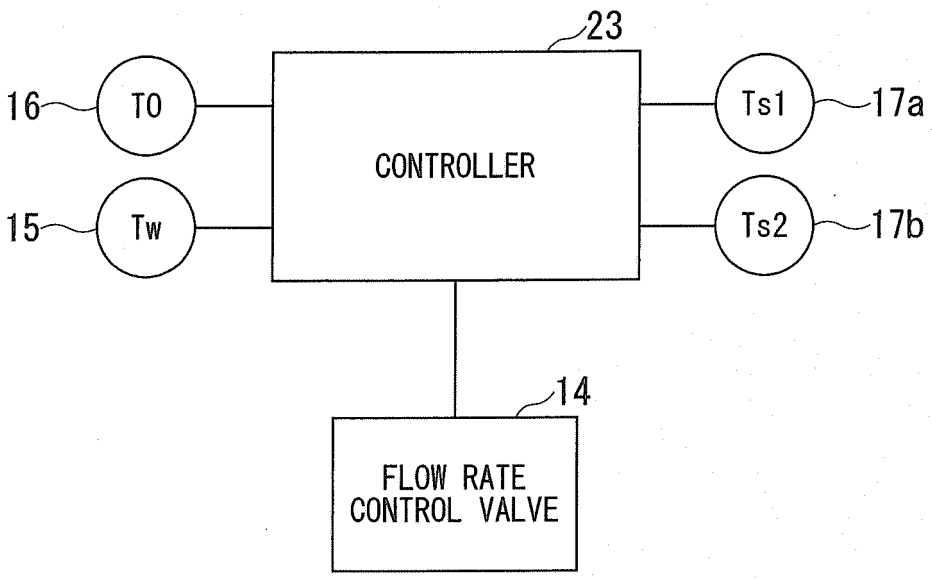
23
16
TO
CONTROLLER
Ts1
17a
15
Tw
Ts2
17b
14
FLOW RATE
CONTROL VALVE

FIG. 2

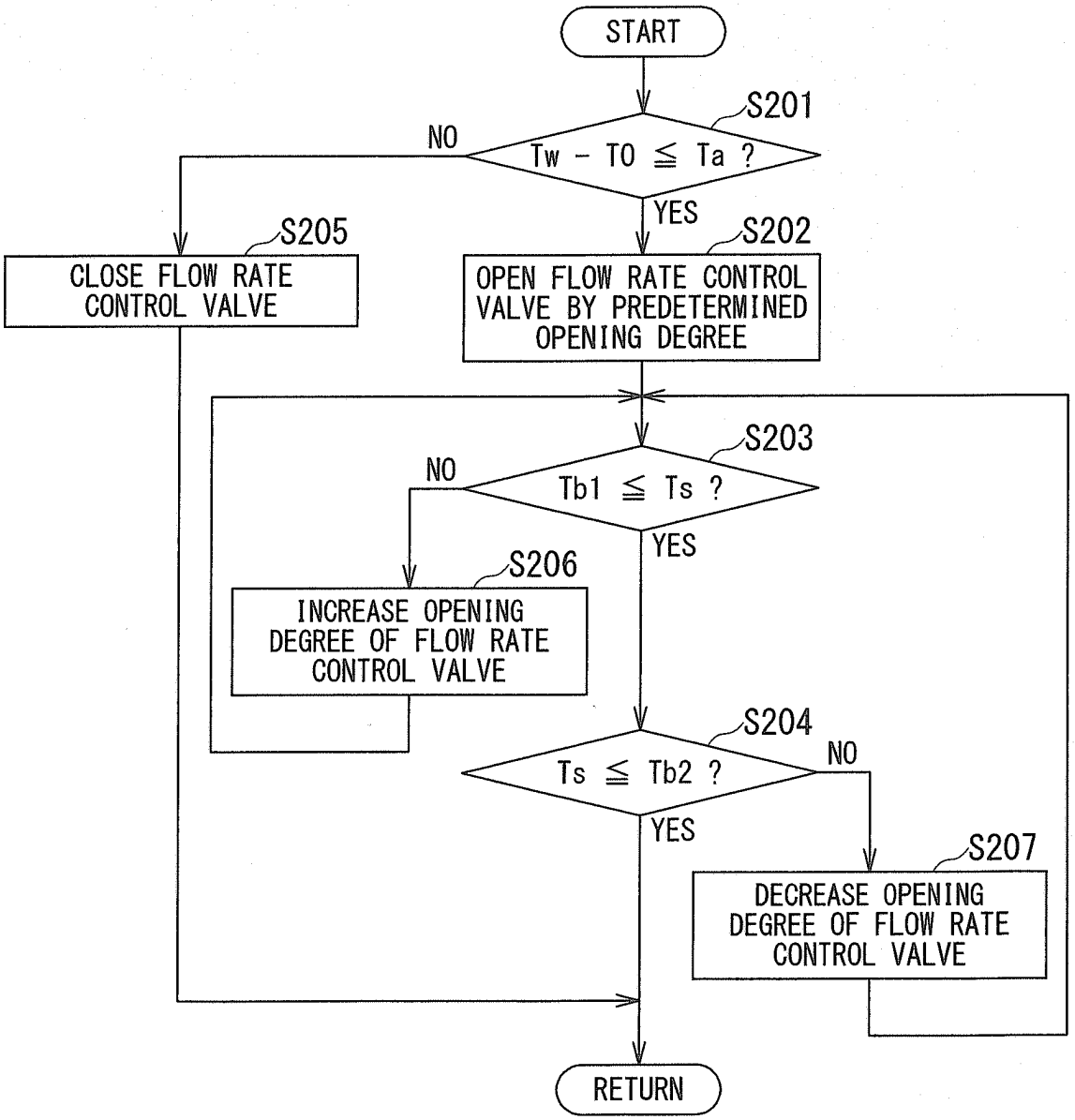
START
S201
Tw - TO ≦ Ta ?
NO
YES
S205
CLOSE FLOW RATE CONTROL VALVE
S202
OPEN FLOW RATE CONTROL VALVE BY PREDETERMINED OPENING DEGREE
S203
Tb1 ≦ Ts ?
NO
YES
S206
INCREASE OPENING DEGREE OF FLOW RATE CONTROL VALVE
S204
Ts ≦ Tb2 ?
NO
YES
S207
DECREASE OPENING DEGREE OF FLOW RATE CONTROL VALVE
RETURN

FIG. 3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2012/055951

A. CLASSIFICATION OF SUBJECT MATTER
F25B7/00(2006.01)i, *F25B1/00*(2006.01)i

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)
F25B7/00, F25B1/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2012
Kokai Jitsuyo Shinan Koho 1971-2012 Toroku Jitsuyo Shinan Koho 1994-2012

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 2010-276230 A (Sanyo Electric Co., Ltd.), 09 December 2010 (09.12.2010), fig. 1; paragraph [0047] & US 2010/0300135 A1 & EP 2261570 A2 & CN 101900455 A	1,2
A	JP 2002-235953 A (Toshiba Carrier Corp.), 23 August 2002 (23.08.2002), fig. 1; paragraph [0028] (Family: none)	1,2
A	JP 2000-18712 A (Kyocera Corp.), 18 January 2000 (18.01.2000), fig. 1; paragraph [0020] (Family: none)	1,2

☐ 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
25 May, 2012 (25.05.12)	05 June, 2012 (05.06.12)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2012/055951

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:
See extra sheet.

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

1 and 2.

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

Form PCT/ISA/210 (continuation of first sheet (2)) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2012/055951

Continuation of Box No.III of continuation of first sheet(2)

Disclosed in JP2010-276230A (Sanyo Electric Co., Ltd.), 09 December 2010 (09.12.2010), fig. 1; paragraph [0047] (hereinafter referred to as Document 1) is a cascade refrigeration cycle system which comprises: a low temperature-side refrigeration cycle (91); a high-temperature-side refrigeration cycle (92); an intermediate heat exchanger (5) for exchanging heat between refrigerants in the low temperature-side refrigeration cycle and the high-temperature-side refrigeration cycle; a housing (30) for accommodating at least a service-side heat exchanger (32); a bypass passageway connecting to a service-side pipe in parallel with the service-side heat exchanger and feeding a service-side fluid in the service-side pipe at the outlet of the service-side heat exchanger into the inlet of the service-side heat exchanger, the service-side pipe connecting to the service-side heat exchanger and exchanging heat between the flowing service-side fluid and the refrigerant in the high-temperature-side refrigeration cycle so as to supply the resulting heat to the service side; and a fluid control means (53) for controlling the flow of the service-side fluid which flows through the bypass passageway, the fluid control means providing control so as to open the bypass passageway and allow the service-side fluid to flow immediately after a boiling operation is started (corresponding to a case where at a low condensation temperature, a high-temperature-side compressor operates at a low compression ratio.)

Therefore, the inventions according to claims 1 and 2 are not considered to be novel over the invention cited in Document 1 and do not have special technical feature. Therefore, three inventions (invention groups) each having a special technical feature indicated below are involved in claims.

Meanwhile, the invention of claim 1 having no special technical feature is classified into invention 1.

(Invention 1) the inventions set forth in claims 1 and 2

A cascade refrigeration cycle system which is provided with a fluid control means for controlling the flow of a service-side fluid flowing through a bypass passageway so that a high-temperature-side compressor will not operate at a low compression ratio due to a drop in the condensation temperature of a refrigerant in a high-temperature-side refrigeration cycle.

(Invention 2) the invention set forth in claim 3

A cascade refrigeration cycle system which includes: a service-side fluid temperature sensor means for sensing the temperature of a service-side fluid flowing into a service-side heat exchanger; an external heat source temperature sensor means, which is provided in a heat-source-side heat exchanger, for sensing the temperature of an external heat source; and a fluid control means which includes a flow control valve for varying the rate of flow through a bypass passageway and which provides control so as to open the flow control valve when the difference between the temperature of the service-side fluid sensed by the service-side fluid temperature sensor means and the temperature of the external heat source sensed by the external heat source temperature sensor means has reached a predetermined value or less.

(Invention 3) the invention set forth in claim 4

A cascade refrigeration cycle system which is provided with: a refrigerant temperature sensor means for sensing the temperature of a refrigerant in the high-temperature-side refrigeration cycle, the

(continued to next extra sheet)

Form PCT/ISA/210 (extra sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2012/055951

refrigerant flowing into the service-side heat exchanger; and a fluid control means which includes a flow control valve for varying the rate of flow through a bypass passageway and which provides control so as to increase the opening of the flow control valve when the condensation temperature of the refrigerant in the high-temperature-side refrigeration cycle sensed by the refrigerant temperature sensor means is lower than a predetermined temperature.

Form PCT/ISA/210 (extra sheet) (July 2009)

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 8189714 A **[0004]**