(12) STANDARD PATENT (11) Application No. **AU 2016224364 B2**
(19) AUSTRALIAN PATENT OFFICE

(54) Title
REFRIGERATION CYCLE APPARATUS

(51) International Patent Classification(s)
F25B 1/00 (2006.01) ***F25B 49/02*** (2006.01)
F25B 13/00 (2006.01)

(21) Application No: **2016224364** (22) Date of Filing: **2016.02.26**

(87) WIPO No: **WO16/136979**

(30) Priority Data

(31) Number	(32) Date	(33) Country
2015-038470	**2015.02.27**	**JP**

(43) Publication Date: **2016.09.01**
(44) Accepted Journal Date: **2018.09.20**

(71) Applicant(s)
Toshiba Carrier Corporation

(72) Inventor(s)
Matsubara, Kentaro

(74) Agent / Attorney
Phillips Ormonde Fitzpatrick, PO Box 323, Collins Street West, VIC, 8007, AU

(56) Related Art
JP 2007212135 A
JP 2007218532 A

(12) 特許協力条約に基づいて公開された国際出願

(19) 世界知的所有権機関
国際事務局

(43) 国際公開日
2016 年 9 月 1 日(01.09.2016)

WIPO | PCT

(10) 国際公開番号
WO 2016/136979 A1

(51) 国際特許分類:
F25B 1/00 (2006.01) *F25B 13/00* (2006.01)
F24F 11/02 (2006.01) *F25B 49/02* (2006.01)

(21) 国際出願番号: PCT/JP2016/055914

(22) 国際出願日: 2016 年 2 月 26 日(26.02.2016)

(25) 国際出願の言語: 日本語

(26) 国際公開の言語: 日本語

(30) 優先権データ:
特願 2015-038470 2015 年 2 月 27 日(27.02.2015) JP

(71) 出願人: 東芝キヤリア株式会社(**TOSHIBA CARRIER CORPORATION**) [JP/JP]; 〒2128585 神奈川県川崎市幸区堀川町７２番地３４ Kanagawa (JP).

(72) 発明者: 松原 健太朗(**MATSUBARA, Kentaro**); 〒4168521 静岡県富士市蓼原３３６番地 東芝キヤリア株式会社内 Shizuoka (JP).

(74) 代理人: 特許業務法人スズエ国際特許事務所(**S & S INTERNATIONAL PPC**); 〒1050001 東京都港区虎ノ門一丁目１２番９号 スズエ・アンド・スズエビル Tokyo (JP).

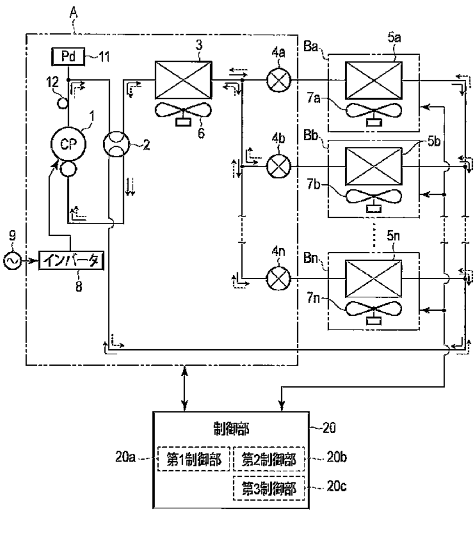
(81) 指定国 (表示のない限り、全ての種類の国内保護が可能): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) 指定国 (表示のない限り、全ての種類の広域保護が可能): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), ユーラシア (AM, AZ, BY, KG, KZ, RU, TJ, TM), ヨーロッパ (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

添付公開書類:
— 国際調査報告（条約第 21 条(3)）

(54) **Title**: REFRIGERATION CYCLE DEVICE

(54) 発明の名称 : 冷凍サイクル装置



8 Inverter
20 Control unit
20a First control unit
20b Second control unit
20c Third control unit

(57) **Abstract**: Through the present invention, a compressor is stopped in response to operation of a high-pressure switch, and subsequently, the compressor is restarted in response to returning of the high-pressure switch, and the lower-limit value of opening degree control for an expansion valve is also shifted to an increased value during the restarting.

(57) 要約: 高圧スイッチの作動に応じて圧縮機を停止し、その後、高圧スイッチの復帰に応じて圧縮機を再起動するするとともに、この再起動に際し膨張弁に対する開度制御の下限値を増大側にシフトする。

WO 2016/136979 A1

D E S C R I P T I O N

REFRIGERATION CYCLE APPARATUS

Technical Field

Embodiments described herein relate generally to a refrigeration cycle apparatus coping with a rise in the pressure on the high-pressure side.

Background Art

A refrigeration cycle apparatus incorporated in an air-conditioning apparatus or the like is provided with a high-pressure switch responding to the pressure on the high-pressure side of a refrigeration cycle, when the pressure on the high-pressure side rises and the high-pressure switch operates, the compressor is stopped, and when thereafter the pressure on the high-pressure side lowers and the high-pressure switch is restored, the compressor is restarted. When the high-pressure switch operates, the compressor is stopped, whereby the pressure on the high-pressure side is prevented from abnormally rising, and the safety of the refrigeration cycle equipment including the compressor is secured.

A reference herein to a patent document or any other matter identified as prior art, is not to be taken as an admission that the document or other matter was known or that the information it contains was part of the common general knowledge as at the priority date of any of the claims.

Summary of Invention

Even when the compressor is restarted in response to the restoration of the high-pressure switch, the pressure on the high-pressure side soon rises again, and the high-pressure switch operates in some cases. In this case, the compressor frequently repeats a stop and restart to thereby cause a variation in the indoor temperature and deteriorate the comfort of air conditioning.

Further, as a refrigerant for the refrigeration cycle, in place of the R410A refrigerant, a changeover to the refrigerant R32 excellent in ability and energy efficiency is advancing. However, as for the refrigerant R32, the pressure thereof at the time when it is discharged from the compressor becomes higher than the case of the refrigerant R410A, and hence a state where the high-pressure switch is liable to operate is brought about.

Embodiments of the present invention may provide a refrigeration cycle apparatus capable of preventing the pressure on the high-pressure side after a restart of the compressor from rising, and thereby preventing frequent repetitions of a stop and restart of the compressor from occurring.

According to one aspect of the invention, there is provided a refrigeration cycle apparatus comprising a refrigeration cycle including a compressor, a condenser, an expansion valve, and an evaporator; a high-pressure switch responding to the pressure on the high-pressure side of the refrigeration cycle; and a control unit configured to control the degree of opening Q of the expansion valve to be within a range of a predetermined upper-limit value Qmax to a predetermined lower-limit value Qmin in order that the degree of superheat of the evaporator or the degree of subcooling of the condenser becomes a constant value, wherein the control unit stops the compressor in response to an operation of the high-pressure switch, thereafter restarts the compressor in response to restoration of the high-pressure switch, and at the time of the restart, shifts the lower-limit value Qmin of opening degree control for the expansion valve toward the increase side by a predetermined value ΔQ.

Brief Description of Drawings

FIG. 1 is a block diagram showing the configuration of an embodiment.

FIG. 2 is a flowchart showing the control of the embodiment.

FIG. 3 is a view showing a relationship between the capacity of a refrigeration cycle at the time of cooling and the pressure on the high-pressure side in the embodiment.

FIG. 4 is a view showing a relationship between the capacity of a refrigeration cycle at the time of heating and the pressure on the high-pressure side in the embodiment.

FIG. 5 is a view showing examples of changes in the pressure on the high-pressure side, expansion valve opening, discharged refrigerant temperature, and compressor rotational speed.

Detailed Description of Example Embodiment(s)

Hereinafter, an embodiment will be described with reference to the drawings.

As shown in FIG. 1, one end of an outdoor heat exchanger 3 is piping-connected to an discharge port of a compressor 1 through a four-way valve 2. One end of each of a plurality of indoor heat exchangers 5a, 5b, ... 5n is piping-connected to the other end of the outdoor heat exchanger 3 through each of a plurality of expansion valves 4a, 4b, ... 4n, and the other end of each of the plurality of indoor heat exchangers 5a, 5b, ... 5n is piping-connected to an inlet port of the compressor 1 through the four-way valve 2. These piping connections constitute a heat pump refrigeration cycle. This heat pump refrigeration cycle system is filled with a refrigerant including the refrigerant R32 in an amount of, for example, 50% or more.

At the time of cooling, as indicated by solid line arrows, the refrigerant discharged from the compressor 1 flows into the indoor heat exchangers (evaporators) 5a, 5b, ... 5n through the four-way valve 2, outdoor heat exchanger (condenser) 3, and expansion valves 4a, 4b, ... 4n, and the refrigerant flowing out of the

2016224364 13 Aug 2018

indoor heat exchangers 5a, 5b, ... 5n is sucked into the compressor 1 through the four-way valve 2. At the time of heating, as indicated by broken line arrows, the flow paths in the four-way valve 2 are changed, whereby the refrigerant discharged from the compressor 1 flows into the indoor heat exchangers (condenser) 5a, 5b, ... 5n, and the refrigerant flowing out of the indoor heat exchangers 5a, 5b, ... 5n is sucked into the compressor 1 through expansion valves 4a, 4b, ... 4n, outdoor heat exchanger (evaporator) 3, and four-way valve 2.

An outdoor fan 6 is arranged in the vicinity of the outdoor heat exchanger 3, and indoor fans 7a, 7b, ... 7n are arranged in the vicinities of the indoor heat exchangers 5a, 5b, ... 5n. An inverter 8 is connected to a motor of the compressor 1. The inverter 8 converts a voltage of an AC source 9 into a DC voltage, and further converts the DC voltage into an AC voltage of a predetermined frequency F to output the AC voltage. The motor of the compressor 1 operates at a rotational speed corresponding to this output frequency F.

A high-pressure switch 11 and refrigerant temperature sensor 12 are attached to the high-pressure side piping between the discharge port of the compressor 1 and the four-way valve 2. The high-pressure switch 11 operates when the pressure (called the pressure on the high-pressure side) Pd of the refrigerant discharged from the compressor 1 rises to a value greater than a set value Pd2, and is restored when the pressure Pd on the high-pressure side lowers to a value smaller than a set value Pd1 (<Pd2). The refrigerant temperature sensor 12 detects the temperature Td of the refrigerant discharged from the compressor 1.

Each of the expansion valves 4a, 4b, ... 4n is a so-called pulse-motor valve in which the degree of opening continuously changes according to the number of pulses of a drive pulse signal input thereto.

In an outdoor unit A, the compressor 1, four-way valve 2, outdoor heat exchanger 3, expansion valves 4a, 4b, ... 4n, outdoor fan 6, and inverter 8 are incorporated. In a plurality of indoor units Ba, Bb, ... Bn, the indoor heat exchangers 5a, 5b, ... 5n, and indoor fans 7a, 7b, ... 7n are respectively incorporated. A control unit 20 is connected to the outdoor unit A and indoor units Ba, Bb, ... Bn.

The control unit 20 is constituted of a microcomputer and peripheral circuit thereof, and includes, as main functions, a first control section 20a, second control section 20b, and third control section 20c.

The first control section 20a stops the compressor 1 in response to an operation of the high-pressure switch 11, and thereafter restarts the compressor 1 in response to the restoration of the high-pressure switch 11.

The second control section 20b controls, at the time of the operation of the heat pump refrigeration cycle, the degree of opening Q of each of the expansion valves 4a, 4b, ... 4n to be within a range of a predetermined upper-limit value Qmax to a predetermined lower-limit value Qmin in order that the degree of superheat (at the time of cooling) or the degree of subcooling (at the time of heating) of the indoor heat exchangers 5a, 5b, ... 5n may become a constant value.

The third control section 20c shifts (opening-narrowing control), at the time of a restart of the compressor 1 based on the restoration of the high-pressure switch 11, the lower-limit value Qmin of the opening degree control for each of the expansion valves 4a, 4b, ... 4n toward the increase side by a predetermined value ΔQ.

It should be noticed that the second control section 20b sets the predetermined value ΔQ which is the shift amount to different values (ΔQ1, ΔQ2, ... ΔQn) according to the capacity (the number of indoor units Ba, Bb, ... Bn in operation) of the heat pump refrigeration cycle. More specifically, the second control section 20b sets the predetermined value ΔQ to a value proportional to the capacity of the heat pump refrigeration cycle at the time of cooling, and to a value inversely proportional to the capacity of the heat pump refrigeration cycle at the time of heating. Further, the second control section 20b selectively executes the opening-narrowing control of shifting the lower-limit value Qmin on the basis of a comparison between the discharged refrigerant temperature Td to be detected by the refrigerant temperature sensor 12 and a set value Tds. Furthermore, the second control section 20b cancels the selective execution of the opening-narrowing control concomitantly with shutdown of the heat pump refrigeration cycle.

Next, the control to be executed by the control unit 20 will be described below with reference to the flowchart of FIG. 2.

At the time of a start of an operation of at least one of the indoor units Ba, Bb, ... Bn (YES in step S1), the control unit 20 starts the compressor 1 (step S2). Concomitantly with the start, the control unit 20 confirms whether or not an opening degree limiting flag f is "0" (step S3).

When the opening degree limiting flag f is "0" (YES in step S3), the control unit 20 controls the degree of opening Q of each of the expansion valves 4a, 4b, ... 4n to be within the range of the predetermined upper-limit value Qmax to the predetermined lower-limit value Qmin in order that the degree of superheat (at the time of cooling) or the degree of subcooling (at the time of heating) of the indoor heat exchangers 5a, 5b, ... 5n may become a constant value (step S4).

The control unit 20 monitors the operation of the high-pressure switch 11 concomitantly with the opening degree control (step S7). When the high-pressure switch 11 does not operate (NO in step S7), the control unit 20 monitors a shutdown of the indoor units Ba, Bb, ... Bn (step S14).

When a shutdown of the indoor units Ba, Bb, ... Bn is not needed (NO in step S14), the control unit 20 returns to the flag determination of step S3. When a shutdown of the indoor units Ba, Bb, ... Bn is needed (YES in step S14), the control unit 20 stops the compressor 1 (step S15). Further, the control unit 20 resets the opening degree limiting flag f to "0" (step S16), and returns to the operation start determination of first step S1.

On the other hand, when the high-pressure switch 11 operates (YES in step S7), the control unit 20 stops the compressor 1 (step S8). By this stop, the pressure on the high-pressure side is prevented from abnormally rising. Further, the control unit 20 starts time measurement t (step S9), and monitors the restoration of the high-pressure switch 11 (step S10). When the restoration of the high-pressure switch 11 is not obtained (NO in step S10), the time measurement t is continued (step S9).

When the pressure on the high-pressure side lowers, and the high-pressure switch 11 is restored (YES in step S10), the control unit 20 determines whether or not the time measurement t has reached a fixed time ts (step S11). The fixed time ts is a restart limiting time for preventing the damage or the like of the compressor 1.

When the time measurement t has not reached the fixed time ts (NO in step S11), the control unit 20 continues the time measurement t (step S9). When the time measurement t has reached the fixed time ts (YES in step S11), the control unit 20 restarts the compressor 1 (step S12), and sets the opening degree limiting flag f to "1" (step S13). Further, the controller 20 monitors a shutdown of the indoor units Ba, Bb, ... Bn (step S14).

When a shutdown of the indoor units Ba, Bb, ... Bn is not needed (NO in step S14), the control unit 20 returns to the flag determination of step S3. At this time, the opening degree limiting flag f is "1" (NO in step S3), and hence the control unit 20 compares the discharged refrigerant temperature (detected temperature) Td detected by the refrigerant temperature sensor 12 and the set value Tds with each other (step S5).

When the discharged refrigerant temperature Td is lower than the set value Tds (NO in step S5), the control unit 20 controls the degree of opening Q of each of the expansion valves 4a, 4b, ... 4n to be within the range of the upper-limit value Qmax to the normal lower-limit value Qmin (step S4).

When the discharged refrigerant temperature Td is higher than or equal to the set value Tds (YES in step S5), the control unit 20 shifts the lower-limit value Qmin of the opening degree control toward the increase side by a predetermined value ΔQ, and controls the degree of opening Q of each of the expansion valves 4a, 4b, ... 4n to be within the range of the upper-limit value Qmax to the lower-limit value "Qmin+ΔQ" (step S6).

A relationship between the outdoor air temperature and the pressure Pd on the high-pressure side, and a relationship between the outdoor air temperature and the discharged refrigerant temperature Td are respectively proportional relations. When the outdoor air temperature rises, the pressure Pd on the high-pressure side and the discharged refrigerant temperature Td also rise. In this state, when the degree of opening Q of each of the expansion valves 4a, 4b, ... 4n is narrowed to the lower-limit value Qmin, there is a possibility of the high-pressure switch 11 operating after an elapse of not so long a time from the restart of the compressor 1, and thereby stopping the compressor 1.

Thus, when the discharged refrigerant temperature Td is higher than or equal to the set value Tds, the opening-narrowing control of shifting the lower-limit value Qmin of the opening degree control toward the increase side is executed, whereby it is possible to prevent the pressure Pd on the high-pressure side after the restart of the compressor 1 from rising. Particularly, even when the refrigerant with which the heat pump refrigeration cycle system is filled is the refrigerant R32, by carrying out the opening-narrowing control as in the case of the refrigerant R410A, it is possible to prevent the pressure Pd on the high-pressure side after the restart of the compressor 1 from rising.

Accordingly, it is possible to prevent the operation of the high-pressure switch 11 at the time of the restart of the compressor 1 from being carried out, and by extension, to prevent frequent repetitions of a stop and restart of the compressor 1 from occurring.

Thereby, the indoor temperature which is the load can be stabilized, and the comfort of air conditioning is improved.

It should be noted that when the outdoor air temperature lowers, the pressure Pd on the high-pressure side and the discharged refrigerant temperature Td also lower, and hence there is a possibility of the opening-narrowing control becoming unnecessary. When the opening-narrowing control is furthermore carried out under such circumstances, there is a possibility of the operational state of the heat pump refrigeration cycle becoming unable to be held appropriate, and thereby causing a shortage of air-conditioning capability. In consideration of these circumstances, when the discharged refrigerant temperature Td is lower than the set value Tds (NO in step S5), the control unit 20 controls the degree of opening Q to be within the range of the upper-limit value Qmax to the normal lower-limit value Qmin without executing the opening-narrowing control (step S4).

Thereafter, when a state where a shutdown of the indoor units Ba, Bb, ... Bn is needed is brought about (YES in step S14), the control unit 20 stops the compressor 1 (step S15). Then, the control unit 20 resets the opening degree limiting flag f (=1) to "0" (step S16), and returns to the operation start determination of first step S1. By resetting the opening degree limiting flag f to "0", the selective execution of the opening-narrowing control corresponding to the discharged refrigerant temperature Td is canceled.

Incidentally, the pressure Pd on the high-pressure side changes according to the capacity (the number of indoor units Ba, Bb, ... Bn in operation) of the heat pump refrigeration cycle. That is, at the time of cooling, as shown in FIG. 3, the larger the capacity, the higher the pressure Pd on the high-pressure side rises. Conversely, at the time of heating, as shown in FIG. 4, the smaller the capacity, the higher the pressure Pd on the high-pressure side rises.

In consideration of these circumstances, the control unit 20 sets the predetermined value ΔQ which is the shift amount of the opening-narrowing control to different values (ΔQ1, ΔQ2, ... ΔQn) according to the number of indoor units Ba, Bb, ... Bn in operation. That is, at the time of cooling, in consideration of the fact that the larger the number of indoor units in operation, the higher the pressure Pd on the high-pressure side rises, the control unit 20 sets the predetermined value ΔQ1 when the number of indoor units in operation is 1, sets the predetermined value ΔQ2 (>Q1) when the number is 2, sets the predetermined value ΔQ3 (>Q2) when the number is 3, and sets the predetermined value ΔQn (... >Q3) when the number is the largest number n. At the time of heating, in consideration of the fact that the smaller the number of indoor units in operation, the higher the pressure Pd on the high-pressure side rises, the control unit 20 sets the predetermined value ΔQn when the number of indoor units in operation is 1, and sets the predetermined values ΔQ3, ΔQ2, and ΔQ1 in sequence with the increase in the number of indoor units in operation. In short, on the side on which the rise in the pressure Pd on the high-pressure side is remarkable, the predetermined value ΔQ is made large.

Further, concomitantly with the switching of the predetermined values ΔQ1, ΔQ2, ... ΔQn, the control unit 20 switches the set value Tds which is the criterion of the selective execution of the opening-narrowing control. That is, the control unit 20 selects a set value Tds1 when the predetermined value ΔQ1 is set, selects a set value Tds2 (>Tds1) when the predetermined value ΔQ2 is set, selects a set value Tds3 (>Tds2) when the predetermined value ΔQ3 is set, and selects a set value Tdsn (... >Tds3) when the predetermined value ΔQn is set.

As described above, the predetermined value ΔQ which is the shift amount of the opening-narrowing control is set to different values according to the number of indoor units Ba, Bb, ... Bn in operation, and the set value Tds which is the criterion of the selective execution of the opening-narrowing control is switched according to the predetermined value ΔQ, whereby it is possible to prevent frequent repetitions of a stop and restart of the compressor 1 from occurring irrespective of a change in the number of indoor units Ba, Bb, ... Bn in operation, i.e., irrespective of a change in the capacity of the heat pump refrigeration cycle.

Examples of changes in the pressure Pd on the high-pressure side, degree of opening Q of the expansion valve, discharged refrigerant temperature Td, and compressor rotational speed are shown in FIG. 5. As the degree of opening Q is narrowed, the pressure Pd on the high-pressure side rises, and when the pressure Pd on the high-pressure side rises to a set value Pd2≈4.1 MPa, the high-pressure switch 11 operates to thereby stop the compressor 1. Thereafter, when the pressure Pd on the high-pressure side lowers to a set value Pd1≈3.2 MPa, the high-pressure switch 11 is restored, and the compressor 1 is restored, however the discharged refrigerant temperature Td exceeds a set value Tds≈65 °C, and hence narrowing of the degree of opening Q is limited to the minimum value Qmin≈200 pls which is the value after the shift, and concomitantly with this, the rise in the pressure Pd on the high-pressure side is held to about 3.7 MPa.

It should be noticed that although in the above embodiment, a description has been given by taking the refrigeration cycle apparatus to be incorporated in the air-conditioning apparatus as an example, the embodiment is also similarly applicable to a refrigeration cycle apparatus to be incorporated in other apparatuses.

The above embodiment and modification examples have been presented by way of example only, and are not intended to limit the scope of the inventions. Indeed, the novel embodiment and modification examples described herein may be embodied in a variety of other forms; furthermore, various omissions, substitutions and changes in the form of the embodiment and modification examples described herein may be made without departing from the spirit of the inventions. The accompanying claims and their equivalents are intended to cover such forms or modifications as would fall within the scope and spirit of the inventions.

Reference Signs List

1 ... compressor, 2 ... four-way valve, 3 ... outdoor heat exchanger, 4a, 4b, ... 4n .... expansion valve, 5a, 5b, ... 5n .... indoor heat exchanger, 8 ... inverter, 9 ... AC source, and 20 ... control unit

Where any or all of the terms "comprise", "comprises", "comprised" or "comprising" are used in this specification (including the claims) they are to be interpreted as specifying the presence of the stated features, integers, steps or components, but not precluding the presence of one or more other features, integers, steps or components.

C L A I M S

1. A refrigeration cycle apparatus comprising:

a refrigeration cycle including a compressor, a condenser, an expansion valve, and an evaporator;

a high-pressure switch responding to the pressure on the high-pressure side of the refrigeration cycle; and

a control unit configured to control the degree of opening Q of the expansion valve to be within a range of a predetermined upper-limit value Qmax to a predetermined lower-limit value Qmin in order that the degree of superheat of the evaporator or the degree of subcooling of the condenser becomes a constant value,

wherein

the control unit stops the compressor in response to an operation of the high-pressure switch, thereafter restarts the compressor in response to restoration of the high-pressure switch, and at the time of the restart, shifts the lower-limit value Qmin of opening degree control for the expansion valve toward the increase side by a predetermined value ΔQ.

2. The refrigeration cycle apparatus of Claim 1, wherein

the control unit sets the predetermined value ΔQ to different values according to the capacity of the refrigeration cycle.

3. The refrigeration cycle apparatus of Claim 2, wherein

the refrigeration cycle is a heat pump refrigeration cycle capable of carrying out cooling and heating, and

the control unit sets the predetermined value ΔQ to a value proportional to the capacity of the refrigeration cycle at the time of cooling, and to a value inversely proportional to the capacity of the refrigeration cycle at the time of heating.

4. The refrigeration cycle apparatus of any one of Claim 1 to Claim 3, further comprising temperature detecting section for detecting a temperature of a refrigerant discharged from the compressor, wherein

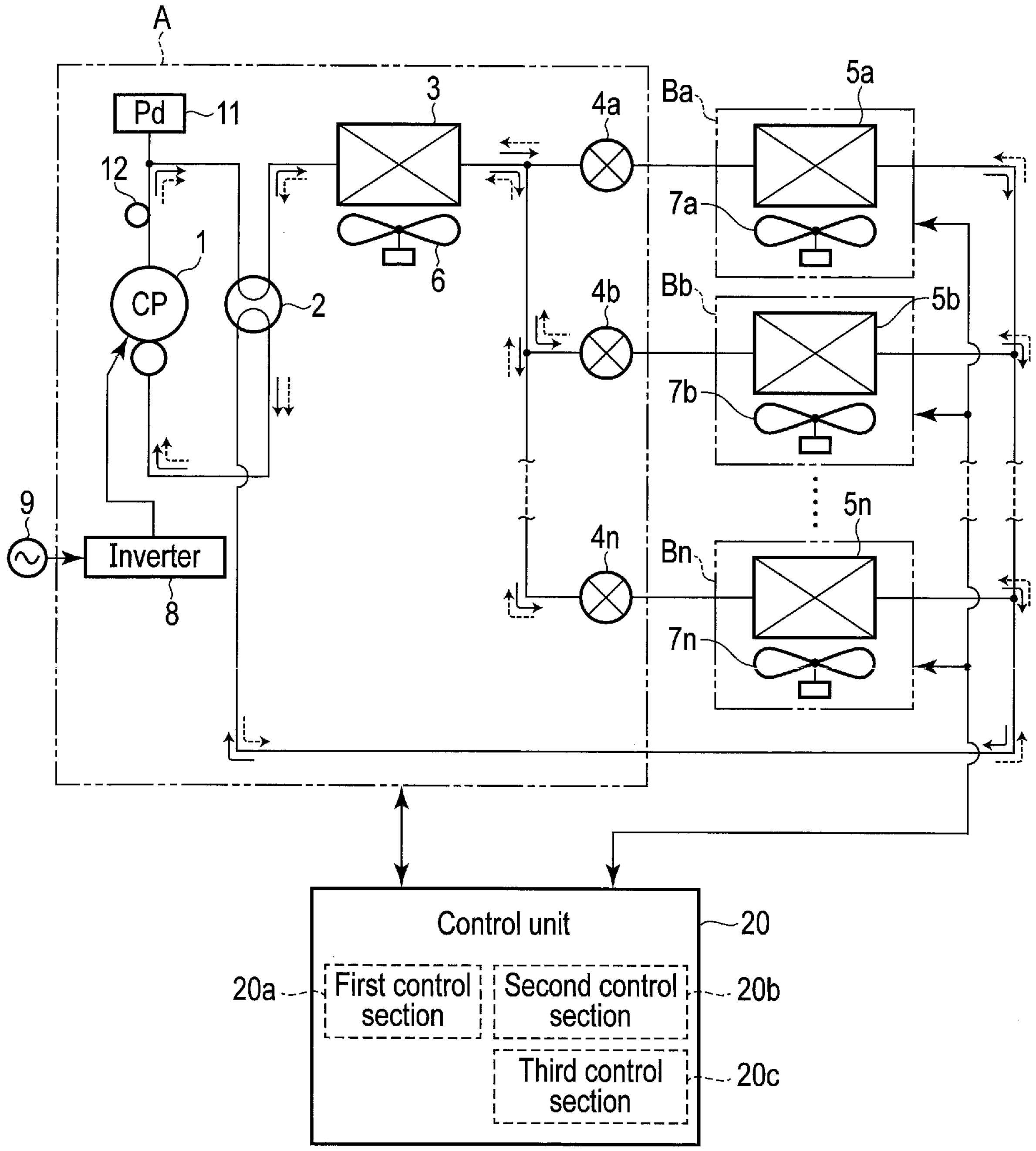
the control unit selectively executes shifting of the lower-limit value Qmin according to whether or not a detected temperature of the temperature detecting section is higher than or equal to a set value.

5. The refrigeration cycle apparatus of Claim 4, wherein

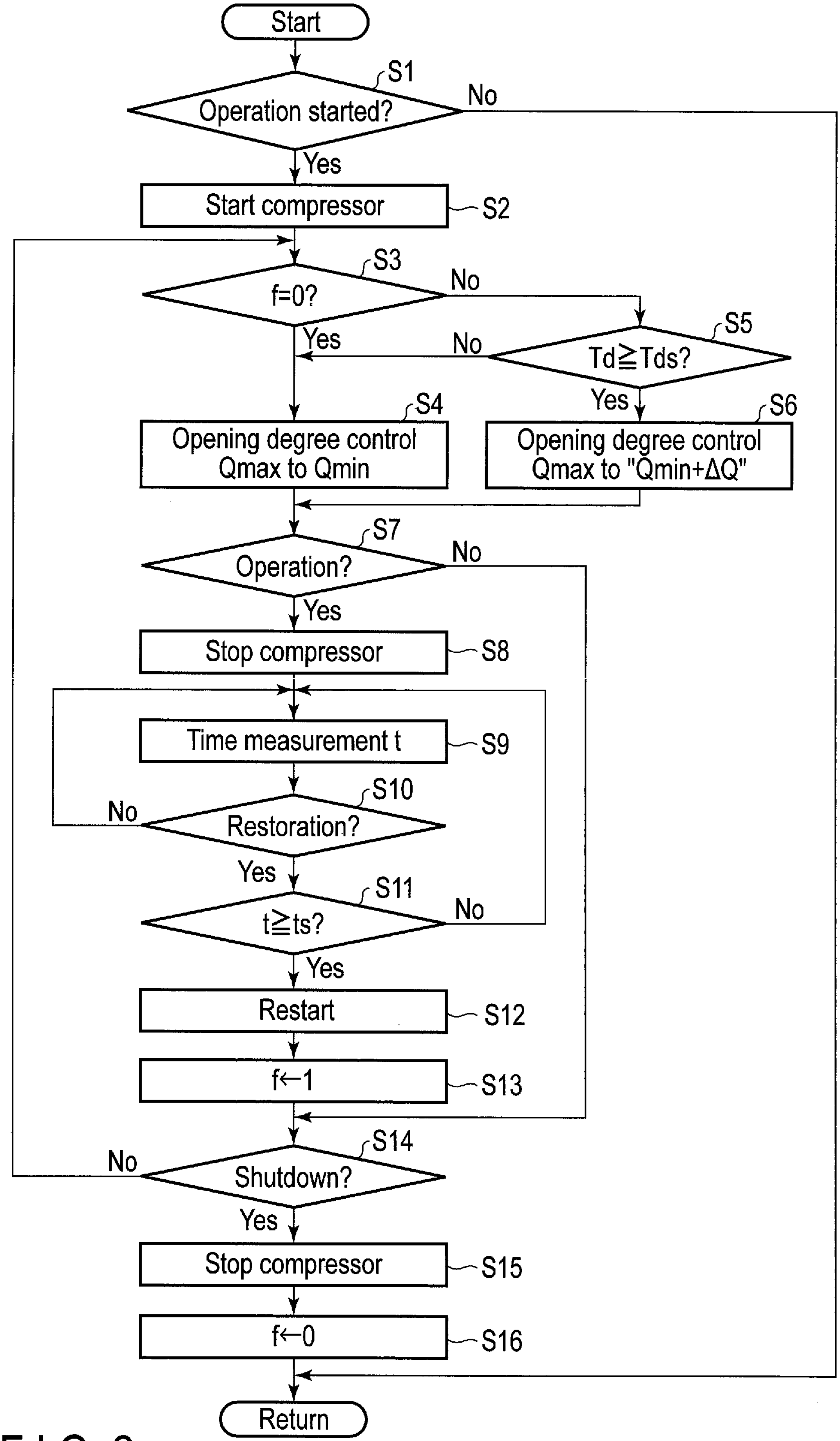
the control unit cancels the selective execution of the shifting of the lower-limit value Qmin concomitantly with a shutdown of the refrigeration cycle.

6. The refrigeration cycle apparatus of any one of Claim 1 to Claim 3, wherein

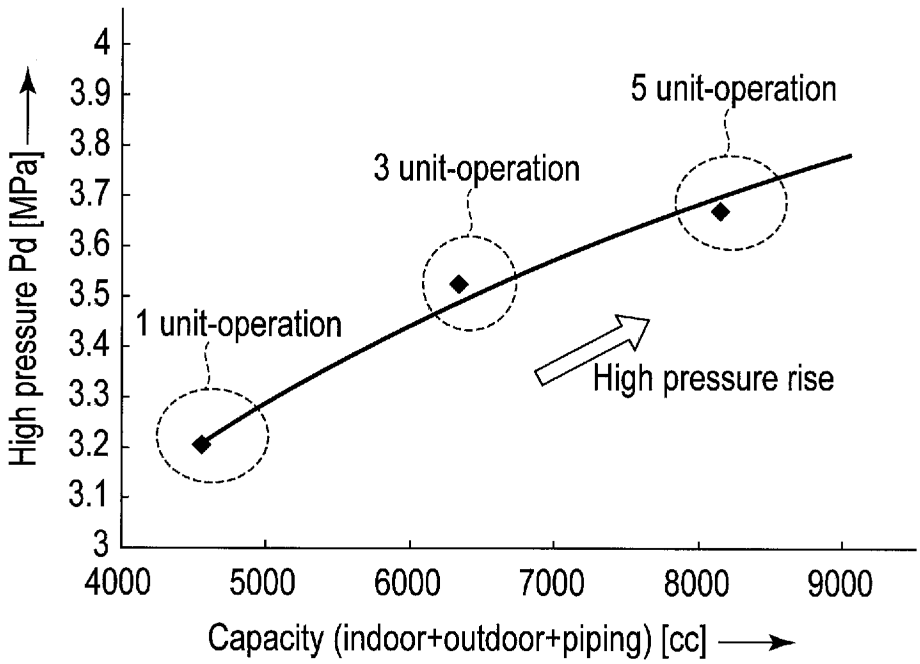
the refrigerant of the refrigeration cycle contains the refrigerant R32 in an amount of 50% or more.


A
Pd
11
12
1
CP
2
3
6
4a
4b
4n
Ba
Bb
Bn
5a
5b
5n
7a
7b
7n
9
Inverter
8
Control unit
20
20a
First control section
Second control section
20b
Third control section
20c

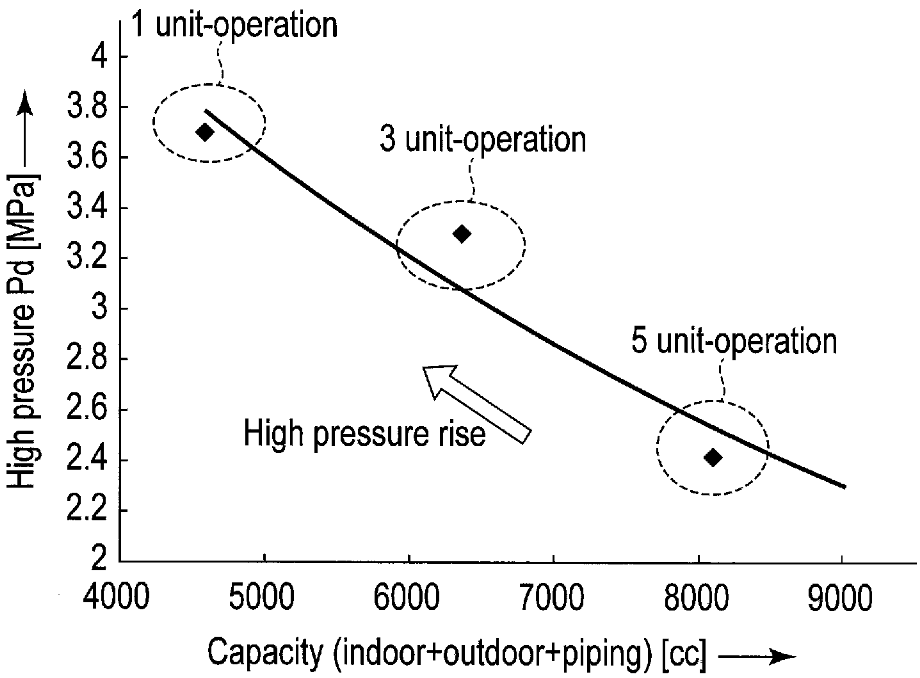
F I G. 1


Start
S1
Operation started?
No
Yes
Start compressor
S2
S3
f=0?
No
Yes
S5
No
Td≧Tds?
Yes
S4
Opening degree control
Qmax to Qmin
S6
Opening degree control
Qmax to "Qmin+ΔQ"
S7
Operation?
No
Yes
Stop compressor
S8
Time measurement t
S9
S10
No
Restoration?
Yes
S11
t≧ts?
No
Yes
Restart
S12
f←1
S13
S14
No
Shutdown?
Yes
Stop compressor
S15
f←0
S16
Return

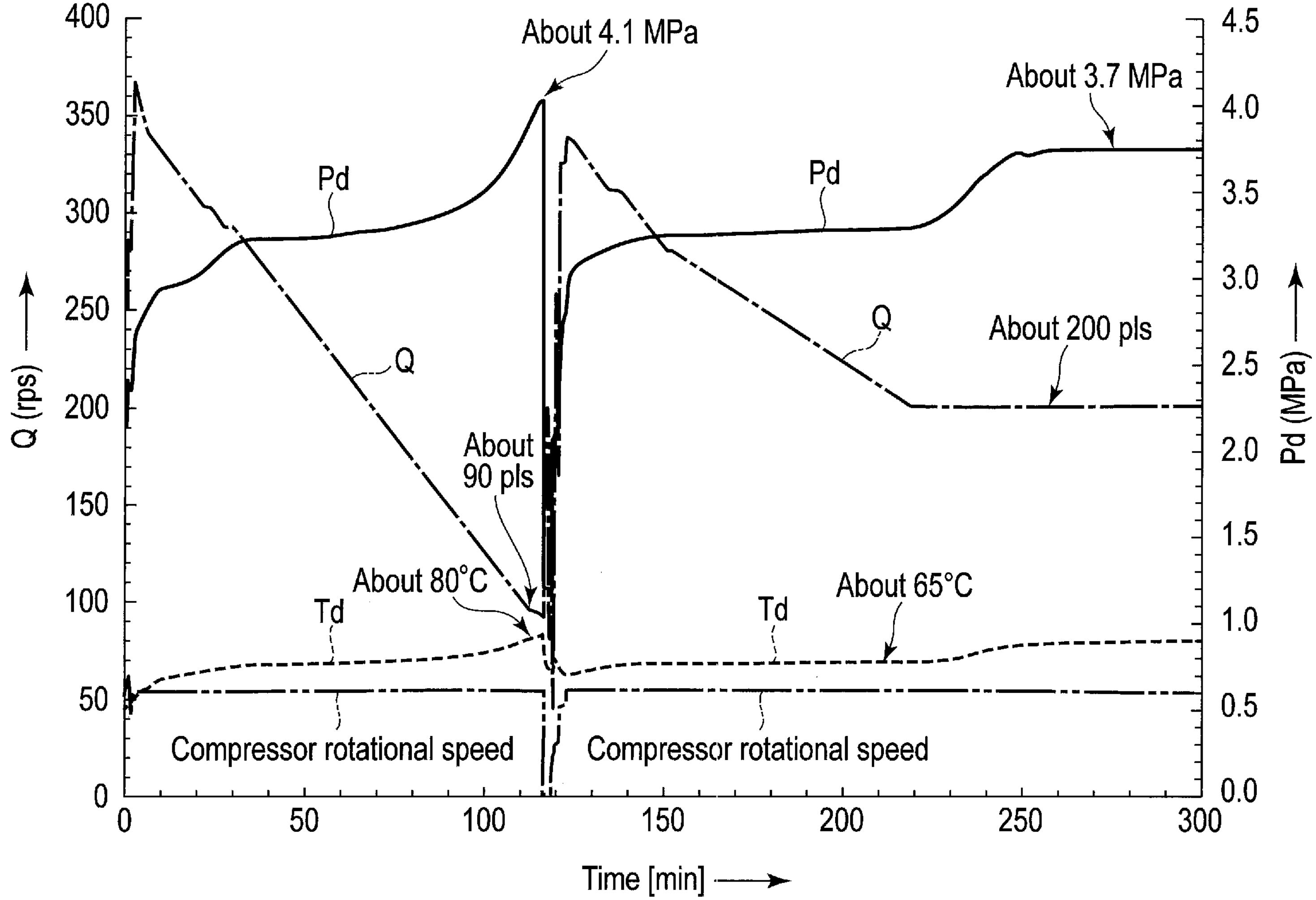
F I G. 2


High pressure Pd [MPa]
4
3.9
3.8
3.7
3.6
3.5
3.4
3.3
3.2
3.1
3
4000
5000
6000
7000
8000
9000
Capacity (indoor+outdoor+piping) [cc]
1 unit-operation
3 unit-operation
5 unit-operation
High pressure rise

F I G. 3


High pressure Pd [MPa]
4
3.8
3.6
3.4
3.2
3
2.8
2.6
2.4
2.2
2
4000
5000
6000
7000
8000
9000
Capacity (indoor+outdoor+piping) [cc]
1 unit-operation
3 unit-operation
5 unit-operation
High pressure rise

F I G. 4


About 4.1 MPa
About 3.7 MPa
Pd
Pd
Q
Q
About 200 pls
About 90 pls
About 80°C
About 65°C
Td
Td
Compressor rotational speed
Compressor rotational speed
Q (rps)
Pd (MPa)
Time [min]
0
50
100
150
200
250
300
350
400
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5

F I G. 5