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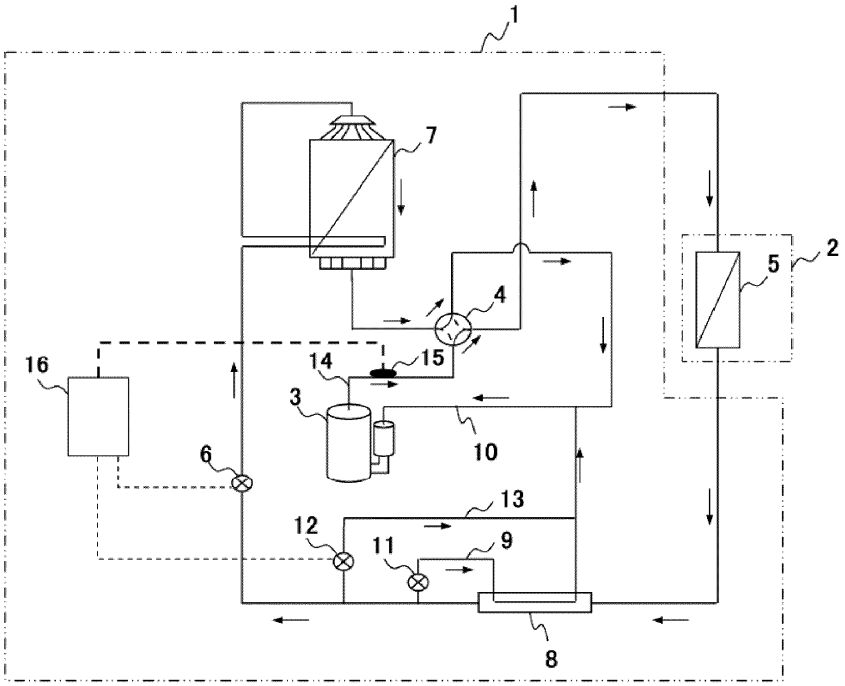
(54) **Refrigeration cycle apparatus and hydronic heater having the refrigeration cycle apparatus**

(57) According to a refrigeration cycle apparatus of the present invention, the refrigeration cycle apparatus includes a first bypass pipe (9), a second bypass pipe (13) and control means (16), one end of the second bypass pipe (13) is connected to a portion of the pipe extending from the supercooling heat exchanger (8) to the decompressing means (6), the other end of the second bypass pipe (13) is connected to a portion of the pipe extending from the evaporator (7) to the compressor (3), second flow rate adjusting means is disposed in the second bypass pipe (13). The control means (16) operates the decompressing means (5) and the second flow rate adjusting valve (12) in accordance with a temperature detected by the temperature sensor (15). Even if a compressor discharge temperature abruptly rises, it is possible to lower the discharge temperature while maintaining a stable operation of the refrigeration cycle.

[Fig. 1]



EP 2 538 159 A2

Description

[Technical Field]

[0001] The present invention relates to a refrigeration cycle apparatus and a hydronic heater having the refrigeration cycle apparatus.

[Background Technique]

[0002] Generally, when a heating operation is carried out under an extremely low temperature condition where an outdoor temperature is - 20°C or the like, a discharge temperature of a compressor extremely rises in the case of a general refrigeration cycle apparatus because an evaporating pressure is reduced and a high condensation temperature is required.
Especially in a transient operation state of the refrigeration cycle apparatus when its operation is started or when a variation in an indoor load is large, the apparatus receives an influence of uneven distribution of refrigerant in the refrigeration cycle or an amount of operation of an opening degree of an expansion valve, and a temperature of a refrigerant (discharge temperature) discharged from the compressor abruptly rises until the refrigeration cycle is stabilized in some cases.
According to patent document 1 for example, to solve the discharge temperature rise of such a compressor, a refrigerant pipe extending from a condenser to an expansion valve and a suction refrigerant pipe of a compressor are connected to each other by means of a bypass pipe through the expansion valve and a supercooling heat exchanger, and the compressor sucks a liquid refrigerant.
[0003] Fig. 6 shows a conventional refrigeration cycle apparatus described in patent document 1.
As shown in Fig. 6, in a refrigeration cycle in which a compressor 101, a four-way valve 102, a condenser 103, a bridge circuit 104 and an evaporator 105 are annularly connected to one another, the condenser 103 is connected to a first input terminal of the bridge circuit 104. One of first output terminals of the bridge circuit 104 is connected to a second input terminal of the bridge circuit 104 through a supercooling heat exchanger 106 and decompressing means 107, and a second output terminal of the bridge circuit 104 is connected to the evaporator 105. The other first output terminal of the bridge circuit 104 is connected to a suction refrigerant pipe of the compressor 101 by means of a bypass pipe 108 through the supercooling heat exchanger 106. A flow rate adjusting valve 109 for the supercooling heat exchanger is connected to the bypass pipe 108 at a location upstream of the supercooling heat exchanger 106. A discharge pipe of the compressor 101 includes a discharge temperature sensor 110.
An opening degree of the flow rate adjusting valve 109 is adjusted based on a discharge temperature detected by the discharge temperature sensor 110, and an amount of a refrigerant flowing to the bypass pipe 108 is controlled.

[Prior Art Document]

[Patent Document]

[0004] [Patent Document 1] Japanese Patent Publication No.3440910

[Summary of the Invention]

[Problem to be Solved by the Invention]

[0005] According to the conventional configuration, however, a liquid refrigerant which reduces the discharge temperature once passes through the supercooling heat exchanger 106, a portion of latent heat of the liquid refrigerant is absorbed by the supercooling heat exchanger 106. Hence, there is a problem that an abrupt discharge temperature rise generated in a transient operating state can not swiftly be suppressed.
[0006] The present invention has been accomplished to solve the problem, and it is an object of the invention to provide a refrigeration cycle apparatus capable of swiftly suppressing the abrupt discharge temperature rise while maintaining a stable operation of the refrigeration cycle.

[Means for Solving the Problem]

[0007] To solve the conventional problem, the present invention provides a refrigeration cycle apparatus in which a compressor, a condenser, decompressing means and an evaporator are annularly connected to one another through pipes in order, thereby forming a refrigeration cycle, a supercooling heat exchanger is disposed between the condenser and the decompressing means, one end of a first bypass pipe is connected to a portion of the pipe extending from the supercooling heat exchanger to the decompressing means, first flow rate adjusting means is connected to the first bypass pipe, heat of a refrigerant which flows out from the first flow rate adjusting means is exchanged with heat of a refrigerant which flows through the supercooling heat exchanger, the other end of the first bypass pipe is connected to the compressor or connected to the portion of the pipe extending from the evaporator to the compressor, the refrigeration cycle apparatus also includes a temperature sensor which detects a discharge temperature of the compressor, **characterized in that** the refrigeration cycle apparatus further comprises a second bypass pipe, one end of the second bypass pipe is connected to the portion of the pipe extending from the supercooling heat exchanger to the decompressing means, the other end of the second bypass pipe is connected to the portion of the pipe extending from the evaporator to the compressor, and second flow rate adjusting means is disposed in the second bypass pipe, and the refrigeration cycle

apparatus further comprises control means which operates the decompressing means and the second flow rate adjusting means by means of a temperature detected by the temperature sensor.

According to the configuration of the refrigeration cycle apparatus of the first aspect of the invention, a liquid refrigerant which sufficiently secures a supercooled state in a high pressure liquid pipe can be made to directly bypass the compressor suction pipe through the second bypass pipe. It is possible to vary an amount of a refrigerant flowing through the decompressing means in accordance with a variation in the amount of the refrigerant flowing through the second bypass pipe such that a total sum of amounts of refrigerants flowing through the decompressing means and the second bypass pipe is constantly maintained.

[0008] According to the refrigeration cycle apparatus of a second aspect of the invention, when a temperature detected by the temperature sensor is higher than a first predetermined value, the control means operates the decompressing means in its closing direction and operates the second flow rate adjusting means in its opening direction.

According to the configuration of the refrigeration cycle apparatus of the second aspect, it is possible to reduce an amount of a refrigerant flowing through the decompressing means in accordance with an increased amount of the refrigerant flowing through the second bypass pipe such that the total sum of amounts of the refrigerants flowing through the decompressing means and the second bypass pipe is constantly maintained.

As a result, even if the discharge temperature from the compressor abruptly increases, it is possible to swiftly lower the discharge temperature by the bypassing operation of liquid, and reliability can be enhanced.

Further, even if the bypassing amount of liquid is increased to restrain the discharge temperature from rising, since an amount of a refrigerant flowing to the compressor is constantly maintained, it is possible to suppress the variation in high and low pressures of the refrigeration cycle. That is, it is possible to stably maintain the refrigeration cycle, and to suppress the efficiency deterioration of the refrigeration cycle apparatus to the minimum level.

[0009] According to the refrigeration cycle apparatus of the third aspect of the invention, when a temperature detected by the temperature sensor is lower than a second predetermined value, the control means operates the decompressing means in its opening direction and operates the second flow rate adjusting means in its closing direction.

According to the configuration of the refrigeration cycle apparatus of the third aspect, it is possible to increase the amount of a refrigerant flowing through the decompressing means in accordance with a reduction amount of the refrigerant flowing through the second bypass pipe such that the total sum of the amounts of the refrigerants flowing through the decompressing means and the second bypass pipe is constantly maintained.

As a result, it is possible to restrain a liquid refrigerant from returning to the compressor which configures the refrigerant circuit. Hence, moisture compression can be prevented and the reliability can be enhanced.

Even if the bypassing amount of liquid is reduced, since the amount of the refrigerant which flows into the compressor is constantly maintained, a variation in the suction pressure of the compressor can be suppressed. That is, since it is possible to suppress the variation in high and low pressures of the refrigeration cycle caused by the bypassing operation of liquid, it is possible to stably maintain the refrigeration cycle. According to this, it is possible to suppress the efficiency deterioration of the hydronic heater to the minimum level.

[0010] According to the refrigeration cycle apparatus of the fourth aspect of the invention, the radiator in the refrigeration cycle apparatus according to any one of the first to third aspects is a heat exchanger which heats water by exchanging heat between a refrigerant and water. Therefore, the present invention can be applied not only to a case where the radiator is a heat exchanger between refrigerant and air, but also to a case where the radiator is a heat exchanger between refrigerant and water. In addition, the same effect as that of the first or second aspect can be obtained.

Further, the refrigeration cycle apparatus of the invention is **characterized in that** the condenser is a heat exchanger which heats water by exchanging heat between the refrigerant and the water, and hot water heated by the condenser is used for heating a room.

[Effect of the Invention]

[0011] According to the invention, it is possible to provide a refrigeration cycle apparatus capable of swiftly suppressing the abrupt discharge temperature rise while maintaining a stable operation of the refrigeration cycle.

[Brief Description of the Drawings]

[0012]

Fig. 1 is a circuit diagram of a refrigeration cycle apparatus according to a first embodiment of the present invention;

Fig. 2 is a control flowchart of a flow rate adjusting valve;

Fig. 3 is a control conceptual diagram when control of the flow rate adjusting valve is started;

Fig. 4 is a control conceptual diagram of a variation in a discharge temperature and control of an opening degree of the flow rate adjusting valve;

Fig. 5 is a control conceptual diagram during control of the flow rate adjusting valve; and

Fig. 6 is a circuit diagram of a conventional refrigeration cycle apparatus.

[Explanation of Symbols]

[0013]

3 compressor
5 condenser (radiator)
6 expansion valve (decompressing means)
7 evaporator
8 supercooling heat exchanger
9 first bypass pipe
11 first flow rate adjusting valve (first flow rate adjusting means)
12 second flow rate adjusting valve (second flow rate adjusting means)
13 second bypass pipe
15 discharge temperature sensor
16 control means

[Mode for Carrying Out the Invention]

[0014] An embodiment of the present invention will be explained with reference to the drawings. The invention is not limited to the embodiment.

[0015] Fig. 1 is a circuit diagram of a refrigeration cycle apparatus according to a first embodiment of the present invention. Fig. 2 is a control flowchart of a flow rate adjusting valve. Fig. 3 is a control conceptual diagram when control of the flow rate adjusting valve is started. Fig. 4 is a control conceptual diagram of a variation in a discharge temperature and control of an opening degree of the flow rate adjusting valve. Fig. 5 is a control conceptual diagram during control of the flow rate adjusting valve. As a refrigerant, it is possible to use a zeotropic refrigerant mixture such as R407C, a pseudo-azeotropic refrigerant mixture such as R410A or a single refrigerant.

[0016] In Fig. 1, the refrigeration cycle apparatus of the embodiment includes an outdoor unit 1 and an indoor unit 2.

The refrigeration cycle is formed by annularly connecting the following members to one another through pipes: that is, a compressor 3 which compresses a refrigerant, a four-way valve 4 which switches between flowing directions of the refrigerant, a condenser (radiator) 5 (when the indoor unit 2 is used for a heating operation) which condenses and liquefies a high-temperature and high-pressure refrigerant, and expansion valve 6 (decompressing means) which decompresses and expands a high-pressure liquid refrigerant, and an evaporator 7 (when the indoor unit 2 is used for the heating operation) which evaporates and vaporizes a low-temperature two-phase refrigerant.

The indoor unit 2 includes the condenser 5, and the outdoor unit 1 includes the compressor 3, the four-way valve 4, the expansion valve 6 and the evaporator 7.

By switching the four-way valve 4, it is possible to switch a normal heating operation to a cooling operation, or from the normal heating operation to a defrosting operation.

[0017] A supercooling heat exchanger 8 is disposed between the condenser 5 and the expansion valve 6. The outdoor unit 1 includes the supercooling heat exchanger 8.

One end of a first bypass pipe 9 is connected to a pipe extending from the supercooling heat exchanger 8 to the expansion valve 6. First flow rate adjusting means 11 is connected to the first bypass pipe 9. The first flow rate adjusting valve 11 adjusts a bypassing amount of a refrigerant flowing to the first bypass pipe 9.

The other end of the first bypass pipe 9 is connected to a pipe extending from the evaporator 7 to the compressor 3. The other end of the first bypass pipe 9 may be connected to a compression chamber of the compressor 3.

A refrigerant which flows out from the first flow rate adjusting valve 11 exchanges heat with a refrigerant which flows through the supercooling heat exchanger 8 and then, the refrigerant is supplied to a suction pipe 10 of the compressor 3.

In the supercooling heat exchanger 8, heat is exchanged between a high-pressure refrigerant which flows out from the condenser 5 and a low-pressure bypassing refrigerant which flows out from the first flow rate adjusting valve 11.

[0018] One end of a second bypass pipe 13 is connected to a pipe extending from the supercooling heat exchanger 8 to the expansion valve 6. A second flow rate adjusting valve 12 is connected to the second bypass pipe 13. The second flow rate adjusting valve 12 adjusts a bypassing amount of a refrigerant which flows to the second bypass pipe 13.

The other end of the second bypass pipe 13 is connected to a pipe extending from the evaporator 7 to the compressor 3. The other end of the second bypass pipe 13 may be connected to the compression chamber of the compressor 3. A refrigerant which flows out from the second bypass pipe 13 is supplied to the suction pipe 10 of the compressor 3 without exchanging heat with a refrigerant which flows through the supercooling heat exchanger 8.

[0019] A discharge temperature sensor 15 which detects a discharge temperature of the compressor 3 is connected to the discharge pipe 14 of the compressor 3. Control means 16 controls an - of the second flow rate adjusting valve 12 and an opening degree of the expansion valve 6 in accordance with a temperature detected by the discharge temperature sensor 15. The opening degree of the expansion valve 6 is controlled in accordance with a controlled amount of the opening degree of the second flow rate adjusting valve 12.

[0020] First, in the refrigeration cycle shown in Fig. 1, a high-pressure gas refrigerant discharged from the compressor 3 flows from the discharge pipe 14 and reaches the four-way valve 4. When the indoor unit 2 is used for the heating operation, the high-pressure gas refrigerant flows into the condenser 5, radiates heat, and is condensed and liquefied. The condensed and liquefied high-pressure liquid refrigerant is supercooled by the supercooling heat exchanger 8, the refrigerant is decom-

pressed and expanded by the expansion valve 6 and becomes a low-temperature and low-pressure two-phase refrigerant. Then, the low-temperature low-pressure two-phase refrigerant flows into the evaporator 7, and evaporates and vaporizes. Thereafter, the refrigerant again passes through the four-way valve 4 and is sucked from the suction pipe 10 into the compressor 3.

[0021] The control means 16 adjusts an opening degree of the first flow rate adjusting valve 11 such that an outlet state of the first bypass pipe 9 becomes a saturated gas refrigerant. According to this adjustment, performance of the supercooling heat exchanger 8 is sufficiently exerted, and the supercooled state of a liquid refrigerant in the refrigerant pipe which connects the supercooling heat exchanger 8 and the expansion valve 6 to each other is sufficiently secured.

In the second bypass pipe 13 which branches off from between the supercooling heat exchanger 8 and the decompressing means (expansion valve 6), and which is connected to a portion between the compressor 3 and the evaporator 7 through second flow rate adjusting means (second flow rate adjusting valve 12), a discharge temperature of the compressor 3 is detected by a discharge temperature sensor 15 disposed in the discharge pipe 14, and when the discharge temperature becomes equal to or higher than a preset predetermined temperature, the second flow rate adjusting valve 12 disposed at the second bypass pipe 13 is opened by a predetermined opening degree by the control means 16, and the expansion valve 6 is closed by a predetermined opening degree by the control means 16 in accordance with the opening degree of the second flow rate adjusting valve 12.

Similarly, in the second bypass pipe 13, a discharge temperature of the compressor 3 is detected by the discharge temperature sensor 15 disposed in the discharge pipe 14, and when the discharge temperature becomes equal to or lower than a preset predetermined temperature, the second flow rate adjusting valve 12 disposed at the second bypass pipe 13 is closed by a predetermined opening degree by the control means 16, and the expansion valve 6 is opened by a predetermined opening degree by the control means 16 in accordance with the opening degree of the second flow rate adjusting valve 12.

[0022] Next, a control operation and effect with respect to a variation in a discharge temperature will be explained using Figs. 2 to 5.

According to the refrigeration cycle apparatus of the embodiment, a bypassing refrigerant is made to flow to the first bypass pipe 9 at the time of a normal operation, thereby carrying out the operation using the supercooling heat exchanger 8.

At the time of the normal operation, a discharge temperature Td is detected by the discharge temperature sensor 15 (step 101).

At this time, a refrigerant in the pipe which connects the supercooling heat exchanger 8 and the expansion valve 6 to each other is sufficiently supercooled by the supercooling heat exchanger 8.

[0023] Next, a discharge temperature Td and a previously set first set temperature TdH are compared with each other (step 102). At that time, the first set temperature TdH is set in accordance with a specification of the compressor 3. It is preferable that the first set temperature TdH is set to a normal discharge temperature, or a temperature which is lower than an upper limit discharge temperature by a predetermined temperature, i.e., a temperature at which reliability of the compressor 3 can not be deteriorated when the compressor 3 is used.

In step 102, if the detected discharge temperature Td is lower than the first set temperature TdH, it is determined whether the refrigeration cycle apparatus keeps operating (step 103), and if the apparatus keeps operating, the procedure is again returned to step 101, and the discharge temperature Td is detected.

[0024] If the detected discharge temperature Td is equal to or higher than the first set temperature TdH, the second flow rate adjusting valve 12 is opened by the predetermined opening degree, and the expansion valve 6 is closed by the predetermined opening degree in accordance with the opening degree of the second flow rate adjusting valve 12 (step 104).

The operation in step 104 is shown in Fig. 3. In Fig. 3, a lateral axis shows valve opening degrees of the expansion valve 6 and the second flow rate adjusting valve 12, and a vertical axis shows refrigerant flow rates of these valves 11 and 12.

The second flow rate adjusting valve 12 is opened from a closed state PLSLO to a predetermined opening degree PLSL1. An opening operation of the expansion valve 6 is carried out simultaneously with the opening operation of the second flow rate adjusting valve 12.

A flow rate variation amount Gl is generated when the opening degree of the second flow rate adjusting valve 12 is varied from PLSLO to PLSL1.

Therefore, the expansion valve 6 is closed by varying the opening degree from PLSSO to PLSS1 so that a flow rate variation amount Gs (absolute value) which is equal to the flow rate variation amount Gl is generated.

[0025] Next, a variation state of the discharge temperature generated by operation of step 103 is determined (step 105).

In step 105, in a state where the discharge temperature Td is equal to or higher than a set temperature TdH, if the discharge temperature Td is rising, the second flow rate adjusting valve 12 is opened by the predetermined opening degree, and the expansion valve 6 is closed by the predetermined opening degree (step 106).

If the discharge temperature Td is lowering in step 105 on the contrary, the second flow rate adjusting valve 12 is closed by the predetermined opening degree and the expansion valve 6 is opened by the predetermined opening degree (step 107).

Fig. 4 shows a variation in the discharge temperature. A case where the discharge temperature Td is lowering will be explained. As shown in Fig. 4, a discharge tempera-

ture Td before a predetermined time discharge temperature and a variation amount dTd of the discharge temperature Td after the predetermined time dT are compared with each other, and if the variation amount is lower than 0°C, it is determined that the discharge temperature Td is lowering.

[0026] An operation in step 107 is shown in Fig. 5. The second flow rate adjusting valve 12 is controlled into the closing direction by the predetermined opening degree. The expansion valve 6 is controlled into the opening direction by the predetermined opening degree. That is, the second flow rate adjusting valve 12 is closed by ΔG1 from the opening degree PLSL1 to the opening degree PLSL2. The expansion valve 6 is opened by ΔGs from the opening degree PLSS1 to PLSS2 so that the flow rate variation amount of the expansion valve 6 becomes equal to a reverse direction of the flow rate variation amount of the second flow rate adjusting valve 12.

[0027] Next, the discharge temperature Td is detected, and this is compared with a second set temperature TdL (step 108).

If the discharge temperature Td is equal to or higher than the second set temperature TdL in step 108, operations from step 105 to step 107 are repeated. If the discharge temperature Td is lower than the second set temperature TdL, a variation state of the discharge temperature Td is determined (step 109). This determining operation of the variation state in step 109 is the same as that in step 105. If the discharge temperature Td is in the lowering state based on the determination result in step 109, the second flow rate adjusting valve 12 is closed by the predetermined opening degree. The expansion valve 6 is opened by the predetermined opening degree (step 110).

After step 110, operation in step 103 is checked, and if the operation is stopped, the control is completed. If the discharge temperature Td is in the rising state on the contrary, the second flow rate adjusting valve 12 is opened by the predetermined opening degree. The expansion valve 6 is closed by the predetermined opening degree (step 111).

After step 111, the operation in step 103 is checked, and if the operation is stopped, the control is completed.

[0028] By repeating the operations from step 101 to step 111, even if the discharge temperature abruptly rises when a load is varied, it is possible to bypass the liquid refrigerant from the high pressure liquid refrigerant pipe between the radiator 5 and the decompressing means 6 to the suction pipe of the compressor 3 by the second bypass pipe 13. Hence, it is possible to swiftly lower the discharge temperature. At the same time, even when the refrigerant flow rate of the second bypass pipe 13 becomes excessively large, the second flow rate adjusting valve 12 is controlled into the closing direction and the expansion valve 6 is controlled into the opening direction. Therefore, it is possible to prevent a liquid refrigerant from returning to the compressor, and to enhance the reliability.

A refrigerant state at an inlet of the second bypass pipe 13 is a liquid refrigerant whose supercooled state is sufficiently secured after the refrigerant passes through the supercooling heat exchanger 8. Therefore, even under a low outside air temperature condition of even when a heating load is abruptly increased, it is possible to bypass the liquid refrigerant from the high pressure liquid refrigerant pipe between the condenser 5 and the decompressing means 6 to the suction pipe of the compressor 3. Hence, it is possible to lower the discharge temperature in a wide operation range, and to enhance the reliability of the compressor 3.

The expansion valve 6 is controlled into the reverse direction in accordance with a refrigerant flow rate of the second flow rate adjusting valve 12 of the second bypass pipe 13, and it is possible to reduce a variation amount of a total sum of the flow rates of a refrigerants flowing through the expansion valve 6 and the second bypass pipe 13. Therefore, it is possible to suppress a variation in high and low pressures at the time of the bypassing operation, to stably maintain the refrigeration cycle, and to suppress the deterioration in efficiency of the refrigeration cycle apparatus of the present application to the minimum.

Further, it is not absolutely necessary that the first bypass pipe 9 branches off from between the supercooling heat exchanger 8 and the expansion valve 6, and the first bypass pipe 9 may branch off from the refrigerant circuit 2 between the radiator 5 and the supercooling heat exchanger 8.

It is not absolutely necessary that a connected portion of the first bypass pipe 9 is the suction pipe of the compressor 3. In the case of a compressor having an injection mechanism, the first bypass pipe 9 may be connected to an injection port.

[Industrial Applicability]

[0029] As described above, according to the refrigeration cycle apparatus of the invention, even when a discharge temperature abruptly rises when a load is varied, it is possible to suppress a discharge temperature rise while stably maintaining the refrigeration cycle. Therefore, the refrigeration cycle apparatus can also be applied to a general air conditioner, a heat pump hydronic heater, a professional-use freezing machine, and a heat pump hot water supply apparatus.

Claims

1. A refrigeration cycle apparatus in which a compressor, a condenser, decompressing means and an evaporator are annularly connected to one another through pipes in order, thereby forming a refrigeration cycle,
   a supercooling heat exchanger is disposed between the condenser and the decompressing means,
   one end of a first bypass pipe is connected to a por-

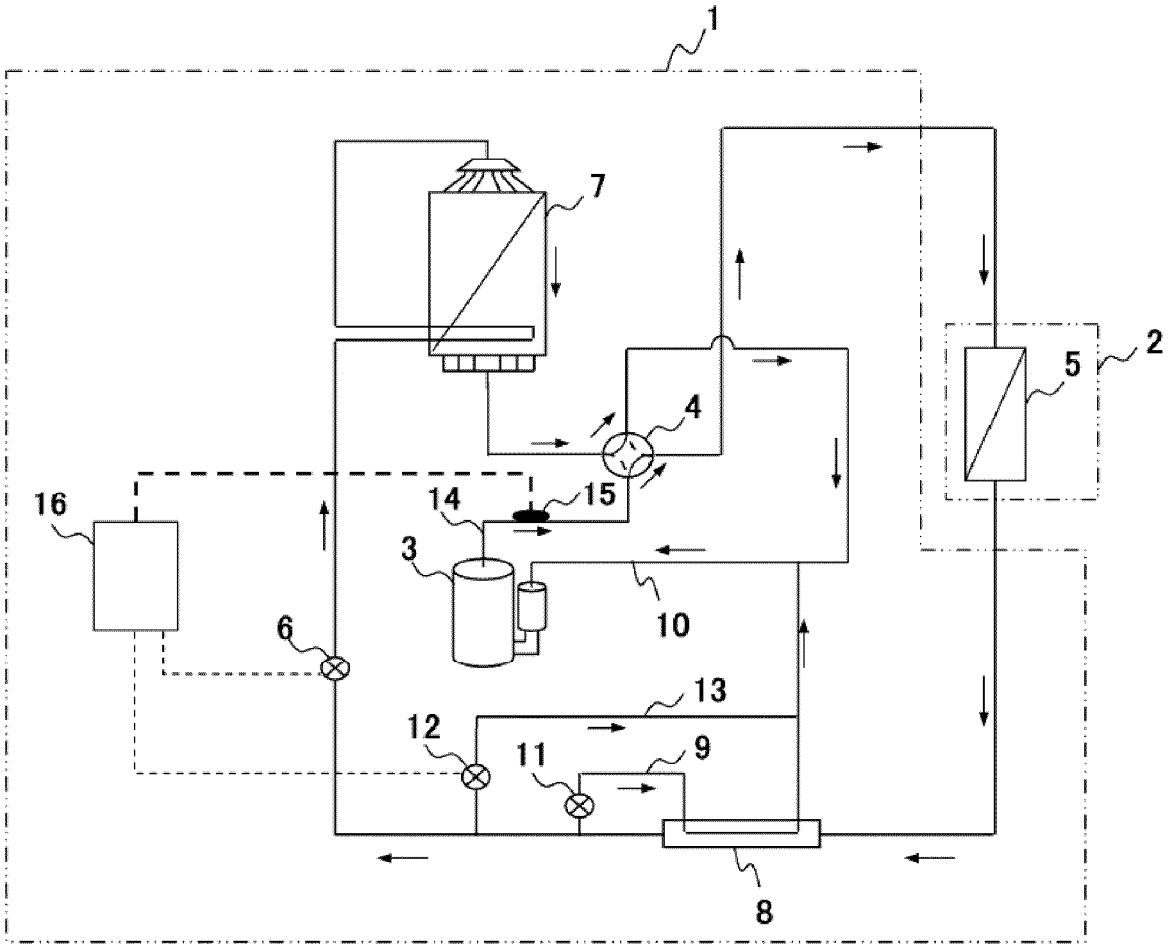
tion of the pipe extending from the supercooling heat exchanger to the decompressing means,
first flow rate adjusting means is connected to the first bypass pipe,
heat of a refrigerant which flows out from the first flow rate adjusting means is exchanged with heat of a refrigerant which flows through the supercooling heat exchanger,
the other end of the first bypass pipe is connected to the compressor or connected to the portion of the pipe extending from the evaporator to the compressor,
the refrigeration cycle apparatus also includes a temperature sensor which detects a discharge temperature of the compressor, **characterized in that**
the refrigeration cycle apparatus further comprises a second bypass pipe,
one end of the second bypass pipe is connected to the portion of the pipe extending from the supercooling heat exchanger to the decompressing means,
the other end of the second bypass pipe is connected to the portion of the pipe extending from the evaporator to the compressor, and second flow rate adjusting means is disposed in the second bypass pipe, and
the refrigeration cycle apparatus further comprises control means which operates the decompressing means and the second flow rate adjusting means by means of a temperature detected by the temperature sensor.

2. The refrigeration cycle apparatus according to claim 1, **characterized in that** when a temperature detected by the temperature sensor is higher than a first predetermined value, the control means operates the decompressing means in its closing direction and operates the second flow rate adjusting means in its opening direction.

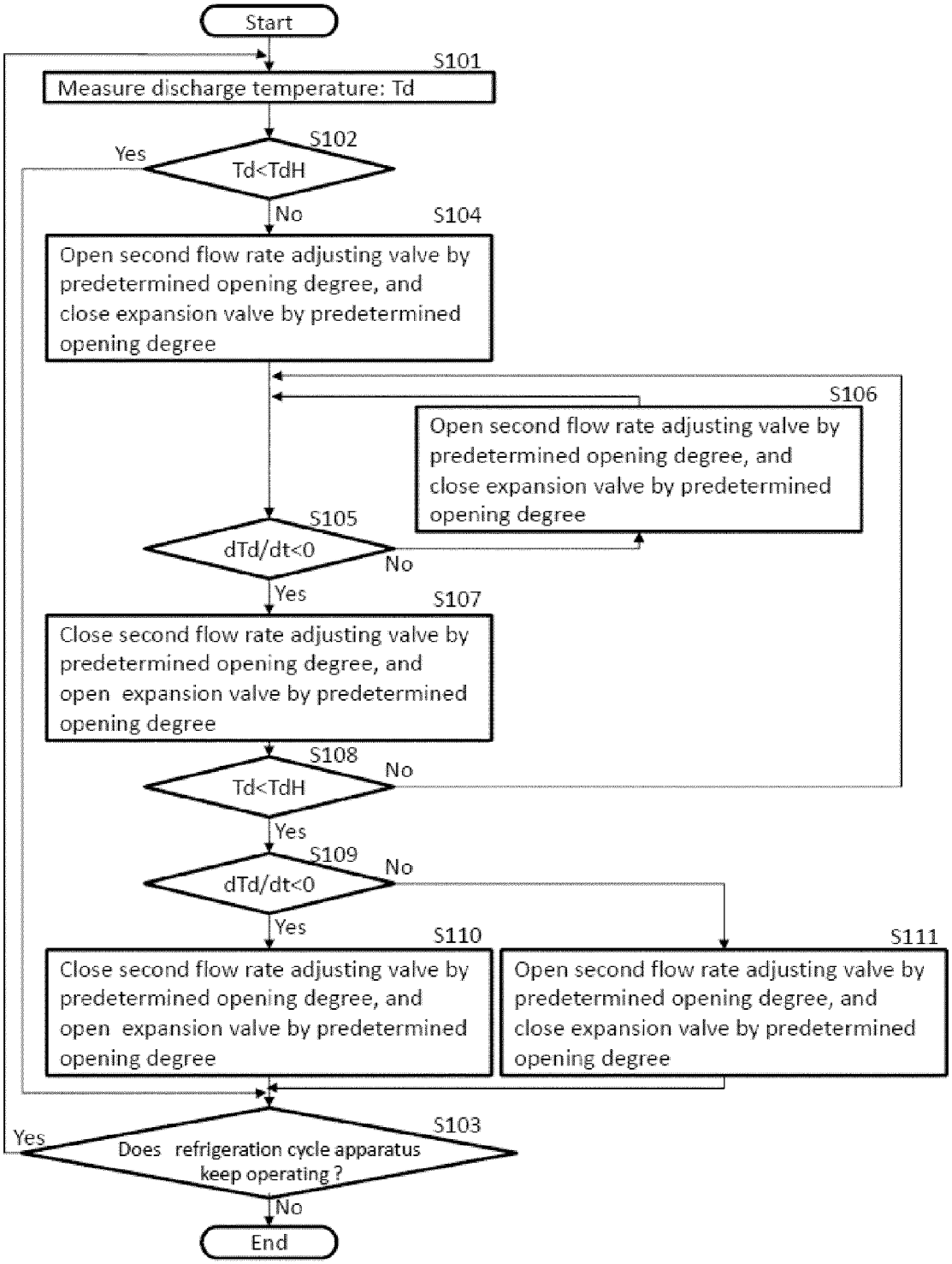
3. The refrigeration cycle apparatus according to any one of claims 1 or 2, **characterized in that** when a temperature detected by the temperature sensor is lower than a second predetermined value, the control means operates the decompressing means in its opening direction and operates the second flow rate adjusting means in its closing direction.

4. A hydronic heater **characterized in that** the radiator in the refrigeration cycle apparatus according to any one of claims 1 to 3 is a heat exchanger which heats water by exchanging heat between a refrigerant and water.

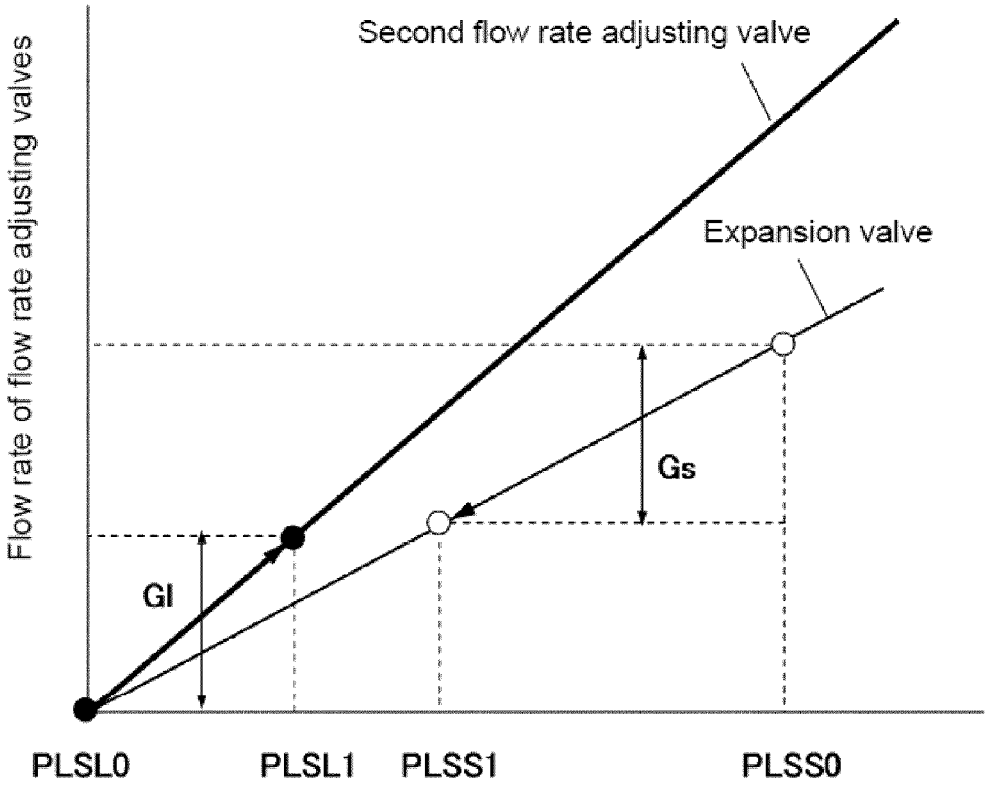
[Fig. 1]



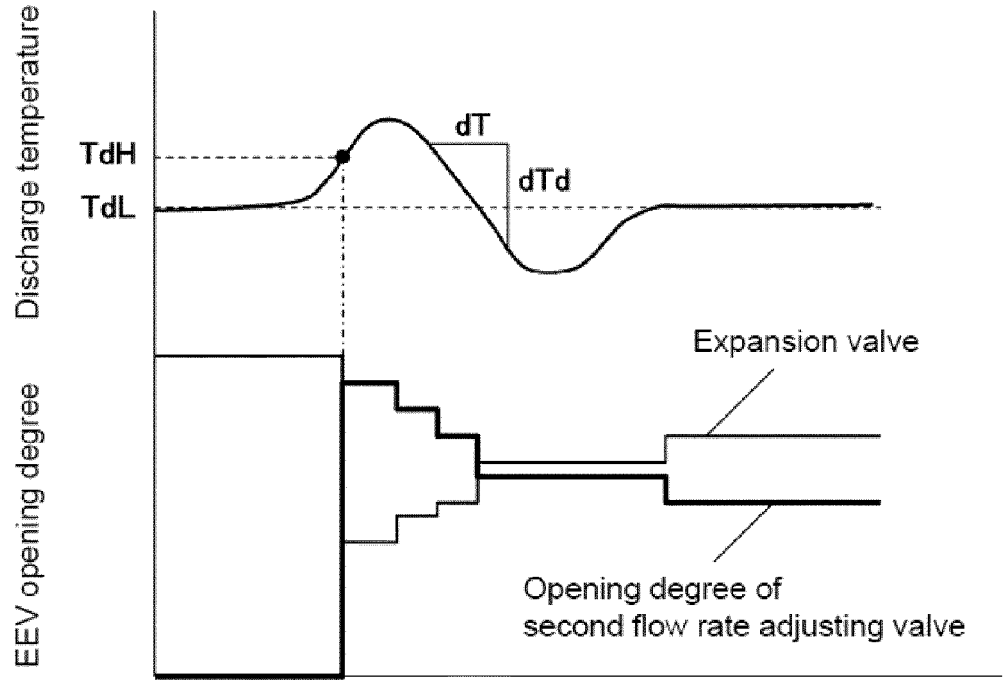
[Fig. 2]


Start
S101
Measure discharge temperature: Td
S102
Yes
Td<TdH
No
S104
Open second flow rate adjusting valve by predetermined opening degree, and close expansion valve by predetermined opening degree
S106
Open second flow rate adjusting valve by predetermined opening degree, and close expansion valve by predetermined opening degree
S105
dTd/dt<0
No
Yes
S107
Close second flow rate adjusting valve by predetermined opening degree, and open expansion valve by predetermined opening degree
S108
Td<TdH
No
Yes
S109
dTd/dt<0
No
Yes
S110
Close second flow rate adjusting valve by predetermined opening degree, and open expansion valve by predetermined opening degree
S111
Open second flow rate adjusting valve by predetermined opening degree, and close expansion valve by predetermined opening degree
S103
Yes
Does refrigeration cycle apparatus keep operating ?
No
End

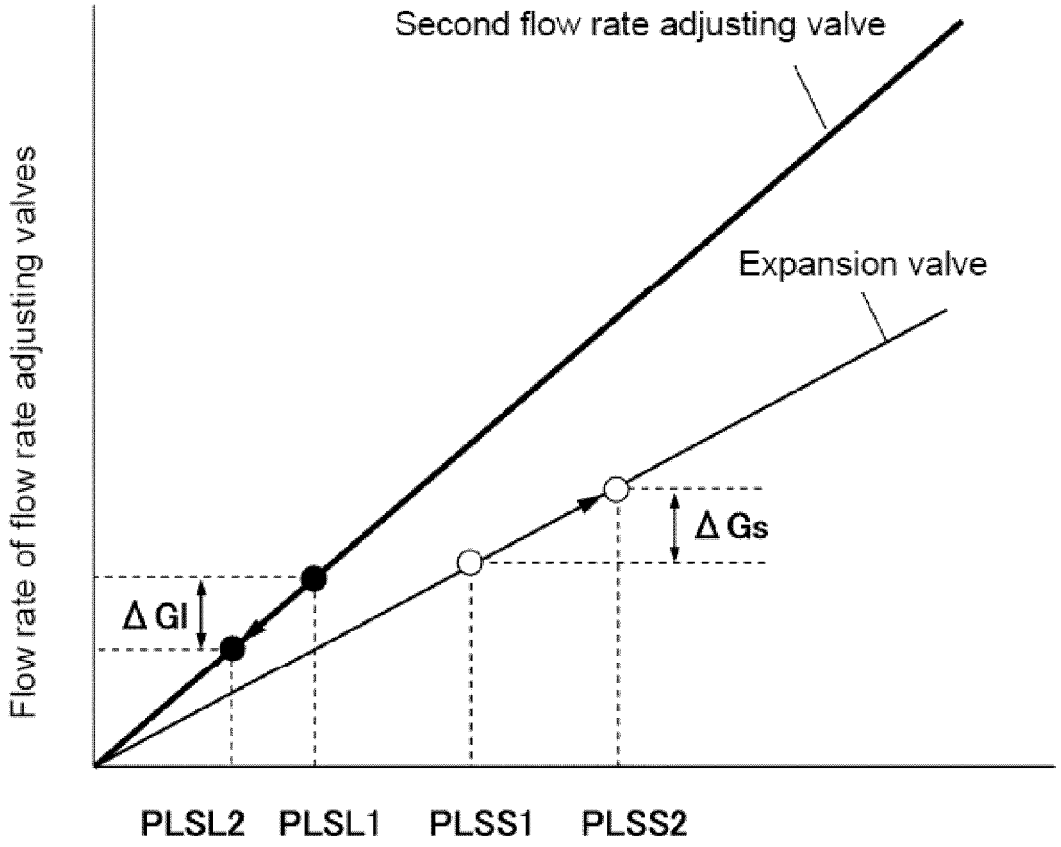
[Fig. 3]


Second flow rate adjusting valve
Expansion valve
Flow rate of flow rate adjusting valves
Gs
Gl
PLSL0
PLSL1
PLSS1
PLSS0

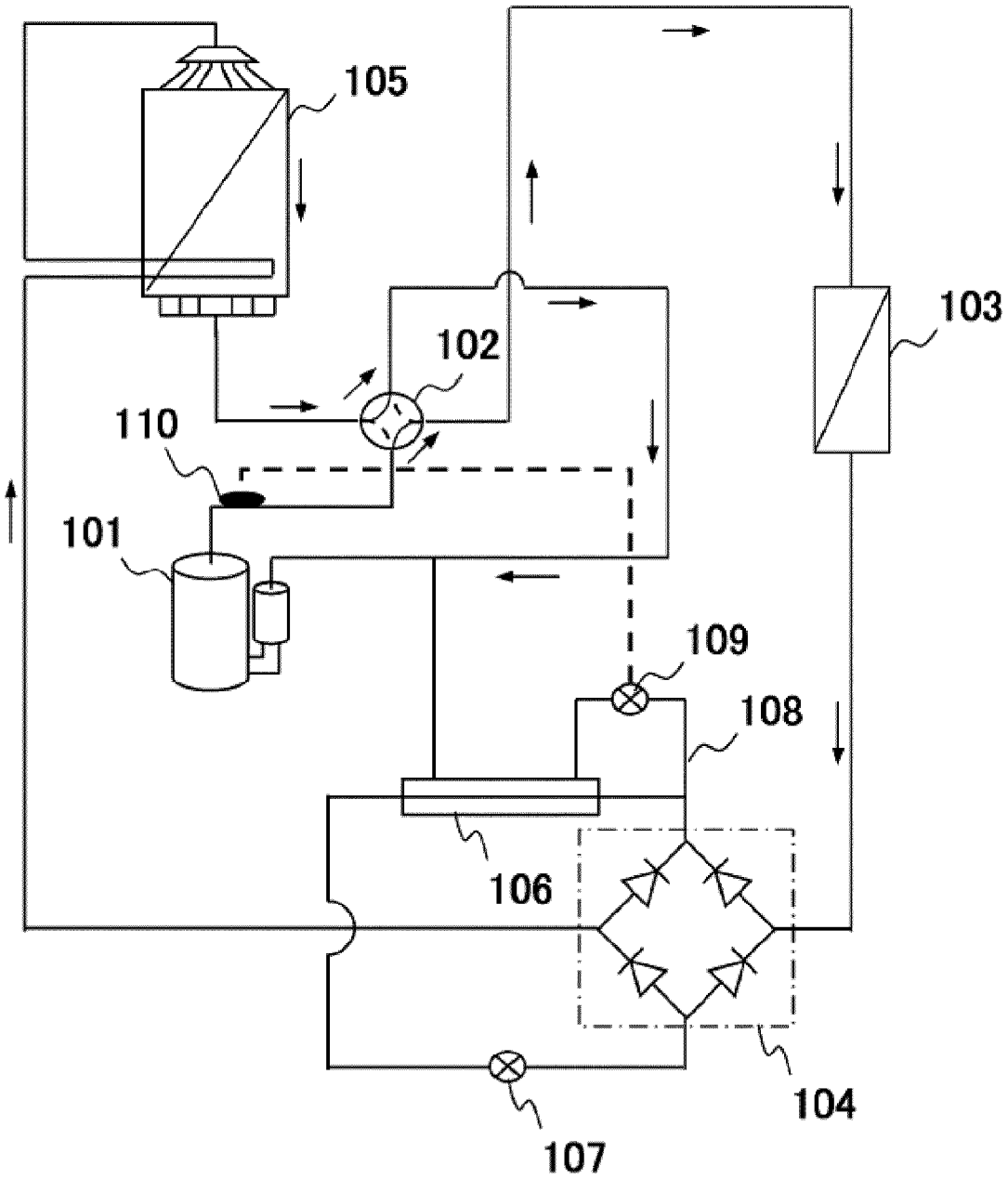
[Fig. 4]


Discharge temperature
TdH
TdL
dT
dTd
Expansion valve
EEV opening degree
Opening degree of
second flow rate adjusting valve

[Fig. 5]


Second flow rate adjusting valve
Expansion valve
Flow rate of flow rate adjusting valves
ΔGs
ΔGl
PLSL2
PLSL1
PLSS1
PLSS2

[Fig. 6]



REFERENCES CITED IN THE DESCRIPTION

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