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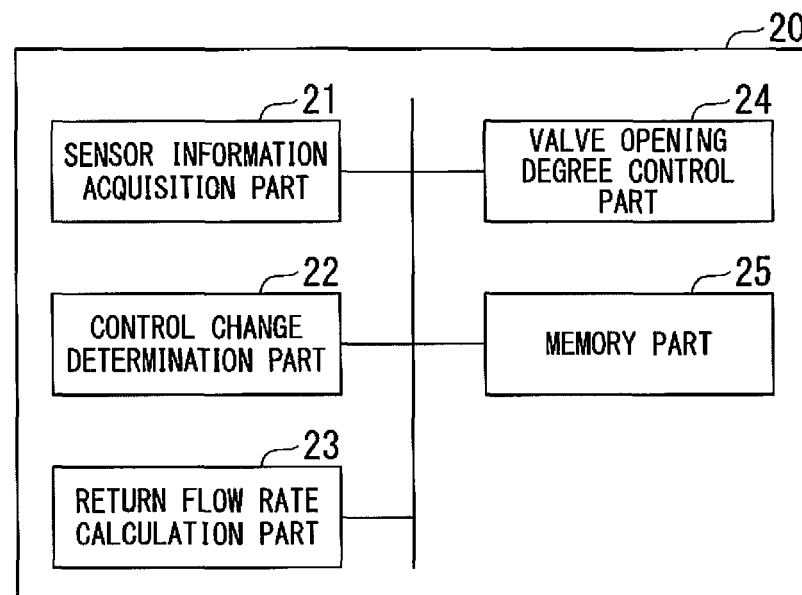
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(54) **CONTROL DEVICE, REFRIGERANT CIRCUIT SYSTEM, CONTROL METHOD AND PROGRAM**

(57) A control device (20) which performs control for returning an appropriate amount of refrigerator oil to a compressor (1) according to an operation state is provided. The control device (20) in a refrigerant circuit (10) which includes a compressor (1) configured to compress a refrigerant, an oil separator (9) configured to separate refrigerator oil contained in the refrigerant discharged from the compressor (1) from the refrigerant, an oil return pipe (8c) configured to return the separated refrigerator

oil to the compressor (1), and a flow rate control valve (11) provided in the oil return pipe includes a valve opening degree control part (24) configured to control a valve opening degree of the flow rate control valve (11) on the basis of a target return flow rate of the refrigerator oil that needs to be returned to the compressor (1) and a pressure difference (ΔP) between a discharge side pressure (HP) and a suction side pressure (LP) of the compressor (1).

FIG. 2



Description

CROSS-REFERENCE TO RELATED APPLICATION

[0001] Priority is claimed on Japanese Patent Application No. 2016-197346, filed October 5, 2016, the content of which is incorporated herein by reference.

BACKGROUND OF THE INVENTION

Field of the Invention

[0002] The present invention relates to a control device, a refrigerant circuit system, a control method and a program.

Description of Related Art

[0003] In a refrigerant circuit of an air conditioner or the like, refrigerator oil for lubrication is sealed in a compressor. The refrigerator oil is discharged from the compressor to the refrigerant circuit together with a refrigerant. The refrigerator oil discharged to the refrigerant circuit is captured and separated out by an oil separator and is recovered to the compressor. When an amount of refrigerator oil recovered to the compressor is insufficient, a problem such as burning may occur in the compressor, and thus return control for the refrigerator oil needs to be performed so that an appropriate amount of refrigerator oil is recovered.

[0004] Patent Document 1 discloses a technique in which an electromagnetic on-off valve is provided in an oil return pipe for returning the refrigerator oil from the oil separator to the compressor and a valve opening degree of the electromagnetic on-off valve is controlled according to a frequency of the compressor and a pressure difference between a suction side and a discharge side of the compressor and thus an appropriate amount of refrigerator oil is returned to the compressor.

[Patent Documents]

[0005] [Patent Document 1] Japanese Unexamined Patent Application, First Publication No. 2011-208860

[0006] Generally, the amount of refrigerator oil recovered from the oil separator to the compressor is determined by a pressure difference between a discharge side pressure and a suction side pressure of the compressor. Further, a size (diameter) of the oil return pipe from the oil separator to the compressor is constant. When the size of the oil return pipe is designed to recover a maximum necessary amount of refrigerator oil even in a state in which the pressure difference between the discharge side pressure and the suction side pressure of the compressor is small, the size thereof has a large diameter, and the refrigerant easily bypasses from the discharge side of the compressor to the suction side thereof via the oil return pipe, and there is a possibility that the refrigerant

circuit may become insufficient in capacity. Further, when the size of the oil return pipe is reduced, a breakdown in the compressor may occur due to an insufficient return amount.

SUMMARY OF THE INVENTION

[0007] Accordingly, it is an object of the present invention to provide a control device, a refrigerant circuit system, a control method and a program.

[0008] A first aspect of the present invention is a control device for a refrigerant circuit system which includes a compressor configured to compress a refrigerant, an oil separator configured to separate refrigerator oil contained in the refrigerant discharged from the compressor from the refrigerant, an oil return pipe configured to return the separated refrigerator oil to the compressor, and a flow rate control valve provided in the oil return pipe, including a valve opening degree control part configured to control a valve opening degree of the flow rate control valve on the basis of a target return flow rate of the refrigerator oil that needs to be returned to the compressor and a pressure difference between a discharge side pressure and a suction side pressure of the compressor.

[0009] The control device in a second aspect of the present invention may further include a return flow rate calculation part configured to calculate the target return flow rate of the refrigerator oil on the basis of an under-dome temperature of the compressor, the suction side pressure of the compressor and the rotational speed of the compressor.

[0010] The return flow rate calculation part in a third aspect of the present invention may determine a flow rate of the refrigerator oil discharged from the compressor as the target return flow rate.

[0011] The control device in a fourth aspect of the present invention may further include a control change determination part configured to determine a timing of change of valve opening degree control by the valve opening degree control part.

[0012] The control change determination part in a fifth aspect of the present invention may determine a case in which there is a change in the target return flow rate as a timing of change of the valve opening degree of the flow rate control valve.

[0013] The control change determination part in a sixth aspect of the present invention may determine a case in which there is a change in the pressure difference between the discharge side pressure and the suction side pressure of the compressor as a timing of change of the valve opening degree of the flow rate control valve.

[0014] A seventh aspect of the present invention is a refrigerant circuit system including a compressor configured to compress a refrigerant, an oil separator configured to separate refrigerator oil contained in the refrigerant discharged from the compressor from the refrigerant, an oil return pipe configured to return the separated refrigerator oil to the compressor, a flow rate control valve

provided in the oil return pipe, and the control device described in any one of the first to sixth aspects.

[0015] A eighth aspect of the present invention is a control method of a refrigerant circuit system which includes a compressor configured to compress a refrigerant, an oil separator configured to separate refrigerator oil contained in the refrigerant discharged from the compressor from the refrigerant, an oil return pipe configured to return the separated refrigerator oil to the compressor, and a flow rate control valve provided in the oil return pipe, wherein a valve opening degree of the flow rate control valve is controlled on the basis of a target return flow rate of the refrigerator oil that needs to be returned to the compressor and a pressure difference between a discharge side pressure and a suction side pressure of the compressor.

[0016] A ninth aspect of the present invention is a program which allows a computer of a control device configured to control a refrigerant circuit system including a compressor configured to compress a refrigerant, an oil separator configured to separate refrigerator oil contained in the refrigerant discharged from the compressor from the refrigerant, an oil return pipe configured to return the separated refrigerator oil to the compressor and a flow rate control valve provided in the oil return pipe to serve as a valve opening degree control part configured to control a valve opening degree of the flow rate control valve on the basis of a target return flow rate of the refrigerator oil that needs to be returned to the compressor and a pressure difference between a discharge side pressure and a suction side pressure of the compressor.

[0017] According to the present invention, an appropriate amount of refrigerator oil according to an operation state of the refrigerant circuit can be returned to the compressor.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018]

FIG. 1 is a view showing an example of a refrigerant circuit system in one embodiment of the present invention.

FIG. 2 is a schematic block diagram of a control device in one embodiment of the present invention.

FIG. 3 is a flowchart showing an example of a refrigerator oil returning process of the control device according to one embodiment of the present invention.

FIG. 4 is a view showing a discharge flow rate of the refrigerator oil in one embodiment of the present invention.

FIG. 5 is a view showing a method of calculating a valve opening degree of a flow rate control valve in one embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

<Embodiment>

[0019] Hereinafter, a refrigerant circuit system according to one embodiment of the present invention will be described with reference to FIGS. 1 to 5.

[0020] FIG. 1 is a view showing an example of a refrigerant circuit system in one embodiment of the present invention.

[0021] For example, a refrigerant circuit system 10 may be a refrigerant circuit system used for an air conditioner. As illustrated in FIG. 1, the refrigerant circuit system 10 includes a compressor 1, an indoor heat exchanger 2, an outdoor heat exchanger 3, an expansion valve 4, a four-way valve 5, an accumulator 6, a receiver 7, pipes 8, an oil separator 9, a flow rate control valve 11, and a control device 20. Further, the pipes 8 include a suction pipe 8a, a discharge pipe 8b, and an oil return pipe 8c. Furthermore, the specific constitution of the refrigerant circuit system 10 illustrated in FIG. 1 schematically illustrates a basic constitution of the refrigerant circuit system 10 and may further include other elements.

[0022] The compressor 1 compresses a refrigerant and supplies the compressed high pressure refrigerant to the refrigerant circuit. The four-way valve 5 switches a flow direction of the refrigerant in a heating operation and a cooling operation. The outdoor heat exchanger 3 performs heat exchange between the refrigerant and outdoor air. For example, the outdoor heat exchanger 3 may serve as a condenser during the cooling operation and radiates heat to an outside and serves as an evaporator during the heating operation and absorbs heat from the outside. The expansion valve 4 depressurizes the refrigerant by a throttle function. For example, the expansion valve 4 may serve as a valve for reducing a pressure of a high-pressure refrigerant liquid during the heating operation.

[0023] The indoor heat exchanger 2 exchanges heat between the refrigerant and indoor air. The indoor heat exchanger 2 serves as the evaporator during the cooling operation, evaporates the refrigerant to absorb heat from an interior of a room and serves as the condenser during the heating operation and radiates heat into the room. The expansion valve 4 serves as an expansion valve during the cooling operation and reduces the pressure of the high pressure refrigerant liquid.

[0024] The accumulator 6 is a pressure container provided on an upstream side of the suction pipe 8a of the compressor 1. The accumulator 6 performs gas-liquid separation of the refrigerant supplied to the compressor 1 and prevents the liquid refrigerant from being suctioned into the compressor 1.

[0025] The receiver 7 is a tank which stores the liquid state refrigerant liquefied by the condenser.

[0026] The oil separator 9 is a device which is provided on a discharge side (downstream side) of the compressor 1 and separates refrigerator oil from the refrigerant mixed

with the refrigerator oil delivered through the discharge pipe 8b. For example, the oil separator 9 has a cylindrical shape of which upper and lower sides are closed and can store the separated refrigerator oil. One end of the oil return pipe 8c is connected to a lower portion of a container of the oil separator 9. An opposite end of the oil return pipe 8c is connected to the compressor 1. Further, the flow rate control valve 11 is provided in the oil return pipe 8c, and an amount of refrigerator oil returning from the oil separator 9 to the compressor 1 can be adjusted by adjusting a valve opening degree of the flow rate control valve 11.

[0027] Also, a pressure sensor 32 is provided on the suction side of the compressor 1, and a pressure sensor 33 is provided on the discharge side thereof. Further, a temperature sensor 31 is provided under a dome of the compressor 1. The control device 20 of the refrigerant circuit system 10 adjusts the valve opening degree of the flow rate control valve 11 on the basis of an under-dome temperature of the compressor 1 which is measured by the temperature sensor 31, a suction side pressure of the compressor 1 which is measured by the pressure sensor 32, a discharge side pressure of the compressor 1 which is measured by the pressure sensor 33, the rotational speed of the compressor 1, and so on. The control device 20 will be described in detail with reference to FIG. 2.

[0028] FIG. 2 is a schematic block diagram of the control device in one embodiment of the present invention.

[0029] For example, the control device 20 is a computer device such as a microcomputer. The control device 20 controls each device included in the refrigerant circuit system 10. For example, the control device 20 controls the rotational speed of the compressor 1, the valve opening degree of the expansion valve 4, the switching of the four-way valve 5, and so on. Particularly, in the embodiment, the control device 20 is connected to the temperature sensor 31, the pressure sensor 32, and the pressure sensor 33, adjusts the valve opening degree of the flow rate control valve 11 on the basis of measurement values obtained by the sensors and adjusts the flow rate of the refrigerator oil returned to the compressor 1. As illustrated in FIG. 2, the control device 20 includes a sensor information acquisition part 21, a control change determination part 22, a return flow rate calculation part 23, a valve opening degree control part 24, and a memory part 25.

[0030] The sensor information acquisition part 21 acquires an under-dome temperature T_d of the compressor 1 which is measured by the temperature sensor 31. Also, the sensor information acquisition part 21 acquires a suction side pressure LP of the compressor 1 which is measured by the pressure sensor 32. The sensor information acquisition part 21 acquires a discharge side pressure HP of the compressor 1 which is measured by the pressure sensor 33.

[0031] The control change determination part 22 determines a timing of change of the valve opening degree

control of the flow rate control valve 11 by the valve opening degree control part 24. For example, the control change determination part 22 determines a case in which there is a change in the flow rate (target return flow rate) of the refrigerator oil that needs to be returned to the compressor 1 as a timing of change of the valve opening degree control of the flow rate control valve 11. Further, for example, the control change determination part 22 determines a case in which there is a change in the pressure difference between the discharge side pressure and the suction side pressure of the compressor 1 as a timing of change of the valve opening degree control of the flow rate control valve 11.

[0032] The return flow rate calculation part 23 calculates the target return flow rate of the refrigerator oil on the basis of the under-dome temperature T_d of the compressor 1, the suction side pressure LP of the compressor 1 and the rotational speed of the compressor 1. More specifically, the return flow rate calculation part 23 calculates an under-dome superheating degree ΔT on the basis of the under-dome temperature T_d and the suction side pressure LP . Further, the return flow rate calculation part 23 calculates the circulation amount Q of the refrigerant on the basis of the rotational speed of the compressor 1. Additionally, the return flow rate calculation part 23 calculates the flow rate of the refrigerator oil discharged from the compressor 1 on the basis of the under-dome superheating degree ΔT and the circulation amount Q of the refrigerant and determines the calculated flow rate as the target return flow rate.

[0033] The valve opening degree control part 24 calculates the valve opening degree of the flow rate control valve 11 on the basis of the target return flow rate of the refrigerator oil that needs to be returned to the compressor 1 and the pressure difference between the discharge side pressure HP and the suction side pressure LP of the compressor 1 and sets the calculated valve opening degree in the flow rate control valve 11.

[0034] The memory part 25 stores various measurement values acquired by the sensor information acquisition part 21, various data tables used for calculating the target return flow rate or calculating the valve opening degree of the flow rate control valve 11, parameters and so on. Further, the memory part 25 stores a program realizing the function of the control device 20.

[0035] Further, functions of the control change determination part 22, the return flow rate calculation part 23 and the valve opening degree control part 24 are realized when a central processing unit (CPU) included in the control device 20 reads and executes a program from the memory part 25.

[0036] Next, a valve opening degree control process of the flow rate control valve 11 for recovering the refrigerator oil which is performed by the control device 20 will be described with reference to FIGS. 3 to 5.

[0037] FIG. 3 is a flowchart showing an example of a refrigerator oil returning process of the control device according to one embodiment of the present invention.

[0038] FIG. 4 is a view showing a discharge flow rate of the refrigerator oil in one embodiment of the present invention.

[0039] FIG. 5 is a view showing a method of calculating the valve opening degree of the flow rate control valve in one embodiment of the present invention.

[0040] First, the sensor information acquisition part 21 acquires sensor information (Step S11). Specifically, the sensor information acquisition part 21 acquires, for example, the under-dome temperature T_d measured by the temperature sensor 31 at predetermined time intervals and records the acquired under-dome temperature T_d in the memory part 25. Also, the sensor information acquisition part 21 acquires the suction side pressure LP measured by the pressure sensor 32 and the discharge side pressure HP measured by the pressure sensor 33 at predetermined time intervals and records the acquired suction side pressure LP and discharge side pressure HP in the memory part 25. Further, the control device 20 controls the rotational speed of the compressor 1 and the valve opening degree of the flow rate control valve 11, and values thereof during an operation are recorded in the memory part 25.

[0041] Next, the return flow rate calculation part 23 calculates the discharge flow rate Q of the refrigerator oil discharged from the compressor 1 (Step S12). A specific calculation procedure of the discharge flow rate Q will be described below.

(S12-1) First, the return flow rate calculation part 23 reads the suction side pressure LP acquired by the sensor information acquisition part 21 from the memory part 25 and converts the suction side pressure LP to a compressor suction saturation temperature (CSST). The suction side pressure LP and the CSST have a predetermined relationship, and a conversion table, a function or the like which defines the relationship therebetween is recorded in the memory part 25. The return flow rate calculation part 23 calculates the CSST from the suction side pressure LP , the conversion table recorded in the memory part 25, or the like.

(S12-2) Next, the return flow rate calculation part 23 obtains the under-dome superheating degree ΔT . The under-dome superheating degree ΔT can be obtained by the following Equation (1).

$$\Delta T = T_d - \text{CSST} \cdots (1)$$

[0042] Next, the return flow rate calculation part 23 obtains the discharge flow rate Q of the refrigerator oil for the under-dome superheat degree ΔT and the rotational speed N_c of the compressor 1 recorded in the memory part 25.

(S12-3)

[0043] FIG. 4 is a view showing a relationship between the under-dome superheat degree ΔT for each of the rotational speeds N_{cx} ($x = 1$ to 3) of the compressor 1 and the discharge flow rate Q of the refrigerator oil. For example, a graph 41 shows the relationship between the under-dome superheat degree ΔT and the discharge flow rate Q at the rotational speed N_{c3} of the compressor 1. Similarly, a graph 42 shows the relationship between the under-dome superheat degree ΔT and the discharge flow rate Q at the rotational speed N_{c2} , and a graph 43 shows the relationship between the under-dome superheat degree ΔT and the discharge flow rate Q at the rotational speed N_{c1} . A data table (conversion map) exemplified in FIG. 4 is recorded in the memory part 25, and thus when the rotational speed N_c of the compressor and the under-dome superheat degree ΔT are provided, the return flow rate calculation part 23 can determine the discharge flow rate Q . In general, when the discharge flow rate Q of the refrigerator oil flowing out from the compressor 1 is calculated, the circulation amount of the refrigerant is required. To appropriately obtain this, a specific volume of the refrigerant on the suction side of the compressor 1 is required. In the embodiment, for the sake of simplicity, the refrigerant circulation amount is expressed by the rotational speed N_c of the compressor 1, as described below. That is, since the circulation amount of the refrigerant discharged from the compressor 1 increases in proportion to the rotational speed N_c of the compressor 1, the refrigerant circulation amount can be expressed by the rotational speed N_c of the compressor. For example, the refrigerant circulation amount is fixed at a certain value with respect to the rotational speed N_c of the compressor as follows.

[0044] First, a range of the refrigerant circulation amount is divided within a range in which the compressor 1 is actually operated. More specifically, the rotational speed N_c (corresponding to the refrigerant circulation amount) of the compressor 1 is divided into three ranges of the rotational speed within the range in which the compressor 1 is actually operated. Further, the division of the range of the rotational speed N_c of the compressor 1 is not limited to three ranges and the range may be divided more finely. In addition, when the range of the rotational speed N_c of the compressor 1 at which the compressor 1 is actually operated is narrow, the range of the rotational speed N_c of the compressor 1 may be divided more coarsely than three ranges.

[0045] Next, in each range of the rotational speed, the highest number of rotation of the compressor 1 is selected, and the rotational speed in each region is fixed to the selected number of rotation of the compressor 1. Therefore, a large discharge flow rate Q of the refrigerator oil from the compressor 1 can be estimated. That is, a return amount of the refrigerator oil in a state in which there is a margin in the discharge flow rate Q from the compressor 1 can be calculated. As a result, the risk of insufficient

lubrication of the compressor 1 or the like can be reduced. Here, this will be described with an assumption that the highest number of rotation of the compressor 1 in each range NNc1, NNc2, NNc3 is Nc1, Nc2, Nc3.

[0046] Additionally, in each selected number of rotation Nc1, Nc2, Nc3 of the compressor 1, a pressure Pi and a temperature Ti on the suction side of the compressor when the compressor, the outdoor heat exchanger, the indoor heat exchanger and so on corresponding to the refrigerant circuit system 10 are connected and operated under predetermined conditions are obtained by, for example, a simulation or the like. Additionally, a specific volume and a superheat degree of the refrigerant in that state are obtained from the obtained suction side pressure Pi and suction side temperature Ti of the compressor. At the same time, a volumetric efficiency of the compressor 1 is obtained from an operation conditions table of the compressor 1, and the refrigerant circulation amount is calculated.

[0047] For example, assuming that when the rotational speed of the compressor is Nc1, the refrigerant circulation amount is A(kg/min), when the rotational speed of the compressor is Nc2, the refrigerant circulation amount B (kg/min) and when the rotational speed of the compressor is Nc3, the refrigerant circulation amount C, (kg/min), the refrigerant circulation amounts in the ranges NNc1, NNc2 and NNc3 of the rotational speed of the compressor 1 described above are represented by A, B and C, respectively. Here, $A < B < C$. With the processing so far, a relationship between the superheat degree (under-dome superheat degree ΔT) of the refrigerant on the suction side of the compressor, the refrigerant circulation amount and the rotational speed Nc (representative value) of the compressor can be obtained. Next, a relationship between the under-dome superheat degree ΔT and the discharge flow rate Q of the refrigerator oil discharged from the compressor 1 is obtained.

[0048] The discharge flow rate Q(kg/min) of the refrigerator oil discharged from the compressor 1 per unit time can be obtained by a product of the refrigerant circulation amount Gr (kg/min) and an oil separation efficiency OC% (%). Further, the obtained discharge flow rate Q may be converted into a volumetric flow rate, if necessary. The oil separation efficiency OC% increases with the under-dome superheat degree ΔT . As illustrated in FIG. 4, a relationship between the under-dome superheat degree ΔT and the discharge flow rate Q for each number of rotation Nc of the compressor can be obtained by obtaining the oil separation efficiency OC% by actual measurement. With such a procedure, the relationship between the under-dome superheat degree ΔT and the discharge flow rate Q for each number of rotation Nc of the compressor is obtained, and a data table or the like which defines the relationships is recorded in the memory part 25. The return flow rate calculation part 23 obtains the discharge flow rate Q of the refrigerator oil at the rotational speed Nc of the compressor 1 from the data table and the under-dome superheat degree ΔT and the rota-

tional speed Nc of the compressor 1 recorded in the memory part 25.

[0049] In addition, the return flow rate calculation part 23 determines the discharge flow rate Q as the target return flow rate when the discharge flow rate Q is obtained.

[0050] Next, the control change determination part 22 calculates the pressure difference between the discharge side and the suction side of the compressor 1 (Step S12). The control change determination part 22 reads the suction side pressure LP and the discharge side pressure HP of the compressor 1 recorded in the memory part 25, subtracts the suction side pressure LP from the discharge side pressure HP and calculates the pressure difference ΔP .

[0051] Next, the control change determination part 22 determines whether there has been a change in an operation point (Step S14). Specifically, the control change determination part 22 compares information of the operation point recorded last time with information of a current operation point to determine whether there has been a change therebetween. Here, the operation point information is the discharge flow rate Q of the refrigerator oil calculated in Step S12 and the pressure difference ΔP between the discharge side and the suction side of the compressor 1 calculated in Step S13. When the discharge flow rate Q of the refrigerator oil discharged to the refrigerant circuit changes, it is necessary to adjust the valve opening degree of the flow rate control valve 11 accordingly. When the pressure difference ΔP between the discharge side and the suction side of the compressor 1 changes, the pressure difference between the discharge side and the suction side of the compressor 1 affects the flow rate of the refrigerator oil recovered from the oil separator 9 to the compressor 1, and thus it is necessary to adjust the valve opening degree of the flow rate control valve 11 according to the change in the pressure difference ΔP . Therefore, the control change determination part 22 acquires the discharge flow rate Q of the refrigerator oil from the return flow rate calculation part 23 and compares it with the previous discharge flow rate recorded in the memory part 25. Further, the control change determination part 22 compares the pressure difference ΔP calculated in Step S13 with the previous pressure difference recorded in the memory part 25. Additionally, the control change determination part 22 determines that the operation point has changed when at least one of a result of comparison of the discharge flow rates and a result of comparison of the pressure differences is different. When the operation point has not changed (Step S14; No), the process proceeds to Step S18.

[0052] When the operation point has changed (Step S14; Yes), the valve opening degree control part 24 calculates the valve opening degree of the flow rate control valve 11 (Step S15). Specifically, the control change determination part 22 instructs the valve opening degree control part 24 to reset the valve opening degree. Then, the valve opening degree control part 24 acquires the

discharge flow rate Q of the refrigerator oil from the return flow rate calculation part 23 and acquires the pressure difference ΔP from the control change determination part 22. Next, the valve opening degree control part 24 calculates the valve opening degree of the flow rate control valve 11 on the basis of the discharge flow rate Q , the pressure difference ΔP and the data table defining a relationship between the return flow rate and the valve opening degree of the flow rate control valve 11 for each pressure difference illustrated in FIG. 5.

[0053] FIG. 5 is a view showing a relationship between the return flow rate of the refrigerator oil and the valve opening degree of the flow rate control valve 11 for each pressure difference between the discharge side and the suction side of the compressor 1. For example, when the pressure difference is ΔP_1 , the return flow rate and the valve opening degree have a relationship shown in a graph 51, when the pressure difference is ΔP_2 , the return flow rate and the valve opening degree have a relationship shown in a graph 52, and when the pressure difference is ΔP_3 , the return flow rate and the valve opening degree have a relationship shown by a graph 53. Here, $\Delta P_1 > \Delta P_2 > \Delta P_3$. A data table showing flow rate characteristics of the flow rate control valve 11 exemplified in FIG. 5 is recorded in the memory part 25. When the target value (target return flow rate) of the return flow rate of the refrigerator oil and the pressure difference between the discharge side and the suction side of the compressor 1 are provided, the valve opening degree control part 24 can calculate the appropriate valve opening degree of the flow rate control valve 11.

[0054] Next, the valve opening degree control part 24 controls the valve opening degree of the flow rate control valve 11 (Step S16). The valve opening degree control part 24 outputs an instruction value corresponding to the calculated valve opening degree to the flow rate control valve 11 and sets the appropriate valve opening degree. Accordingly, it is possible to set the return amount (target return flow rate) of the refrigerator oil suitable for the current operation point.

[0055] Next, the valve opening degree control part 24 records the information of the operation point calculated this time in the memory part 25 (Step S17). Specifically, the valve opening degree control part 24 records the discharge flow rate Q and the pressure difference ΔP used for calculating the valve opening degree in the memory part 25.

[0056] Next, the control change determination part 22 determines whether the operation is to be continued (Step S18). For example, when an instruction to stop the operation is input, the control change determination part 22 determines to stop the operation. Further, when an operation instruction is input, the control change determination part 22 determines to continue the operation. When it is determined that the operation is to be continued (Step S18; Yes), the process from Step S11 is repeated. When it is determined that the operation is to be stopped (Step S18; No), the processing flow is terminat-

ed.

[0057] According to the embodiment, the flow rate control valve 11 in which flow rate control is variable is provided between the oil separator 9 and an oil return port of the compressor 1. Further, the conversion table (FIG. 5) defining the relationship between the valve opening degree of the flow rate control valve 11 and the return flow rate of the refrigerator oil according to the pressure difference between the discharge side pressure and the suction side pressure of the compressor 1 is stored in the control device 20. Additionally, the target return flow rate and the pressure difference are calculated, and the opening degree of the flow rate control valve 11 is controlled such that it is set to the valve opening degree according to the calculated target return flow rate and pressure difference. As described above, by controlling the opening degree of the flow rate control valve 11, it is possible to return an amount of the refrigerator oil to the compressor 1 in accordance with operation conditions, regardless of the size of the oil return pipe 8c. Accordingly, for example, it is possible to prevent an insufficient return amount caused by a small size of the oil return pipe 8c or insufficient capacity due to bypassing of the refrigerant caused by a large size of the oil return pipe 8c.

[0058] The processing in each process in the above-described control device 20 is stored in a computer readable recording medium in the form of a program, and the processing is performed by reading and executing the program by a computer of the control device 20. Here, the computer-readable recording medium is a magnetic disk, a magneto-optical disk, a CD-ROM, a DVD-ROM, a semiconductor memory, or the like. Further, the computer program may be delivered to a computer through a communication line, and the computer receiving the program may execute the program. Further, the above-described program may be for realizing a part of the above-described functions. * Furthermore, the program may be a so-called differential file (differential program) which can be realized by a combination with a program already recorded in the computer system.

[0059] In addition, it is possible to substitute well-known elements with the elements in the above-described embodiment within a scope not deviating from the gist of the present invention. Further, the technical scope of the present invention is not limited to the above-described embodiment, and various modifications can be made without departing from the spirit of the present invention.

EXPLANATION OF REFERENCES

[0060]

- 1 Compressor
- 2 Indoor heat exchanger
- 3 Outdoor heat exchanger
- 4 Expansion valve
- 5 Four-way valve

6 Accumulator
 7 Receiver
 8 Pipes
 8a Suction pipe
 8b Discharge pipe
 8c Oil return pipe
 9 Oil separator
 10 Refrigerant circuit system
 11 Flow rate control valve
 20 Control device
 21 Sensor information acquisition part
 22 Control change determination part
 23 Return flow rate calculation part
 24 Valve opening degree control part
 25 Memory part
 31 Temperature sensor
 32, 33 Pressure sensor

Claims

1. A control device (20) for a refrigerant circuit system (10) which comprises a compressor (1) configured to compress a refrigerant, an oil separator (9) configured to separate refrigerator oil contained in the refrigerant discharged from the compressor (1) from the refrigerant, an oil return pipe (8c) configured to return the separated refrigerator oil to the compressor (1), and a flow rate control valve (11) provided in the oil return pipe (8c), comprising a valve opening degree control part (24) configured to control a valve opening degree of the flow rate control valve (11) on the basis of a target return flow rate of the refrigerator oil that needs to be returned to the compressor (1) and a pressure difference (ΔP) between a discharge side pressure (HP) and a suction side pressure (LP) of the compressor (1).
2. The control device (20) according to claim 1, further comprising a return flow rate calculation part (23) configured to calculate the target return flow rate of the refrigerator oil on the basis of an under-dome temperature (T_d) of the compressor (1), the suction side pressure (LP) of the compressor and the rotational speed (N_c) of the compressor.
3. The control device (20) according to claim 2, wherein the return flow rate calculation part (23) determines a flow rate of the refrigerator oil discharged from the compressor (1) as the target return flow rate.
4. The control device (20) according to any one of claims 1 to 3, further comprising a control change determination part (22) configured to determine a timing of change of valve opening degree control by the valve opening degree control part (24).
5. The control device (20) according to of claim 4,

wherein the control change determination part (22) determines a case in which there is a change in the target return flow rate as a timing of change of the valve opening degree of the flow rate control valve (11).

6. The control device (20) according to claim 4 or 5, wherein the control change determination part (22) determines a case in which there is a change in the pressure difference (ΔP) between the discharge side pressure (HP) and the suction side pressure (LP) of the compressor (1) as a timing of change of the valve opening degree of the flow rate control valve (11).

7. A refrigerant circuit system (10) comprising:

a compressor (1) configured to compress a refrigerant,
 an oil separator (9) configured to separate refrigerator oil contained in the refrigerant discharged from the compressor (1) from the refrigerant,
 an oil return pipe (8c) configured to return the separated refrigerator oil to the compressor (1),
 a flow rate control valve (11) provided in the oil return pipe (8c), and
 the control device (20) according to any one of claims 1 to 6.

8. A control method of a refrigerant circuit system (10) which comprises a compressor (1) configured to compress a refrigerant, an oil separator (9) configured to separate refrigerator oil contained in the refrigerant discharged from the compressor (1) from the refrigerant, an oil return pipe (8c) configured to return the separated refrigerator oil to the compressor (1), and a flow rate control valve (11) provided in the oil return pipe (8c), wherein a valve opening degree of the flow rate control valve (11) is controlled on the basis of a target return flow rate of the refrigerator oil that needs to be returned to the compressor and a pressure difference (ΔP) between a discharge side pressure (HP) and a suction side pressure (LP) of the compressor (1).

9. A program which allows a computer of a control device (20) configured to control a refrigerant circuit system (10) comprising a compressor (1) configured to compress a refrigerant, an oil separator (9) configured to separate refrigerator oil contained in the refrigerant discharged from the compressor (1) from the refrigerant, an oil return pipe (8c) configured to return the separated refrigerator oil to the compressor (1) and a flow rate control valve (11) provided in the oil return pipe (8c) to serve as a valve opening degree control part (24) configured to control a valve opening degree of the flow rate control valve (11) on

the basis of a target return flow rate of the refrigerator oil that needs to be returned to the compressor (1) and a pressure difference (ΔP) between a discharge side pressure (HP) and a suction side pressure (LP) of the compressor (1).

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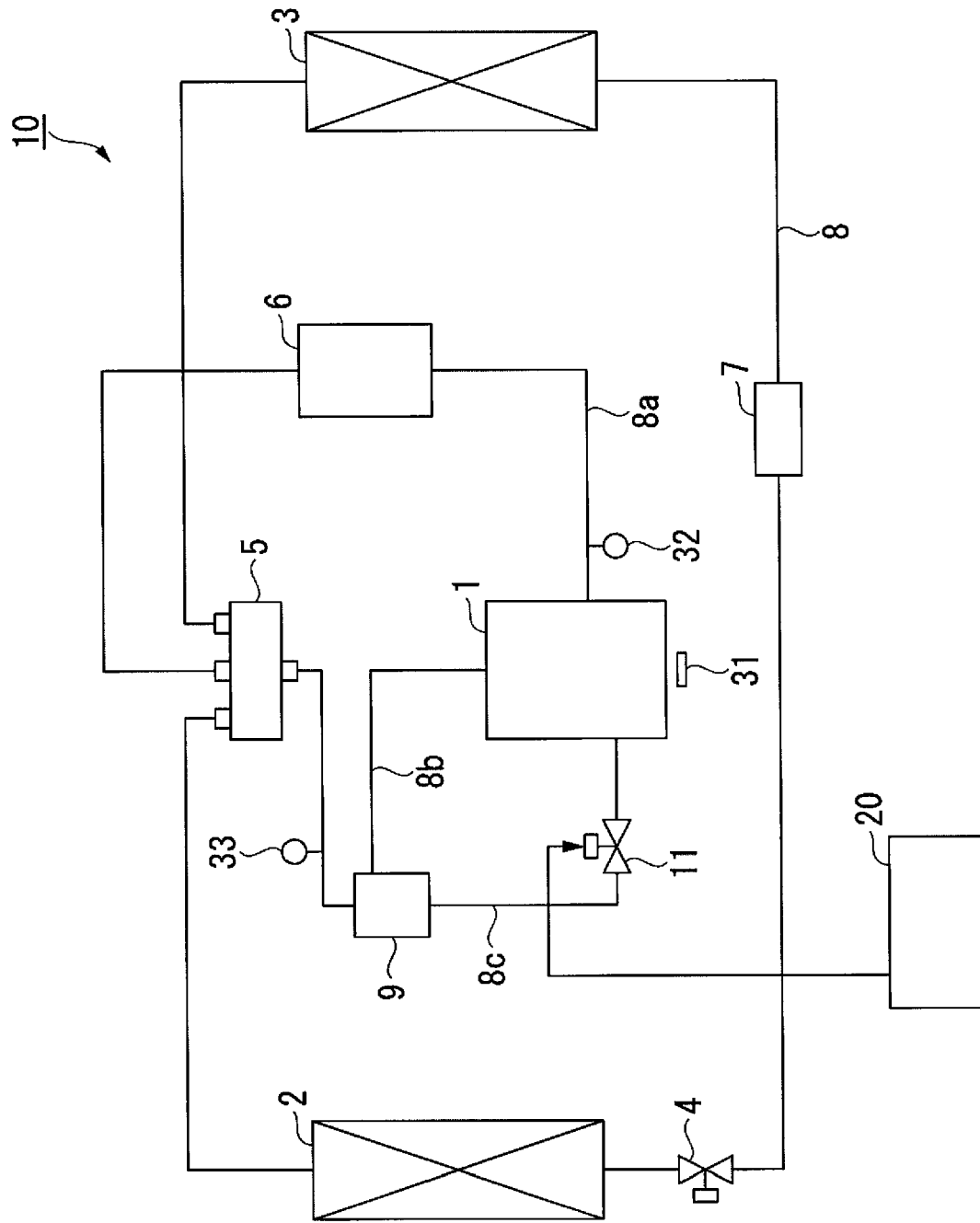


FIG. 1

FIG. 2

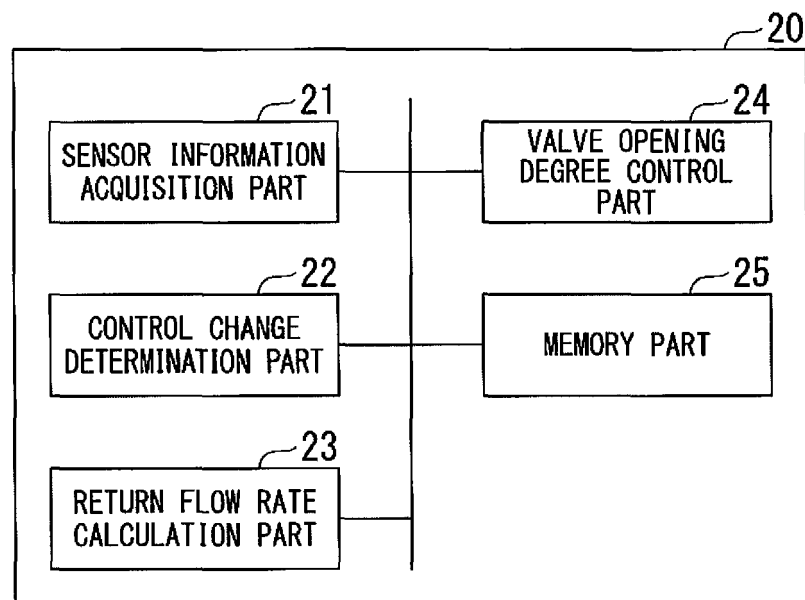


FIG. 3

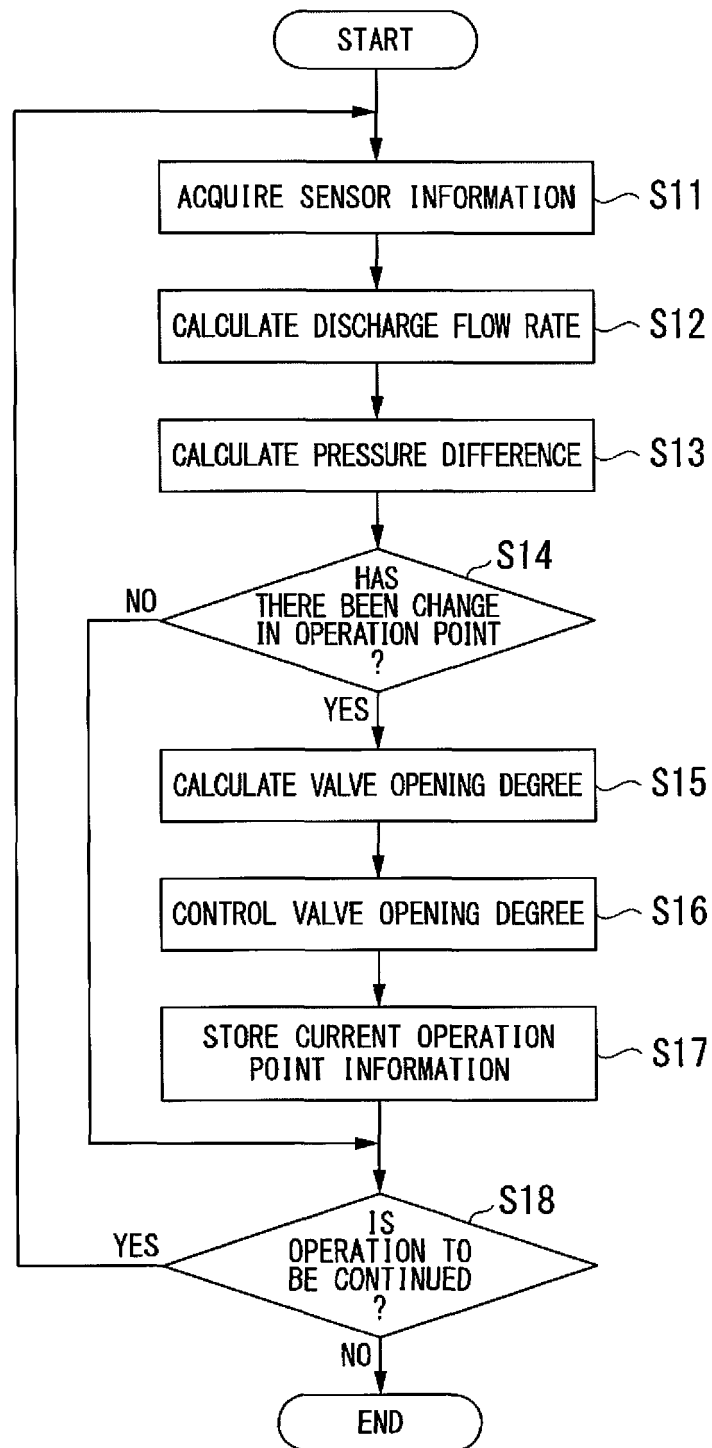


FIG. 4

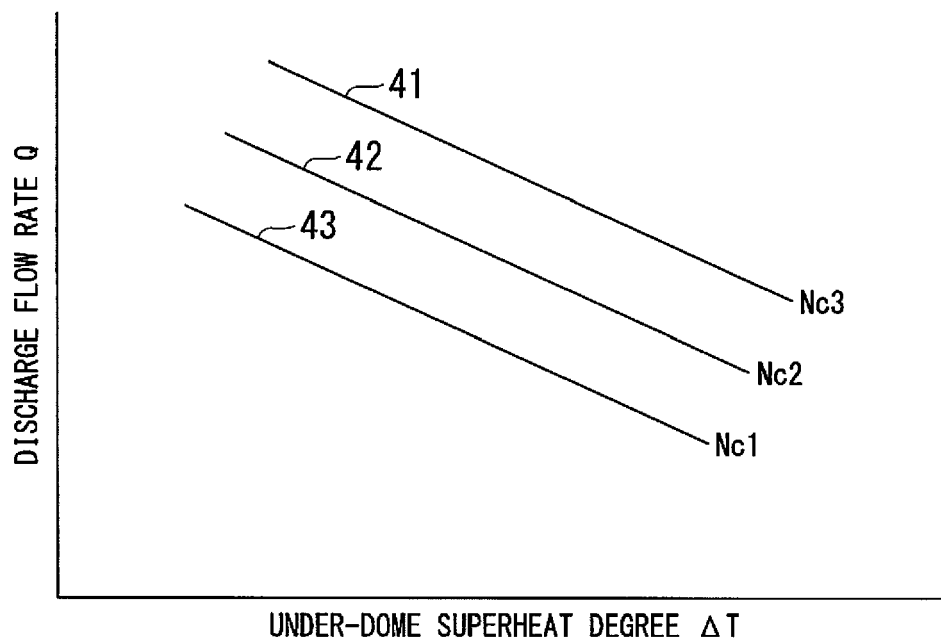
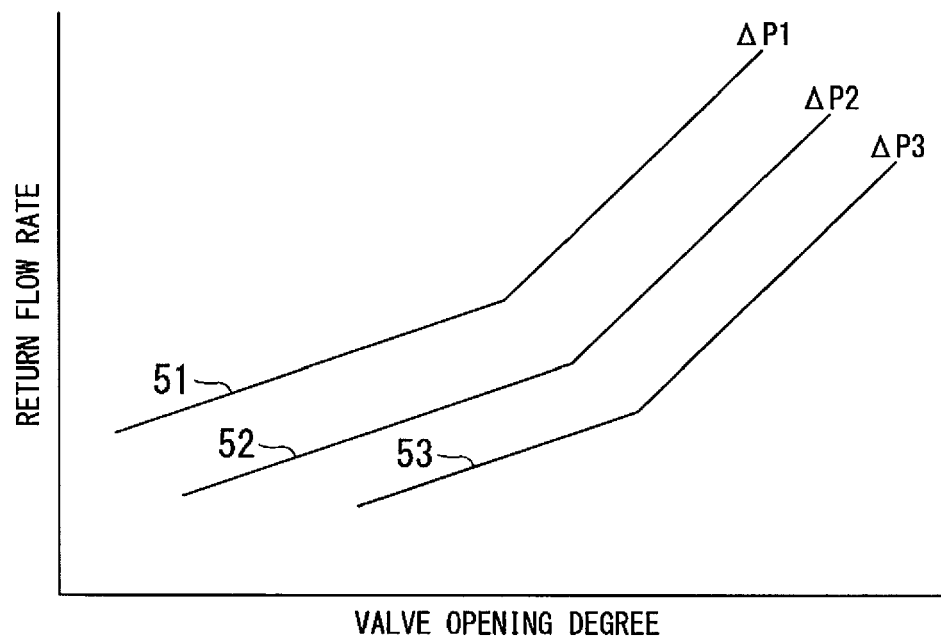


FIG. 5





EUROPEAN SEARCH REPORT

 Application Number
 EP 17 19 4422

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			TECHNICAL FIELDS SEARCHED (IPC)
			F25B
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 23 January 2018	Examiner Szilagyi, Barnabas
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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23-01-2018

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