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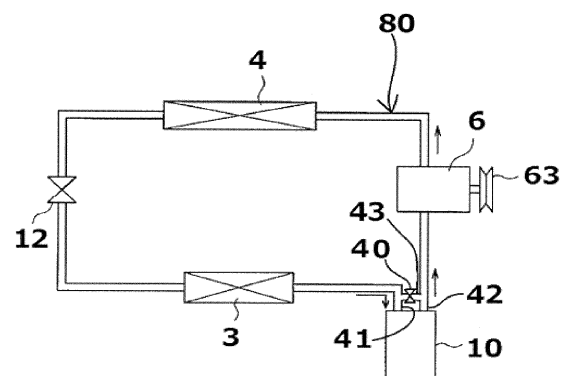
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(54) **VEHICLE AIR CONDITIONING APPARATUS**

(57) A vehicle air conditioning apparatus according to the present disclosure includes a refrigeration cycle 80 which includes at least a compressor 6, an outdoor heat exchanger 4, an expanding device 12, an evaporator 3, and an accumulator 10 and in which these elements are connected in this order by piping; a bypass passage 43 which connects outside the accumulator a refrigerant inlet pipe 41, which causes a refrigerant circulating through the refrigeration cycle to flow into the accumulator, and a refrigerant outlet pipe 42, which causes the refrigerant to flow out from the accumulator, thus short-circuiting the refrigerant, enabling the refrigerant to circulate; a valve device 40 which, being provided in the bypass passage, has an opening/closing function; and a control device 23 which controls at least the compressor and the valve device.

Figure 1



Description

BACKGROUND OF THE INVENTION

5 1. Field of the Invention

[0001] The present disclosure relates to a vehicle air conditioning apparatus including a refrigeration cycle having an accumulator.

10 2. Description of the Related Art

[0002] In a refrigeration cycle having an accumulator on the upstream side of a compressor, there is a case in which a refrigerant boils inside the accumulator immediately after the compressor is started, causing an abnormal noise to occur. Therefore, a technology which aims to suppress the noise occurring and the refrigerant boiling down is provided (for example, refer to Patent Literature 1).

[0003] Patent Literature 1 aims to suppress the refrigerant coming to a boil by driving a stirring device utilizing the flow of refrigerant flowing into the accumulator and thus stirring a liquid-phase refrigerant accumulated inside the accumulator.

[0004] Also, an idea is disclosed wherein a vent is provided in an upper portion of a refrigerant outflow pipe inside the accumulator, short-circuiting a gas-phase refrigerant inside the accumulator (for example, refer to Patent Literature 2) .

Patent Literature 1: JP-A-2017-058070

Patent Literature 2: JP-A-2000-088402

[0005] In the technology of Patent Literature 1, however, there is a disadvantage in that a stirring device 90 is installed, thus leading to a complexity in the internal structure of the accumulator.

[0006] Also, in the technology of Patent Literature 2, it is necessary, from a liquid-phase refrigerant accumulated in a lower portion inside the accumulator, to suck out a lubricant dissolved therein, and it is essential for the refrigerant outflow pipe extending to the lower portion inside the accumulator to exert a certain suction power at the lower side leading end, so that a vent such as shown by sign 17 in Patent Literature 2 cannot be set to be indiscriminately large in size.

[0007] In the meantime, it is because the internal space of the accumulator is sharply reduced in pressure that the liquid-phase refrigerant boils immediately after the compressor is started. It is considered to take countermeasures thereagainst, for example, by restricting the rotation speed (keeping the rotation speed low) immediately after the compressor is started and thus preventing excessive refrigerant from being sucked in, but by so doing, there is a problem in that it is not possible to obtain an adequate rapid cooling or heating capacity required for the refrigeration cycle.

SUMMARY OF THE INVENTION

[0008] Therefore, the present disclosure has for its object to provide a vehicle air conditioning apparatus having a refrigeration cycle, which, while fully performing a desired temperature control function required for the vehicle air conditioning apparatus, can avoid an excessively depressurized state inside an accumulator.

[0009] The present inventors, after their earnest studies, have found out that an abnormal noise due to bumping can be suppressed by providing a bypass passage which connects outside the accumulator a refrigerant inlet pipe, which causes a refrigerant circulating through a refrigeration cycle to flow into an accumulator, and a refrigerant outlet pipe, which causes the refrigerant to flow out from the accumulator, thus short-circuiting the refrigerant, enabling the refrigerant to circulate, and has completed the present invention. That is, the vehicle air conditioning apparatus according to the present invention includes a refrigeration cycle which includes at least a compressor, an outdoor heat exchanger, an expanding device, an evaporator, and an accumulator and in which these elements are connected in this order by piping; a bypass passage which connects outside the accumulator a refrigerant inlet pipe, which causes a refrigerant circulating through the refrigeration cycle to flow into the accumulator, and a refrigerant outlet pipe, which causes the refrigerant to flow out from the accumulator, thus short-circuiting the refrigerant, enabling the refrigerant to circulate; a valve device which, being provided in the bypass passage, has an opening/closing function; and a control device which controls at least the compressor and the valve device.

[0010] In the vehicle air conditioning apparatus according to the present invention, it is preferable that the valve device is an on/off valve which allows or blocks the flow of the refrigerant in the bypass passage. The flow of the refrigerant in the bypass passage can be controlled with a simple structure.

[0011] In the vehicle air conditioning apparatus according to the present invention, it is preferable that the valve device is a three-way valve which is disposed at the confluence of the bypass passage and the refrigerant outlet pipe. The flow of the refrigerant in the bypass passage can be controlled with a simple structure.

[0012] In the vehicle air conditioning apparatus according to the present invention, it is preferable to further include a refrigerant temperature detection unit which can detect the temperature of a liquid-phase refrigerant inside the accumulator, wherein the compressor is of an electric type, and wherein the control device starts the compressor at a specified rotation speed and sets the state in which the flow of the refrigerant in the bypass passage is allowed by the valve device, subsequently, calculates an estimated superheat degree T_{est} of a gas-phase refrigerant inside the accumulator, which is obtained when the flow of the refrigerant in the bypass passage is blocked, from the specified rotation speed of the compressor and from temperature information obtained from the refrigerant temperature detection unit, compares the estimated superheat degree T_{est} and a predetermined threshold superheat degree T_{def} , and when the estimated superheat degree T_{est} falls below the threshold superheat degree T_{def} , causes the valve device to block the flow of the refrigerant in the bypass passage. It is possible to estimate the time at which to close the valve device and thus possible to accurately suppress an occurrence of bumping.

[0013] In the vehicle air conditioning apparatus according to the present invention, it is preferable that a temperature sensor portion of the refrigerant temperature detection unit is disposed on the lower side of the center in the internal space of the accumulator or on the outer bottom surface of the accumulator. It is possible to more accurately estimate the time at which to close the valve device, and as a result, it is possible to more accurately suppress an occurrence of bumping.

[0014] In the vehicle air conditioning apparatus according to the present invention, it is preferable that the control device, when the compressor is started, sets the state in which the flow of the refrigerant in the bypass passage is allowed by the valve device, and subsequently, after a predetermined time has passed, sets the state in which the flow of the refrigerant in the bypass passage is blocked by the valve device. It is possible, even without providing the refrigerant temperature detection unit, to accurately suppress an occurrence of bumping with the configuration remaining simple.

[0015] In the vehicle air conditioning apparatus according to the present invention, it is preferable to further include a vehicle exterior temperature detection unit, wherein the control device, when the compressor is started, sets the state in which the flow of the refrigerant in the bypass passage is allowed by the valve device when a vehicle exterior temperature obtained from the vehicle exterior temperature detection unit is lower than a predetermined temperature, and sets the state in which the flow of the refrigerant in the bypass passage is blocked by the valve device when the vehicle exterior temperature is equal to or higher than the predetermined temperature. It is possible, by using the vehicle exterior temperature detection unit, to accurately suppress an occurrence of bumping with the configuration remaining simple.

[0016] According to the present disclosure, it is possible to provide the vehicle air conditioning apparatus having the refrigeration cycle, which, while fully performing the desired temperature control function required for the vehicle air conditioning apparatus, can avoid the excessively depressurized state inside the accumulator.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017]

Fig. 1 is a schematic diagram showing a first example of the configuration of a cooling refrigeration cycle in a vehicle air conditioning apparatus according to the present embodiment.

Fig. 2 is a schematic diagram showing a first example of an accumulator including a bypass passage.

Fig. 3 is a schematic diagram showing a second example of the accumulator including the bypass passage.

Fig. 4 is a schematic diagram showing a third example of the accumulator including the bypass passage.

Figs. 5A and 5B are schematic diagrams showing a second example of the configuration of the refrigeration cycle in the vehicle air conditioning apparatus according to the present embodiment.

Figs. 6A and 6B are schematic diagrams showing a third example of the configuration of the refrigeration cycle in the vehicle air conditioning apparatus according to the present embodiment.

Fig. 7 is a schematic diagram showing a fourth example of the configuration of the refrigeration cycle in the vehicle air conditioning apparatus according to the present embodiment.

Fig. 8 is a schematic diagram showing a fifth example of the configuration of the refrigeration cycle in the vehicle air conditioning apparatus according to the present embodiment.

Fig. 9 is a schematic diagram showing the state in which the flow of refrigerant in the bypass passage is "allowed" in the accumulator of the first example.

Fig. 10 is a schematic diagram showing the state in which the flow of refrigerant in the bypass passage is "blocked" in the accumulator of the first example.

Fig. 11 is a flowchart showing a first example of controlling the flow of refrigerant in the bypass passage when a compressor is started.

Fig. 12 is a schematic diagram showing the state in which the flow of refrigerant in the bypass passage is "allowed" in the accumulator of the second example.

Fig. 13 is a schematic diagram showing the state in which the flow of refrigerant in the bypass passage is "blocked"

in the accumulator of the second example.

Fig. 14 is a flowchart showing a second example of controlling the flow of refrigerant in the bypass passage when the compressor is started.

Fig. 15 is a flowchart showing a third example of controlling the flow of refrigerant in the bypass passage when the compressor is started.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0018] Hereafter, a description will be given, referring to the accompanying drawings, of one aspect of the present invention. An embodiment to be described hereafter is a working example of the present invention, and the present invention is not limited to the following embodiment. In the present description and drawings, component elements with the same signs shall indicate mutually identical ones. The embodiment may be modified in various ways as long as the modifications exert advantageous effects of the present invention.

[0019] A description will be given, referring to Figs. 1 and 2, of a vehicle air conditioning apparatus according to the present embodiment. The vehicle air conditioning apparatus according to the present embodiment includes a refrigeration cycle 80, which includes at least a compressor 6, an outdoor heat exchanger 4, an expanding device 12, an evaporator 3, and an accumulator 10 and in which these elements are connected in this order by piping, a bypass passage 43, which connects outside the accumulator 10 a refrigerant inlet pipe 41, which causes a refrigerant circulating through the refrigeration cycle 80 to flow into the accumulator 10, and a refrigerant outlet pipe 42, which causes the refrigerant to flow out from the accumulator 10, thus short-circuiting the refrigerant, enabling the refrigerant to circulate, a valve device 40 which, being provided in the bypass passage 43, has an opening/closing function, and a control device 23 which controls at least the compressor 6 and the valve device 40.

First Example of Refrigeration Cycle

[0020] The basic configuration of the refrigeration cycle for cooling includes the compressor 6, the outdoor heat exchanger 4, the expanding device 12, the evaporator 3, and the accumulator 10, as shown in Fig. 1. The compressor 6 sucks in and compresses the refrigerant. The compressor 6 is rotary driven by a not-shown vehicle driving engine via a pulley 63, a belt, and the like. As the compressor 6, either a variable capacity compressor or a fixed capacity compressor may be used. Also, in the event of using an electric compressor as the compressor 6, the capability to discharge the refrigerant can be adjusted by adjusting the rotation speed of an electric motor. Also, the use of the electric compressor can obviate the necessity of the connection with the vehicle driving engine via the belt and the like. A high-pressure gas-phase refrigerant discharged from the compressor 6 flows into the outdoor heat exchanger 4 and herein is heat exchanged with outside air, cooled, and condensed. A liquid refrigerant condensed in the outdoor heat exchanger 4 is next reduced in pressure to a low pressure in the expanding device 12, turning into a misty, gas-liquid two-phase state. The expanding device 12 is formed of a fixed aperture, such as an orifice or a nozzle, or an appropriate variable aperture. The low-pressure refrigerant reduced in pressure, in the evaporator 3, absorbs heat from the air blown by a not-shown air conditioning blower and evaporates. The evaporator 3 is disposed in a not-shown air-conditioner casing, and cold air cooled in the evaporator 3, after being adjusted in temperature by a not-shown heater core section, is blown out into a vehicle interior. The refrigerant having passed through the evaporator 3, after being gas-liquid separated in the accumulator 10, is sucked into the compressor 6. The accumulator 10 plays the role of separating the refrigerant having flowed out from the evaporator 3 into a gas-phase refrigerant and a liquid-phase refrigerant, storing the liquid-phase refrigerant, and causing the gas-phase refrigerant to be sucked into the compressor 6. The accumulator 10 also plays the role of causing oil, which is dissolved in the liquid refrigerant accumulating in a tank bottom portion, to be sucked into the compressor 6.

Accumulator

[0021] A refrigerant 44 shown in Fig. 2 is a refrigerant which has flowed out from the evaporator 3 and is in the gas-liquid two-phase state. The refrigerant 44 having passed through the refrigerant inlet pipe 41 connected to the evaporator 3 flows into the internal space of a tank 45 through an inflow opening 46 provided in the tank 45. An accumulated liquid-phase refrigerant 47 and a gas-phase refrigerant 48 exist in the internal space of the tank 45. The refrigerant 44 in the gas-liquid two-phase state is separated by a gas-liquid separator 52 into the gas-phase refrigerant and the liquid-phase refrigerant. The gas-phase refrigerant 48 is sent to the compressor 6 through the refrigerant outlet pipe 42 connected to an outflow opening 49 provided in the tank 45.

Bypass Passage

[0022] The bypass passage 43 connects outside the accumulator 10 the refrigerant inlet pipe 41 and the refrigerant outlet pipe 42 which causes the refrigerant to flow out from the accumulator 10, thus short-circuiting the refrigerant, enabling the refrigerant to circulate. The valve device 40 for carrying out the opening/closing of the bypass passage 43 is provided in the bypass passage 43. The flow of refrigerant in the bypass passage 43 is "allowed" or "blocked" by the valve device 40. It is preferable here that the valve device 40 is an on/off valve such as shown in Fig. 2. The on/off valve can control the flow of refrigerant in the bypass passage 43 with a simple structure. That is, when the on/off valve is opened, the flow of refrigerant in the bypass passage is "allowed". As the refrigerant inlet pipe 41 and the refrigerant outlet pipe 42 are not closed at this time, the refrigerant can flow into the accumulator 10, but airflow resistance is lower when the refrigerant flows in the bypass passage 43 than when the refrigerant flows in the accumulator 10, so that the refrigerant flows dominantly in the bypass passage 43. At this time, the pressure in the bypass passage 43 and the pressure in the accumulator 10 are spontaneously approximated to each other. On the other hand, when the on/off valve is closed, the flow of refrigerant in the bypass passage is "blocked", and the refrigerant flows into the accumulator 10.

[0023] It is preferable, as shown in Fig. 3, that the valve device 40 is a three-way valve which is disposed at the confluence of the bypass passage 43 and the refrigerant outlet pipe 42. The three-way valve can control the flow of refrigerant in the bypass passage 43 with a simple structure. That is, when the three-way valve opens the bypass passage and closes the refrigerant outlet pipe 42, the flow of refrigerant in the bypass passage is "allowed". At this time, the refrigerant outlet pipe 42 is closed, and so the refrigerant does not flow into the accumulator 10. However, as the refrigerant inlet pipe 41 is not closed, the pressure in the bypass passage 43 and the pressure in the accumulator 10 are spontaneously approximated to each other. On the other hand, when the three-way valve closes the bypass passage and opens the refrigerant outlet pipe 42, the flow of refrigerant in the bypass passage is "blocked", and the refrigerant flows into the accumulator 10.

[0024] The valve device 40, whether it is the on/off valve shown in Fig. 2 or the three-way valve shown in Fig. 3, acts equally in both "allowing" and "blocking" the flow of refrigerant in the bypass passage 43, as heretofore described.

Refrigerant Temperature Detection Unit

[0025] In the vehicle air conditioning apparatus according to the present embodiment, it is preferable, as shown in Fig. 2, that it further has a refrigerant temperature detection unit 50 which can detect the temperature of the liquid-phase refrigerant 47 inside the accumulator 10. It is preferable here that a temperature sensor portion of the refrigerant temperature detection unit 50 is disposed on the lower side of the center in the internal space of the accumulator 10 or on the outer bottom surface of the accumulator 10. The temperature sensor portion is disposed in such a place, and thereby the temperature of the liquid-phase refrigerant 47 can be accurately detected. Fig. 2 shows the mode in which the temperature sensor portion of the refrigerant temperature detection unit 50 is disposed on the outer bottom surface of the accumulator 10. It is possible to more accurately estimate the time at which to close the valve device, and as a result, it is possible to more accurately suppress an occurrence of bumping. Also, the temperature sensor portion of the refrigerant temperature detection unit 50, when being disposed on the lower side of the center in the internal space of the accumulator 10, can accurately measure the liquid temperature of the liquid-phase refrigerant 47 even in the event that the amount of liquid-phase refrigerant 47 accumulated in the accumulator 10, which can fluctuate, fluctuates.

Vehicle Exterior Temperature Detection Unit

[0026] In the vehicle air conditioning apparatus according to the present embodiment, it is preferable, as shown in Fig. 4, to further have a vehicle exterior temperature detection unit 51. In the modes shown in Figs. 2 and 3, too, it is preferable to further have the vehicle exterior temperature detection unit 51. The refrigerant boils inside the accumulator 10 immediately after the compressor 6 is started, and although depending also on what the rotation speed of the compressor is, an abnormal noise is generally more apt to occur under the condition that the vehicle exterior temperature is moderate (for example, 20°C) or lower (for example, 10°C) than under the condition that it is relatively high (for example, 35°C), so that the timing with which to operate opening/closing of the valve device 40 can be accurately adjusted by comprehending the vehicle exterior temperature.

Control Device

[0027] The control device 23 controls whether the valve device 40 is to "allow" or "block" the flow of refrigerant in the bypass passage 43. For example, the control device 23 controls switching between opening and closing the on/off valve. Also, the control device 23 controls the switching of the three-way valve between both opening the bypass passage 43 and closing the refrigerant outlet pipe 42 and both closing the bypass passage 43 and opening the refrigerant outlet

pipe 42. Furthermore, the control device 23 carries out the control of the operation of the compressor 6. For example, when the compressor 6 is an electric compressor, the control device 23 specifies the rotation speed of the electric compressor, and the electric compressor is driven so as to achieve the specified rotation speed. Also, the control device 23, in addition to carrying out the control of the valve device 40 and the compressor 6, may carry out the control of another device. Furthermore, the control device 23 may obtain information from each kind of sensor, for example, may obtain information on the temperature of the liquid-phase refrigerant inside the accumulator from the refrigerant temperature detection unit 50. Furthermore, the control device 23 may obtain information on the vehicle exterior temperature from the vehicle exterior temperature detection unit 51.

Modification Example of Refrigeration Cycle

[0028] In the vehicle air conditioning apparatus according to the present embodiment, the bypass passage 43 and the valve device 40 may be applied not only to a simple cooling refrigeration cycle (a first example of the refrigeration cycle), but to a refrigeration cycle which enables dehumidification heating. The bypass passage 43 and the valve device 40 may be applied, for example, to a vehicle air conditioning apparatus disclosed in International Publication WO 2013/035130. Specifically, the bypass passage 43 and the valve device 40 can be applied to the apparatus described in Fig. 1, 5, 6, or 7 of the same publication.

Second Example of Refrigeration Cycle

[0029] Figs. 5A and 5B show schematic diagrams of a second example of the configuration of the refrigeration cycle in the vehicle air conditioning apparatus according to the present embodiment. The second example of the configuration of the refrigeration cycle is an example in which the bypass passage 43 and the valve device 40 are applied to the apparatus described in Fig. 1 of International Publication WO 2013/035130. An on/off valve 17 in the drawing of the same publication is common to the on/off valve 17 in the drawings of the present application.

Third Example of Refrigeration Cycle

[0030] Figs. 6A and 6B show schematic diagrams of a third example of the configuration of the refrigeration cycle in the vehicle air conditioning apparatus according to the present embodiment. The third example of the configuration of the refrigeration cycle is an example in which the bypass passage 43 and the valve device 40 are applied to the apparatus described in Fig. 5 of International Publication WO 2013/035130.

Fourth Example of Refrigeration Cycle

[0031] Fig. 7 shows a schematic diagram of a fourth example of the configuration of the refrigeration cycle in the vehicle air conditioning apparatus according to the present embodiment. The fourth example of the configuration of the refrigeration cycle is an example in which the bypass passage 43 and the valve device 40 are applied to the apparatus described in Fig. 6 of International Publication WO 2013/035130.

Fifth Example of Refrigeration Cycle

[0032] Fig. 8 shows a schematic diagram of a fifth example of the configuration of the refrigeration cycle in the vehicle air conditioning apparatus according to the present embodiment. The fifth example of the configuration of the refrigeration cycle is an example in which the bypass passage 43 and the valve device 40 are applied to the apparatus described in Fig. 7 of International Publication WO 2013/035130.

[0033] Next, a more detailed description will be given, referring to Figs. 2, 9, and 10, of the vehicle air conditioning apparatus according to the present embodiment. In the vehicle air conditioning apparatus according to the present embodiment, it is preferable to further have the refrigerant temperature detection unit 50 which can detect the temperature of the liquid-phase refrigerant inside the accumulator, wherein the compressor 6 is of an electric type, and wherein the control device 23 starts the compressor 6 at the specified rotation speed, and sets the state in which the flow of refrigerant in the bypass passage 43 is allowed by the valve device 40 (sets the state shown in Fig. 9), subsequently, calculates an estimated superheat degree T_{est} of the gas-phase refrigerant 48 inside the accumulator 10, which is obtained when the flow of refrigerant in the bypass passage 43 is blocked, from the specified rotation speed of the compressor 6 and from the temperature information obtained from the refrigerant temperature detection unit 50, compares the estimated superheat degree T_{est} and a predetermined threshold superheat degree T_{def} , and when the estimated superheat degree T_{est} falls below the threshold superheat degree T_{def} , causes the valve device 40 to block the flow of refrigerant in the bypass passage 43 (sets the state shown in Fig. 10). It is possible to estimate the time at which to close the valve

device and thus possible to accurately suppress an occurrence of bumping. The specific details are as follows. Fig. 11 shows a specific control flowchart of the control device 23. As the compressor 6 is of an electric type, it is possible to control the compressor 6 at the rotation speed specified by the control device 23. Then, it is possible, from the rotation speed of the compressor 6, to estimate the pressure (hereafter referred to as the estimated pressure) of the gas-phase refrigerant 48 in the accumulator 10 after blocking the flow of refrigerant in the bypass passage 43. The estimated superheat degree T_{est} is calculated from the estimated pressure and from the temperature information obtained from the refrigerant temperature detection unit 50. Here, the formula to calculate a superheat degree is, as a premise, a formula to estimate that there occurs no bumping when the valve device 40 having been open is closed. The superheat degree is defined as the "estimated superheat degree T_{est} " when the valve device 40 is closed. The more a refrigerant intake V_s of the compressor 6, the lower a gas-phase pressure P_{vs} of the internal space of the accumulator 10 when the valve device 40 is closed. Also, the higher a temperature T_{liq} of the liquid refrigerant, the higher a boiling point temperature, while the larger also a refrigerant evaporation amount V_{eva} of the liquid refrigerant, and so it is not necessarily true that the higher the temperature of the liquid refrigerant is, the more easily the liquid refrigerant boils. Taking these into account, the estimated superheat degree T_{est} is calculated as in the following formula (Math. 1). Here, α , β , and γ are each a coefficient.

$$[\text{Math. 1}] \quad T_{est1} = \alpha \cdot T_{liq} - (\beta \cdot V_{eva} \times \gamma \cdot P_{vs})$$

Furthermore, the higher an outside air load (an outside air temperature) T_{out} , the smaller the amount of refrigerant accumulated in the accumulator, and the larger a gas-phase region, so that a decrement in the gas-phase pressure P_{vs} is gradual even though the refrigerant is sucked in by the compressor 6, and a rise in the gas-phase pressure P_{vs} is also gradual even in the event that the refrigerant evaporation amount V_{eva} is constant. Because of this, the estimated superheat degree T_{est} can be calculated with higher accuracy by reflecting the outside air temperature T_{out} in Math. 1. Specifically, the estimated superheat degree T_{est} is calculated as in the following formula (Math. 2).

$$[\text{Math. 2}] \quad T_{est2} = \alpha \cdot T_{liq} - (\beta \cdot V_{eva} \times \gamma \cdot P_{vs} / T_{out})$$

Then, the estimated superheat degree calculated by Math. 1 or Math. 2 is compared with the threshold superheat degree, and when the estimated superheat degree T_{est} falls below the threshold superheat degree T_{def} , the control to close the valve device 40 is carried out. It is preferable to set the threshold superheat degree T_{def} to be lower by a predetermined temperature than the boiling temperature of the liquid refrigerant. The lower the threshold superheat degree T_{def} is set to be than the boiling temperature, the higher an anti-bumping effect is. Here, the predetermined temperature is set to be, preferably, a prescribed temperature which is selected from a range of 1°C to 6°C, more preferably, a prescribed temperature which is selected from a range of 2°C to 5°C. The threshold superheat degree T_{def} is set to be, for example, preferably 2°C, more preferably 5°C, lower than the boiling temperature.

[0034] Next, Figs. 3, 12, and 13 will be referred to. This mode is an example in which the on/off valve of the mode shown in Figs. 2, 9, and 10 is changed to the three-way valve. Fig. 12 shows the state in which the flow of refrigerant in the bypass passage 43 is allowed by the valve device 40. Fig. 13 shows the state in which the flow of refrigerant in the bypass passage 43 is blocked by the valve device 40. The control in the control flowchart shown in Fig. 11 can also be applied to the mode shown in Figs. 3, 12, and 13.

[0035] Next, a description will be given, referring to Figs. 2, 9, and 10, of an example in which another control is carried out in the vehicle air conditioning apparatus according to the present embodiment. In the vehicle air conditioning apparatus according to the present embodiment, it is preferable that the control device 23 sets the state in which the flow of refrigerant in the bypass passage 43 is allowed by the valve device 40 when the compressor 6 is started (sets the state shown in Fig. 9), and subsequently, sets the state in which the flow of refrigerant in the bypass passage 43 is blocked by the valve device 40 after a predetermined time has passed (sets the state shown in Fig. 10). The control device 23 includes a timer function. It is possible, even without providing the refrigerant temperature detection unit, to accurately suppress an occurrence of bumping with the configuration remaining simple. Fig. 14 shows a specific control flowchart of the control device 23. The predetermined time is a prescribed time which is selected from a range of, for example, 90 to 180 seconds.

[0036] Next, a description will be given, referring to Fig. 4, of the vehicle air conditioning apparatus according to the present embodiment. In the vehicle air conditioning apparatus according to the present embodiment, it is preferable to further have the vehicle exterior temperature detection unit 51, wherein the control device 23, when the compressor 6 is started, sets the state in which the flow of refrigerant in the bypass passage 43 is allowed by the valve device 40 when the vehicle exterior temperature obtained from the vehicle exterior temperature detection unit 51 is lower than the

predetermined temperature, and sets the state in which the flow of refrigerant in the bypass passage 43 is blocked by the valve device 40 when the vehicle exterior temperature is equal to or higher than the predetermined temperature. It is possible, by using the vehicle exterior temperature detection unit 51, to accurately suppress an occurrence of bumping with the configuration remaining simple. Fig. 15 shows a specific control flowchart of the control device 23. The predetermined temperature of the vehicle exterior temperature is a prescribed temperature which is selected from a range of, for example, 5°C or lower.

[0037] The vehicle air conditioning apparatus according to the present embodiment can, in any mode, avoid an excessively depressurized state of the internal space in the accumulator 10. It is thereby possible to suppress an occurrence of bumping of the liquid-phase refrigerant, and therefore possible to suppress an abnormal noise occurring in the accumulator due to the bumping phenomenon.

Description of Reference Numerals and Signs

[0038]

- 3: evaporator
- 4: outdoor heat exchanger
- 6: compressor
- 10: accumulator
- 12: expanding device
- 17: on/off valve
- 23: control device
- 40: valve device
- 41: refrigerant inlet pipe
- 42: refrigerant outlet pipe
- 43: bypass passage
- 44: refrigerant
- 45: tank
- 46: inflow opening
- 47: liquid-phase refrigerant
- 48: gas-phase refrigerant
- 49: outflow opening
- 50: refrigerant temperature detection unit
- 51: vehicle exterior temperature detection unit
- 52: gas-liquid separator
- 63: pulley
- 80: refrigeration cycle

Claims

1. A vehicle air conditioning apparatus, comprising:

a refrigeration cycle (80) which includes at least a compressor (6), an outdoor heat exchanger (4), an expanding device (12), an evaporator (3), and an accumulator (10) and in which these elements are connected in this order by piping;

a bypass passage (43) which connects outside the accumulator a refrigerant inlet pipe (41), which causes a refrigerant circulating through the refrigeration cycle to flow into the accumulator, and a refrigerant outlet pipe (42), which causes the refrigerant to flow out from the accumulator, thus short-circuiting the refrigerant, enabling the refrigerant to circulate;

a valve device (40) which, being provided in the bypass passage, has an opening/closing function; and

a control device (23) which controls at least the compressor and the valve device.

2. The vehicle air conditioning apparatus according to claim 1, wherein

the valve device is an on/off valve which allows or blocks the flow of the refrigerant in the bypass passage.

3. The vehicle air conditioning apparatus according to claim 1, wherein

the valve device is a three-way valve which is disposed at the confluence of the bypass passage and the refrigerant

outlet pipe.

4. The vehicle air conditioning apparatus according to any one of claims 1 to 3, further comprising:

a refrigerant temperature detection unit (50) which can detect the temperature of a liquid-phase refrigerant inside the accumulator, wherein the compressor is of an electric type, and wherein the control device starts the compressor at a specified rotation speed and sets the state in which the flow of the refrigerant in the bypass passage is allowed by the valve device, subsequently, calculates an estimated superheat degree T_{est} of a gas-phase refrigerant (48) inside the accumulator, which is obtained when the flow of the refrigerant in the bypass passage is blocked, from the specified rotation speed of the compressor and from temperature information obtained from the refrigerant temperature detection unit, compares the estimated superheat degree T_{est} and a predetermined threshold superheat degree T_{def} , and when the estimated superheat degree T_{est} falls below the threshold superheat degree T_{def} , causes the valve device to block the flow of the refrigerant in the bypass passage.

5. The vehicle air conditioning apparatus according to claim 4, wherein a temperature sensor portion of the refrigerant temperature detection unit is disposed on the lower side of the center in the internal space of the accumulator or on the outer bottom surface of the accumulator.

6. The vehicle air conditioning apparatus according to any one of claims 1 to 3, wherein the control device, when the compressor is started, sets the state in which the flow of the refrigerant in the bypass passage is allowed by the valve device, and subsequently, after a predetermined time has passed, sets the state in which the flow of the refrigerant in the bypass passage is blocked by the valve device.

7. The vehicle air conditioning apparatus according to any one of claims 1 to 3, further comprising:

a vehicle exterior temperature detection unit (51), wherein the control device, when the compressor is started, sets the state in which the flow of the refrigerant in the bypass passage is allowed by the valve device when a vehicle exterior temperature obtained from the vehicle exterior temperature detection unit is lower than a predetermined temperature, and sets the state in which the flow of the refrigerant in the bypass passage is blocked by the valve device when the vehicle exterior temperature is equal to or higher than the predetermined temperature.

Figure 1

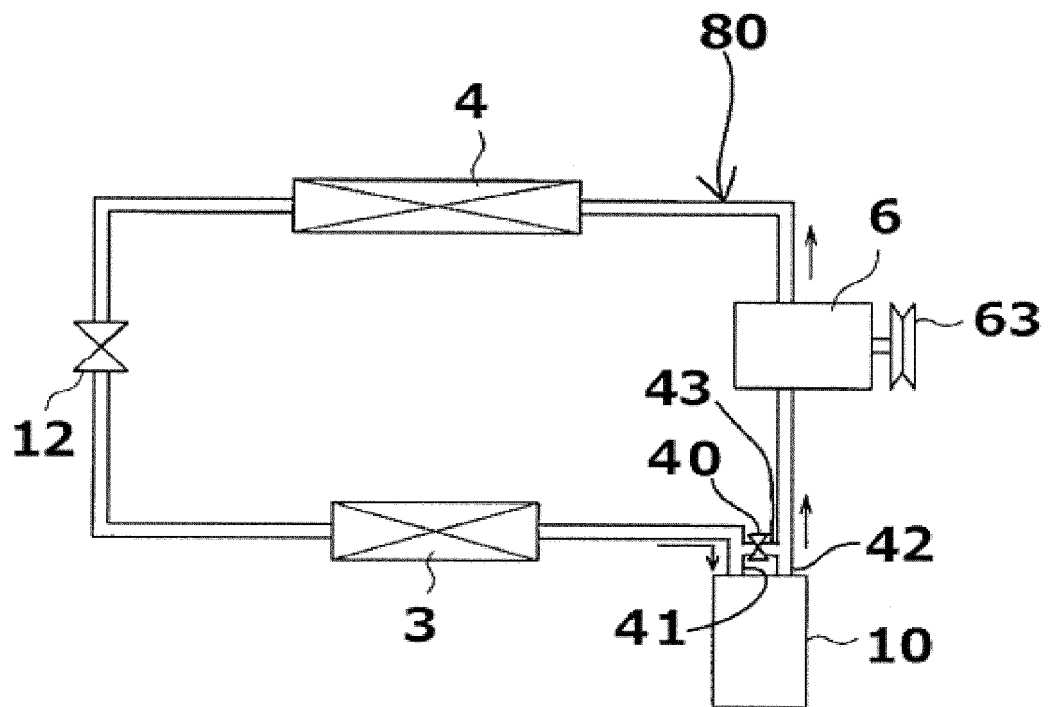


Figure 2

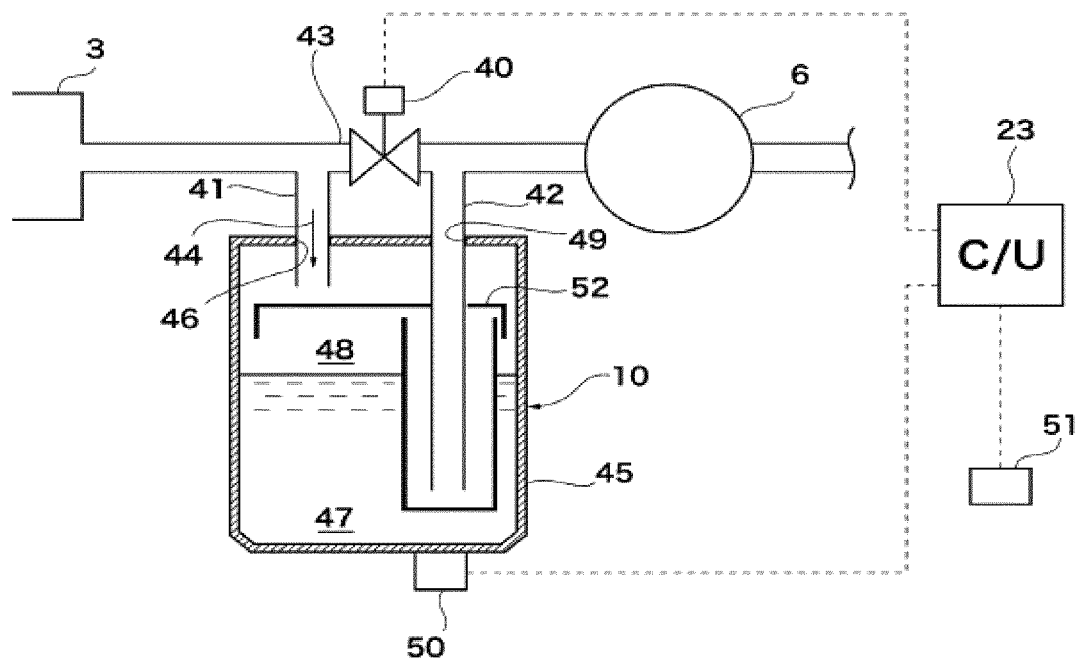


Figure 3

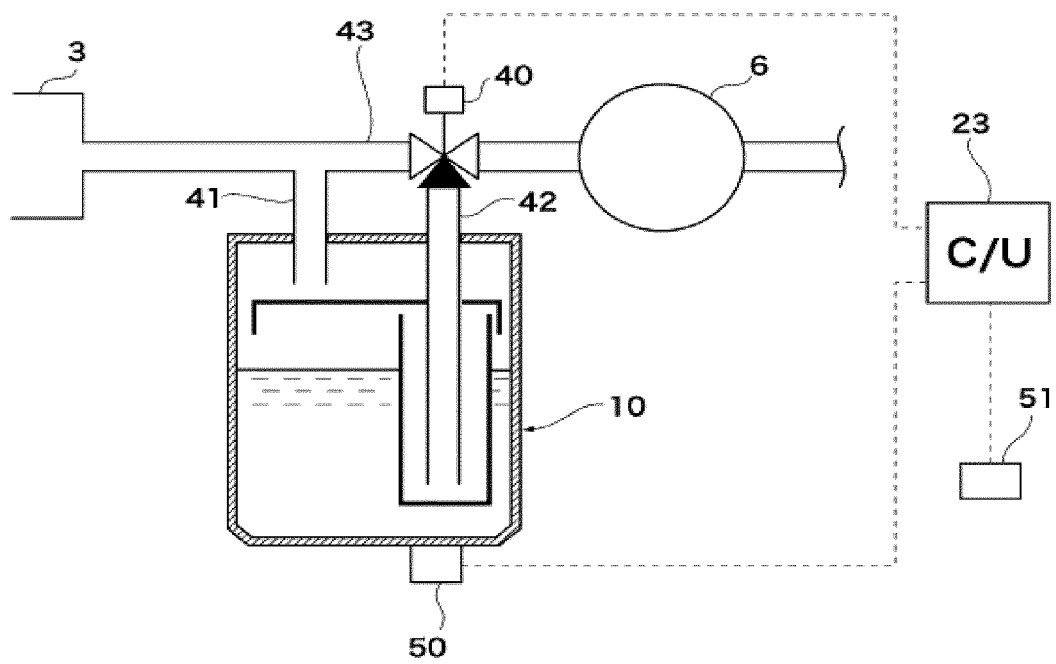


Figure 4

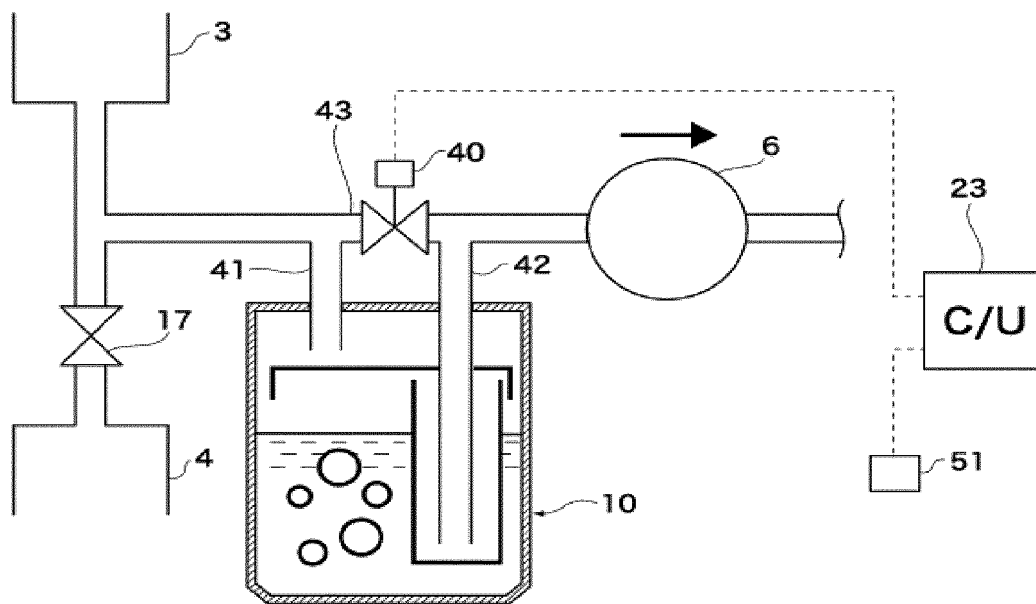


Figure 5A

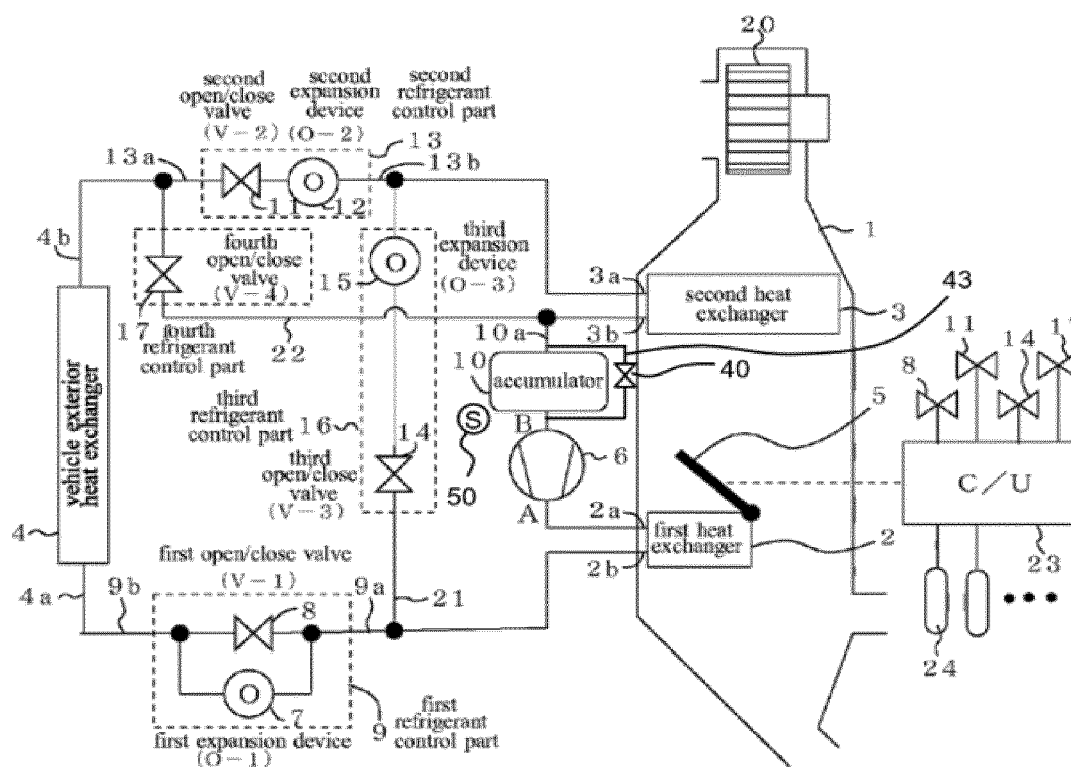


Figure 5B

mode	V-1 (8)	V-2 (11)	V-3 (14)	V-4 (17)	damper (5)
cooling	opened	opened	closed	closed	Full Cool
heating	closed	closed	closed	opened	Full Hot
dehumidifying (low load heating : 5~15°C)	closed	closed	opened	opened	Full Hot, or intermediate position
dehumidifying (intermediate load heating : 15~25°C)	closed	opened	opened	closed	Full Hot, or intermediate position

Figure 6A

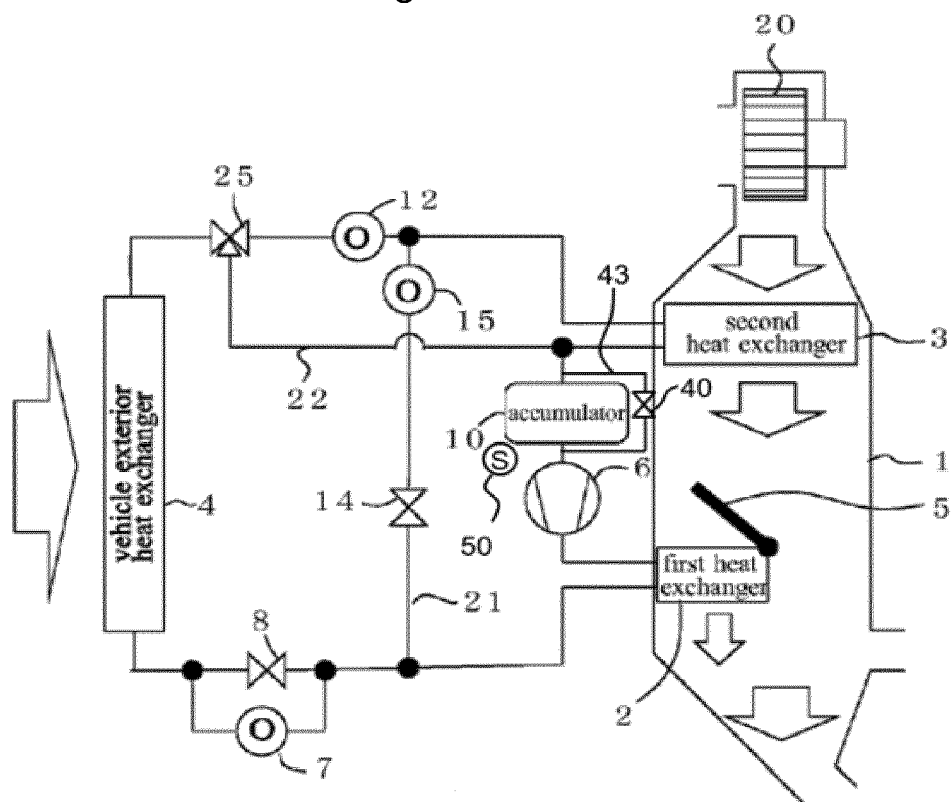


Figure 6B

mode	V-1 (8)	three-way valve (25)	V-3 (14)	damper (5)
cooling	opened	second heat exchanger side	closed	Full Cool
heating	closed	Accum side	closed	Full Hot
dehumidifying (low load : 5~15°C)	closed	Accum side	opened	Full Hot or intermediate position
dehumidifying (intermediate load : 15~25°C)	closed	second heat exchanger side	opened	Full Hot or intermediate position

Figure 7

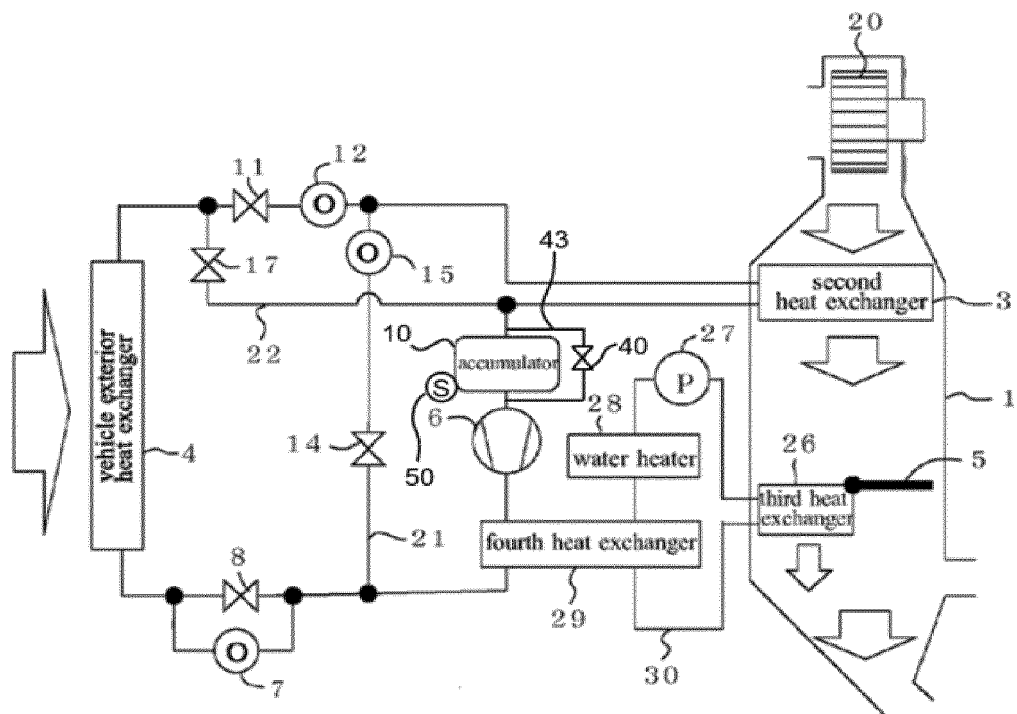


Figure 8

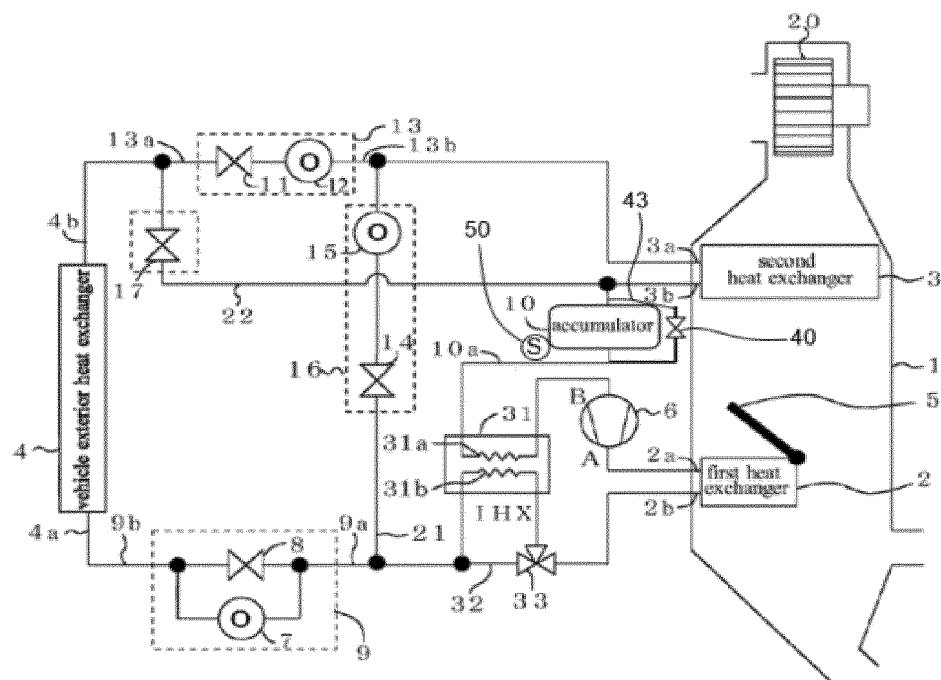


Figure 9

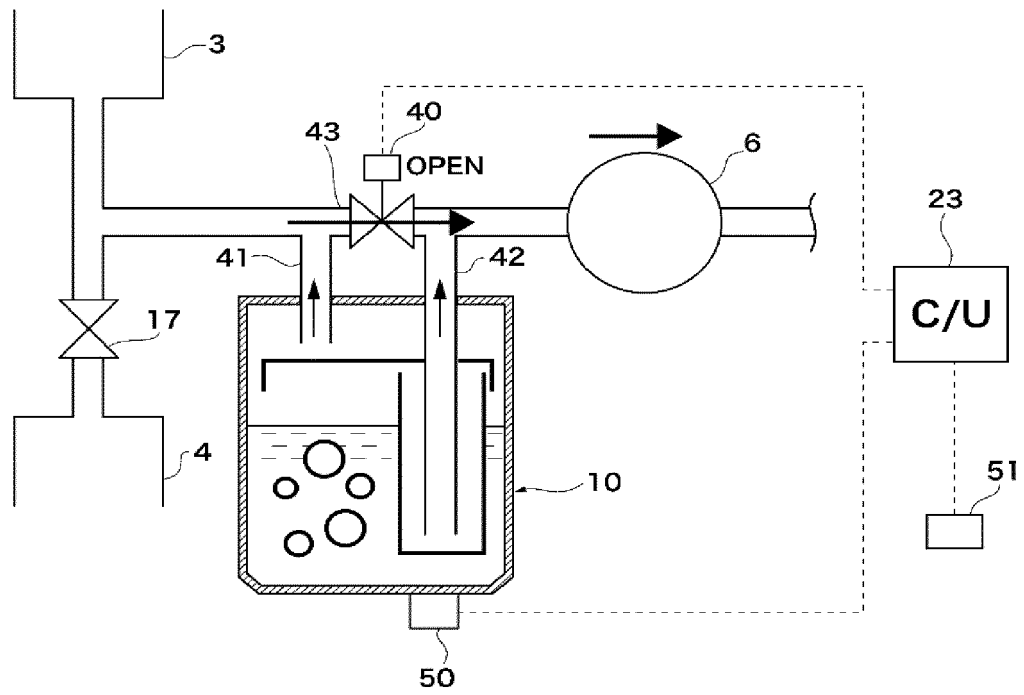


Figure 10

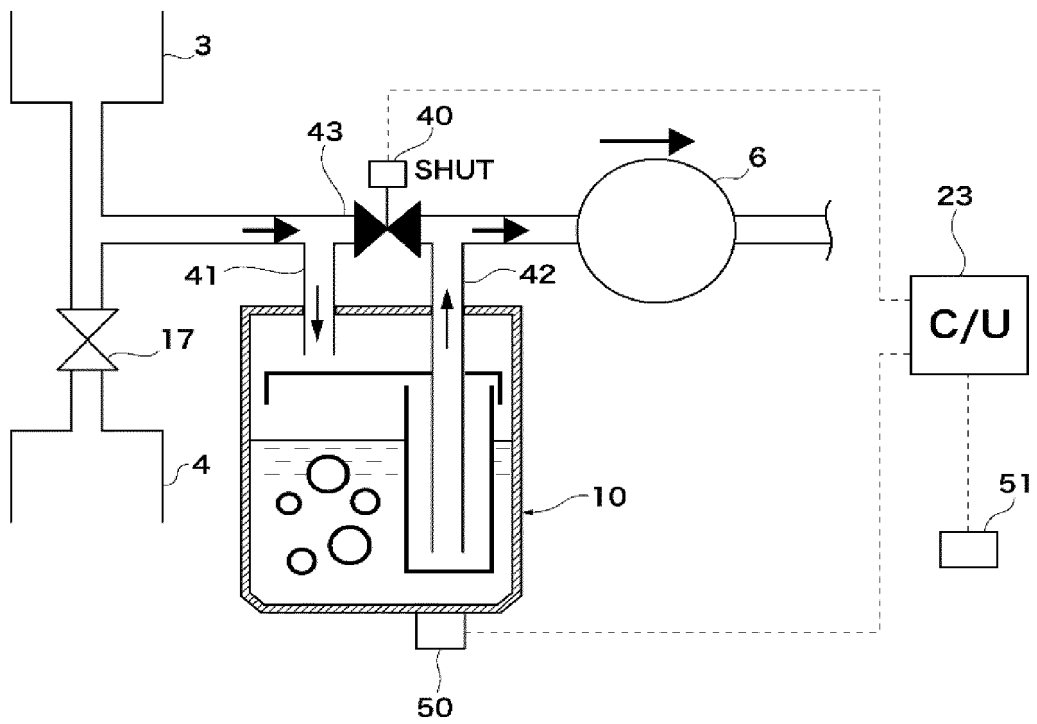


Figure 11

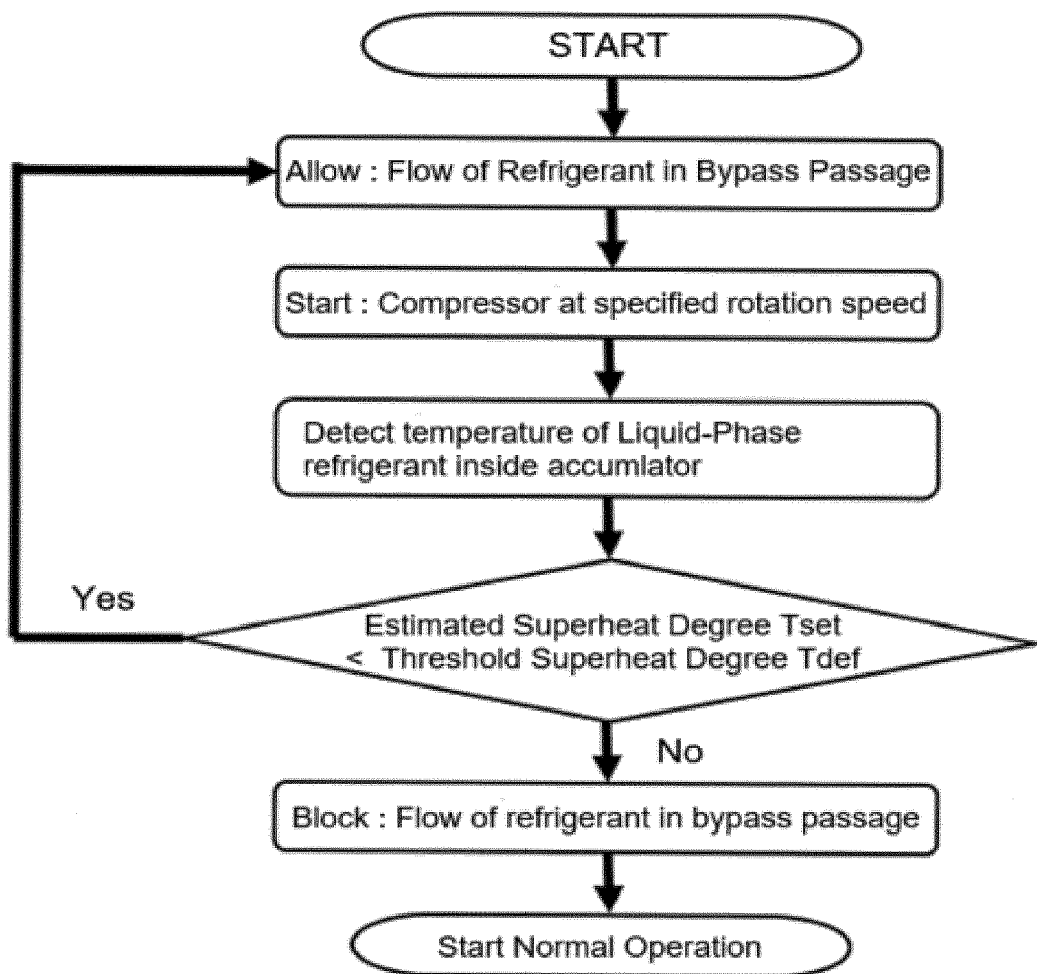


Figure 12

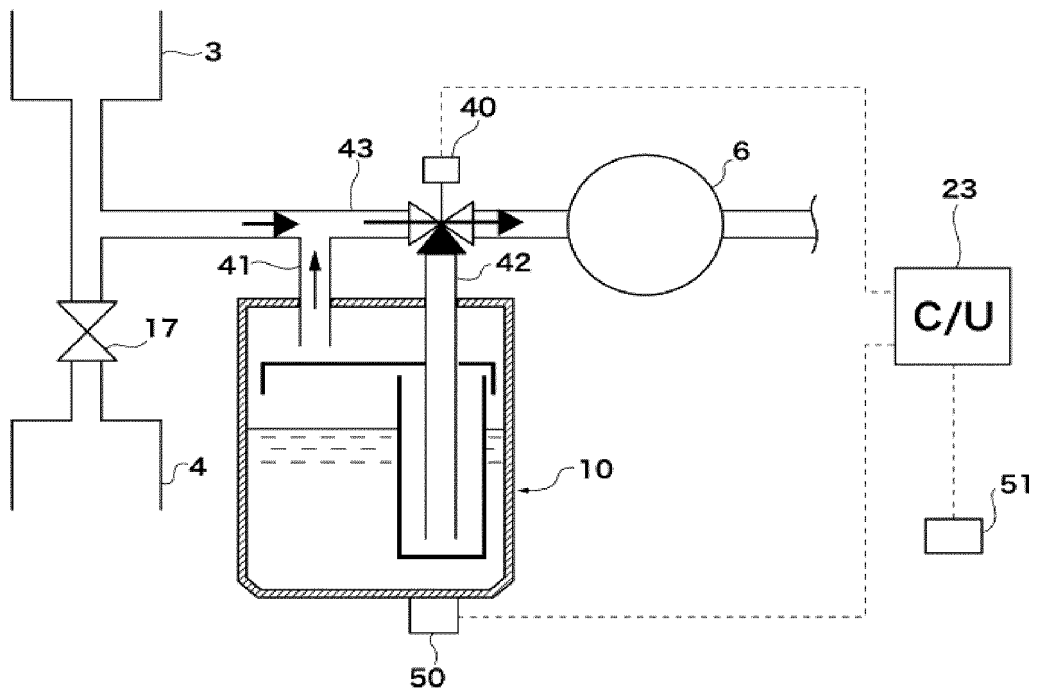


Figure 13

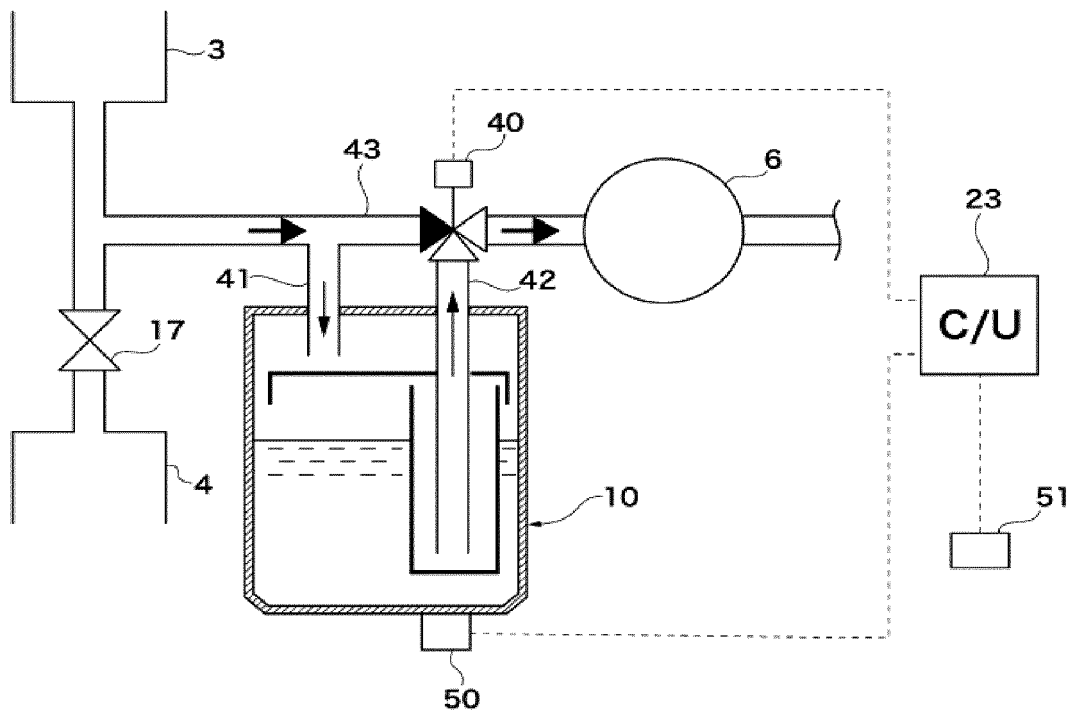


Figure 14

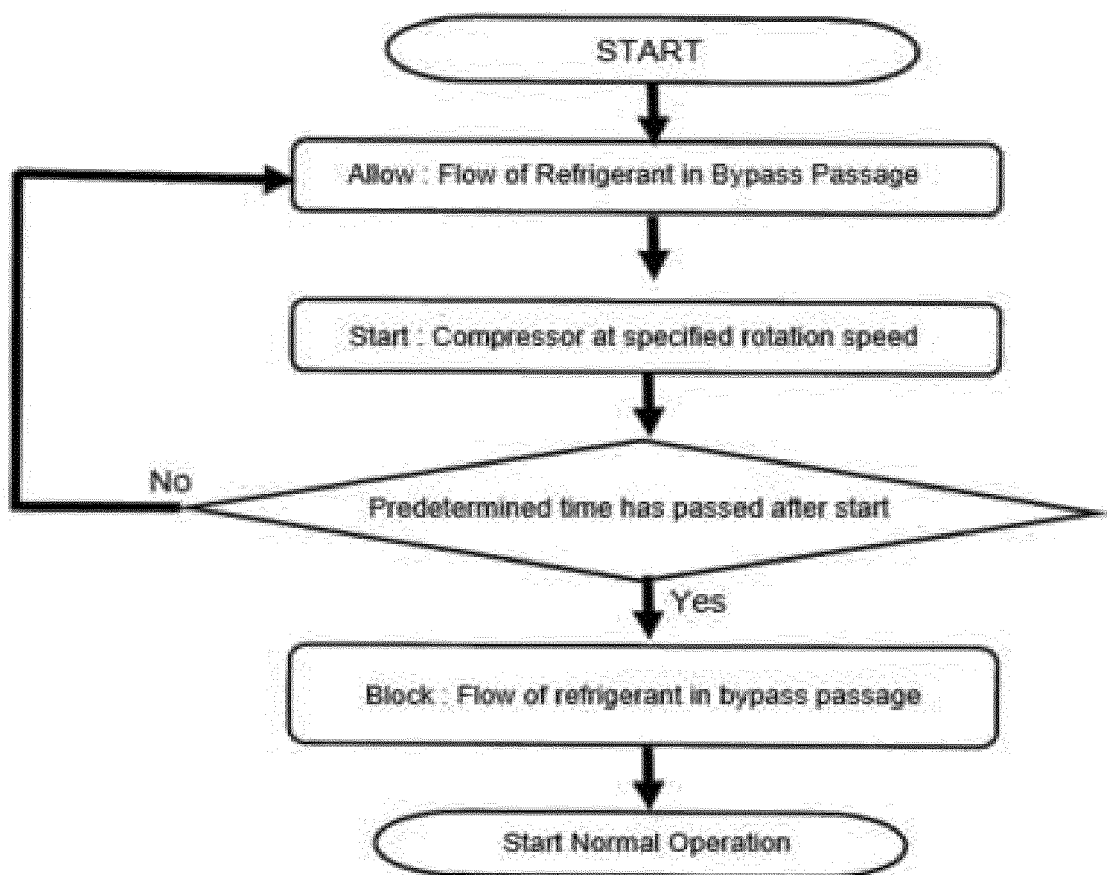
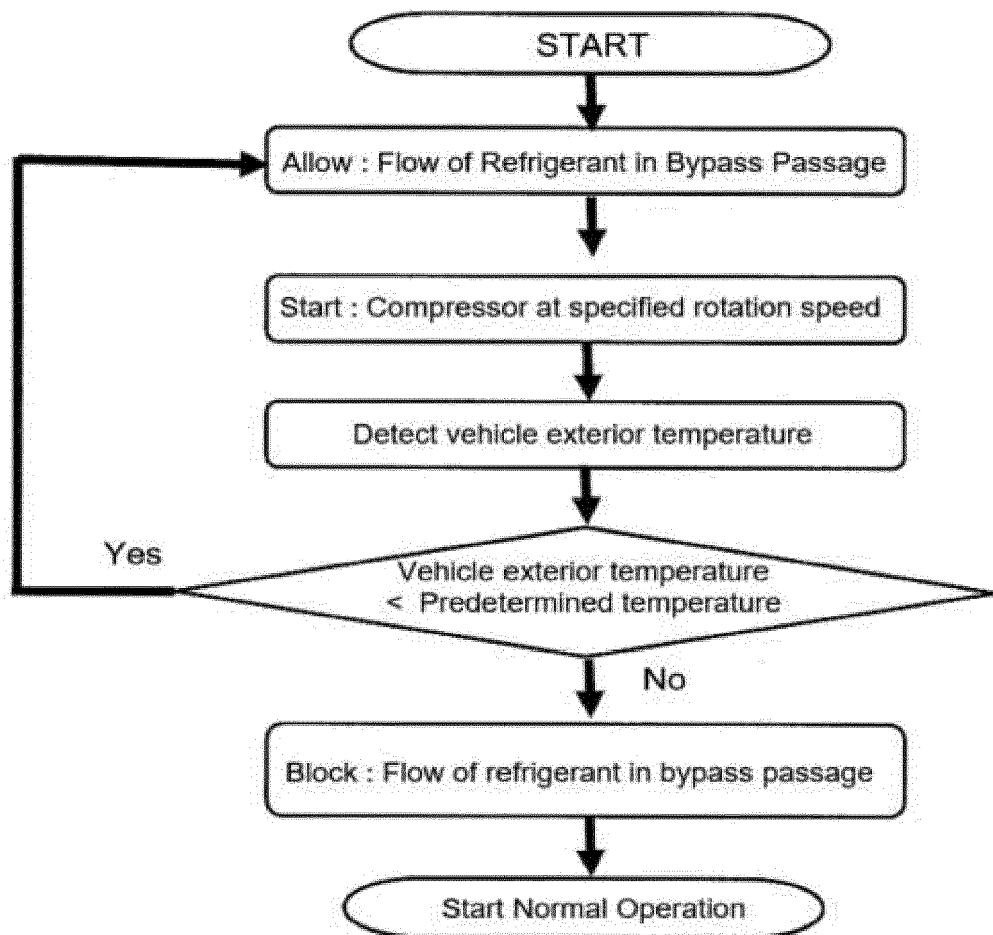


Figure 15





EUROPEAN SEARCH REPORT

Application Number
EP 19 21 8445

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The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (IPC)
			F25B
Place of search		Date of completion of the search	Examiner
Munich		18 March 2020	Amous, Moez
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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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18-03-2020

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