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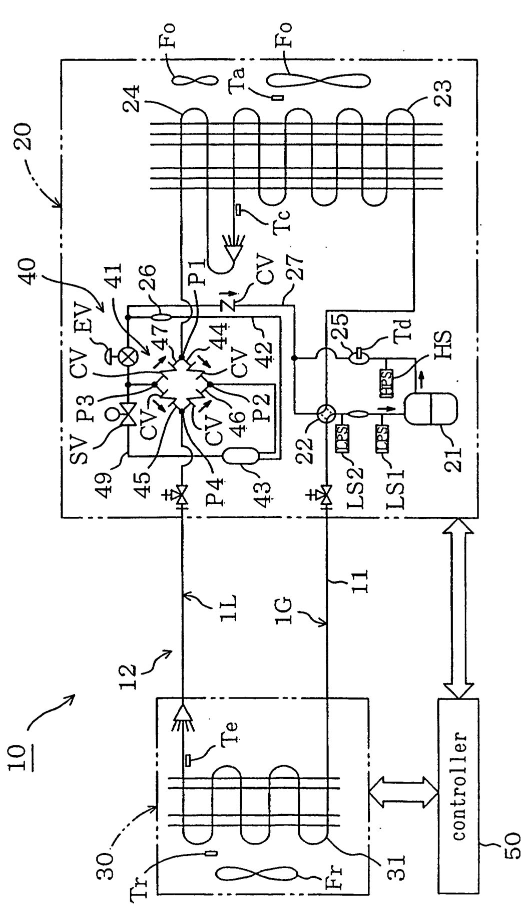
(54) REFRIGERATING DEVICE

(57) In a refrigerating apparatus comprising a refrigerant circuit (**12**) for carrying out a vapor compression refrigeration cycle by using a non-azeotropic mixture refrigerant, a high-pressure liquid line is provided with a reservoir (**43**) for storing the refrigerant therein while allowing a liquid refrigerant to flow out thereof, and the outlet side of an evaporator (**31**, **23**) is connected to the suction side of a compressor (**21**) with no accumulator provided therebetween. Thus, the composition of the non-azeotropic mixture refrigerant flowing through the refrigerant circuit (**12**) is stabilized to prevent a decrease in the reliability of the refrigerating apparatus (**10**).

Fig. 1



EP 1 235 043 A1

Description

TECHNICAL FIELD

[0001] The present invention relates to a refrigerating apparatus that uses a non-azeotropic mixture refrigerant and more particularly relates to the technique of stabilizing the composition of a non-azeotropic mixture refrigerant circulating through a refrigerant circuit.

BACKGROUND ART

[0002] Conventionally, a refrigerant circuit in a refrigerating apparatus which carries out a vapor compression refrigeration cycle is generally formed by connecting, via a refrigerant pipe, a compressor, a condenser, an expansion valve, and an evaporator in order. Further, as disclosed in Japanese Unexamined Patent Publication NO. 11-72257, some of the refrigerant circuits of this type are provided, at the suction pipe of a compressor thereof, with an accumulator. In this accumulator, a liquid refrigerant mixed in a low-pressure gas refrigerant is separated from the gas refrigerant. Therefore, as shown in FIG. **2**, a part of the refrigerant in the circuit stands in the accumulator (**1**) as a liquid refrigerant (**RL**).

[0003] Meanwhile, a non-azeotropic mixture refrigerant such as R407C is prepared by mixing together a plurality of refrigerants having different boiling points. And, if the ratio between the constituent refrigerants, i.e., the composition ratio, varies, the property of the mixture refrigerant varies accordingly. Therefore, the composition ratio is strictly determined so that the non-azeotropic mixture refrigerant exhibits its predetermined property.

[0004] Now, a low-pressure refrigerant flowing into the accumulator (**1**) is basically a gas refrigerant (**RG**). In the case of using a non-azeotropic mixture refrigerant in the above refrigerant circuit, if the low-pressure refrigerant contains a liquid refrigerant (**RL**), the liquid refrigerant (**RL**) has a composition ratio in which the content of hard-to-evaporate high-boiling refrigerant (R134a if R407C is used) is high while the content of easy-to-evaporate low-boiling refrigerant (R32 if R407C is used) is low, due to the property of the non-azeotropic mixture refrigerant.

[0005] Besides, since the density of the liquid refrigerant (**RL**) is higher compared with that of the gas refrigerant (**RG**), the liquid refrigerant in the accumulator (1), in which the refrigerant stands, contains a large amount of high-boiling refrigerant, whereas the gas refrigerant (**RG**) has a considerably lower content of high-boiling refrigerant compared with the original composition of the non-azeotropic mixture refrigerant. Accordingly, the gas refrigerant (**RG**) having a low content of high-boiling refrigerant and a high content of low-boiling refrigerant flows out of the accumulator and is sucked into the compressor.

[0006] Thus, in the above-described example, the non-azeotropic mixture refrigerant with a composition ratio different from the original composition ratio circulates through the refrigerant circuit. Therefore, due to a change in the refrigerant property, the pressure of high-pressure refrigerant might be increased, for example, so that the refrigerating apparatus might not exhibit its inherent performance, causing a decrease in the reliability of the refrigerating apparatus such as a drop in the operating efficiency.

[0007] The present invention has been made in view of these problems and its object is to stabilize the composition of a non-azeotropic mixture refrigerant flowing through a refrigerant circuit to prevent a decrease in the reliability of a refrigerating apparatus.

DISCLOSURE OF INVENTION

[0008] The present invention is directed to a refrigerating apparatus using a non-azeotropic mixture refrigerant, in which the refrigerant is stored in a reservoir such as a high-pressure receiver while being circulated through a refrigerant circuit.

[0009] More specifically, a solution taken by the present invention is based on a refrigerating apparatus comprising a refrigerant circuit (**12**) for carrying out a vapor compression refrigeration cycle by using a non-azeotropic mixture refrigerant. Further, this refrigerating apparatus is formed so that a high-pressure liquid line of the refrigerant circuit (**12**) is provided with a reservoir (**43**) for storing the refrigerant therein while allowing a liquid refrigerant to flow out thereof.

[0010] In the above arrangement, the refrigerant circuit (**12**) is preferably formed as a refrigerant circuit (**12**) having no accumulator on the suction side of a compressor (**21**). In other words, the outlet side of an evaporator (**31**, **23**) is preferably directly connected to the suction side of the compressor (**21**). It should be noted that "directly" used in this case naturally does not mean to exclude an arrangement for connecting, for example, a four-way selector valve between the evaporator (**31**, **23**) and the compressor (**21**) but means to connect the evaporator (**31**, **23**) and the compressor (**21**) without an accumulator provided therebetween.

[0011] Further, in the above arrangement, the refrigerating apparatus is preferably formed by including: a selecting mechanism (**22**) for inverting the direction of circulation of the refrigerant in the refrigerant circuit (**12**); and a directional control circuit (**41**) for allowing the liquid refrigerant from a condenser (**23, 31**) in each direction of circulation to flow into the reservoir (**43**), wherein an expansion mechanism (**EV**) as a component of the refrigerant circuit (**12**) for carrying out a vapor compression refrigeration cycle is connected to the downstream side of the reservoir (**43**).

[0012] Furthermore, in the above arrangement, the refrigerating apparatus is preferably formed by including an anti-liquid seal passage (**27**) connected between a liquid pipe, provided between the reservoir (**43**) and the expansion mechanism (**EV**), and the discharge pipe of the compressor (**21**), wherein the anti-liquid seal passage (**27**) is formed as a one-way passage for allowing the flow of the refrigerant from the liquid pipe to the discharge pipe.

[0013] Besides, in the above arrangement, the refrigerating apparatus is preferably formed by including: a discharge pipe temperature sensor (**Td**); a condenser temperature sensor (**Tc**, **Te**); an evaporator temperature sensor (**Te**, **Tc**); and control means (**50**) for controlling, in response to outputs from the respective temperature sensors (**Td, Tc, Te**), the opening of the expansion mechanism (**EV**) as a component of the refrigerant circuit.

[0014] Moreover, in the above arrangement, R407C may be used as the non-azeotropic mixture refrigerant.

-FUNCTION-

[0015] In the above solution, a non-azeotropic mixture refrigerant such as R407C circulates through the refrigerant circuit (**12**) while a surplus of the refrigerant is stored in the reservoir (**43**) such as a high-pressure receiver. The inside of the reservoir (**43**) is under a high pressure so that most of the refrigerant exists in the state of liquid refrigerant and contains a slight amount of gas compared with that of liquid. Further, the density of gas in the reservoir (**43**) is extremely small compared with that of liquid. Therefore, even if R32 is slightly gasified, the liquid refrigerant stored in the reservoir (**43**) is in the state that the composition ratio between high-boiling refrigerant and low-boiling refrigerant is almost unchanged from the original composition ratio therebetween in the non-azeotropic mixture refrigerant, and this liquid refrigerant flows out of the reservoir (**43**), thus circulating the refrigerant having a stable composition ratio through the refrigerant circuit (**12**).

[0016] In particular, if the refrigerating apparatus is formed to use no accumulator on the suction side of the compressor (**21**) in the above arrangement, the composition of the refrigerant does not change also in a low-pressure gas line of the apparatus.

[0017] Furthermore, the refrigerant circuit (**12**) may be formed to allow the inversion of the circulation direction of the refrigerant and provided with the directional control circuit (**41**) upstream of the reservoir (**43**) and the expansion mechanism (**EV**) downstream of the reservoir (**43**). In that case, even if the circulation direction of the refrigerant is switched to either of forward and reverse directions, the refrigerant circulates in such a manner that it flows from the compressor (**21**) through the condenser (**23, 31**), directional control circuit (**41**), reservoir (**43**), expansion mechanism (**EV**), and evaporator (**31, 23**), and then goes back to the compressor (**21**), thereby carrying out a refrigeration cycle. During the cycle, since the high-pressure reservoir (**43**) stores surplus refrigerant therein while allowing the liquid refrigerant to flow out thereof, the refrigerant still having a stable composition ratio circulates through the refrigerant circuit (**12**).

[0018] Besides, when the anti-liquid seal passage (**27**) is provided, even if the refrigerant stored in the reservoir (**43**) is expanded due to the increase of the ambient temperature at the shutdown of the compressor (**21**), the expanded refrigerant passes through the anti-liquid seal passage (**27**) to escape from the discharge pipe of the compressor (**21**) to the heat exchanger (**21**, **31**).

[0019] Moreover, if the opening of the expansion mechanism (**EV**) is controlled using the respective temperature sensors (**Td**, **Tc, Te**), the temperature at the discharge pipe can be adjusted to a proper value with respect to the temperatures at the evaporator (**31**, **23**) and condenser (**23**, **31**) in operation. Thus, a change in the state of the refrigerant progresses precisely in accordance with a predetermined Mollier diagram, resulting in a further stabilized composition of the refrigerant.

-EFFECTS-

[0020] Therefore, in the above-described solution, since a non-azeotropic mixture refrigerant such as R407C circulates through the refrigerant circuit (**12**) while holding a stabilized state in which its composition ratio is almost unchanged from the original composition ratio, the property of the refrigerant hardly changes and thus the refrigerating apparatus (**10**) can stably exhibit its inherent performance. Accordingly, a decrease in operating efficiency is also suppressed, thus improving the reliability of the refrigerating apparatus (**10**). From this fact, it can be said that the provision of the reservoir (**43**) in the high-pressure liquid line and the arrangement using no accumulator on the suction side of the compressor (**21**) are highly appropriate to the refrigerant circuit (**12**) using a non-azeotropic mixture refrigerant.

[0021] Further, if the refrigerant circuit (**12**) is formed to allow the inversion of the circulation direction of the refrigerant therein, an air conditioning apparatus using a non-azeotropic mixture refrigerant, for example, can stably perform both cooling operation and heating operation.

[0022] Furthermore, providing the anti-liquid seal passage (**27**) can prevent the occurrence of an abnormal pressure rise in the surroundings of the reservoir (**43**) due to the expansion of the liquid refrigerant stored in the reservoir (**43**).

[0023] Besides, if the opening of the expansion mechanism (**EV**) is adjusted using the respective temperature sensors (**Td**, **Tc, Te**), the composition of the refrigerant can be further stabilized and thus the reliability of the apparatus can be further improved.

BRIEF DESCRIPTION OF DRAWINGS

[0024]

FIG. **1** is a diagram of a refrigerant circuit in an air conditioning apparatus according to an embodiment of the present invention.

FIG. **2** is a schematic view showing an accumulator in a conventional refrigerating apparatus.

BEST MODE FOR CARRYING OUT THE INVENTION

[0025] Hereinafter, an embodiment of the present invention will be described in detail with reference to the drawings.

[0026] As shown in FIG. **1**, a refrigerating apparatus (**10**) of the present embodiment is a so-called separate type air conditioning apparatus in which a single indoor unit (**30**) is connected to a single outdoor unit (**20**), and a refrigerant circuit (**12**) of the air conditioning apparatus (**10**) is formed to carry out a vapor compression refrigeration cycle by using R407C as a non-azeotropic mixture refrigerant.

[0027] The outdoor unit (**20**) constitutes a single heat source unit including a compressor (**21**), a four-way selector valve (selecting mechanism) (**22**), an outdoor heat exchanger (**23**), an auxiliary heat exchanger (**24**) and an expansion circuit (**40**). On the other hand, the indoor unit (**30**) includes an indoor heat exchanger (**31**) and constitutes a single heat utilization unit.

[0028] Furthermore, the compressor (**21**), four-way selector valve (**22**), outdoor heat exchanger (**23**), auxiliary heat exchanger (**24**), expansion circuit (**40**) and indoor heat exchanger (**31**) are connected in order with a refrigerant pipe (**11**), thereby forming the refrigerant circuit (**12**) for circulating the refrigerant therethrough to carry out heat transfer. In the refrigerant circuit (**12**), formed between the outdoor and auxiliary heat exchangers (**23**) and (**24**) and the indoor heat exchanger (**31**) are a liquid line (**1L**) including, for example, the expansion circuit (**40**) and a gas line (**1G**) including, for example, the compressor (**21**). It should be noted that no accumulator is provided on the suction side of the compressor (**21**) in the present embodiment.

[0029] For example, the compressor (**21**) is formed as a scroll type compressor the operating frequency (operating capacity) of which is variably adjusted by an inverter. The discharge side of the compressor (**21**) is connected with a silencer (**25**) for attenuating noise during the operation of the compressor (**21**). The silencer (**25**) has another function as a check valve for allowing only the refrigerant flow in the direction from the compressor (**21**) to the four-way selector valve (**22**).

[0030] The four-way selector valve (**22**) is switched as indicated by the solid lines in FIG. **1** during cooling operation and is switched as indicated by the broken lines in FIG. **1** during heating operation, thus inverting the circulation direction of the refrigerant in the refrigerant circuit (**12**). The outdoor heat exchanger (**23**) and auxiliary heat exchanger (**24**) are the heat source side heat exchangers functioning as a condenser during cooling operation and as an evaporator during heating operation with outdoor fans (**Fo**) provided in the vicinity thereof. On the other hand, the indoor heat exchanger (**31**) is the heat utilization side heat exchanger functioning as an evaporator during cooling operation and as a condenser during heating operation with an indoor fan (**Fr**) provided in the vicinity thereof.

[0031] The expansion circuit (**40**) is so formed as to reduce the pressure of the refrigerant. The expansion circuit (**40**) includes: a directional control circuit (**41**) formed by a bridge circuit; and a one-way passage (**42**) connected to the directional control circuit (**41**). The directional control circuit (**41**) is formed so that, during both cooling operation and heating operation, the liquid refrigerant from the heat exchangers (**23**, **24**) or heat exchanger (**31**) which function as a condenser during the corresponding operation is guided to the one-way passage (**42**).

[0032] Provided in series in the one-way passage (**42**) are a receiver (reservoir) (**43**), which is located on the upstream side, for storing the refrigerant therein while allowing the liquid refrigerant to flow out thereof, and an electronic expansion valve (expansion mechanism) (**EV**) which is located on the downstream side of the receiver (**43**) and the opening of which is adjustable. In the above arrangement, the receiver (**43**) is always located in a high-pressure liquid line upstream of the electronic expansion valve (**EV**), and thus the high-pressure liquid refrigerant flows into the receiver (**43**) from the condenser (**23**, **23**) or (**31**) regardless of the circulation direction of the refrigerant. It should be noted that a filter (**26**) through which dust present in the refrigerant is removed is provided between the receiver (**43**) and the electronic expansion valve (**EV**).

[0033] The directional control circuit (**41**) is, specifically, formed by making a bridge-like connection among a first inflow path (**44**), a first outflow path (**45**), a second inflow path (**46**) and a second outflow path (**47**). The inflow paths (**44**, **46**) and the outflow paths (**45**, **47**) are each provided with a check valve (**CV**, **CV,** ···).

[0034] The first inflow path (**44**) allows the refrigerant flow from a first connection point (**P1**), to which the outdoor heat exchanger (**23**) is connected, to a second connection point (**P2**), to which the upstream end of the one-way passage (**42**) is connected. On the other hand, the first outflow path (**45**) allows the refrigerant flow from a third connection point (**P3**), to which the downstream end of the one-way passage (**42**) is connected, to a fourth connection point (**P4**), to which the indoor heat exchanger (**31**) is connected.

[0035] The second inflow path (**46**) allows the refrigerant flow from the fourth connection point (**P4**) to the second connection point (**P2**). On the other hand, the second outflow path (**47**) allows the refrigerant flow from the third connection point (**P3**) to the first connection point (**P1**).

[0036] In the one-way passage (**42**), the liquid pipe (high-pressure liquid line) between the receiver (**43**) and the electronic expansion valve (**EV**) (more specifically, between the filter (**26**) and the electronic expansion valve (**EV**)) is connected to the discharge pipe of the compressor (**21**) via an anti-liquid seal passage (**27**) for preventing liquid seal at the shutdown of the compressor (**21**). The anti-liquid seal passage (**27**) is a one-way passage for allowing the flow of the refrigerant from the liquid pipe to the discharge pipe, and includes therein a check valve (**CV**).

[0037] A by-path passage (**49**) is connected between an upper portion of the receiver (**43**) and a portion of the one-way passage (**42**) downstream of the electronic expansion valve (**EV**) (this portion invariably forms a low-pressure liquid line). The by-path passage (**49**) is provided with a solenoid valve (**SV**) and is formed to let out the gas refrigerant inside the receiver (**43**).

[0038] Meanwhile, the discharge pipe of the compressor (**21**) is provided with a discharge pipe temperature sensor (**Td**) for detecting the temperature at the discharge pipe of the compressor (**21**). Further, an air inlet of the outdoor unit (**20**) is provided with an outdoor temperature sensor (**Ta**) for detecting the temperature of outdoor air, while the outdoor heat exchanger (**23**) is provided with an outdoor heat exchanger temperature sensor (**Tc**) for detecting the temperature at the outdoor heat exchanger which will be a condensation temperature during cooling operation and an evaporation temperature during heating operation. Furthermore, an air inlet of the indoor unit (**30**) is provided with a room temperature sensor (**Tr**) for detecting the temperature of room air, while the indoor heat exchanger (**31**) is provided with an indoor heat exchanger temperature sensor (**Te**) for detecting the temperature at the indoor heat exchanger which will be an evaporation temperature during cooling operation and a condensation temperature during heating operation.

[0039] The discharge pipe of the compressor (**21**) is provided with a high-pressure protection pressure switch (**HS**) for detecting the pressure of high-pressure refrigerant and for outputting a high-pressure protection signal by being turned on as a result of an excessive increase in the pressure of the high-pressure refrigerant. On the other hand, the suction pipe of the compressor (**21**) is provided with: a low-pressure protection pressure switch (**LS1**) for detecting the pressure of low-pressure refrigerant and for outputting a low-pressure protection signal by being turned on as a result of an excessive decrease in the pressure of the low-pressure refrigerant; and a low-pressure control pressure switch (**LS2**) for detecting the pressure of the low-pressure refrigerant and for outputting a low-pressure control signal by being turned on when the pressure of the low-pressure refrigerant reaches a predetermined value.

[0040] Moreover, the refrigerant circuit is formed so that output signals from the respective temperature sensors (**Td**, **Ta**, **Tc**, **Tr**, **Te**), high-pressure protection pressure switch (**HS**), low-pressure protection pressure switch (**LS1**) and low-pressure control switch (**LS2**) are inputted to a controller (**50**) as a control means and the controller (**50**) controls air conditioning operation based on the input signals.

[0041] The controller (**50**) is formed to control each equipment in order to carry out cooling operation and heating operation in addition to carrying out control so as to stabilize the composition of the non-azeotropic mixture refrigerant flowing through the refrigerant circuit (**12**).

[0042] More specifically, the controller (**50**) divides the operating frequency of the inverter for the compressor (**21**) into a predetermined number of frequency steps N and controls the frequency steps N so that room temperature becomes a preset temperature. Further, the controller (**50**) calculates, from a condensation temperature and an evaporation temperature detected by the outdoor heat exchanger temperature sensor (**Tc**) and the indoor heat exchanger temperature sensor (**Te**), the optimum value for the discharge pipe temperature which attains the optimum refrigerating effect, and then controls the opening of the electronic expansion valve (**EV**) by setting the opening of the valve so that the discharge pipe temperature will be at the optimum value.

[0043] Carrying out such control ensures the operation of the refrigerant circuit (**12**) in accordance with a predetermined Mollier diagram during the circulation of the refrigerant therethrough, resulting in suppression of the change in the composition of the non-azeotropic mixture refrigerant. In other words, the composition ratio between R32 and R134a in R407C is stabilized.

[0044] It should be noted that, as described above, the refrigerant circuit (**12**) of the present embodiment is formed as a circuit using no accumulator on the suction side of the compressor (**21**). Therefore, the refrigerant circuit (**12**) is controlled so as to sufficiently increase the degree of superheat of the refrigerant sucked into the compressor (**21**) and is formed so as to adjust the outflow of the liquid refrigerant from the receiver (**43**), thereby preventing liquid back to the compressor (**21**).

-OPERATION-

[0045] Next, a specific operation of the air conditioning apparatus (**10**) will be described.

[0046] First, during cooling operation, the gas refrigerant discharged from the compressor (**21**) is condensed and liquefied in the outdoor heat exchanger (**23**) and auxiliary heat exchanger (**24**), and then this liquid refrigerant passes through the first inflow path (**44**) and is temporarily stored in the receiver (**43**). Further, the liquid refrigerant flows out of the receiver (**43**), has its pressure reduced through the electronic expansion valve (**EV**), passes through the first outflow path (**45**), evaporates in the indoor heat exchanger (**31**), and then goes back to the compressor (**21**).

[0047] On the other hand, during heating operation, the gas refrigerant discharged from the compressor (**21**) is condensed and liquefied in the indoor heat exchanger (**31**), and then this liquid refrigerant passes through the second inflow path (**46**) and is temporarily stored in the receiver (**43**). Further, the liquid refrigerant flows out of the receiver (**43**), has its pressure reduced through the electronic expansion valve (**EV**), passes through the second outflow path (**47**), evaporates in the auxiliary heat exchanger (**24**) and the outdoor heat exchanger (**23**), and then goes back to the compressor (**21**). In this case, the operation of circulating the refrigerant is performed while storing surplus refrigerant in the receiver (**43**).

[0048] It should be noted that, during both cooling operation and heating operation, the solenoid valve (**SV**) is normally set to be closed so as to prevent the gas refrigerant from flowing out of the receiver (**43**).

[0049] In the above operation, the inside of the receiver (**43**) is under a high pressure; therefore, even if a gas refrigerant of R32 is created due to the surroundings, for example, its created amount is small and the density of the gas is extremely small compared with that of the liquid. Accordingly, the composition of the liquid refrigerant flowing out of the receiver (**43**) is almost unchanged from the original composition of R407C as the non-azeotropic mixture refrigerant used in the circuit (**12**), and thus the liquid refrigerant having this stabilized composition flows out of the receiver (**43**) to circulate through the circuit (**12**).

[0050] Further, during each of the cooling and heating operations, the controller (**50**) sets each frequency step N at an appropriate value to control the capacity of the compressor (**21**), calculates, from a condensation temperature and an evaporation temperature detected by the outdoor heat exchanger temperature sensor (**Tc**) and the indoor heat exchanger temperature sensor (**Te**), the optimum value for the discharge pipe temperature which attains the optimum refrigerating effect, and sets the opening of the electronic expansion valve so that the discharge pipe temperature will be at the optimum value. Then, the controller (**50**) transmits a pulse signal by which the valve opening will be attained to the electronic expansion valve (**EV**) to control the opening of the electronic expansion valve (**EV**), thereby performing the air conditioning operation that will meet a room load.

[0051] Thus, during the circulation of the non-azeotropic mixture refrigerant through the refrigerant circuit (**12**), the operation of the refrigerant circuit (**12**) in accordance with a predetermined Mollier diagram is ensured, and the ratio between R32 and R134a in R407C can also be stabilized in this regard.

[0052] Furthermore, although the refrigerant circuit (**12**) is formed as a circuit using no accumulator on the suction side of the compressor (**21**) in the present embodiment, liquid back to the compressor (**21**) does not occur because the refrigerant circuit (**12**) is controlled so as to sufficiently increase the degree of superheat of the refrigerant sucked into the compressor (**21**) and is formed so as to adjust the outflow of the liquid refrigerant from the receiver (**43**), as described above. Besides, since no accumulator is used, the change of the composition ratio for the refrigerant, due to the refrigerant standing on the suction side of the compressor (**21**), does not occur unlike the prior art example.

[0053] It should be noted that, even if the liquid refrigerant inside the receiver (**43**) is expanded due to the increase of the ambient temperature in the state where the electronic expansion valve (**EV**) and the solenoid valve (**SV**) are closed at the shutdown of the operation, this refrigerant flows through the one-way passage (**42**) to the anti-liquid seal passage (**27**) to escape toward the heat exchanger (**23, 31**). In other words, liquid seal is prevented.

-EFFECT OF EMBODIMENT-

[0054] As described above, according to the present embodiment, R407C as the non-azeotropic mixture refrigerant used, during both heating operation and cooling operation, circulates through the refrigerant circuit (**12**) while its amount of circulation is adjusted through the storage of surplus refrigerant in the high-pressure receiver (**43**). Further, since the inside of the receiver (**43**) is under a high pressure, most of the refrigerant therein is present in the state of liquid refrigerant, and the density of gas is extremely small compared with that of liquid; therefore, the liquid refrigerant stored in the receiver (**43**) has a composition ratio almost unchanged from the original composition ratio for R407C even if R32 is gasified. Further, since the refrigerant having such a stabilized composition ratio circulates through the refrigerant circuit (**12**) and the composition ratio does not change on the suction side of the compressor (**21**), the property of the refrigerant remains almost unchanged, thus allowing the air conditioning apparatus (**10**) to stably exhibit its inherent performance. Accordingly, a decrease in operating efficiency is suppressed to improve the reliability of the apparatus (**10**).

[0055] Furthermore, since the opening of the electronic expansion valve (**EV**) is controlled using the respective temperature sensors (**Td, Tc, Te**), a change in the state of the refrigerant progresses accurately in accordance with a predetermined Mollier diagram. Thus, since the composition of the refrigerant is further stabilized, it is possible to further improve the reliability of the apparatus.

[0056] In addition, according to the present embodiment, even if the refrigerant with its composition slightly changed flows into the receiver (**43**), the composition ratio for the refrigerant is corrected in the receiver (**43**) to a value close to the original composition ratio since the pressure inside the receiver (**43**) is high. Therefore, it is possible to surely prevent the composition ratio of R407C from drastically changing during operation.

[0057] Further, since the anti-liquid seal passage (**27**) is provided, even if the ambient temperature increases during the shutdown of the operation, an abnormal pressure increase can be prevented.

-OTHER EMBODIMENT-

[0058] In the present invention, the refrigerating apparatus of the above embodiment may be formed as follows.

[0059] For example, in the above embodiment, the refrigerating apparatus is formed as a refrigerating apparatus of the type in which one indoor unit (**30**) is connected to one outdoor unit (**20**). Alternatively, the refrigerating apparatus may be of the type in which a plurality of indoor units (**30**) are connected to one outdoor unit (**20**). Further, in the above embodiment, the refrigerating apparatus of the present invention is formed as an air conditioning apparatus that can perform heating operation and cooling operation. Alternatively, the present invention is also applicable to an air conditioning apparatus that performs only heating operation or one that performs only cooling operation. Furthermore, the present invention may also be applied to any refrigerating apparatus other than air conditioning apparatuses.

[0060] Besides, the refrigerant used is not limited to R407C, but any other non-azeotropic mixture refrigerant may be used.

Claims

1. A refrigerating apparatus comprising a refrigerant circuit (**12**) for carrying out a vapor compression refrigeration cycle by using a non-azeotropic mixture refrigerant,
   wherein a high-pressure liquid line is provided with a reservoir (**43**) for storing the refrigerant therein while allowing a liquid refrigerant to flow out thereof.

2. The refrigerating apparatus according to Claim 1, wherein the refrigerant circuit (**12**) is formed as a refrigerant circuit (**12**) having no accumulator on the suction side of a compressor (**21**).

3. The refrigerating apparatus according to Claim 1, further comprising: a selecting mechanism (**22**) for inverting the direction of circulation of the refrigerant in the refrigerant circuit (**12**); and a directional control circuit (**41**) for allowing the liquid refrigerant from a condenser (**23, 31**) in each direction of circulation to flow into the receiver (**43**), wherein an expansion mechanism (**EV**) of the refrigerant circuit (**12**) is connected to the downstream side of the reservoir (**43**).

4. The refrigerating apparatus according to Claim 3, further comprising an anti-liquid seal passage (**27**) connected between a liquid pipe, provided between the reservoir (**43**) and the expansion mechanism (**EV**), and the discharge pipe of the compressor (**21**), wherein the anti-liquid seal passage (**27**) is formed as a one-way passage for allowing the flow of the refrigerant from the liquid pipe to the discharge pipe.

5. The refrigerating apparatus according to Claim 1, further comprising: a discharge pipe temperature sensor (**Td**); a condenser temperature sensor (**Tc**, **Te**); an evaporator temperature sensor (**Te**, **Tc**); and control means (**50**) for controlling, in response to outputs from the respective temperature sensors (**Td**, **Tc**, **Te**), the opening of the expansion mechanism (**EV**) of the refrigerant circuit (**12**).

6. The refrigerating apparatus according to Claim 1, wherein the non-azeotropic mixture refrigerant is R407C.

Fig. 1

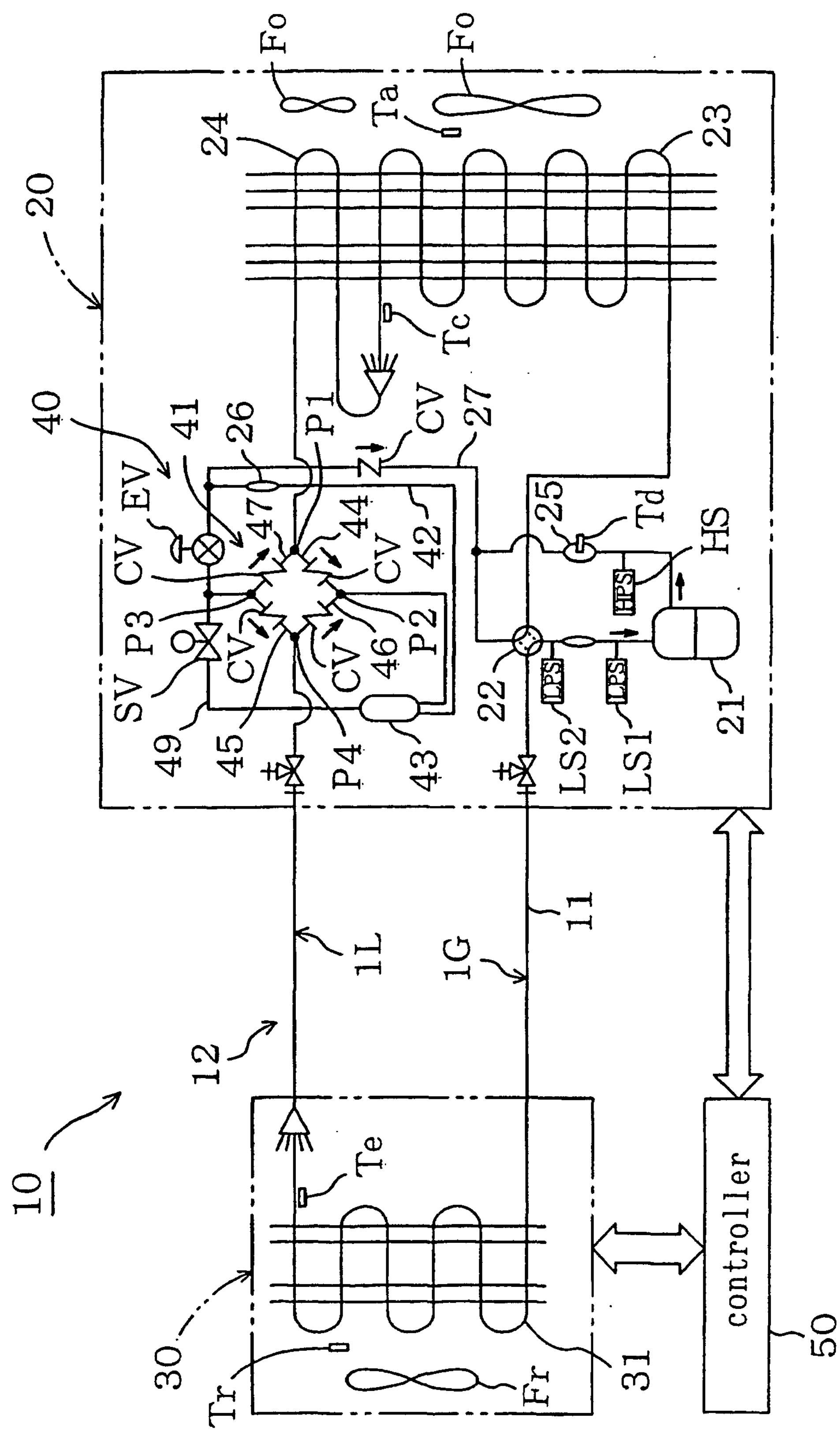

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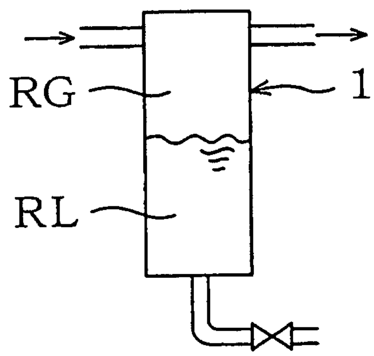
Fig. 2



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP00/08279

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl[7] F25B13/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int.Cl[7] F25B13/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho	1926-1996	Toroku Jitsuyo Shinan Koho	1994-2001
Kokai Jitsuyo Shinan Koho	1971-2001	Jitsuyo Shinan Toroku Koho	1996-2001

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP, 61-55562, A (Daikin Industries, Ltd.), 20 March, 1986 (20.03.86), Full text (Family: none)	1-6
Y	US, 5533351, A (Daikin Industries, Ltd.), 09 July, 1996 (09.07.96), the whole document & JP, 7-139833, A	1-6
Y	JP, 57-198968, A (Hitachi, Ltd.), 06 December, 1982 (06.12.82), Full text (Family: none)	1-6
Y	JP, 7-103622, A (Toshiba Corporation), 18 April, 1995 (18.04.95), Full text (Family: none)	1-6
Y	JP, 63-153367, A (Matsushita Electric Ind. Co., Ltd.), 25 June, 1988 (25.06.88), Full text	1-6

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
02 February, 2001 (02.02.01)	13 February, 2001 (13.02.01)
Name and mailing address of the ISA/ Japanese Patent Office	Authorized officer
Facsimile No.	Telephone No.

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