(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 3 173 714 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
31.05.2017 Bulletin 2017/22

(51) Int Cl.:
F25B 43/00 *(2006.01)* ***F25B 49/02*** *(2006.01)*
F25B 13/00 *(2006.01)*

(21) Application number: **16198071.9**

(22) Date of filing: **10.11.2016**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
MA MD

(30) Priority: **25.11.2015 JP 2015229750**

(71) Applicant: **Mitsubishi Heavy Industries, Ltd.**
Tokyo 108-8215 (JP)

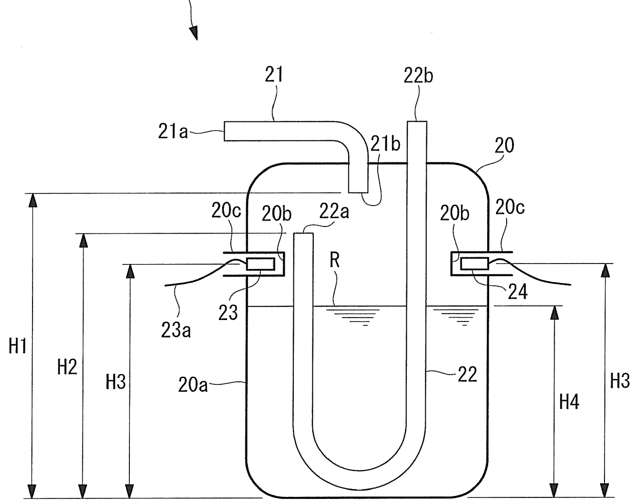
(72) Inventors:
- **KAWANISHI, Akio**
  MINATO-KU, TOKYO, 108-8215 (JP)
- **TAKEDA, Takeshi**
  MINATO-KU, TOKYO, 108-8215 (JP)
- **MURAKAMI, Kenichi**
  MINATO-KU, TOKYO, 108-8215 (JP)
- **SATO, Hitonobu**
  NAGOYA-SHI, AICHI, 453-0862 (JP)

(74) Representative: **Intès, Didier Gérard André et al**
Cabinet Beau de Loménie
158 rue de l'Université
75340 Paris Cedex 07 (FR)

(54) REFRIGERATING CYCLE SYSTEM AND LIQUID FLOW-BACK PREVENTION METHOD

(57) Liquid flow-back is prevented, and a compressor (4) is protected by a simple and low-cost configuration having high reliability and an excellent maintenance property. In a heating and cooling air conditioning system of the present invention, a gas-liquid mixed refrigerant sucked into an electric compressor (4) is separated, and only a vaporized refrigerant is sucked by an electric compressor (4), an electric heating element (23, 23A) is provided at a position of an allowable highest liquid level (H3) of a liquefied refrigerant (R) in an accumulator (12) storing a predetermined amount of the liquefied refrigerant (R), and a controller detects change of a heating value of the electric heating element (23) as change of power consumption, and performs protection operation for lowering the liquid level of the liquefied refrigerant (R) in a case where the power consumption reaches a predetermined threshold value.

FIG. 2



Printed by Jouve, 75001 PARIS (FR)

Description

BACKGROUND OF THE INVENTION

1. FIELD OF THE INVENTION

[0001] The present invention relates to a refrigerating cycle system and a liquid flow-back prevention method for preventing liquid flow-back to a compressor.

2. DESCRIPTION OF RELATED ART

[0002] In an air conditioning system used in a store, an office, a house, or the like, a pressure vessel shaped accumulator is connected to the suction side of a compressor that compresses and liquefies a gas refrigerant. The accumulator stores gas-liquid mixed refrigerant gas returned from an evaporator to a compressor once to perform gas-liquid separation by gravity therein, and makes the compressor suck only a vaporized refrigerant. Consequently, a phenomenon that a liquefied refrigerant is sucked by the compressor, called so-called liquid flow-back, is prevented, and breakage of the compressor by liquid compression is avoided.

[0003] As disclosed in Japanese Unexamined Patent Application, Publication No. 2001-27460, the accumulator is provided with a liquid level detector at a predetermined liquid level position such that the capacity of a stored liquefied refrigerant does not exceed. The liquid level detector is exposed inside a pressure vessel of the accumulator so as to be in contact with a liquefied refrigerant. When the liquid level reaches the position of the liquid level detector, the liquid level detector electrically outputs a detection signal.

[0004] When receiving this detection signal, a controller of the air conditioning system takes a measure such as reduction in the rotational speed of the compressor, temporal shutdown of the compressor, and reduction in the opening of an expansion valve, and performs protection operation for lowering the liquid level of the liquefied refrigerant in the accumulator to prevent liquid flow-back. In an air conditioning system of Japanese Unexamined Patent Application, Publication No. 2001-27460, the temperature of a heating apparatus provided in a bottom of the accumulator is raised, so that a liquefied refrigerant is heated to a temperature not lower than a saturation temperature to be vaporized, and the liquid level is lowered.

[0005] {PTL 1}

Japanese Unexamined Patent Application, Publication No. 2001-27460

BRIEF SUMMARY OF THE INVENTION

[0006] However, as disclosed in Japanese Unexamined Patent Application, Publication No. 2001-27460, providing of the liquid level detector in the pressure vessel of the accumulator causes complication of the structure of the accumulator and increase in a manufacturing cost, and use of the liquid level detector which easily causes failure causes reduction in reliability of the air conditioning system. At the time of failure of the liquid level detector, the refrigerant in the entire air conditioning system has to be removed when the liquid level detector is detached from the pressure vessel of the accumulator, and labor and time for filling the refrigerant again are required, and a maintenance property is poor.

[0007] The present invention has been made in view of the above circumstances, and an object of the invention is to provide a refrigerating cycle system capable of preventing liquid flow-back so as to protect a compressor by a simple and low-cost configuration having high reliability and an excellent maintenance property, and a liquid flow-back prevention method.

[0008] In order to solve the above problem, the present invention employs the following solutions.

[0009] A refrigerating cycle system according to the present invention includes: a compressor that compresses a refrigerant; a condenser that condenses compressed refrigerant discharged from the compressor; an expansion valve that expands the compressed refrigerant condensed by the condenser; an evaporator that vaporizes the compressed refrigerant expanded by the expansion valve; and an accumulator that once stores a gas-liquid mixed refrigerant returned from the evaporator to the compressor, separates the gas-liquid mixed refrigerant into a liquefied refrigerant and a vaporized refrigerant, and makes the compressor suck only the vaporized refrigerant, wherein the accumulator includes: a pressure vessel; a refrigerant inflow section that allows the gas-liquid mixed refrigerant to flow into the pressure vessel; a refrigerant outflow section that allows the vaporized refrigerant to flow toward the compressor; and an electric heating element provided at a position of an allowable highest liquid level of the liquefied refrigerant in the pressure vessel, of the pressure vessel, the refrigerating cycle system further including a controller that detects change of a heating value of the electric heating element by change of power consumption, and performs protection operation for lowering the liquid level of the liquefied refrigerant in a case where the power consumption reaches a predetermined threshold value.

[0010] In a case of the above configuration, a heating value of the electric heating element provided in the accumulator, namely, power consumption (e.g., a current value) when the electric heating element is adjacent to the liquefied refrigerant having a larger specific heat is larger than power consumption when the electric heating element is adjacent to the vaporized refrigerant having a smaller specific heat. Therefore, when the liquid level of the liquefied refrigerant reaches the height of the electric heating element, the power consumption of the electric heating element is increased. Accordingly, the controller monitors the power consumption of the electric heating element, so that it is possible to determine whether the electric heating element is adjacent to the vaporized refrigerant or the liquefied refrigerant.

[0011] When the power consumption of the electric heating element reaches a predetermined threshold value, the controller performs the protection operation for lowering the liquid level of the liquefied refrigerant. More specifically, a measure such as reduction in the rotational speed of the compressor, temporal shutdown of the compressor, and reduction in the opening of the expansion valve is taken, and the liquid level of the liquefied refrigerant in the accumulator is lowered. Consequently, it is possible to prevent liquid flow-back to protect the compressor.

[0012] The electric heating element is not a sensor, and therefore it is possible to carry out this simple and low-cost configuration compared with a configuration in which a liquid level detector is provided in the accumulator like a conventional technology. Additionally, a failure rate is reduced, and therefore reliability of the refrigerating cycle system is also improved. Accordingly, with the simple and low-cost configuration having high reliability, it is possible to prevent liquid flow-back from the accumulator to protect the compressor.

[0013] In the above configuration, it is considered that a voltage applied to the electric heating element is set in such a range that a temperature of the vaporized refrigerant is raised by heat generation of the electric heating element when the electric heating element is adjacent to the vaporized refrigerant, and the temperature of the electric heating element is lowered by cold heat of the liquefied refrigerant when the electric heating element is adjacent to the liquefied refrigerant.

[0014] Consequently, the heating value of the electric heating element can warm the vaporized refrigerant, but cannot warm the liquefied refrigerant, and becomes such a weak heating value that the electric heating element is cooled by the liquefied refrigerant. Even this enables determination between the vaporized refrigerant and the liquefied refrigerant, and therefore rise of the liquid level of the liquefied refrigerant can be detected by required minimum power, and liquid flow-back can be prevented.

[0015] Moreover, the heating value of the electric heating element is minimized, and therefore the gas-liquid refrigerant in the accumulator is not heated more than necessary. Accordingly, an excessive degree of superheat is not given to the refrigerant by the electric heating element, and the efficiency of the refrigerating cycle system can be prevented from lowering.

[0016] In the above configuration, the electric heating element may be a temperature measuring resistor that is utilizable also as a temperature sensor. Consequently, in a case of the refrigerating cycle system provided with the refrigerant temperature sensor in the accumulator, the single electric heating element can be used as both the liquid level detection sensor for the liquefied refrigerant, and the refrigerant temperature sensor, and it is possible to simplify a system configuration to reduce a cost and improve reliability.

[0017] In the above configuration, the electric heating element may be inserted into a recess from an outer side of the pressure vessel, the recess being provided in the pressure vessel and being depressed to an inner side from the outer side of the pressure vessel.

[0018] According to this configuration, the electric heating element can be detachably mounted from the outside of the pressure vessel of the accumulator, and therefore, for example, in a case where the electric heating element is replaced for maintenance, the refrigerant in the entire refrigerating cycle system does not have to be removed, and it is possible to greatly improve a maintenance property.

[0019] Moreover, a surface of the electric heating element is immersed with a wide area into the gas-liquid refrigerant through the recess of the pressure vessel, and therefore a heat-exchange rate between the electric heating element and the gas-liquid refrigerant can be increased compared to a case where the electric heating element is simply stuck to the side wall of the pressure vessel.

[0020] Consequently, when the liquid level of the liquefied refrigerant in the pressure vessel rises to reach the height of the electric heating element, time until the power consumption of the electric heating element is increased is shortened. Accordingly, time until the protection operation by the controller is started is also shortened. Therefore, it is possible to improve control responsiveness to prevent liquid flow-back, and reliably protect the compressor.

[0021] That is, a liquid flow-back prevention method according to the present invention includes: providing an electric heating element at a liquid level of a liquefied refrigerant in an accumulator, the accumulator separating a gas-liquid mixed refrigerant returned from an evaporator to a compressor into the liquefied refrigerant and a vaporized refrigerant in a refrigerating cycle system, the liquid level being a maximum storage amount of the liquefied refrigerant; detecting change of a heating value of the electric heating element by change of a current value; and detecting that the liquid level of the liquefied refrigerant reaches an allowable highest liquid level.

[0022] According to the above liquid flow-back prevention method, by the simple method of providing the electric heating element at the liquid level being the maximum storage amount of the accumulator, and monitoring the change of the power consumption, it is possible to reliably detect that the liquid level of the liquefied refrigerant in the accumulator rises, perform operation for lowering this liquid level to prevent liquid flow-back, and protect the compressor.

[0023] As described above, according to the refrigerating cycle system and the liquid flow-back prevention method according to the present invention, it is possible to prevent liquid flow-back to protect a compressor by a simple and low-cost configuration having high reliability and an excellent maintenance property.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

[0024]

FIG. 1 is a circuit diagram illustrating a basic configuration of a heating and cooling air conditioning system according to embodiments of the present invention;
FIG. 2 is a longitudinal sectional view of an accumulator illustrating a first embodiment of the present invention;
FIG. 3 is a graph illustrating an example of change of a current value in an electric heating element; and
FIG. 4 is a longitudinal sectional view of an accumulator illustrating a second embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0025] Hereinafter, embodiments according to the present invention will be described with reference to FIG. 1 to FIG. 3.

[0026] FIG. 1 is a circuit diagram illustrating a basic configuration of a heating and cooling air conditioning system 1 (an example of a refrigerating cycle system) according to embodiments of the present invention. This heating and cooling air conditioning system 1 is a heat pump type heating and cooling air conditioning system applied to a house, an office, a store, or the like, and has a general configuration including an outdoor unit 2 installed outdoor, and an indoor unit 3 installed indoor.

[0027] Inside the outdoor unit 2, a sealed electric compressor 4 (compressor) that compresses a refrigerant, a four-way valve 5 that controls flow of the refrigerant, an outdoor heat exchanger 6 that functions as a condenser for condensing a refrigerant during cooling operation, and functions as an evaporator for evaporating a refrigerant during heating operation, a receiver drier 7 that removes moisture in the refrigerant, and an expansion valve 8 that expands the refrigerant are connected in this order by a pipeline member 10. From the expansion valve 8, a pipeline member 11 extends to be connected to the indoor unit 3.

[0028] An accumulator 12 is connected to the suction side of the electric compressor 4, and a cooling fan 13 is provided in the outdoor heat exchanger 6. Furthermore, a controller 14 that controls this heating and cooling air conditioning system 1 is installed. The controller 14 controls the electric compressor 4, the four-way valve 5, and the expansion valve 8 by sending control signals S1, S2, S3 to the electric compressor 4, the four-way valve 5, and the expansion valve 8, respectively.

[0029] On the other hand, inside the indoor unit 3, an indoor heat exchanger 15 that functions as an evaporator for evaporating a refrigerant during cooling operation, and functions as a condenser for condensing a refrigerant during heating operation is incorporated, and a blower fan 16 is provided along with the indoor heat exchanger 15. The pipeline member 11 extending from the outdoor unit 2 is connected to one end of the indoor heat exchanger 15, a pipeline member 17 extending from the other end of the indoor heat exchanger 15 is connected to the accumulator 12 through the four-way valve 5 inside the outdoor unit 2.

[0030] When the four-way valve 5 is at the angle illustrated in FIG. 1, the heating and cooling air conditioning system 1 is in a cooling operation mode, high temperature and high pressure refrigerant compressed by the electric compressor 4 to be discharged flows into the outdoor heat exchanger 6 through the four-way valve 5, and is heat-exchanged with outside air by the cooling fan 13 to be cooled in the outdoor heat exchanger 6, so that the cooled refrigerant is brought into a liquid phase state. Then, after moisture is removed by the receiver drier 7, the refrigerant is expanded by the expansion valve 8 to be set to suitable pressure. Thereafter, the refrigerant flows into the indoor heat exchanger 15 of the indoor unit 3 through the pipeline member 11, and is vaporized in the indoor heat exchanger 15, so that heat of the indoor heat exchanger 15 is eliminated. At the same time, the blower fan 16 operates, so that indoor air is cooled by the indoor heat exchanger 15 to be blown into a room and used for indoor air cooling. The refrigerant vaporized by the indoor heat exchanger 15 is sucked into the electric compressor 4 again through the pipeline member 17, the four-way valve 5, and the accumulator 12.

[0031] When the four-way valve 5 rotates clockwise or counterclockwise by 90 degrees from the angle illustrated in FIG. 1, the heating and cooling air conditioning system 1 enters a heating operation mode. That is, the refrigerant compressed by the electric compressor 4 flows into the indoor heat exchanger 15 through the four-way valve 5 and the pipeline member 17, is heat-exchanged with indoor air in the indoor heat exchanger 15 by the blower fan 16 to be cooled, and is brought into the liquid phase state. At this time, air warmed by heat exchange with the refrigerant is brown into the room by the blower fan 16 to be used for indoor air heating. Then, the refrigerant that passes through the indoor heat exchanger 15 to be brought into the liquid phase state is expanded by the expansion valve 8, and is set to suitable pressure. Thereafter, after moisture is removed by the receiver drier 7, the refrigerant flows into the outdoor heat exchanger 6, is vaporized in the outdoor heat exchanger 6 to release heat to the outside, and is sucked into the electric compressor 4 again through the accumulator 12.

{First embodiment}

[0032] FIG. 2 is a longitudinal sectional view illustrating a first embodiment of the accumulator 12.

[0033] The accumulator 12 once stores a gas-liquid mixed refrigerant returned from the outdoor heat exchanger 6 or the indoor heat exchanger 15 to the electric compressor 4, and performs gas-liquid separation by gravity therein, makes the electric compressor 4 suck only a vaporized refrigerant, and stores a predetermined amount of liquefied refrigerant R. The accumulator 12 includes a tank-shaped pressure vessel 20 having predetermined capacity, a pipe-shaped refrigerant inflow section 21 and a pipe-shaped refrigerant outflow section 22 provided at a top of the pressure vessel 20, an electric heating element 23, and a temperature sensor 24.

[0034] The refrigerant inflow section 21 is a short pipe member bent at a right angle, an inlet opening 21a provided in one end of the refrigerant inflow section 21 is connected to the four-way valve 5, and an outlet opening 21b provided in the other end of the refrigerant inflow section 21 penetrates a top board of the pressure vessel 20 to be opened downward at an upper section of the inside of the pressure vessel 20.

[0035] The refrigerant outflow section 22 is a U-shaped pipe member longer than the refrigerant inflow section 21, and an inlet opening 22a provided in one end of the refrigerant outflow section 22 is opened upward at an upper section of the inside of the pressure vessel 20, and the other end of the refrigerant outflow section 22 penetrates the top board of the pressure vessel 20, an outlet opening 22b provided in this end is connected to the electric compressor 4. An intermediate section of the refrigerant outflow section 22 is deeply curved in a U-shape so as to protrude downward the inside the pressure vessel 20, and a curve section is located near a bottom of the pressure vessel 20.

[0036] When the height of the outlet opening 21b of the refrigerant inflow section 21 inside the pressure vessel 20 is denoted by H1, the height H2 of the inlet opening 22a of the refrigerant outflow section 22 is set to be lower than H1. The height H3 of the electric heating element 23 and the height H3 of the temperature sensor 24 are each set to further lower than H2. That is, the relation of these heights are H1 > H2 > H3. The installation height H3 of each of the electric heating element 23 and the temperature sensor 24 is the allowable highest liquid level of the liquefied refrigerant R inside the pressure vessel 20.

[0037] In the accumulator 12, the gas-liquid mixed refrigerant returned from the outdoor heat exchanger 6 or the indoor heat exchanger 15 to the electric compressor 4 flows from the inlet opening 21a of the refrigerant inflow section 21, and flows down from the outlet opening 21b to enter the pressure vessel 20. This gas-liquid mixed refrigerant is separated by gravity, and the liquefied refrigerant R which is a liquid phase of the gas-liquid mixed refrigerant is stored in the pressure vessel 20 along with lubricant oil. Thus, the liquid level H4 of the liquefied refrigerant R stored in the pressure vessel 20 is adjusted so as to be lower than the height H3 of each of the electric heating element 23 and the temperature sensor 24 during normal operation of the heating and cooling air conditioning system 1. Therefore, during normal operation, the inlet opening 22a of the refrigerant outflow section 22 sufficiently protrudes above the liquid level of the liquefied refrigerant R.

[0038] A vaporized refrigerant that is separated from the gas-liquid mixed refrigerant enters the refrigerant outflow section 22 from the inlet opening 22a, and flows out from the outlet opening 22b to be sucked into the electric compressor 4. Thus, the liquefied refrigerant R is stored in the pressure vessel 20, and only the vaporized refrigerant is sucked into the electric compressor 4, so that the liquefied refrigerant R is never sucked into the electric compressor 4.

[0039] On a side wall 20a forming a side surface of the pressure vessel 20, a recess 20b depressed to the inner side from the outer side of the pressure vessel 20 is formed. This recess 20b is formed by, for example, boring a through hole in the side wall 20a, and inserting a pipe material 20c having a closed tip into this through hole by a predetermined length to be welded. Then, the electric heating element 23 and the temperature sensor 24 are inserted into this recess 20b from the outer side of the pressure vessel 20.

[0040] The temperature sensor 24 is not an essential element for carrying out the present invention, and therefore can be omitted. Alternatively, a pressure sensor may be provided along with the temperature sensor 24. The pressure sensor is provided, so that the pressure of the inside of the pressure vessel 20 is detected, and it is possible to determine to some extent whether or not the liquefied refrigerant R exists near the installation heights H3 of the electric heating element 23 and the temperature sensor 24, from a difference between the saturation evaporation temperature of the liquefied refrigerant R under the detected pressure, and an actual temperature measured by the temperature sensor 24.

[0041] During operation of the heating and cooling air conditioning system 1 thus configured, power is supplied to the electric heating element 23 from the controller 14 (or a power source not illustrated) through a harness 23a. At this time, a voltage applied to the electric heating element 23 is set to such a constant voltage that the temperature of the vaporized refrigerant is raised by heat generation of the electric heating element 23 when the electric heating element 23 is adjacent to the vaporized refrigerant, and the temperature of the electric heating element 23 is lowered by cold heat of the liquefied refrigerant R when the electric heating element 23 is adjacent to the liquefied refrigerant R.

[0042] That is, as illustrated in FIG. 2, when the liquid level of the liquefied refrigerant R stored in the pressure vessel 20 is lower than the height H3 of the electric heating element 23, the electric heating element 23 is adjacent to the vaporized refrigerant, and the vaporized refrigerant in the pressure vessel 20 is warmed by heat generated by the electric heating element 23. In a case where the liquid level of the liquefied refrigerant R reaches the height H3 of the electric heating element 23, the electric heating element 23 is adjacent to the liquefied refrigerant R, the electric heating element 23 is cooled by the cold heat of the liquefied refrigerant R having larger specific heat than the vaporized refrigerant.

[0043] The controller 14 detects the above change of the heating value of the electric heating element 23 by change of power consumption. As illustrated in FIG. 3, in a case where the power consumption reaches a predetermined threshold value A, protection operation for lowering the liquid level of the liquefied refrigerant R is performed.

[0044] For example, when the liquid level of the liquefied refrigerant R in the pressure vessel 20 of the accumulator 12 rises to reach the height H3 of the electric heating element 23 at a time point when time T1 elapses from operation start, the heating value of the electric heating element 23 to which a constant voltage is supplied, namely, a current value starts rising from a steady-state value N. This is because a current amount required for generating the heat of the electric heating element 23 when the electric heating element 23 is adjacent to the liquefied refrigerant having a larger specific heat is larger than a current required for generating the heat of the electric heating element 23 when the electric heating element 23 is adjacent to the vaporized refrigerant R having a smaller specific heat. Accordingly, the controller 14 monitors the current amount of the electric heating element 23, so that it is possible to determine whether the electric heating element 23 is adjacent to the vaporized refrigerant or the liquefied refrigerant R.

[0045] When the current value reaches the predetermined threshold value A at time T2, the controller 14 starts the protection operation. More specifically, a measure such as reduction in the rotational speed of the electric compressor 4 or temporal shutdown of the electric compressor 4, and reduction in the opening of the expansion valve 8 is taken (suitably selected in accordance with an operation state), and the liquid level of the liquefied refrigerant R in the accumulator 12 is lowered. Consequently, it is possible to prevent liquid flow-back to protect the electric compressor 4.

[0046] Thereafter, when the current value exceeds a peak value and lowers, and drops to a threshold value B lower than the threshold value A at time T3, the controller 14 ends the protection operation. Thus, the reason why the threshold value A when the protection operation is started is set to be lower than the threshold value B when the protection operation is ended is because when the current value rises or lowers near the threshold value A, the protection operation is prevented from frequently repeating the start and the end (hysteresis).

[0047] In FIG. 3, at time T4, the liquid level of the liquefied refrigerant R lowers to an initial value, and the current value is returned to the steady-state value N. However, during actual operation, the current value rises and lowers between the steady-state value N and the threshold value A.

[0048] Thus, in the heating and cooling air conditioning system 1 of this embodiment, gas-liquid separation of the gas-liquid mixed refrigerant sucked into the electric compressor 4 is performed, the electric heating element 23 is provided at the position of the allowable highest liquid level H3 of the liquefied refrigerant R in the accumulator 12 that makes the electric compressor 4 suck only the vaporized refrigerant, the change of the heating value of the electric heating element 23 is detected as the change of the power consumption by the controller 14, and the protection operation for lowering the liquid level is performed in a case where the power consumption reaches the predetermined threshold value A.

[0049] In a case of this configuration, the electric heating element 23 is not a sensor, and therefore it is possible to carry out this simple and low-cost configuration compared with a configuration in which a liquid level detector is provided in the accumulator 12 like a conventional technology. Additionally, a failure rate as a liquid level detection unit is reduced, and therefore it is possible to greatly improve reliability of the heating and cooling air conditioning system 1. Accordingly, with the simple and low-cost configuration having high reliability, it is possible to prevent liquid flow-back from the accumulator 12 to protect the electric compressor 4.

[0050] The voltage applied to the electric heating element 23 is set in such a range that the temperature of the vaporized refrigerant is raised by the heat generation of the electric heating element 23 when the electric heating element 23 is adjacent to the vaporized refrigerant, and the temperature of the electric heating element 23 is lowered by the cold heat of the liquefied refrigerant R when the electric heating element 23 is adjacent to the liquefied refrigerant R.

[0051] Consequently, the heating value of the electric heating element 23 can warm the vaporized refrigerant, but cannot warm the liquefied refrigerant, and becomes such a weak heating value that the electric heating element 23 is cooled. Even this enables sufficient determination between the vaporized refrigerant and the liquefied refrigerant R, and therefore rise of the liquid level of the liquefied refrigerant R can be detected by required minimum power, and liquid flow-back can be prevented.

[0052] Moreover, the heating value of the electric heating element 23 is minimized, and therefore the gas-liquid refrigerant in the accumulator 12 is not heated more than necessary. Accordingly, an excessive degree of superheat is not given to the refrigerant by the electric heating element 23, and the efficiency of the heating and cooling air conditioning system 1 can be prevented from lowering.

[0053] The electric heating element 23 is inserted, from the outer side, into the recess 20b provided in the side wall 20a of the accumulator 12 (pressure vessel 20) and depressed to the inner side from the outer side of the pressure vessel 20.

[0054] According to this structure, the electric heating element 23 can be detachably mounted from the outside of the pressure vessel 20, and therefore, for example, in a case where the electric heating element 23 is replaced for maintenance, the refrigerant in the entire heating and cooling air conditioning system 1 does not have to be removed, and it is possible to greatly improve a maintenance property.

[0055] Moreover, a surface of the electric heating element 23 is immersed with a wide area into the gas-liquid refrigerant through the recess 20b of the pressure vessel 20, and therefore a heat-exchange rate between the electric heating element 23 and the gas-liquid refrigerant can be increased compared to a case where the electric heating element 23 is simply stuck to the side wall 20a of the pressure vessel 20.

[0056] Consequently, when the liquid level of the liquefied refrigerant R in the pressure vessel 20 rises to reach the height H3 of the electric heating element 23, time until the power consumption of the electric heating element 23 is increased (time between T1 and T2 in FIG. 3) is shortened. Accordingly, time until the protection operation by the controller 14 is started is also shortened. Therefore, it is possible to improve control responsiveness to prevent liquid flow-back, and reliably protect the electric compressor 4.

{Second Embodiment}

[0057] FIG. 4 is a longitudinal sectional view illustrating a second embodiment of an accumulator.

[0058] This accumulator 12A is different from the accumulator 12 of the first embodiment illustrated in FIG. 2 in two points, namely in that an electric heating element 23A is a temperature measuring resistor which is utilizable also as a temperature sensor, and the temperature sensor 24 illustrated in FIG. 2 is not provided. Other components are the same as the components of the accumulator 12 illustrated in FIG. 2, and therefore are denoted by the same reference numerals, and description thereof will be omitted.

[0059] Thus, a constant voltage is supplied to the electric heating element 23A by use of a temperature measuring resistor as the electric heating element 23A, similarly to the first embodiment, so that the electric heating element 23A can be used as a liquid level detection sensor of a liquefied refrigerant R.

[0060] In a case of a heating and cooling air conditioning system in which a refrigerant temperature sensor is provided in the accumulator 12A, temperature data detected by the electric heating element 23A is sent to a controller 14, so that the temperature of a refrigerant can be detected.

[0061] That is, the single electric heating element 23A can be used as both the liquid level detection sensor for the liquefied refrigerant R, and the refrigerant temperature sensor, and it is possible to simplify a system configuration to reduce a cost and improve reliability.

[0062] As described above, according to the refrigerating cycle system and the liquid flow-back prevention method of this embodiment, it is possible to prevent liquid flow-back to protect a compressor by a simple and low-cost configuration having high reliability and an excellent maintenance property.

[0063] The present invention is not limited to only the configurations of the above embodiments, changes or modifications can be suitably added to the embodiments, and embodiments including the changes or the modifications are included in the technical scope of the present invention.

[0064] For example, the recess 20b into which the electric heating element 23, 23A is inserted is not always provided in the side wall 20a of the pressure vessel 20. For example, the recess 20b may be formed so as to be suspended toward the inner section of the pressure vessel 20 of the top board of the pressure vessel 20, and the electric heating element 23, 23A may be inserted into the inner section.

REFERENCE SIGNS LIST

[0065]

1 Heating and cooling air conditioning system (refrigerating cycle system)
2 Outdoor unit
3 Indoor unit
4 Electric compressor (compressor)
5 Four-way valve
6 Outdoor heat exchanger (condenser)
7 Receiver drier
8 Expansion valve
12, 12A Accumulator
14 Controller
15 Indoor heat exchanger (evaporator)
20 Pressure vessel
20a Side wall of pressure vessel
20b Recess
20c Pipe material
21 Refrigerant inflow section
22 Refrigerant outflow section
23 Electric heating element
23A Electric heating element (temperature measuring resistor)
A Threshold value
H3 Allowable highest liquid level
R Liquefied refrigerant

Claims

1. A refrigerating cycle system comprising:

a compressor (4) configured to compress a refrigerant;
a condenser (6) configured to condens compressed refrigerant discharged from the compressor (4);
an expansion valve (8) configured to expand the compressed refrigerant condensed by the condenser (6);
an evaporator (15) configured to vaporize the

compressed refrigerant expanded by the expansion valve (8); and
an accumulator (12, 12A) configured to, once a stored gas-liquid mixed refrigerant has returned from the evaporator (15) to the compressor (4), separate the gas-liquid mixed refrigerant into a liquefied refrigerant (R) and a vaporized refrigerant, and to make the compressor (4) suck only the vaporized refrigerant, wherein

the accumulator (12, 12A) includes:

a pressure vessel (20);
a refrigerant inflow section (21) configured to allow the gas-liquid mixed refrigerant to flow into the pressure vessel (20);
a refrigerant outflow section (22) configured to allow the vaporized refrigerant to flow toward the compressor (4); and
an electric heating element (23, 23A) provided at a position of an allowable highest liquid level of the liquefied refrigerant (R) in the pressure vessel (20), of the pressure vessel (20),
the refrigerating cycle system further comprising a controller (14) configured to detect a change of a heating value of the electric heating element (23, 23A) by detecting a change of power consumption, and to perform protection operation for lowering the liquid level of the liquefied refrigerant (R) in a case where the power consumption reaches a predetermined threshold value.

2. The refrigerating cycle system according to claim 1, wherein
a voltage applied to the electric heating element (23, 23A) is set in such a range that a temperature of the vaporized refrigerant is raised by heat generation of the electric heating element (23, 23A) when the electric heating element (23, 23A) is adjacent to the vaporized refrigerant, and the temperature of the electric heating element (23, 23A) is lowered by cold heat of the liquefied refrigerant (R) when the electric heating element (23, 23A) is adjacent to the liquefied refrigerant (R).

3. The refrigerating cycle system according to claim 1 or 2, wherein
the electric heating element (23, 23A) is a temperature measuring resistor (23A) that is utilizable also as a temperature sensor.

4. The refrigerating cycle system according to any of claims 1 to 3, wherein
the electric heating element (23, 23A) is inserted into a recess (20b) from an outer side of the pressure vessel (20), the recess (20b) being provided in the pressure vessel (20) and being depressed to an inner side from the outer side of the pressure vessel (20).

5. A liquid flow-back prevention method comprising:

providing an electric heating element (23, 23A) at a liquid level of a liquefied refrigerant (R) in an accumulator (12, 12A), the accumulator (12, 12A) separating a gas-liquid mixed refrigerant returned from an evaporator (15) to a compressor (4) into the liquefied refrigerant (R) and a vaporized refrigerant in a refrigerating cycle system, the liquid level being a maximum storage amount of the liquefied refrigerant (R);
detecting change of a heating value of the electric heating element (23, 23A) by change of a current value; and
detecting that the liquid level of the liquefied refrigerant (R) reaches an allowable highest liquid level.

FIG. 1

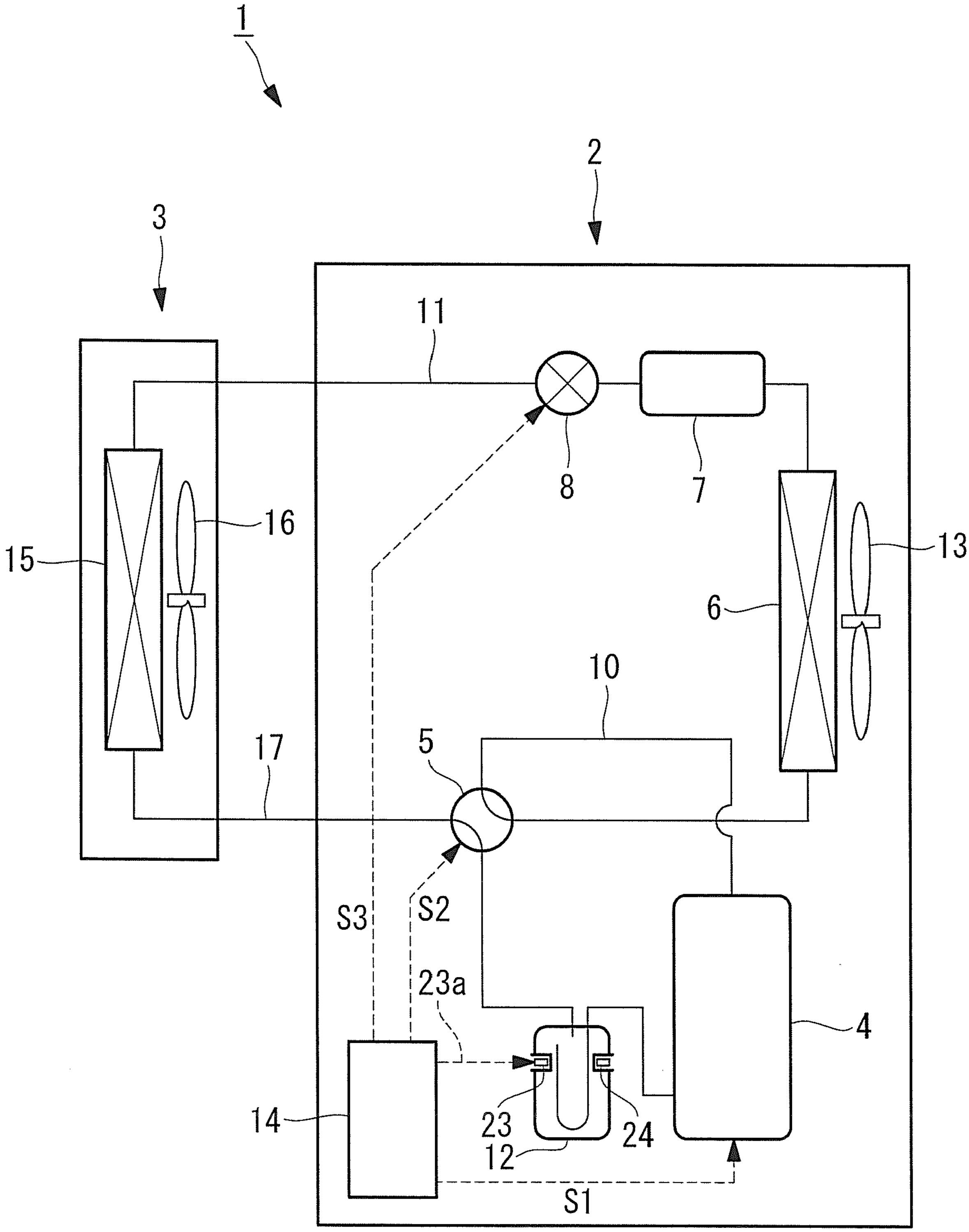


FIG. 2

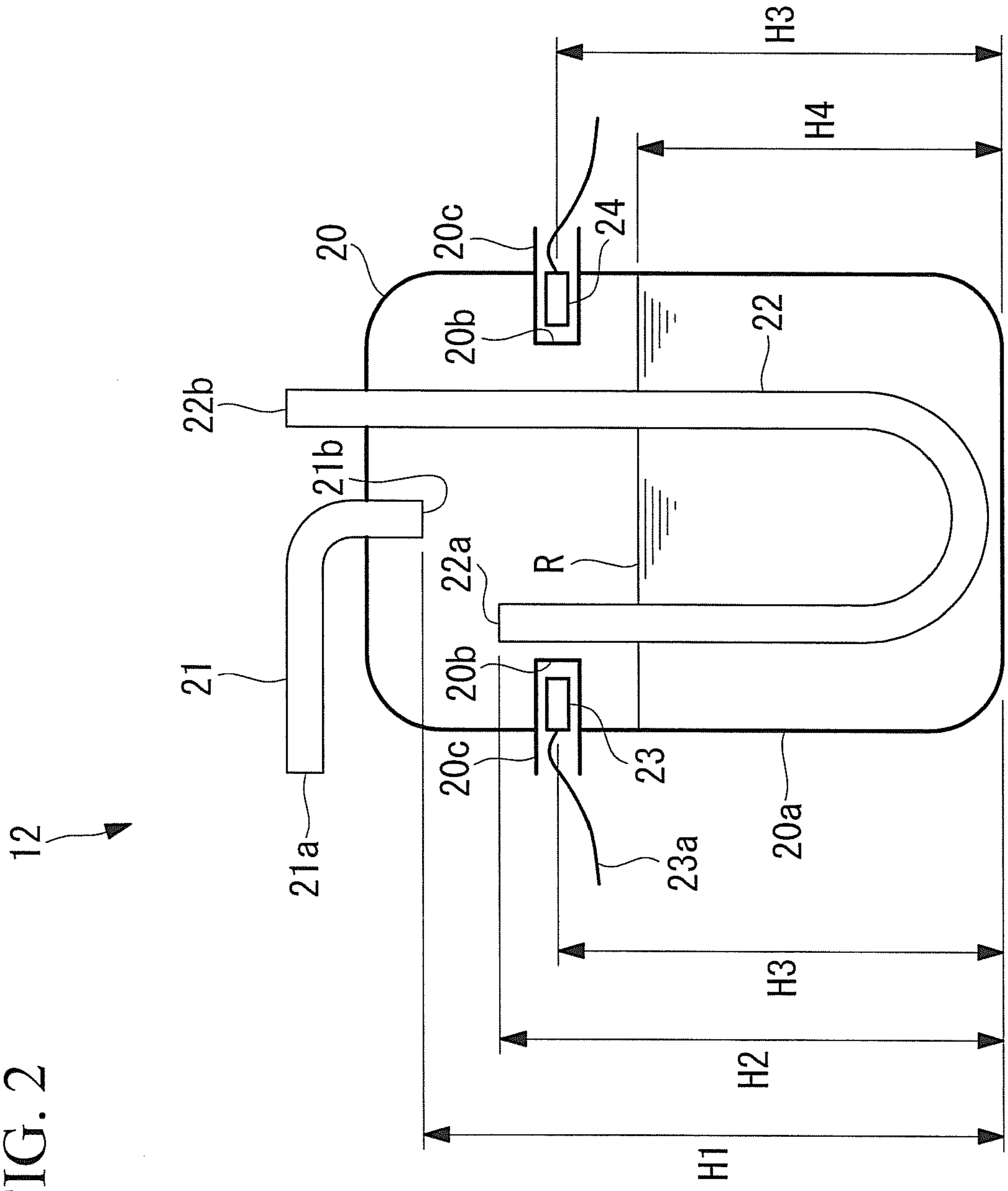


FIG. 3

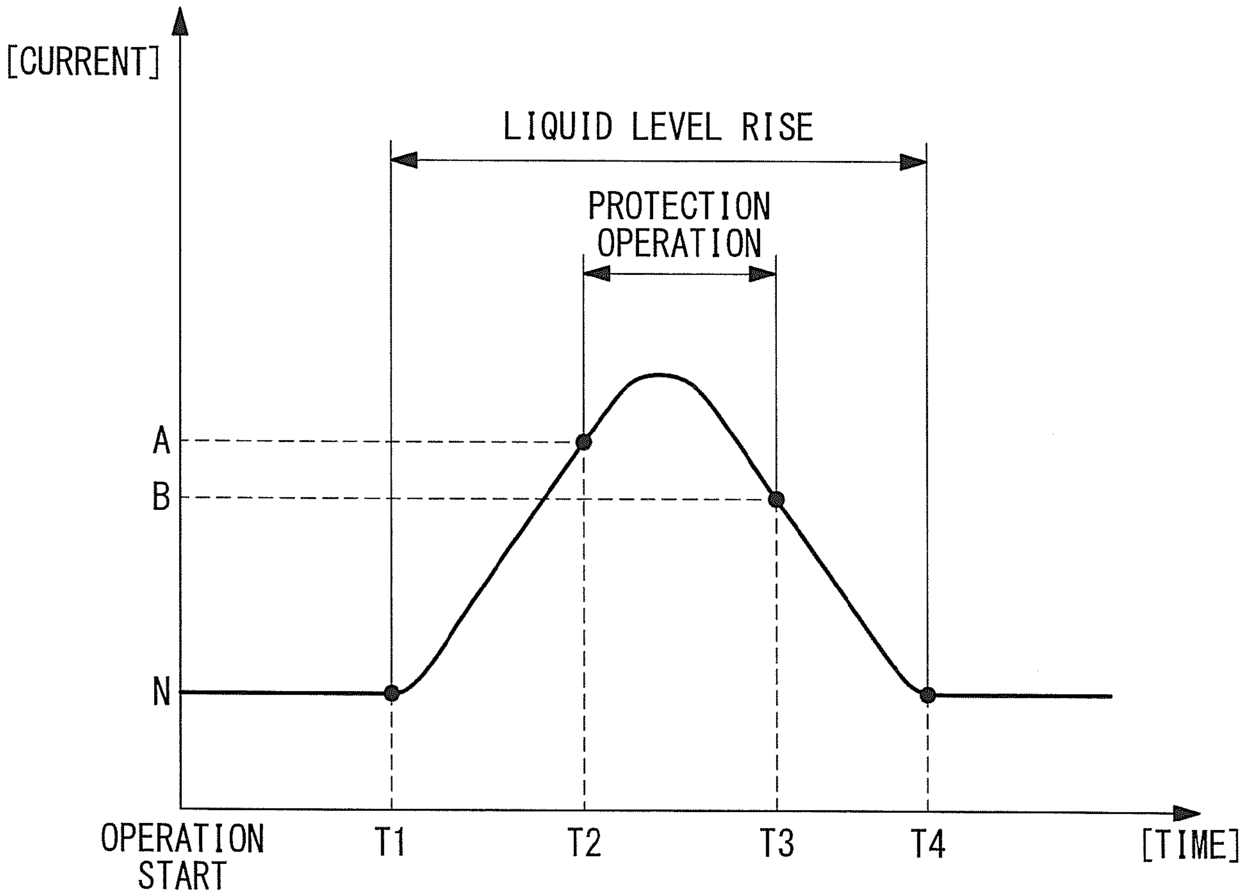
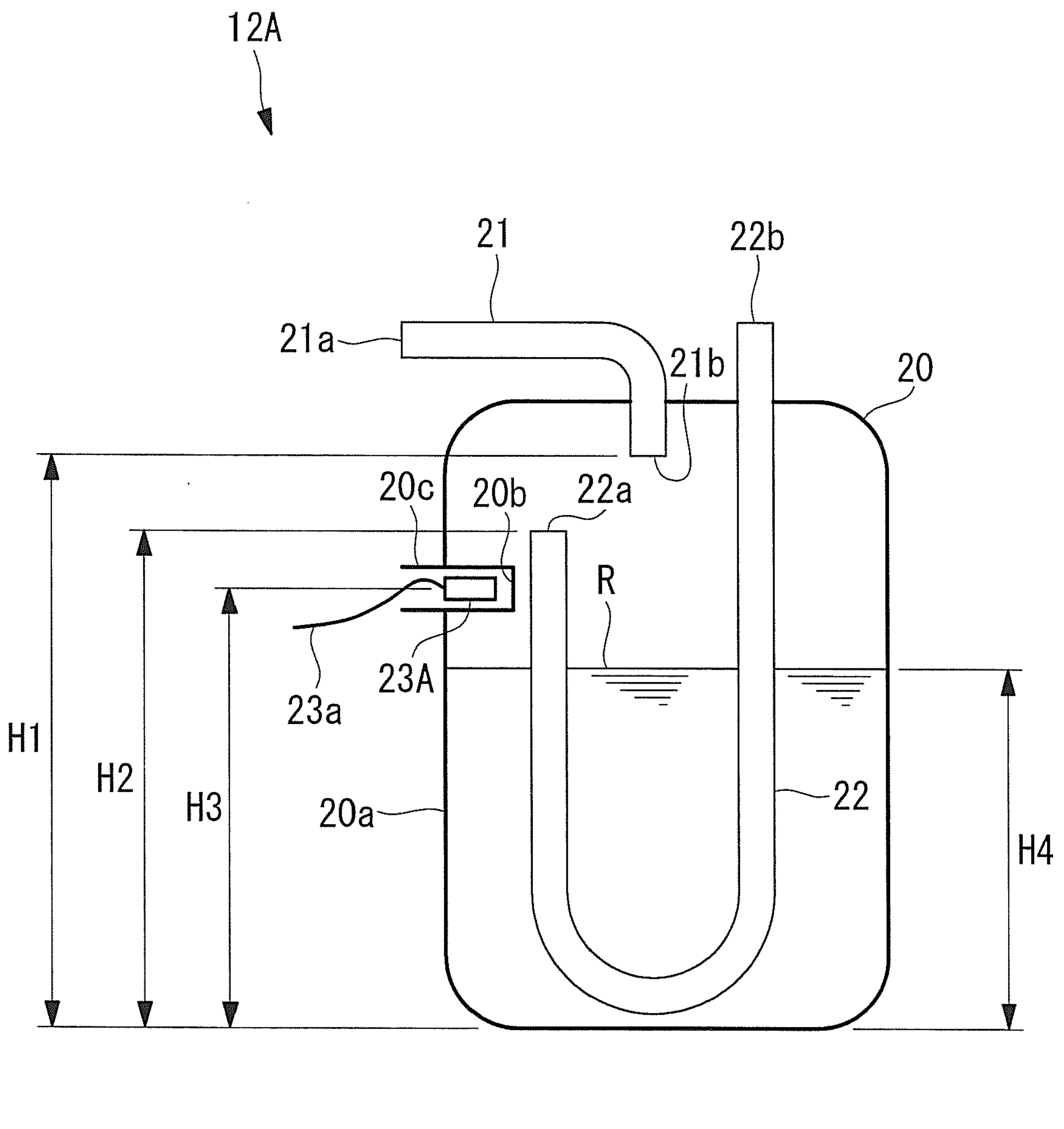

[CURRENT]
LIQUID LEVEL RISE
PROTECTION OPERATION
A
B
N
OPERATION START
T1
T2
T3
T4
[TIME]

FIG. 4



Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 16 19 8071

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A,D	JP 2001 027460 A (MITSUBISHI ELECTRIC CORP) 30 January 2001 (2001-01-30) * abstract; figures 2,12 * * paragraphs [0001] - [0006], [0027] - [0028] * -----	1-5	INV. F25B43/00 F25B49/02 ADD. F25B13/00
A	JP H01 305264 A (TOSHIBA CORP) 8 December 1989 (1989-12-08) * abstract; figure 1 * -----	1-5	
A	JP H02 298770 A (DAIKIN IND LTD) 11 December 1990 (1990-12-11) * abstract; figure 1 * -----	1-5	
A	JP H08 327185 A (MATSUSHITA ELECTRIC IND CO LTD) 13 December 1996 (1996-12-13) * paragraph [0001] - paragraph [0007]; figure 1 * * paragraph [0013] - paragraph [0018] * -----	1-5	

TECHNICAL FIELDS SEARCHED (IPC)

F25B

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
Munich	23 February 2017	Weisser, Meinrad

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

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 16 19 8071

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 The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

23-02-2017

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
JP 2001027460 A	30-01-2001	JP 3439178 B2 JP 2001027460 A	25-08-2003 30-01-2001
JP H01305264 A	08-12-1989	NONE	
JP H02298770 A	11-12-1990	NONE	
JP H08327185 A	13-12-1996	NONE	

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

Patent documents cited in the description

- JP 2001027460 A **[0003] [0004] [0005] [0006]**