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(54) **CO2 REFRIGERATION SYSTEM AND CONTROL METHOD THEREOF**

CO2-KÜHLSYSTEM UND STEUERUNGSVERFAHREN DAFÜR

SYSTÈME DE RÉFRIGÉRATION AU CO2 ET SON PROCÉDÉ DE COMMANDE

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(73) Proprietor: **Carrier Corporation**
**Jupiter, FL 33478 (US)**

(72) Inventor: **ZHAO, Bo**
**Shanghai 201206 (CN)**

(74) Representative: **Dehns**
**St. Bride's House**
**10 Salisbury Square**
**London EC4Y 8JD (GB)**

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## Description

### FIELD OF THE INVENTION

**[0001]** The present invention relates to the field of refrigeration, and more particularly, relates to a carbon dioxide refrigeration system and a pressure relief and recovery control method.

### BACKGROUND ART

**[0002]** Currently, a carbon dioxide refrigeration system is applied to various types of refrigeration applications due to unique properties thereof. However, for such refrigeration system, an overpressure condition tends to occur during its operating state or stop state, i.e., a pressure value of the system exceeds a preset pressure value. In order to solve such overpressure problem, a plurality of technical solutions have been proposed in the art.

**[0003]** For example, a pressure relief valve or a pressure relief tank is introduced in the carbon dioxide refrigeration system, so that when the overpressure condition occurs, part of a carbon dioxide refrigerant is discharged into the atmosphere via the pressure relief valve or discharged into the pressure relief tank for subsequent processing. Such design relieves the overpressure problem of the carbon dioxide refrigeration system to a certain degree. However, such design is not environmental-friendly in one aspect; and in the other aspect, part of carbon dioxide in the system is discharged, which may influence refrigeration capacity of the system in the normal operating state, so maintenance personnel needs to constantly execute a refrigerant refilling action, which will increase maintenance costs.

**[0004]** For another example, for the overpressure problem of the carbon dioxide refrigeration system in a shutdown state, a condensing unit can be additionally arranged, and after the system is shut down, the condensing unit will inject cooling capacity to the system so as to prevent the occurrence of the carbon dioxide overpressure problem to the system. However, it will increase additional unit costs. EP 0860309 discloses a carbon dioxide gas refrigeration cycle comprising a main body of the cycle and a buffer tank separate from the main body of the cycle; the buffer tank may be connected to either the high-pressure side or the low-pressure side of the main body of the refrigeration cycle.

### SUMMARY OF THE INVENTION

**[0005]** The present invention aims to provide a carbon dioxide refrigeration system capable of unloading and recovering a carbon dioxide refrigerant.

**[0006]** The present invention further aims to provide a control method of a carbon dioxide refrigeration system capable of unloading and recovering a carbon dioxide refrigerant.

**[0007]** In order to fulfill the objective of the present invention, the present invention provides a carbon dioxide refrigeration system, comprising: a refrigeration loop, which comprises: a compressor, a condenser, a throttling element and an evaporator which are connected by pipelines, wherein a high-pressure side flow passage of the refrigeration loop is formed from the downstream of the compressor to the upstream of the throttling element, and a low-pressure side flow passage of the refrigeration loop is formed from the downstream of the throttling element to the upstream of the compressor; and a pressure relief and recovery loop, which comprises: a gas storage reservoir, which is used for storing gas-phase carbon dioxide; a pressure relief flow passage, which is used for connecting the gas storage reservoir and the refrigeration loop and used for discharging the gas-phase carbon dioxide in the refrigeration loop into the gas storage reservoir; and a recovery flow passage, which is used for connecting the gas storage reservoir and the refrigeration loop and provided with a driving apparatus, the recovery flow passage being used for recovering the gas-phase carbon dioxide in the gas storage reservoir into the refrigeration loop under the drive of the driving apparatus; characterized in that the pressure relief flow passage is used for connecting the gas storage reservoir and the high-pressure side flow passage of the refrigeration loop; and the pressure relief flow passage is used for connecting the gas storage reservoir and the low-pressure side flow passage of the refrigeration loop.

**[0008]** In order to fulfill the further objective of the present invention, the present invention further provides a control method of the carbon dioxide refrigeration system according to any one of claims 1 to 8, comprising: a pressure relief control step S100, which comprises: a switch-on step S110: when a pressure of the high-pressure side flow passage is not smaller than a first preset pressure, and when a pressure of the low-pressure side flow passage is not smaller than a third preset pressure, switching on the pressure relief flow passage; a switch-off step S120: when the pressure of the high-pressure side flow passage is not greater than a second preset pressure, and when the pressure of the low-pressure side flow passage is not greater than a fourth preset pressure, switching off the pressure relief flow passage; and a maintenance step S130: when the pressure of the high-pressure side flow passage is smaller than the first preset pressure and greater than the second preset pressure, and when the pressure of the low-pressure side flow passage is smaller than the third preset pressure and greater than the fourth preset pressure, maintaining a current on/off state of the pressure relief flow passage; and/or a refrigerant recovery control step S200, which comprises: S210: when the compressor of the refrigeration loop operates and a pressure of the gas storage reservoir is not smaller than a fifth preset pressure, operating the driving apparatus in the recovery flow passage; S220: when the pressure of the gas storage reservoir is not greater than a sixth preset pressure, stopping the driving apparatus in the recovery flow passage; S230: when the pressure of the gas storage reservoir is greater than the sixth preset pressure and smaller than the fifth preset pressure, maintaining a current working state of the driving apparatus; and S240: when the compressor of the refrigeration loop stops operating, stopping the driving apparatus in the recovery flow passage.

## DETAILED DESCRIPTION OF THE DRAWINGS

**[0009]** FIG. 1 is a schematic diagram of a system flow passage of a carbon dioxide refrigeration system of the present invention.

## DETAILED DESCRIPTION

**[0010]** With reference to FIG. 1, it shows a carbon dioxide refrigeration system. The system includes a refrigeration loop 200 for providing cooling capacity and a pressure relief and recovery loop 100 for providing pressure relief and carbon dioxide recovery.

**[0011]** Here, the refrigeration loop 200 includes a compressor 210, a condenser 220, a throttling element 230 and an evaporator 240 which are connected by pipelines; a high-pressure side flow passage of the refrigeration loop is formed from the downstream of the compressor 210 to the upstream of the throttling element 230; and a low-pressure side flow passage of the refrigeration loop is formed from the downstream of the throttling element 230 to the upstream of the compressor 210. The above is one relatively common refrigeration loop 200, and a carbon dioxide refrigerant enters the condenser 220 to dissipate heat and is condensed after compressed via the compressor 210, then is throttled by the throttling element 230 for pressure reduction, and finally enters the evaporator 240 to absorb heat for refrigeration.

**[0012]** Moreover, the pressure relief and recovery loop 100 includes: a gas storage reservoir 110, which is used for storing gas-phase carbon dioxide; a pressure relief flow passage 120, which is used for connecting the gas storage reservoir 110 and the refrigeration loop and is used for discharging the gas-phase carbon dioxide in the refrigeration loop into the gas storage reservoir 110; and a recovery flow passage 130, which is used for connecting the gas storage reservoir 110 and the refrigeration loop, and on which a recovery compressor131 is arranged, the recovery flow passage 130 being used for recovering the gas-phase carbon dioxide in the gas storage reservoir 110 into the refrigeration loop under the drive of the recovery compressor 131.

**[0013]** According to the carbon dioxide refrigeration system in the above-mentioned embodiment, when refrigerant overpressure occurs in a system operating or shutdown state, the over-pressured refrigerant in the refrigeration loop 200 can be led into the gas storage reservoir 110 in the pressure relief and recovery loop 100 via the pressure relief flow passage 120, and after the system is normal, the refrigerant can be recovered into the refrigeration loop 200 under the drive of the recovery compressor 131. Therefore, not only is a refrigerant overpressure phenomenon avoided, but also a problem that the refrigerant needs to be constantly refilled is solved, and considerations to maintenance cost and system operation stability are balanced.

**[0014]** For junctions between the pressure relief and recovery loop 100 and the refrigeration loop 200, a detailed description will be provided below.

**[0015]** Particularly, the pressure relief flow passage 120 is used for connecting the gas storage reservoir 110 and the high-pressure side flow passage of the refrigeration loop; and/or the pressure relief flow passage 120 is used for connecting the gas storage reservoir 110 and the low-pressure side flow passage of the refrigeration loop. This is because that the high-pressure side flow passage and the low-pressure side flow passage of the same carbon dioxide refrigeration system have different overpressure determination standards. Such arrangement can implement pressure relief on the high-pressure side flow passage when overpressure occurs on the high-pressure side and pressure relief on the low-pressure side flow passage when overpressure occurs on the low-pressure side, and such regulation mode is more targeted. More particularly, the pressure relief flow passage 120 can be from the gas storage reservoir 110 to a high-pressure side pressure relief junction 125 located on a flow passage between the condenser 220 and the throttling element 230 of the refrigeration loop; or alternatively, the pressure relief flow passage 120 can be from the gas storage reservoir 110 to a high-pressure side pressure relief junction 125 located on a flow passage between the condenser 220 and the compressor 210 of the refrigeration loop; and/or the pressure relief flow passage 120 can be from the gas storage reservoir 110 to a low-pressure side pressure relief junction 126 located on a flow passage between the evaporator 240 and the compressor 210 of the refrigeration loop; or alternatively, the pressure relief flow passage 120 can be from the gas storage reservoir 110 to a low-pressure side pressure relief junction 126 located on a flow passage between the evaporator 240 and the throttling element 230 of the refrigeration loop.

**[0016]** Similarly, the recovery flow passage 130 is used for connecting the gas storage reservoir 110 and the low-pressure side flow passage of the refrigeration loop, so that after the system is recovered to a normal pressure state, the discharged carbon dioxide refrigerant is recovered into the refrigeration loop again, thus avoiding an influence on refrigeration capacity of the system due to insufficiency of the refrigerant. At the moment, the refrigerant is introduced via the low-pressure side flow passage, so that in one aspect, the resistance acting on the refrigerant when it is introduced into the system can be reduced, and in the other aspect, the refrigerant can directly enter the compressor to participate in a new round of working cycle. More particularly, the recovery flow passage 130 is from the gas storage reservoir 110 to a recovery junction 133 located on the flow passage between the evaporator 240 and the compressor 210 of the refrigeration loop.

[0017] Optionally, when the refrigeration loop 200 further includes a gas-liquid separator 250 arranged between the evaporator 240 and the compressor 210, the recovery flow passage 130 is used for connecting the gas storage reservoir 110 and a flow passage between the evaporator 240 and the gas-liquid separator 250 of the refrigeration loop.

[0018] Moreover, possible improvements on part of components and parts to which the system relates will be further illustrated below.

[0019] For example, the recovery flow passage 130 can be a flow passage connecting the gas storage reservoir 110 and an air suction port of the compressor 210 of the refrigeration loop.

[0020] For another example, an electromagnetic valve for controlling on-off of the flow passage can be arranged on the pressure relief flow passage 120. When the pressure relief flow passage 120 includes a high-pressure side pressure relief branch 121 and a low-pressure side pressure relief branch 122, the electromagnetic valve described herein is correspondingly a high-pressure side pressure relief electromagnetic valve 123 and a low-pressure side pressure relief electromagnetic valve 124, respectively.

[0021] For yet another example, a check valve 132 for preventing backflow can be arranged on the recovery flow passage 130. In addition, the recovery compressor 131 on the recovery flow passage 130 may also be other driving apparatuses capable of pressurizing a gas.

[0022] According to the teaching of the above-mentioned embodiment, it can be known that the related pressure relief and recovery loop 100 can also be applicable to other types of carbon dioxide refrigeration systems, as long as the systems also have a demand for solving the carbon dioxide overpressure problem. Moreover, for junctions between the pressure relief flow passage 120 and the recovery flow passage 130 in the pressure relief and recovery loop 100 and the associated carbon dioxide refrigeration system, reference can also be made to the above-mentioned embodiment. Namely, the pressure relief flow passage 120 is joined to the high-pressure side flow passage or the low-pressure side flow passage of the carbon dioxide refrigeration system, and the recovery flow passage 130 is joined to the low-pressure side flow passage of the carbon dioxide refrigeration system.

[0023] Moreover, a control method of the carbon dioxide refrigeration system is also provided herein, and optionally, it can be applicable to the above-mentioned embodiment. The method includes a pressure relief control step S100 for carrying out pressure relief when the system is over-pressured and a refrigerant recovery control step S200 for recovering the unloaded refrigerant after the system normally operates. Here, the pressure relief control step S100 includes: a switch-on step S110: when a pressure of the high-pressure side flow passage is not smaller than a first preset pressure, and/or when a pressure of the low-pressure side flow passage is not smaller than a third preset pressure, which shows that the pressure in the high-pressure side flow passage and/or the low-pressure side flow passage has exceeded a normal operation range, at the moment, switching on the pressure relief flow passage; a switch-off step S120: when the pressure of the high-pressure side flow passage is not greater than a second preset pressure, and/or when the pressure of the low-pressure side flow passage is not greater than a fourth preset pressure, which shows that the pressure in the high-pressure side flow passage and/or the low-pressure side flow passage has fallen back into the normal operation range, at the moment, switching off the pressure relief flow passage; and a maintenance step S130: when the pressure of the high-pressure side flow passage is smaller than the first preset pressure and greater than the second preset pressure, and/or when the pressure of the low-pressure side flow passage is smaller than the third preset pressure and greater than the fourth preset pressure, which shows that the pressure in the high-pressure side flow passage and/or the low-pressure side flow passage is in a regulation control process, at the moment, maintaining a current on/off state of the pressure relief flow passage; and/or a refrigerant recovery control step S200, which includes: S210: when the compressor of the refrigeration loop operates and a pressure of the gas storage reservoir is not smaller than a fifth preset pressure, which shows that a stock of the carbon dioxide refrigerant in the gas storage reservoir is very high, at the moment, operating the driving apparatus in the recovery flow passage; S220: when the pressure of the gas storage reservoir is not greater than a sixth preset pressure, which shows that the stock of the carbon dioxide refrigerant in the gas storage reservoir is very low and there is no need to continuously recover the carbon dioxide refrigerant, at the moment, stopping the driving apparatus in the recovery flow passage; and S230: when the pressure of the gas storage reservoir is greater than the sixth preset pressure and smaller than the fifth preset pressure, which shows that the stock of the carbon dioxide refrigerant in the gas storage reservoir is in a regulation control process, at the moment, maintaining a current working state of the driving apparatus. When the compressor of the refrigeration loop stops operating, the system stops working, at which the refrigerant does not need to be recovered, and the step S240 of stopping the driving apparatus in the recovery flow passage should be executed.

[0024] The working process of the carbon dioxide refrigeration system will be further described below in connection with the above-mentioned embodiments. With reference to FIG. 1, when the system normally operates, the refrigerant enters the condenser 220 to be condensed and dissipate heat after compressed via the compressor 210, then, after subjected to throttling and pressure reduction by the throttling element 230, the refrigerant enters the evaporator 240 to evaporate and absorb heat, so as to provide cooling capacity for an application environment, and subsequently, the refrigerant is dried in the gas-liquid separator, and enters the compressor 210 to start a new round of cycle.

**[0025]** In the working cycle process, if the pressure of the high-pressure side flow passage (for example, a pressure at the condenser 220) is greater than or equal to the first preset pressure, it shows that the high-pressure side flow passage of the refrigeration system has an overpressure condition, and the high-pressure side pressure relief electromagnetic valve 123 should be opened; and at the moment, part of the high-pressure refrigerant flows from the high-pressure side pressure relief junction 125 into the gas storage reservoir 110 via the switched-on high-pressure side pressure relief branch 121 for temporary storage. After the high-pressure side pressure relief electromagnetic valve 123 is opened transiently, the pressure of the high-pressure side flow passage can easily fall below the first preset pressure, and at the moment, it is apparently unreasonable to immediately close the high-pressure side pressure relief electromagnetic valve 123, which will result in that the pressure of the high-pressure side flow passage is always around the first preset pressure and a pressure reducing effect cannot be really achieved. Therefore, after the pressure of the high-pressure side flow passage falls below the first preset voltage, the high-pressure side pressure relief electromagnetic valve 123 is continuously kept open until the pressure of the high-pressure side flow passage is reduced to a pressure smaller than or equal to the second preset pressure value, at which the overpressure condition of the refrigeration system has been really regulated and controlled, and the high-pressure side pressure relief electromagnetic valve 123 can be closed. Conversely, when the pressure of the high-pressure side flow passage is greater than the second preset pressure value, the high-pressure side pressure relief electromagnetic valve 123 is still kept in a closed state until the pressure of the high-pressure side flow passage is continuously risen above the first preset pressure value, and the high-pressure side pressure relief electromagnetic valve 123 is opened again. The working cycle above is repeated.

**[0026]** Similarly, when the pressure of the low-pressure side flow passage (for example, the pressure at the evaporator 240) is greater than or equal to the third preset pressure, it shows that the low-pressure side flow passage of the refrigeration system has the overpressure condition, and the low-pressure side pressure relief electromagnetic valve 124 should be opened; and at the moment, part of the low-pressure refrigerant flows from the low-pressure side pressure relief junction 126 into the gas storage reservoir 110 via the switched-on low-pressure side pressure relief branch 122 for temporary storage. After the low-pressure side pressure relief electromagnetic valve 124 is opened transiently, the pressure of the low-pressure side flow passage can easily fall below the third preset pressure, and at the moment, it is also unreasonable to immediately close the low-pressure side pressure relief electromagnetic valve 124, which will result in that the pressure of the low-pressure side flow passage is always around the third preset pressure and a pressure reducing effect cannot be really achieved. Therefore, after the pressure of the low-pressure side flow passage falls below the third preset voltage, the low-pressure side pressure relief electromagnetic valve 124 is continuously kept open until the pressure of the low-pressure side flow passage is reduced to a pressure smaller than or equal to the fourth preset pressure value, at which the overpressure condition of the refrigeration system has been really regulated and controlled , and the low-pressure side pressure relief electromagnetic valve 124 can be closed. Conversely, when the pressure of the low-pressure side flow passage is greater than the fourth preset pressure value, the low-pressure side pressure relief electromagnetic valve 124 is still kept in a closed state until the pressure of the low-pressure side flow passage is continuously risen above the third preset pressure value, and the low-pressure side pressure relief electromagnetic valve 124 is opened again. The working cycle above is repeated.

**[0027]** By the above-mentioned process, pressure relief can be effectively performed on a refrigeration system when the system is over-pressured. However, pressure relief will cause a decrease in the stock of the working refrigerant in the system. Therefore, when the system is in the normal working state, the unloaded refrigerant should also be recovered into the original refrigeration system.

**[0028]** After the overpressure condition of the system is under control, pressure relief can be continuously normally operated or stopped. When the system normally operates, i.e., the compressor of the refrigeration loop operates, if the pressure in the gas storage reservoir 110 is not smaller than the fifth preset pressure, the recovery compressor 131 in the recovery flow passage 130 operates, and at the moment, the refrigerant stored in the gas storage reservoir 110 flows from the recovery junction 133 into the refrigeration loop 200 via the recovery flow passage 130 and participates in the refrigeration working cycle again.

**[0029]** When the recovery compressor 131 has been started transiently, the pressure in the gas storage reservoir 110 can easily fall below the fifth preset pressure, and at the moment, it is apparently unreasonable to immediately stop the recovery compressor 131, which will result in that the refrigerant inadequately enters the refrigeration loop 200 to participate in refrigeration. Therefore, after the pressure in the gas storage reservoir 110 falls below the fifth preset pressure, the recovery compressor 131 is continuously kept started until the pressure in the gas storage reservoir 110 is reduced to a pressure smaller than or equal to the sixth preset pressure value, at which the refrigerant in the gas storage reservoir 110 is basically all recovered into the refrigeration loop 200, and the recovery compressor 131 can be stopped. Conversely, when the pressure in the gas storage reservoir 110 is greater than the sixth preset pressure value, the recovery compressor 131 is still kept in a stop state until the pressure in the gas storage reservoir 110 is continuously risen above the fifth preset pressure value, and the recovery compressor 131 operates again. The working cycle above is repeated.

**[0030]** If the system stops working, i.e., the compressor of the refrigeration loop 200 stops operating, at the moment, the refrigerant does not need to be recovered, and the recovery compressor 131 in the recovery flow passage 130 should be directly stopped.

**[0031]** The examples above mainly illustrate the carbon dioxide refrigeration system and the control method thereof provided by the present invention. Although only some implementation modes of the present invention are described, those skilled in the art should understand that the present invention may be implemented in various other forms without departure from the scope of the present invention. Therefore, the shown examples and implementation modes are intended to be exemplary rather than restrictive, and without departure from the scope of the present invention as defined in the appended claims, the present invention may cover various modifications and replacements.

## Claims

**1.** A carbon dioxide refrigeration system, comprising:

a refrigeration loop (200), which comprises: a compressor (210), a condenser (220), a throttling element (230) and an evaporator (240) which are connected by pipelines, wherein a high-pressure side flow passage of the refrigeration loop is formed from the downstream of the compressor to the upstream of the throttling element, and a low-pressure side flow passage of the refrigeration loop is formed from the downstream of the throttling element to the upstream of the compressor; and

a pressure relief and recovery loop (100), which comprises:

a gas storage reservoir (110), for storing gas-phase carbon dioxide;

a pressure relief flow passage (120), connecting the gas storage reservoir and the refrigeration loop and being suitable for discharging the gas-phase carbon dioxide in the refrigeration loop into the gas storage reservoir; and

a recovery flow passage (130), connecting the gas storage reservoir and the refrigeration loop and provided with a driving apparatus (131), the recovery flow passage being suitable for recovering the gas-phase carbon dioxide in the gas storage reservoir into the refrigeration loop under the drive of the driving apparatus;

**characterized in that** the pressure relief flow passage (120) connects the gas storage reservoir (110) and the high-pressure side flow passage of the refrigeration loop (200); and the pressure relief flow passage (120) connects the gas storage reservoir (110) and the low-pressure side flow passage of the refrigeration loop (200).

**2.** The carbon dioxide refrigeration system according to claim 1, **characterized in that** the pressure relief flow passage (120) connects the gas storage reservoir (110) and a flow passage between the condenser (220) and the throttling element (230) of the refrigeration loop (200); or the pressure relief flow passage connects the gas storage reservoir and a flow passage between the condenser and the compressor of the refrigeration loop.

**3.** The carbon dioxide refrigeration system according to claim 1, **characterized in that** the pressure relief flow passage (120) connects the gas storage reservoir (110) and a flow passage between the evaporator (240) and the compressor (210) of the refrigeration loop (200); or the pressure relief flow passage connects the gas storage reservoir and a flow passage between the evaporator and the throttling element (230) of the refrigeration loop.

**4.** The carbon dioxide refrigeration system according to claim 1, **characterized in that** the recovery flow passage (130) connects the gas storage reservoir (110) and the low-pressure side flow passage of the refrigeration loop (200).

**5.** The carbon dioxide refrigeration system according to claim 4, **characterized in that** the recovery flow passage (130) connects the gas storage reservoir (110) and the flow passage between the evaporator (240) and the compressor (210) of the refrigeration loop (200).

**6.** The carbon dioxide refrigeration system according to claim 1, **characterized in that** the refrigeration loop (200) further comprises a gas-liquid separator (250) arranged between the evaporator (240) and the compressor (210); and the recovery flow passage connects the gas storage reservoir (110) and a flow passage between the evaporator and the gas-liquid separator of the refrigeration loop.

**7.** The carbon dioxide refrigeration system according to any one of claims to 6, **characterized in that** an electromagnetic valve (123, 124) for controlling on-off of the flow passage is arranged on the pressure relief flow passage (120).

**8.** The carbon dioxide refrigeration system according to any one of claims 1 to 6, **characterized in that** a check valve (132) for preventing backflow is arranged on the recovery flow passage (130).

**9.** A control method of the carbon dioxide refrigeration system according to any one of claims 1 to 8, comprising:
a pressure relief control step S100, which comprises:

a switch-on step S110: when a pressure of the high-pressure side flow passage is not smaller than a first preset pressure, and when a pressure of the low-pressure side flow passage is not smaller than a third preset pressure, switching on the pressure relief flow passage (120);
a switch-off step S120: when the pressure of the high-pressure side flow passage is not greater than a second preset pressure, and when the pressure of the low-pressure side flow passage is not greater than a fourth preset pressure, switching off the pressure relief flow passage (120); and
a maintenance step S130: when the pressure of the high-pressure side flow passage is smaller than the first preset pressure and greater than the second preset pressure, and when the pressure of the low-pressure side flow passage is smaller than the third preset pressure and greater than the fourth preset pressure, maintaining a current on/off state of the pressure relief flow passage (120); and/or
a refrigerant recovery control step S200, which comprises:

S210: when the compressor (210) of the refrigeration loop (200) operates and a pressure of the gas storage reservoir (110) is not smaller than a fifth preset pressure, operating the driving apparatus (131) in the recovery flow passage (130);
S220: when the pressure of the gas storage reservoir (110) is not greater than a sixth preset pressure, stopping the driving apparatus (131) in the recovery flow passage (130);
S230: when the pressure of the gas storage reservoir (110) is greater than the sixth preset pressure and smaller than the fifth preset pressure, maintaining a current working state of the driving apparatus (131); and
S240: when the compressor (210) of the refrigeration loop (200) stops operating, stopping the driving apparatus (131) in the recovery flow passage (130).

**Patentansprüche**

**1.** Kohlendioxid-Kühlsystem, umfassend:

eine Kühlschleife (200), die umfasst: einen Kompressor (210), einen Kondensator (220), ein Drosselelement (230) und einen Verdampfer (240), die durch Rohrleitungen verbunden sind, wobei ein hochdruckseitiger Stromdurchlass der Kühlschleife von der stromabwärtigen Seite des Kompressors zur stromaufwärtigen Seite des Drosselelements ausgebildet ist, und ein niederdruckseitiger Stromdurchlass der Kühlschleife von der stromabwärtigen Seite des Drosselelements zur stromaufwärtigen Seite des Kompressors ausgebildet ist; und
eine Druckentlastungs- und Rückgewinnungsschleife (100), die umfasst:

einen Gasspeicherbehälter (110) zur Speicherung von Gasphasen-Kohlendioxid;
einen Druckentlastungsstromdurchlass (120), der den Gasspeicherbehälter und die Kühlschleife verbindet und der geeignet ist, das Gasphasen-Kohlendioxid in der Kühlschleife in den Gasspeicherbehälter abzuführen; und
einen Rückgewinnungsstromdurchlass (130), der den Gasspeicherbehälter und die Kühlschleife verbindet und mit einer Antriebseinrichtung (131) versehen ist, wobei der Rückgewinnungsstromdurchlass geeignet ist, das Gasphasen-Kohlendioxid im Gasspeicherbehälter unter dem Antrieb der Antriebseinrichtung in die Kühlschleife zurückzugewinnen;
**dadurch gekennzeichnet, dass** der Druckentlastungsstromdurchlass (120) den Gasspeicherbehälter (110) und den hochdruckseitigen Stromdurchlass der Kühlschleife (200) verbindet; und der Druckentlastungsstromdurchlass (120) den Gasspeicherbehälter (110) und den niederdruckseitigen Stromdurchlass der Kühlschleife (200) verbindet.

**2.** Kohlendioxid-Kühlsystem nach Anspruch 1, **dadurch gekennzeichnet, dass** der Druckentlastungsstromdurchlass (120) den Gasspeicherbehälter (110) und einen Stromdurchlass zwischen dem Kondensator (220) und dem Drosselelement (230) der Kühlschleife (200) verbindet; oder der Druckentlastungsstromdurchlass den Gasspeicherbehälter und einen Stromdurchlass zwischen dem Kondensator und dem Kompressor der Kühlschleife verbindet.

**3.** Kohlendioxid-Kühlsystem nach Anspruch 1, **da-**

**durch gekennzeichnet, dass** der Druckentlastungsstromdurchlass (120) den Gasspeicherbehälter (110) und einen Stromdurchlass zwischen dem Verdampfer (240) und dem Kompressor (210) der Kühlschleife (200) verbindet; oder der Druckentlastungsstromdurchlass den Gasspeicherbehälter und einen Stromdurchlass zwischen dem Verdampfer und dem Drosselelement (230) der Kühlschleife verbindet.

4. Kohlendioxid-Kühlsystem nach Anspruch 1, **dadurch gekennzeichnet, dass** der Rückgewinnungsstromdurchlass (130) den Gasspeicherbehälter (110) und den niederdruckseitigen Stromdurchlass der Kühlschleife (200) verbindet.

5. Kohlendioxid-Kühlsystem nach Anspruch 4, **dadurch gekennzeichnet, dass** der Rückgewinnungsstromdurchlass (130) den Gasspeicherbehälter (110) und den Stromdurchlass zwischen dem Verdampfer (240) und dem Kompressor (210) der Kühlschleife (200) verbindet.

6. Kohlendioxid-Kühlsystem nach Anspruch 1, **dadurch gekennzeichnet, dass** die Kühlschleife (200) weiter einen Gas-Flüssigkeits-Abscheider (250) umfasst, der zwischen dem Verdampfer (240) und dem Kompressor (210) angeordnet ist; und dass der Rückgewinnungsstromdurchlass den Gasspeicherbehälter (110) und einen Stromdurchlass zwischen dem Verdampfer und dem Gas-Flüssigkeits-Abscheider der Kühlschleife verbindet.

7. Kohlendioxid-Kühlsystem nach einem der Ansprüche 1 bis 6, **dadurch gekennzeichnet, dass** am Druckentlastungsstromdurchlass (120) ein elektromagnetisches Ventil (123, 124) zum Steuern des Ein- und Ausschaltens des Stromdurchlasses angeordnet ist.

8. Kohlendioxid-Kühlsystem nach einem der Ansprüche 1 bis 6, **dadurch gekennzeichnet, dass** am Rückgewinnungsstromdurchlass (130) ein Rückschlagventil (132) zur Verhinderung des Rückflusses angeordnet ist.

9. Steuerungsverfahren für das Kohlendioxid-Kühlsystem nach einem der Ansprüche 1 bis 8, umfassend: einen Druckentlastungssteuerungsschritt S100, der umfasst:

einen Einschaltschritt S110: wenn ein Druck des hochdruckseitigen Stromdurchlasses nicht kleiner als ein erster voreingestellter Druck ist, und wenn ein Druck des niederdruckseitigen Stromdurchlasses nicht kleiner als ein dritter voreingestellter Druck ist, Einschalten des Druckentlastungsstromdurchlasses (120);

einen Abschaltschritt S120: wenn der Druck des hochdruckseitigen Stromdurchlasses nicht größer als ein zweiter voreingestellter Druck ist, und wenn der Druck des niederdruckseitigen Stromdurchlasses nicht größer als ein vierter voreingestellter Druck ist, Abschalten des Druckentlastungsstromdurchlasses (120); und

einen Aufrechterhaltungsschritt S130: wenn der Druck des hochdruckseitigen Stromdurchlasses kleiner als der erste voreingestellte Druck und größer als der zweite voreingestellte Druck ist, und wenn der Druck des niederdruckseitigen Stromdurchlasses kleiner als der dritte voreingestellte Druck und größer als der vierte voreingestellte Druck ist, Aufrechterhalten eines aktuellen Ein/Aus-Zustands des Druckentlastungsstromdurchlasses (120); und/oder

einen Schritt S200 zur Steuerung der Kühlmittelrückgewinnung, der umfasst:

S210: wenn der Kompressor (210) der Kühlschleife (200) arbeitet und ein Druck des Gasspeicherbehälters (110) nicht kleiner als ein fünfter voreingestellter Druck ist, Betreiben der Antriebseinrichtung (131) im Rückgewinnungsstromdurchlass (130);

S220: wenn der Druck des Gasspeicherbehälters (110) nicht höher ist als ein sechster voreingestellter Druck, Stoppen der Antriebseinrichtung (131) im Rückgewinnungsstromdurchlass (130);

S230: wenn der Druck des Gasspeicherbehälters (110) größer als der sechste voreingestellte Druck und kleiner als der fünfte voreingestellte Druck ist, Aufrechterhalten eines aktuellen Arbeitszustands der Antriebseinrichtung (131); und

S240: wenn der Kompressor (210) der Kühlschleife (200) den Betrieb stoppt, Stoppen der Antriebseinrichtung (131) im Rückgewinnungsstromdurchlass (130).

**Revendications**

1. Système de réfrigération au dioxyde de carbone, comprenant :

une boucle de réfrigération (200) qui comprend : un compresseur (210), un condenseur (220), un élément d'étranglement (230) et un évaporateur (240) qui sont reliés par des tuyauteries, dans lequel un passage de flux côté haute pression de la boucle de réfrigération est formé de l'aval du compresseur à l'amont de l'élément d'étranglement, et un passage de flux côté basse pression de la boucle de réfrigération est formé de l'aval de l'élément d'étranglement à l'amont du

compresseur ; et
une boucle de récupération et de décharge de pression (100) qui comprend :

un réservoir de stockage de gaz (110), pour le stockage de dioxyde de carbone en phase gazeuse ;
un passage de flux de décharge de pression (120), reliant le réservoir de stockage de gaz et la boucle de réfrigération et étant adapté pour la décharge du dioxyde de carbone en phase gazeuse dans la boucle de réfrigération dans le réservoir de stockage de gaz ; et
un passage de flux de récupération (130), reliant le réservoir de stockage de gaz et la boucle de réfrigération et doté d'un appareil d'entraînement (131), le passage de flux de récupération étant adapté pour la récupération du dioxyde de carbone en phase gazeuse dans le réservoir de stockage de gaz dans la boucle de réfrigération sous l'entraînement de l'appareil d'entraînement ;
**caractérisé en ce que** le passage de flux de décharge de pression (120) relie le réservoir de stockage de gaz (110) et le passage de flux côté haute pression de la boucle de réfrigération (200) ; et le passage de flux de décharge de pression (120) relie le réservoir de stockage de gaz (110) et le passage de flux côté basse pression de la boucle de réfrigération (200).

**2.** Système de réfrigération au dioxyde de carbone selon la revendication 1, **caractérisé en ce que** le passage de flux de décharge de pression (120) relie le réservoir de stockage de gaz (110) et un passage de flux entre le condenseur (220) et l'élément d'étranglement (230) de la boucle de réfrigération (200) ; ou le passage de flux de décharge de pression relie le réservoir de stockage de gaz et un passage de flux entre le condenseur et le compresseur de la boucle de réfrigération.

**3.** Système de réfrigération au dioxyde de carbone selon la revendication 1, **caractérisé en ce que** le passage de flux de décharge de pression (120) relie le réservoir de stockage de gaz (110) et un passage de flux entre l'évaporateur (240) et le compresseur (210) de la boucle de réfrigération (200) ; ou le passage de flux de décharge de pression relie le réservoir de stockage de gaz et un passage de flux entre l'évaporateur et l'élément d'étranglement (230) de la boucle de réfrigération.

**4.** Système de réfrigération au dioxyde de carbone selon la revendication 1, **caractérisé en ce que** le passage de flux de récupération (130) relie le réservoir de stockage de gaz (110) et le passage de flux côté basse pression de la boucle de réfrigération (200).

**5.** Système de réfrigération au dioxyde de carbone selon la revendication 4, **caractérisé en ce que** le passage de flux de récupération (130) relie le réservoir de stockage de gaz (110) et le passage de flux entre l'évaporateur (240) et le compresseur (210) de la boucle de réfrigération (200).

**6.** Système de réfrigération au dioxyde de carbone selon la revendication 1, **caractérisé en ce que** la boucle de réfrigération (200) comprend en outre un séparateur gaz-liquide (250) agencé entre l'évaporateur (240) et le compresseur (210) ; et le passage de flux de récupération relie le réservoir de stockage de gaz (110) et un passage de flux entre l'évaporateur et le séparateur gaz-liquide de la boucle de réfrigération.

**7.** Système de réfrigération au dioxyde de carbone selon l'une quelconque des revendications 1 à 6, **caractérisé en ce qu'**une valve électromagnétique (123, 124) pour la commande de l'activation/de la désactivation du passage de flux est agencée sur le passage de flux de décharge de pression (120).

**8.** Système de réfrigération au dioxyde de carbone selon l'une quelconque des revendications 1 à 6, **caractérisé en ce qu'**un clapet antiretour (132) pour empêcher un reflux est agencé sur le passage de flux de récupération (130).

**9.** Procédé de commande du système de réfrigération au dioxyde de carbone selon l'une quelconque des revendications 1 à 8, comprenant :
une étape de commande de décharge de pression S100 qui comprend :

une étape d'activation S110 : lorsqu'une pression du passage de flux côté haute pression n'est pas inférieure à une première pression prédéfinie, et lorsqu'une pression du passage de flux côté basse pression n'est pas inférieure à une troisième pression prédéfinie, l'activation du passage de flux de décharge de pression (120) ;
une étape de désactivation S120 : lorsque la pression du passage de flux côté haute pression n'est pas supérieure à une deuxième pression prédéfinie, et lorsque la pression du passage de flux côté basse pression n'est pas supérieure à une quatrième pression prédéfinie, la désactivation du passage de flux de décharge de pression (120) ; et
une étape de maintenance S130 : lorsque la pression du passage de flux côté haute pression est inférieure à la première pression prédéfinie et supérieure à la deuxième pression prédéfinie,

et lorsque la pression du passage de flux côté basse pression est inférieure à la troisième pression prédéfinie et supérieure à la quatrième pression prédéfinie, le maintien d'un état d'activation/de désactivation actuel du passage de flux de décharge de pression (120) ; et/ou
une étape de commande de récupération de réfrigérant S200 qui comprend :

S210: lorsque le compresseur (210) de la boucle de réfrigération (200) fonctionne et qu'une pression du réservoir de stockage de gaz (110) n'est pas inférieure à une cinquième pression prédéfinie, le fonctionnement de l'appareil d'entraînement (131) dans le passage de flux de récupération (130) ;
S220 : lorsque la pression du réservoir de stockage de gaz (110) n'est pas supérieure à une sixième pression prédéfinie, l'arrêt de l'appareil d'entraînement (131) dans le passage de flux de récupération (130) ;
S230 : lorsque la pression du réservoir de stockage de gaz (110) est supérieure à la sixième pression prédéfinie et inférieure à la cinquième pression prédéfinie, le maintien d'un état de travail actuel de l'appareil d'entraînement (131) ; et
S240 : lorsque le compresseur (210) de la boucle de réfrigération (200) arrête de fonctionner, l'arrêt de l'appareil d'entraînement (131) dans le passage de flux de récupération (130).

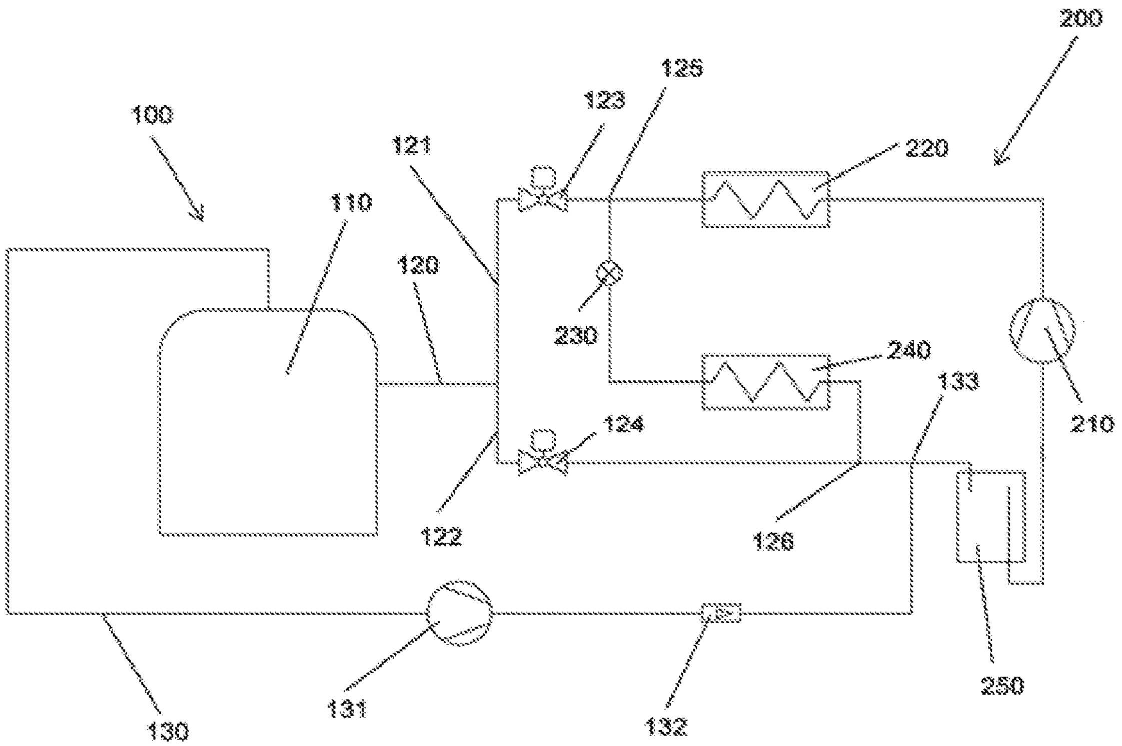
200
125
123
100
121
220
110
120
230
240
133
210
124
122
126
250
131
132
130

FIG. 1

## REFERENCES CITED IN THE DESCRIPTION

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### Patent documents cited in the description

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