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(54) **A COOLING DEVICE AND CONTROL METHOD**

KÜHLVORRICHTUNG UND STEUERVERFAHREN

DISPOSITIF DE REFROIDISSEMENT ET PROCEDE DE COMMANDE

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• **PATENT ABSTRACTS OF JAPAN vol. 2000, no.**
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Description

[0001] This invention relates to a cooling device that includes a cooling circuit which prevents the migration of refrigerant.

[0002] In cooling devices such as refrigerators and air conditioners, during the stop state of a compressor, refrigerant that is under high pressure inside the condenser moves towards the evaporator that has lower pressure; the refrigerant that reaches the evaporator and has a higher temperature rate generates additional cooling load. This process having generated a yield loss is termed as the migration of refrigerant. For this reason, for cooling systems, during the stop state of compressor, the path of refrigerant that moves towards the evaporator from the condenser is blocked; thus, migration of refrigerant is prevented; however, unless no other precaution is taken, until the pressure between the condenser and evaporator is brought to equilibrium, due to the high pressure difference between compressor suction and pumping parts, compressor start-up problem occurs at the beginning of operating period that is after the compressor stop state. In order to tackle the compressor start-up problem, although during start-up the equilibrium pressure environment is achieved with applications such as by-pass lines installed between the suction and pumping parts of the compressor, high current is drawn until a limit torque rate in the compressor during the initial seconds of the operating period, is attained.

[0003] In the United States patents US5088303 and US3722228 and European patent EP0060315, migration of refrigerant is prevented mechanically through the use of valves.

[0004] In the United States patents US4735054 and US4790142, migration of refrigerant is prevented by using an automatically controlled blocking valve in a two way operating heat pump, by initiating a reverse flow valve at the beginning of operating period, pressure between suction and pumping parts is brought to equilibrium and compressor start-up is facilitated.

[0005] In the United States Patent US5309728, migration of refrigerant is prevented in an air conditioner including multi evaporators and within a short period after equipment at the inner circuit is stopped, stop state of compressor is prolonged or the compressor is reverse operated and pressure is set to equilibrium by means of a by-pass line between the condenser and emission lines.

[0006] In the European Patent Application EP0692687, a solenoid valve is utilized at the inlet of capillary tube; thus, preventing the migration of refrigerant and a control mechanism that establishes the timing between the opening of the solenoid valve and operation of compressor is utilized.

[0007] The aim of this invention is to realize a cooling device that prevents migration of refrigerant that occurs in the stop state of a compressor and that enhances the compressor start-up at the beginning of operation period

that is right after the stop state period.

[0008] The cooling device realised in order to attain above mentioned aim of the invention is illustrated in the attached figures, where:

5 **[0009]** Fig 1 is a perspective representation of a cooling device,

[0010] Fig 2 is a schematic representation of a cooling circuit,

10 **[0011]** Fig 3 is a schematic representation of a cooling circuit at an alternative application of the invention.

[0012] The elements illustrated in the figures are numbered individually as follows.

[0013] 1. Cooling device

[0014] 2. Compressor

15 **[0015]** 3. Evaporator

[0016] 4. Condenser

[0017] 5. Capillary tube

[0018] 6, 16, 116 - Solenoid valve

[0019] 7, 17 - By-pass line

20 **[0020]** 8. Control mechanism

[0021] 9. Cooling circuit

[0022] Cooling circuit (9) that achieves the cooling cycle and that is utilized for cooling devices (1) such as refrigerators and air conditioners include a compressor (2); an evaporator (3) that sucks the thermal energy in the environment that is cooled; a condenser (4) that transfers the thermal energy to the outer environment; a capillary tube (5) that expands the refrigerant that leaves the condenser (4) and transfers the refrigerant to the evaporator (3); a preferably two way solenoid valve (6) that prevents migration of refrigerant by blocking the flow in the stop state of compressor (2) and that rests between the condenser (4) and the capillary tube (5); a solenoid valve that prevents reverse flow to the evaporator (3) during the stop state of compressor (2) and that is situated in the compressor (2) suction part; a by-pass line (7) that is located between the solenoid valve (6) and suction part of the compressor (2), that provides the refrigerant blocked during the stop state of the compressor (2) to flow towards the suction part of the compressor (2); thus, setting the equilibrium of the pressure in the suction and pumping parts of the compressor (2); a control mechanism (8) that controls the operation of solenoid valves (6, 16) and the compressor (2) (Figure 2).

35 **[0023]** The solenoid valve (6) allows the cooling cycle to sustain by directing the flow towards the capillary tube during the operation period and diverts the flow towards the by-pass line (7) by blocking the flow that runs towards the capillary tube (5) during the compressor (2) stop state.

40 **[0024]** For the control method of the cooling device (1), in the stop state of the compressor (2), migration of refrigerant occurring towards the evaporator (3) from the condenser (4) is prevented by closing the outlet of capillary tube (5) of solenoid valve (6). At the same time, outlet of by-pass line (7) of the solenoid valve (6) opens up and by diverting the flow towards the suction part of the compressor (2), pressure between the suction and pumping parts of the compressor (2) is brought into equilibrium.

librium. Solenoid valve (16) that is situated at the suction part of the compressor (2) closes up and reverse flow to the evaporator (3) is prevented. When the compressor (2) is in operation mode, in order to sustain cooling cycle, capillary tube outlet of solenoid valve (6) opens up and by-pass line (7) outlet is blocked. If the solenoid valve (16) opens synchronously as the compressor (2) operates right at the operation period, pressure at the compressor (2) suction part decreases partially until a limit torque value which would achieve the compression function after the initial start-up, is reached and during the stop state although the pressure is brought to equilibrium, a pressure difference occurs between the two parts of the compressor (2); this pressure difference generates a high current during the initial start-up of the compressor (2). For the application being the subject of invention, when the compressor (2) switches from the operation period from the stop state, opening of solenoid valve (16) is delayed for a period that is the period between the initial start-up of the compressor (2) until the attainment of limit torque rate. Therefore; equilibrated pressure rates reserved in the compressor (2) stop state are sustained when the limit torque rate is achieved and by the moment that the compressor (2) pressing function is initiated by means of a by-pass line (7) and high current rates drawn by a compressor (2) during initial start-up is prevented.

[0025] At another application of the invention, the cooling circuit (9) includes a solenoid valve (6) that prevents migration of refrigerant by blocking the flow in the stop state of the compressor (2) and that is situated between the condenser (4) and capillary tube (5); a solenoid valve (16) that prevents reverse flow to the evaporator (3) in the compressor (2) stop state and that is installed at the suction part of the compressor (2); a by-pass line (17) that equilibrates the pressure when solenoid valve (6) is blocked in order to prevent migration of refrigerant and that is equipped between the suction and pumping parts of the compressor (2); a solenoid valve (116) that is designed on the by-pass line (17); and a control mechanism (8) that controls the operation of solenoid valves (6, 16, 116) and compressor (2) (Figure 3).

[0026] At the mentioned application of the invention, in the compressor (2) stop state, as soon as the solenoid valve (6) that is located between the condenser (4) and capillary tube (5) is blocked, solenoid valve (116) located on the by-pass line (17) opens up and allows for a flow in the direction that is opposite to the pumping direction; thus, pressure is equilibrated. Solenoid valve (16) located at the suction part of the compressor (2) prevents reverse flow to the evaporator (3) by closing. When compressor (2) switches to operation mode, in order to sustain cooling cycle, solenoid valve (6) that is between the capillary tube (5) and condenser (4) opens up and solenoid valve (116) located on the by-pass (17) line closes. Opening of solenoid valve (16) can be delayed by the control unit (8) for a period that is from the initial start-up of the compressor (2) until the attainment of limit torque rate. Therefore, equilibrated pressure rates reserved during the stop state

of the compressor (2) are preserved by the by-pass line (17) until the attainment of limit torque rate and compressor (2) realizes its pressing function and compressor's (2) drawing of high current rates is prevented.

[0027] The cooling device (1) being the subject of invention, migration of refrigerant that occurs during the stop state of the compressor (2) from the condenser (4) towards the evaporator (3) and that causes yield loss, is prevented; provided that the migration of refrigerant is prevented, pressure between the suction and pumping parts of the compressor (2) are equilibrated, easier start-up of the compressor (2) is achieved and during the initial start-up until the attainment of limit torque rate, drawing of high current rates by the compressor (2) is prevented.

Claims

1. A cooling device (1) comprising;

- A cooling circuit (9) with;

- i. A compressor (2) that realizes the cooling cycle
- ii. An evaporator (3) that sucks the thermal energy in the environment that is cooled;
- iii. A condenser (4) that transfers the thermal energy to the outer environment;
- iv. A capillary tube (5) that expands the refrigerant that leaves the condenser (4) and transfers the refrigerant to the evaporator (3);
- v. A solenoid valve (6) that controls the flow of the refrigerant and that rests between the condenser (4) and the capillary tube (5);
- vi. A by-pass line (7, 17) that equilibrates pressure at the suction and pumping parts of the compressor (2)

And characterized in that

- the cooling circuit (9) comprises

- i. A solenoid valve (16) that prevents the reverse flow to the evaporator (3) during the stop state of the compressor (2) and that is located at the suction part of the compressor (2);
- ii. A control mechanism (8) that delays the opening of solenoid valve (16), when the compressor (2) switches from the stop state to the operation mode, for a period that is the period between the initial start-up of the compressor (2) until the attainment of the limit torque rate.

2. A cooling device (1) as in Claim 1, characterized by;

- A cooling circuit (9) comprising;

i. A by-pass line (7) that is located between the solenoid valve (6) and suction part of the compressor (2) and that provides the refrigerant blocked during the stop state of the compressor (2) to flow towards the suction part of the compressor (2); thus, setting the equilibrium of the pressure in the suction and pumping parts of the compressor (2).

3. A cooling device (1) as in Claim 1, **characterized by**;

- A cooling circuit (9) comprising;

i. A by-pass line (17) that equilibrates the pressure when solenoid valve (6) is blocked in order to prevent migration of refrigerant and that is equipped between the suction and pumping parts of the compressor (2);
ii. A solenoid valve (116) that is designed on the by-pass line (17);

Patentansprüche

1. Kühlvorrichtung (1), umfassend:

- einen Kühlkreislauf (9) mit:

i. einem Kompressor (2), der den Kühlzyklus herstellt
ii. einem Verdampfer (3), der die Wärmeenergie aus der gekühlten Umgebung ansaugt;
iii. einem Kondensator (4), der die Wärmeenergie nach außen abführt;
iv. einem Kapillarrohr (5), das das Kühlmittel, das den Kondensator (4) verlässt, expandieren lässt und das Kühlmittel an den Verdampfer (3) leitet;
v. einem Magnetventil (6), das den Fluss des Kühlmittels steuert, und das zwischen dem Kondensator (4) und dem Kapillarrohr (5) angeordnet ist;
vi. einer Umgehungsleitung (7, 17), die den Druck an den Ansaug- und Pumpteilen des Kompressors (2) ausgleicht,

und **dadurch gekennzeichnet, dass**

- der Kühlkreislauf (9) Folgendes umfasst:

i. ein Magnetventil (16), das während des Stillstands des Kompressors (2) den Rückfluss zum Verdampfer (3) verhindert, und das am Ansaugteil des Kompressors (2) angeordnet ist;

ii. einen Steuermechanismus (8), der das Öffnen des Magnetventils (16) verzögert, wenn der Kompressor (2) aus dem Stillstand in den Betriebsmodus schaltet, und zwar für einen Zeitraum, bei dem es sich um den Zeitraum zwischen dem anfänglichen Start des Kompressors (2) und dem Erreichen des Grenzdrehmoments handelt.

2. Kühlvorrichtung (1) nach Anspruch 1, **gekennzeichnet durch**:

- einen Kühlkreislauf (9), der Folgendes umfasst:

i. eine Umgehungsleitung (7), die zwischen dem Magnetventil (6) und dem Ansaugteil des Kompressors (2) angeordnet ist, und die vorsieht, das Kühlmittel, das während des Stillstands des Kompressors (2) blockiert ist, zum Ansaugteil des Kompressors (2) fließen zu lassen, wodurch an den Ansaug- und Pumpenteilen des Kompressors (2) ein Druckausgleich hergestellt wird.

3. Kühlvorrichtung (1) nach Anspruch 1, **gekennzeichnet durch**:

- einen Kühlkreislauf (9), der Folgendes umfasst:

i. eine Umgehungsleitung (17), die den Druck ausgleicht, wenn das Magnetventil (6) blockiert ist, um zu verhindern, dass Kühlmittel weiterfließt, und die zwischen dem Ansaug- und dem Pumpenteil des Kompressors (2) angeordnet ist;
ii. ein Magnetventil (116), das an der Umgehungsleitung (17) vorgesehen ist.

Revendications

1. Un dispositif de refroidissement (1) comprenant;

- Un circuit de refroidissement (9) avec ;

i. Un compresseur (2) qui réalise le cycle de refroidissement
ii. Un évaporateur (3) qui aspire l'énergie thermique dans l'environnement qui est refroidi
iii. Un condenseur (4) qui transfère l'énergie thermique à l'environnement extérieur ;
iv. Un tube capillaire (5) qui dilate le réfrigérant qui sorti du condenseur (4) et transfère le réfrigérant à l'évaporateur (3) ;
v. Une électrovanne (6) qui contrôle l'écou-

lement du réfrigérant et qui se situe entre le condenseur (4) et le tube capillaire (5) ;
vi. Un conduit by-pass (7, 17) qui équilibre la pression aux parties d'aspiration et pompage du compresseur (2)

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Et caractérisé en ce que

- le circuit de refroidissement (9) comprenant;

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i. Une électrovanne (16) qui empêche l'écoulement inverse à l'évaporateur (3) pendant l'état d'arrêt du compresseur (2) et qui est située à la partie d'aspiration du compresseur (2) ;

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ii. Un mécanisme de contrôle (8) qui retarde l'ouverture de l'électrovanne (16), lorsque le compresseur (2) passe de l'état d'arrêt à l'état de marche, pour une période qui est la période du démarrage initial du compresseur (2) et jusqu'à atteindre le taux de couple limite.

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2. Un dispositif de refroidissement (1) selon la Revendication 1, **caractérisé par:**

25

- Un circuit de refroidissement (9) comprenant ;

i. Un conduit by-pass (7) qui est situé entre l'électrovanne (6) et la partie d'aspiration du compresseur (2) et qui permet au réfrigérant bloqué pendant l'état d'arrêt du compresseur (2) d'écouler vers la partie d'aspiration du compresseur (2), ainsi réglant l'équilibre de la pression des parties d'aspiration et pompage du compresseur (2).

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3. Un dispositif de refroidissement (1) selon la Revendication 1, **caractérisé par;**

40

- Un circuit de refroidissement (9) comprenant ;

i. Un conduit by-pass (17) qui équilibre la pression lorsque l'électrovanne (6) est bloquée afin d'empêcher le déplacement du réfrigérant et qui est disposé entre les parties d'aspiration et pompage du compresseur (2) ;

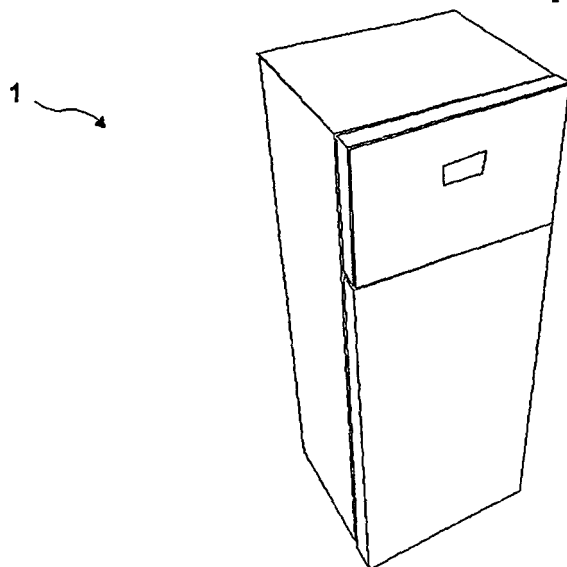
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ii. Une électrovanne (116) qui est désignée sur le conduit by-pass (17).

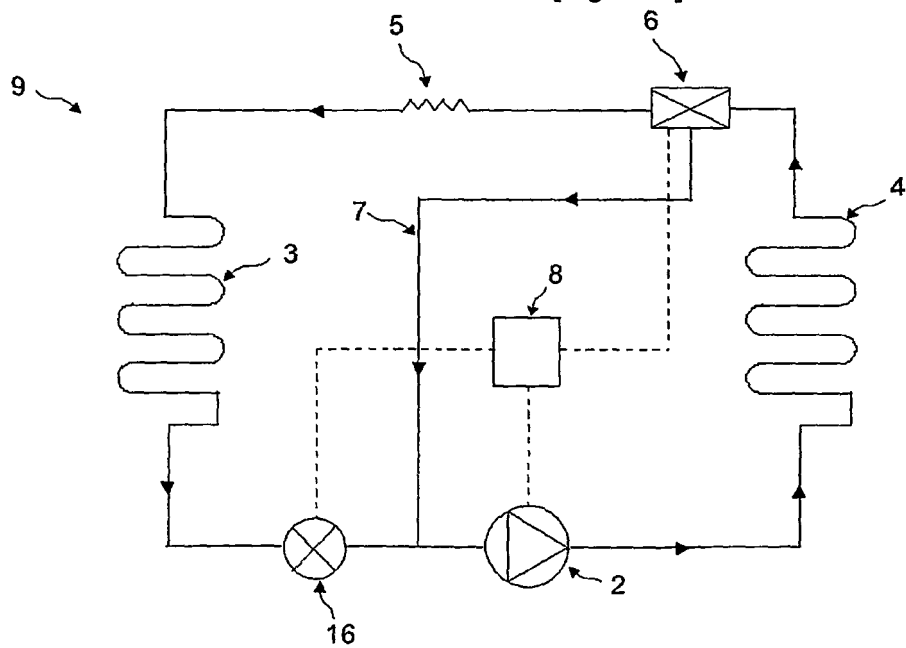
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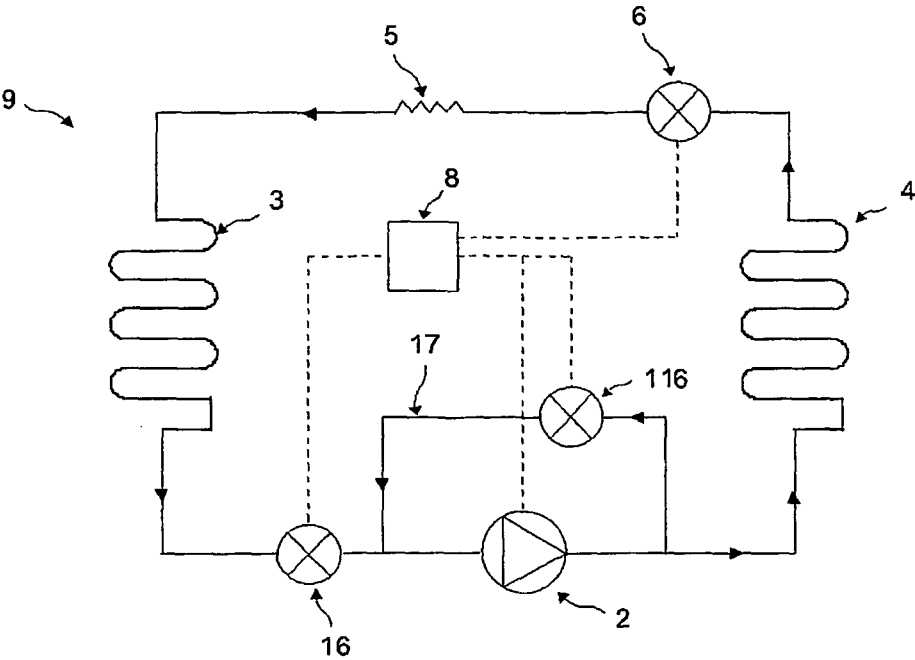
[Fig. 001]



[Fig. 002]



[Fig. 003]



REFERENCES CITED IN THE DESCRIPTION

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