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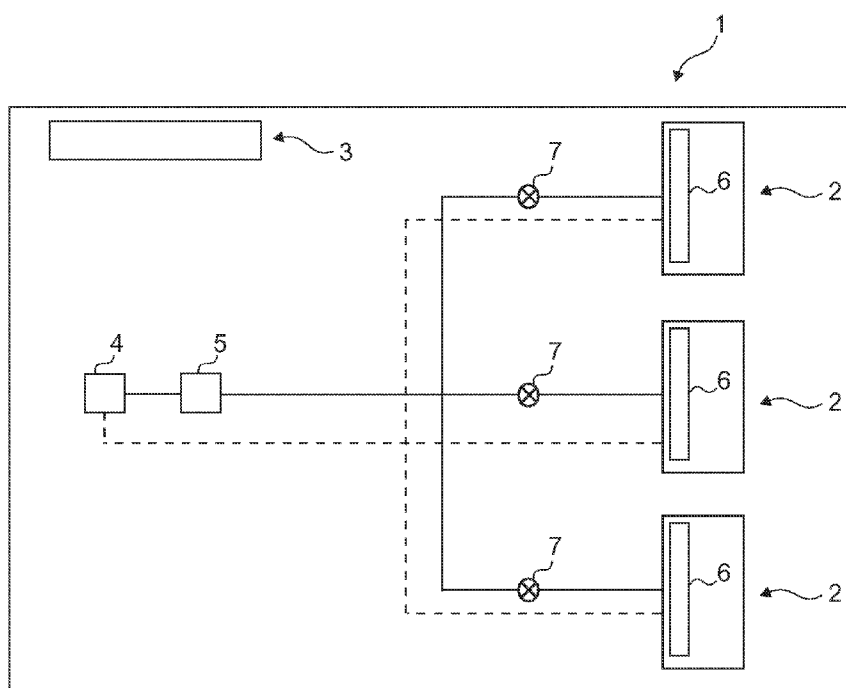
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(54) Title: A COOLING DEVICE



(57) Abstract: This invention relates to a cooling device wherein it is accomplished that the life-span of the compressor is increased and thus the refrigeration cycle is performed in a more effective manner as oil accumulated in the refrigeration cycle is regained by the compressor by performing an oil return procedure.

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Description

A COOLING DEVICE

- [1] This invention relates to a cooling device wherein means are provided to improve the oil circulating in refrigeration cycle.
- [2] In cooling devices, the refrigerant fluid circulating in refrigeration cycle is in superheated vapor phase while leaving the compressor. The refrigerant fluid leaving the compressor in superheated vapor phase, transforms into liquid – vapor phase in condenser and eventually into liquid phase in the neighborhood of capillary pipe inlet. Along the capillary pipe, as pressure drops, the fluid starts to transform into liquid – vapor phase again and reaches the evaporator in liquid – vapor phase with a low level of dryness. The refrigerant fluid transformed into vapor phase under the effect of the heat drawn from the environment, reaches the compressor again.
- [3] Inside the compressor utilized in the refrigeration cycle, there is provided a certain amount of oil whereby moveable parts are protected against high temperature effects and gas leakage from the suction and pump cavities is prevented. While the compressor pumps the refrigerant fluid into the system, certain amount of oil leaks to the refrigeration cycle, as mixed with the refrigerant fluid. Part of the oil leaked to the refrigeration cycle is plastered onto the internal surfaces of the condenser and the evaporator and part of it accumulates at sections where the temperature is relatively low and thus the viscosity is high, especially at the outlet sections and/or final bending forms of the evaporator. The movement of the oil is mostly affected by viscosity change. The higher the refrigerant fluid viscosity, the more difficult the oil returns to the compressor. The most effective factor enabling the movement of the oil at the mentioned sections towards the compressor is the sweep rate of the refrigerant fluid since it has transformed into vapor phase. The higher the sweep rate, the easier the return of the oil accumulated in the refrigeration cycle to the compressor.
- [4] One of the most effective reasons of the problems related with returning the oil in the refrigeration cycle back to the compressor stems from the operating principle of the refrigeration cycle. Particularly in cooling systems utilizing a parallel evaporator, some of the cooling compartments are not activated for a considerably long period of time, while some are activated once in a while, the compressor being operated at low revolutions in case the refrigeration load is relatively small. In cooling compartments which are not activated for longer period of time or activated for a relatively shorter period of time and/or in such cases where the refrigerant fluid could not attain an adequate sweep rate as a result of the compressor being operated at lower revolutions, the oil passing together with refrigerant fluid accumulates inside the refrigeration cycle, especially in evaporator bending forms and return line.

- [5] As the amount of the oil leaked to the refrigeration cycle increases, the oil inside the compressor decreases, resulting a decrease of compressor performance.
- [6] Several methods are developed in order to regain the oil leaked into the refrigeration cycle to the compressor.
- [7] In the current state of the art, in Japanese Patent Applications JP 51121843 and JP 63198788, a description is given of an embodiment wherein the oil accumulated in the refrigeration cycle is returned back to the compressor by operating the compressor at a higher capacity, said compressor having been operated at a lower capacity for a certain period of time.
- [8] Another document in the current state of the art is the Japanese Patent Application JP2004-308925 wherein a description is given of an embodiment developed to regain the oil back to the compressor by changing the operation speed of the compressor according to the flow rate of the fluid in refrigeration cycle.
- [9] Another document in the current state of the art is the United States Patent Document US 6675595 wherein a description is given of an embodiment developed to return the oil back to the compressor by operating the compressor for separated time intervals for a certain period of time just after the instant where the flow rate of the fluid in the refrigeration cycle drops below a certain level.
- [10] The aim of the present invention is the realization of a cooling device wherein means are provided to effectively regain the oil accumulated inside the refrigeration cycle to the compressor.
- [11] In the cooling device designed to fulfill the objectives of the present invention and described in the first claim and the other claims related with this claim, an oil return procedure is performed wherein the compressor is operated at a higher revolution by opening one or more than one valve, in case the compressor has been operated below a certain revolution and the specified time where a valve is to stay open decreases below a certain value or closed increases above a certain value, said valve being utilized to permit the refrigerant fluid flow to an evaporator comprised by any of the cooling compartments. Thereby, it is accomplished that, by means of the force applied by the refrigerant fluid having a certain sweep rate attained as a consequence of the compressor being operated at a predetermined high revolution, the oil accumulated inside the refrigeration cycle because of inadequate sweep rate is mixed with the refrigerant fluid and transferred back to the compressor.
- [12] Furthermore, it is also achieved that oil is regained to the compressor as the possibility of oil accumulation in the refrigeration cycle is eliminated by performing oil return procedure in such cases as the specified time where the valve is to stay open decreases below a certain value or closed increases above a certain value, where the possibility of oil accumulation inside the refrigeration cycle is high.

[13] By means of the present invention, it is accomplished that the life span of the compressor is increased and that the refrigeration cycle is performed in a more effective manner as oil accumulated in the refrigeration cycle is regained to the compressor by performing oil return procedure. Moreover, prevented is the effect of the oil accumulated inside the refrigeration cycle, particularly inside the evaporators, reducing the heat transfer between the refrigerant fluid and the external medium.

[14] The cooling device designed to fulfill the objectives of the present invention is illustrated on the attached figures where:

[15] Fig.1 – is a schematic view of a cooling device.

[16] Elements shown on figures are numbered as follows:

[17] 1. Cooling device

[18] 2. Compartment

[19] 3. Control unit

[20] 4. Compressor

[21] 5. Condenser

[22] 6. Evaporator

[23] 7. Valve

[24] The cooling device (1) in accordance with the present invention comprises a compressor (4) used to pressurize the refrigerant fluid, a condenser (5) whereby the refrigerant fluid leaving the compressor (4) in superheated vapor phase is first condensed and transformed to liquid – vapor phase and then to completely liquid phase, one or more than one compartment (2) where items to be cooled are placed into and which incorporates one or more than one evaporator (6) whereby its environment is cooled as heat is absorbed by the refrigerant fluid circulating there inside, one or more than one valve (7) positioned between the condenser (5) and the evaporator (6), controlling the transfer of the refrigerant fluid to the evaporator (6) and, a control unit (3) used to control the open and closed time periods of each valve (Figure 1).

[25] When the compressor (4) is operated below a certain revolution and the specified time where one or more than one valve (7) is to stay open decreases below a certain period of time or

[26] - when the specified time where one or more than one valve (7) is to stay closed increases above a certain period of time,

[27] in order to improve the circulating of the oil accumulated inside the refrigeration cycle, the control unit (3) realizes the oil return procedure wherein one or more than one valve (7) is opened and the compressor (4) is started to operate at a predetermined revolution for a predetermined period of time.

[28] By performing the oil return procedure, it is achieved that, by means of the force applied by the refrigerant fluid having a certain desired sweep rate attained as a

consequence of the compressor (4) being operated at a predetermined high revolution, the oil accumulated inside the refrigeration cycle because of inadequate sweep rate, is mixed with the refrigerant fluid and transferred back to the compressor (4).

[29] In the preferred embodiment of the present invention, a variable speed compressor (4) is preferably utilized, said compressor (4) being used to circulate the refrigerant fluid in the refrigeration cycle by operating at four different revolutions such as 1700, 2500, 3200, 4000 rpm. The temperatures of each compartment (2) is checked by the control unit (3) and according to a predetermined order, refrigeration process is performed by varying the revolution of the compressor (4) depending on the situation of each compartment where their temperature is above or below a certain temperature value. Unless the refrigeration process applied for one compartment (2) is completed, it is not possible to continue with a refrigeration process defined for other compartments (2).

[30] In the cooling device (1) in accordance with present invention, it is checked whether the compressor (4) is operated below a certain revolution or not. If the compressor (4) is not operated below said certain revolution, regular operation steps are performed. If the compressor (4) is operated below this certain value, the specified time of each valve to stay open or closed is observed. If any of the valves (7) stayed closed for a longer period of time than the one predetermined by the manufacturer or if any of the valves (7) stayed open for a shorter period of time than the one predetermined by the manufacturer, oil return procedure is performed. If any of the aforementioned conditions is not satisfied, regular operation steps are performed.

[31] In another embodiment of the present invention, if the compressor (4) is operated below a certain revolution and the specified time of any of the valves (7) to stay open drops below a certain period of time, by means of the control unit (3) oil return procedure is performed by opening only the valve (7) meeting the condition. In that case, since the other compartments (2) do not satisfy the requirements, energy is saved. Furthermore, the afore-described procedure allows that oil return procedure is applied to the compartment (2) where the procedure is necessary, in its regular turn such that the continuity of refrigeration process in a predetermined order for the compartments (2) is not broken. For instance, if the compressor (4) is operated below 2500 rpm and the specified time of any of the valves (7) to stay open is less than two minutes, oil return procedure is performed by opening the mentioned valve (7) only.

[32] In another embodiment of the present invention, if the compressor (4) is operated below a certain revolution and the specified time of any of the valves (7) to stay open drops below a certain period of time, by means of the control unit (3) oil return procedure is performed by opening every valve (7) in a predetermined order.

[33] In another embodiment of the present invention, if the compressor (4) is operated

below a certain revolution and the total of the specified times of every valve (7) to stay open drops below a certain period of time, by means of the control unit (3) oil return procedure is performed by opening every valve (7) in a predetermined order.

[34] In another embodiment of the present invention, if the compressor (4) is operated below a certain revolution and the specified time of any of the valves (7) to stay closed exceeds a certain period of time, by means of the control unit (3) oil return procedure is performed by opening only the valve (7) satisfying the condition.

[35] In another embodiment of the present invention, a minimum compressor (4) revolution interval is defined for each compartment (2). Oil return procedure is performed if the compressor (4) is operated below the mentioned interval.

[36] By means of the present invention, it is accomplished that the life span of the compressor is increased and that the refrigeration cycle is performed in a more effective manner as oil accumulated in the refrigeration cycle is regained to the compressor by performing the oil return procedure. Moreover, prevented is the effect of the oil accumulated inside the refrigeration cycle, particularly inside the evaporators, reducing the heat transfer.

Claims

- [1] A cooling device (1) comprising
- a compressor (4) used to pressurize the refrigerant fluid,
 - a condenser (5) whereby the refrigerant fluid leaving the compressor (4) in superheated vapor phase is first condensed and transformed to liquid – vapor phase and then to completely liquid phase,
 - one or more than one compartment (2) where items to be cooled are placed into and which incorporates one or more than one evaporator (6) whereby its environment is cooled as heat is absorbed by the refrigerant fluid circulating there inside,
 - one or more than one valve (7) positioned between the condenser (5) and the evaporator (6), controlling the transfer of the refrigerant fluid to the evaporator (6) and,
- characterized by a control unit (3) which
- realizes an oil return procedure in order to improve the circulation of the oil accumulated inside the refrigeration cycle, wherein one or more than one valve (7) is opened and the compressor (4) is started to operate at a predetermined revolution for a predetermined period of time,
 - when the compressor (4) is operated below a certain revolution and the specified time where one or more than one valve (7) is to stay open decreases below a certain period of time or
 - when the specified time where one or more than one valve (7) is to stay closed increases above a certain period of time.
- [2] A cooling device (1) as described in Claim 1, characterized by a control unit (3) which realizes the oil return procedure when the compressor (4) is operated below a certain revolution and the specified time of one more than one valve (7) to stay open drops below a certain period of time.
- [3] A cooling device (1) as described in Claims 1 or 2, characterized by a control unit (3) which realizes the oil return procedure when the compressor (4) is operated below a certain revolution and the specified time of one more than one valve (7) to stay closed exceeds a certain period of time.
- [4] A cooling device (1) as described in Claims 1 or 2, characterized by a control unit (3) which realizes the oil return procedure when the specified time of any of the valves (7) to stay open drops below a certain period of time by opening only the valve (7) satisfying the condition.
- [5] A cooling device (1) as described in Claims 1 or 2, characterized by a control unit (3) which realizes the oil return procedure when the specified time of any of

the valves (7) to stay open drops below a certain period of time by opening every valve (7) in a predetermined order.

[6] A cooling device (1) as described in Claims 1 or 2, characterized by a control unit (3) which realizes the oil return procedure when the total specified time of every valves (7) to stay open drops below a certain period of time by opening every valve (7) in a predetermined order.

[7] A cooling device (1) as described in Claims 1 or 3, characterized by a control unit (3) which realizes the oil return procedure when the specified time of any of the valves (7) to stay closed exceeds a certain period of time by opening only the valve (7) satisfying the condition.

[8] A cooling device (1) as described in any of the above Claims, characterized by a control unit (3) which realizes the oil return procedure when the compressor (4) is operated below the minimum compressor (4) revolution defined for each compartment (2).

Figure 1

