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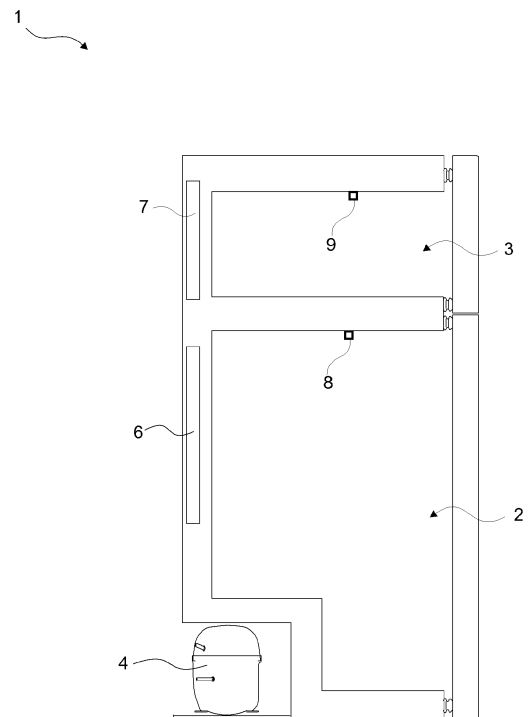
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(54) **A COOLING DEVICE WITH IMPROVED REFRIGERATION PERFORMANCE**

(57) The present invention relates to a cooling device (1) comprising a fresh food compartment (2) wherein foodstuffs are placed to be cooled; a freezing compartment (3) kept at lower temperatures than the fresh food compartment (2) and wherein the foodstuffs are placed to be frozen; a compressor (4) that provides the compression of the refrigerant fluid; a condenser (5) that enables the refrigerant fluid leaving the compressor (4) to be condensed and changed to liquid phase; at least one fresh food compartment evaporator (6) which provides the cooling of the fresh food compartment (2) by enabling heat transfer between the refrigerant fluid and the environment; at least one freezing compartment evaporator (7) which provides the cooling of the freezing compartment (3) by enabling heat transfer between the refrigerant fluid and the environment; a first temperature sensor (8) which measures the temperature of the fresh food compartment (2) for the control of the cooling process, and a second temperature sensor (9) which measures the temperature of the freezing compartment (3) for the control of the freezing process.

Figure 1



Description

[0001] The present invention relates to a cooling device the refrigeration performance of which is improved by controlling the refrigerant circulation.

[0002] In the cooling devices, circulation of the refrigeration cycle fluid used through the units composed of the compressor, the condenser, the capillary tubes and the evaporator makes up the refrigeration cycle. Especially in the cooling devices composed of fresh food and freezing compartments and comprising evaporators connected in parallel in both compartments thereof, the refrigerant fluid is directed by means of valve to one of the compartments. The refrigerant fluid is directed to the evaporator in the compartment where the thermal load has increased and the compartment is cooled by means of the evaporator and the thermal load built up in the compartment is discharged by means of the condenser to the outer environment. After leaving the evaporator in the respective compartment, the refrigerant fluid recirculates the entire refrigeration cycle so as to be cooled again and then directed to the other compartment. The thermal loads occurring in the compartments differ depending on the design and use of the cooling device, in which case the refrigeration cycle cannot meet the thermal load occurring in the compartments efficiently.

[0003] In the state of the art United States Patent Application No. US2010095691A1, a cooling device comprising parallel connected evaporators in the cooling and freezing compartments thereof is disclosed.

[0004] The aim of the present invention is to realize a cooling device of which the refrigeration performance is improved by controlling the condenser capacity according to the temperature value measured inside the compartment.

[0005] The cooling device realized in order to attain the aim of the present invention explicated in the first claim and the respective claims thereof comprises a fresh food compartment; a freezing compartment; a compressor enabling the refrigeration cycle to be carried out; a condenser enabling the refrigerant fluid leaving the compressor as superheated steam to be condensed and to be changed to liquid phase; at least one fresh food compartment evaporator that enables the fresh food compartment to be cooled; at least one freezing compartment evaporator that enables the freezing compartment to be cooled; a first temperature sensor that measures the temperature inside the fresh food compartment; a second temperature sensor that measures the temperature inside the freezing compartment; a first valve located at the outlet of the condenser, and a control unit that enables the refrigerant fluid leaving the condenser to be directed through the first valve to the fresh food compartment evaporator and/or the freezing compartment evaporator by analyzing the data from the first temperature sensor and the second temperature sensor. The condenser is preferably a mini-channel heat exchanger.

[0006] The cooling device (1) of the present invention

comprises

- the condenser comprising a first condenser line extending to the first valve and a second condenser line to which the refrigerant fluid from the first valve is transmitted, and
- the control unit that enables the refrigerant fluid to be directed from the first valve to the fresh food compartment evaporator, the freezing compartment evaporator or the second condenser line depending on the data received from the first temperature sensor and the second temperature sensor. The control unit evaluates the data from the first temperature sensor and the second temperature sensor to determine the thermal load and if the thermal load is high, directs the refrigerant fluid to the second condenser line. If the thermal load in the compartments is low, the control unit detects the compartment where the thermal load has increased and directs the refrigerating fluid to the evaporator of the respective compartment without circulating the same through the second condenser line. Thus, the refrigerant fluid is enabled to be passed through the first condenser line only and directed to the compartments. Thus, the refrigeration cycle is shortened so that the refrigerant fluid is transmitted to the evaporators faster. Thus, the performance of the refrigeration cycle is improved. Moreover, in case that the refrigerant fluid is passed through the first condenser line only, the amount of load occurring in the compressor is reduced.

[0007] In an embodiment of the present invention, the control unit

- compares the temperature of the fresh food compartment detected by the first temperature sensor with the fresh food compartment limit temperature predetermined by the producer, and
- compares the temperature of the freezing compartment detected by the second temperature sensor with the freezing compartment limit temperature predetermined by the producer. If the temperature measured inside the compartments is greater than the limit temperature of the respective compartment, the control unit enables transmission of the refrigerant fluid to the evaporator of the respective compartment to cool down the respective compartment. Thus, the compartment with increased thermal load can be detected by evaluating the temperatures of the compartments, and by providing the cooling of the detected compartment, the foodstuffs in the relevant compartment are prevented from spoiling.

[0008] In another embodiment of the present invention, the control unit

- compares the temperature of the fresh food com-

- partment detected by the first temperature sensor with the critical temperature of the fresh food compartment predetermined by the producer, and
- compares the temperature of the freezing compartment detected by the second temperature sensor with the critical temperature of the freezing compartment as predetermined by the producer. When the thermal load occurring inside the fresh food compartment and the freezing compartment has increased excessively, inner temperatures of the compartments exceed the compartment limit temperatures, reaching the compartment critical temperatures higher than the limit temperatures at which point the food stuff inside the compartment begin to spoil. In this case, the control unit enables the refrigerant fluid leaving the first condenser line to be passed through the second condenser line as well. When the refrigerant fluid is passed through the second condenser line, the amount of heat discharged to the outer environment increases and thus excessive heat load occurred in the fresh food compartment or the freezing compartment is discharged to the outer environment.

[0009] In another embodiment of the present invention, the cooling device comprises a second valve at the outlet of the second condenser line. The second valve is preferably a three-way solenoid valve.

[0010] In another embodiment of the present invention, the control unit enables the refrigerant fluid to be directed from the second valve to the fresh food compartment evaporator or the freezing compartment evaporator depending on the data received from the first temperature sensor and the second temperature sensor. The control unit checks the temperatures of the fresh food department and the freezing department and if the temperature of the fresh food compartment is greater than the critical temperature of the fresh food compartment, the control unit enables the refrigerant fluid to be transmitted to the fresh food compartment evaporator and if the temperature of the freezing compartment is greater than the critical temperature of the freezing compartment, the control unit enables the refrigerant fluid to be transmitted to the freezing compartment evaporator. Thereby, it is ensured that the compartment where the thermal load is high, in which the food stuff run the risk of spoiling, is cooled in the first place efficiently.

[0011] In another embodiment of the present invention, the control unit enables the compressor to be stopped if the temperature of the fresh food compartment is lower than the limit temperature of the fresh food temperature and if the temperature of the freezing compartment is lower than the limit temperature of the freezing compartment, so that transmission of the refrigerant fluid is terminated. In case the fresh food compartment and the freezing compartment are sufficiently cooled, the control unit prevents unnecessary energy consumption by terminating the refrigeration cycle.

[0012] By means of the present invention, a cooling device is realized, wherein the refrigerant fluid is passed through only some part of the condenser and sent to the respective compartment when the refrigeration need in the compartments is low and thus the refrigeration need of the compartments is met faster. The temperatures inside the fresh food compartment and the freezing compartment are detected to determine the refrigeration need and if the refrigeration need in the compartments is low, the refrigerant fluid is passed only through the first condenser line of the condenser and directed to the fresh food compartment evaporator or the freezing compartment evaporator and if the refrigeration need in the compartments is high, the refrigerant fluid is passed through both the first condenser line and the second condenser line of the condenser and directed to the fresh food compartment evaporator or the freezing compartment evaporator.

[0013] The cooling device realized in order to attain the aim of the present invention is illustrated in the attached figures, where:

Figure 1 - is the schematic view of a cooling device.

Figure 2 - is the schematic view of a refrigeration cycle.

[0014] The elements illustrated in the figures are numbered as follows:

1. Cooling device
2. Fresh food compartment
3. Freezing compartment
4. Compressor
5. Condenser
6. Fresh food compartment evaporator
7. Freezing compartment evaporator
8. First temperature sensor
9. Second temperature sensor
10. First valve
11. Control unit
12. First condenser line
13. Second condenser line
14. Second valve

[0015] The cooling device (1) comprises a fresh food compartment (2) wherein foodstuffs are placed to be cooled; a freezing compartment (3) kept at lower temperatures than the fresh food compartment (2) and wherein the foodstuffs are placed to be frozen; a compressor (4) that provides the compression of the refrigerant fluid; a condenser (5) that enables the refrigerant fluid leaving the compressor (4) to be condensed and changed to liquid phase; at least one fresh food compartment evaporator (6) which provides the cooling of the fresh food compartment (2) by enabling heat transfer between the refrigerant fluid and the environment; at least one freezing compartment evaporator (7) which provides the cooling of the freezing compartment (3) by enabling

heat transfer between the refrigerant fluid and the environment; a first temperature sensor (8) which measures the temperature of the fresh food compartment (2) for the control of the cooling process; a second temperature sensor (9) which measures the temperature of the freezing compartment (3) for the control of the freezing process; a first valve (10) at the outlet of the condenser (5), and a control unit (11) which evaluates the data received from the first temperature sensor (8) and the second temperature sensor (9) and enables the refrigerant fluid leaving the condenser (5) to pass through the first valve (10) and to be directed to the fresh food compartment evaporator (6) or the freezing compartment evaporator (7).

[0016] The cooling device (1) of the present invention

- the condenser (5) comprising a first condenser line (12) extending to the first valve (10) and a second condenser line (13) to which the refrigerant fluid leaving the first valve (10) is transmitted, and
- the control unit (11) that enables the refrigerant fluid to be directed from the first valve (10) to the fresh food compartment evaporator (6), to the freezing compartment evaporator (7) or to the second condenser line (13) according to the data received from the first temperature sensor (8) and the second temperature sensor (9) (Figure 1 and Figure 2).

[0017] The control unit (11) evaluates the data received from the first temperature sensor (8) and the second temperature sensor (9) and determines the compartment where the thermal load has increased and enables the refrigerant fluid leaving the first condenser line (12) to pass through the first valve (10) so as to be directed to the determined compartment and to be directed to the fresh food compartment evaporator (6) and/or the freezing compartment evaporator (7). According to the thermal load in the fresh food compartment (2) and the freezing compartment (3), the refrigerant fluid is passed through both the first condenser line (12) and the second condenser line (13) or through only the first condenser line (12) and transmitted to the fresh food compartment (2) and/or the freezing compartment (3). Thus, efficient use of the condenser (5) depending on the thermal load occurred in the fresh food compartment (2) or the freezing compartment (3) is ensured.

[0018] In an embodiment of the present invention, the control unit (11)

- compares the temperature (T_{FF}) of the fresh food compartment (2) detected by the first temperature sensor (8) with the limit temperature (T_{EF}) of the fresh food compartment (2) predetermined by the producer, and
- compares the temperature (T_{FRZ}) of the freezing compartment (3) detected by the second temperature sensor (9) with the limit temperature (T_{FRZlim}) of the freezing compartment (3) predetermined by the producer. If the temperature (T_{FF}) of the fresh

food compartment (2) is greater than the limit temperature (T_{FFlim}) of the fresh food compartment (2), the control unit (11) decides that the fresh food compartment (2) needs to be cooled and enables the refrigerant fluid to be transmitted to the fresh food compartment evaporator (6) so that the fresh food compartment (2) is cooled. If the temperature (T_{FRZ}) of the freezing compartment (3) is greater than the limit temperature (T_{FRZlim}) of the freezing compartment (3), the control unit (11) decides that the freezing compartment (3) needs to be cooled and enables the refrigerant fluid to be transmitted to the freezing compartment evaporator (7) so that the freezing compartment (3) is cooled.

[0019] In another embodiment of the present invention, the control unit (11)

- compares the temperature (T_{FF}) of the fresh food compartment (2) detected by the first temperature sensor (8) with the critical temperature (T_{FFcr}) of the fresh food compartment (2) predetermined by the producer, and
- compares the temperature (T_{FRZ}) of the freezing compartment (3) detected by the second temperature sensor (9) with the critical temperature (T_{FRZcr}) of the freezing compartment (3) predetermined by the producer. The critical temperatures (T_{FFcr} , T_{FRZcr}) determined for the fresh food compartment (2) and the freezing compartment (3) are the limit temperatures where the foodstuff contained therein begin to spoil. If the temperature (T_{FF}) of the fresh food compartment (2) is greater than the critical temperature (T_{FFcr}) and/or the temperature (T_{FRZ}) of the freezing compartment (3) is greater than the critical temperature (T_{FRZcr}) of the freezing compartment, the control unit (11) detects that the thermal load of the fresh food compartment (2) and/or the freezing compartment (3) has increased. In this case, the control unit (11) directs the refrigerant fluid from the first valve (10) to the second condenser line (13), and by passing the refrigerant fluid through the second condenser line (13), ensures that more thermal load is discharged to the outer environment. Thereby, the capacity of the condenser (5) is enabled to be increased so that the thermal load occurring in the fresh food compartment (2) or the freezing compartment (3) is discharged to the outer environment.

[0020] In another embodiment of the present invention, the cooling device (1) comprises a second valve (14) at the outlet of the second condenser line (13). The second valve (14) has one inlet connected to the second condenser line (13) and at least two outlets connected to the fresh food compartment evaporator (6) and the freezing compartment evaporator (7). When the shutter at the outlet of the second valve (14) connected to the fresh food compartment evaporator (6) is in the open position, the

refrigerant fluid leaving the second condenser line (13) is transmitted to the fresh food compartment evaporator (6) and when the shutter at the outlet of the second valve (14) connected to the freezing compartment evaporator (7) is in the open position, the refrigerating fluid leaving the second condenser line (13) is transmitted to the freezing compartment evaporator (7).

[0021] In another embodiment of the present invention, the control unit (11) enables the refrigerant fluid to be directed from the second valve (14) to the fresh food compartment evaporator (7) or the freezing compartment evaporator (7) according to the data received from the first temperature sensor (8) and the second temperature sensor (9). If the temperature (T_{FF}) of the fresh food compartment (2) is greater than the critical temperature (T_{FFcr}) of the fresh food compartment (2), the control unit (11) detects that the fresh food compartment (2) needs to be cooled and ensures the transmission of the refrigerant fluid from the second valve (14) to the fresh food compartment evaporator (6) so that the fresh food compartment (2) is cooled. If the temperature (T_{FRZ}) of the freezing compartment (3) is greater than the critical temperature (T_{FRZcr}) of the freezing compartment (3), the control unit (11) detects that the freezing compartment (3) needs to be cooled and ensures the transmission of the refrigerant fluid from the second valve (14) to the freezing compartment evaporator (7) so that the freezing compartment (3) is cooled.

[0022] In another embodiment of the present invention, if the temperature (T_{FF}) of the fresh food compartment (2) is lower than the limit temperature (T_{FFlim}) of the fresh food compartment (2) and the temperature (T_{FRZ}) of the freezing compartment (3) is lower than the limit temperature (T_{FRZlim}) of the freezing compartment (3), the control unit (11) provides that the compressor (4) is stopped and transmission of the refrigerant fluid is ceased. In this case, the control unit (11) decides that the fresh food compartment (2) and the freezing compartment (3) are not required to be cooled, thus terminates the delivery of the refrigerant fluid to the fresh food compartment evaporator (6) and the freezing compartment evaporator (7).

[0023] In the cooling device (1) of the present invention, depending on the value of the thermal load occurred in the fresh food compartment (2) and the freezing compartment (3), the refrigerant fluid is passed through only the first condenser line (12) of the condenser or through both of the first condenser line (12) and the second condenser line (13). Thereby, the capacity of the condenser (5) is enabled to be increased or decreased so as to meet the different thermal loads occurred.

Claims

1. A cooling device (1) comprising a fresh food compartment (2) wherein foodstuffs are placed to be cooled; a freezing compartment (3) kept at lower temperatures than the fresh food compartment (2)

and wherein the foodstuffs are placed to be frozen; a compressor (4) that provides the compression of the refrigerant fluid; a condenser (5) that enables the refrigerant fluid leaving the compressor (4) to be condensed and changed to liquid phase; at least one fresh food compartment evaporator (6) which provides the cooling of the fresh food compartment (2) by enabling heat transfer between the refrigerant fluid and the environment; at least one freezing compartment evaporator (7) which provides the cooling of the freezing compartment (3) by enabling heat transfer between the refrigerant fluid and the environment; a first temperature sensor (8) which measures the temperature of the fresh food compartment (2) for the control of the cooling process; a second temperature sensor (9) which measures the temperature of the freezing compartment (3) for the control of the freezing process; a first valve (10) at the outlet of the condenser (5), and a control unit (11) which evaluates the data received from the first temperature sensor (8) and the second temperature sensor (9) and enables the refrigerant fluid leaving the condenser (5) to pass through the first valve (10) and to be directed to the fresh food compartment evaporator (6) or the freezing compartment evaporator (7), **characterized by**

- the condenser (5) comprising a first condenser line (12) extending to the first valve (10) and a second condenser line (13) to which the refrigerant fluid leaving the first valve (10) is transmitted, and
- the control unit (11) that enables the refrigerant fluid to be directed from the first valve (10) to the fresh food compartment evaporator (6), to the freezing compartment evaporator (7) or to the second condenser line (13) according to the data received from the first temperature sensor (8) and the second temperature sensor (9).

2. A cooling device (1) as in Claim 1, **characterized by** the control unit (11)

- that compares the temperature (T_{FF}) of the fresh food compartment (2) detected by the first temperature sensor (8) with the limit temperature (T_{FFlim}) of the fresh food compartment (2) predetermined by the producer,
- that compares the temperature (T_{FRZ}) of the freezing compartment detected by the second temperature sensor (9) with the limit temperature (T_{FRZlim}) of the freezing compartment (3) predetermined by the producer,
- that provides the transmission of the refrigerant fluid to the fresh food compartment evaporator (6) if the temperature (T_{FF}) of the fresh food compartment (2) is greater than the limit temperature (T_{FFlim}) of the fresh food compartment (2), and

- that provides the transmission of the refrigerant fluid to the freezing compartment evaporator (7) if the temperature (T_{FRZ}) of the freezing compartment (3) is greater than the limit temperature (T_{FRZlim}) of the freezing compartment. 5

3. A cooling device (1) as in Claim 1 or 2, **characterized** by the control unit (11)

- that compares the temperature (T_{FF}) of the fresh food compartment (2) detected by the first temperature sensor (8) with the critical temperature (T_{FFcr}) of the fresh food compartment (2) predetermined by the producer, 10
 - that compares the temperature (T_{FRZ}) of the freezing compartment detected by the second temperature sensor (9) with the critical temperature (T_{FRZcr}) of the freezing compartment (3) predetermined by the producer, 15
 - that provides the transmission of the refrigerant fluid to the fresh food compartment evaporator (6) if the temperature (T_{FF}) of the fresh food compartment (2) is greater than the critical temperature (T_{FFcr}) of the fresh food compartment (2), 20
 and 25
 - that provides the transmission of the refrigerant fluid to the freezing compartment evaporator (7) if the temperature (T_{FRZ}) of the freezing compartment (3) is greater than the critical temperature (T_{FRZcr}) of the freezing compartment. 30

4. A cooling device (1) as in any of the above claims, **characterized by** a second valve (14) located at the outlet of the second condenser line (13). 35

5. A cooling device (1) as in Claim 4, **characterized** by the control unit (11) that enables the refrigerant fluid to be directed from the second valve (14) to the fresh food compartment evaporator (6) or the freezing compartment evaporator (7) according to the data received from the first temperature sensor (8) and the second temperature sensor (9). 40

6. A cooling device (1) as in any of the above claims, **characterized by** the control unit (11) that enables the compressor (4) to be stopped and the transmission of the refrigerant fluid to be terminated if the temperature (T_{FF}) of the fresh food compartment (2) is lower than the limit temperature (T_{FFlim}) of the fresh food compartment (2) and the temperature (T_{FRZ}) of the freezing compartment (3) is lower than the limit temperature (T_{FRZlim}) of the freezing compartment (3). 45 50

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Figure 1

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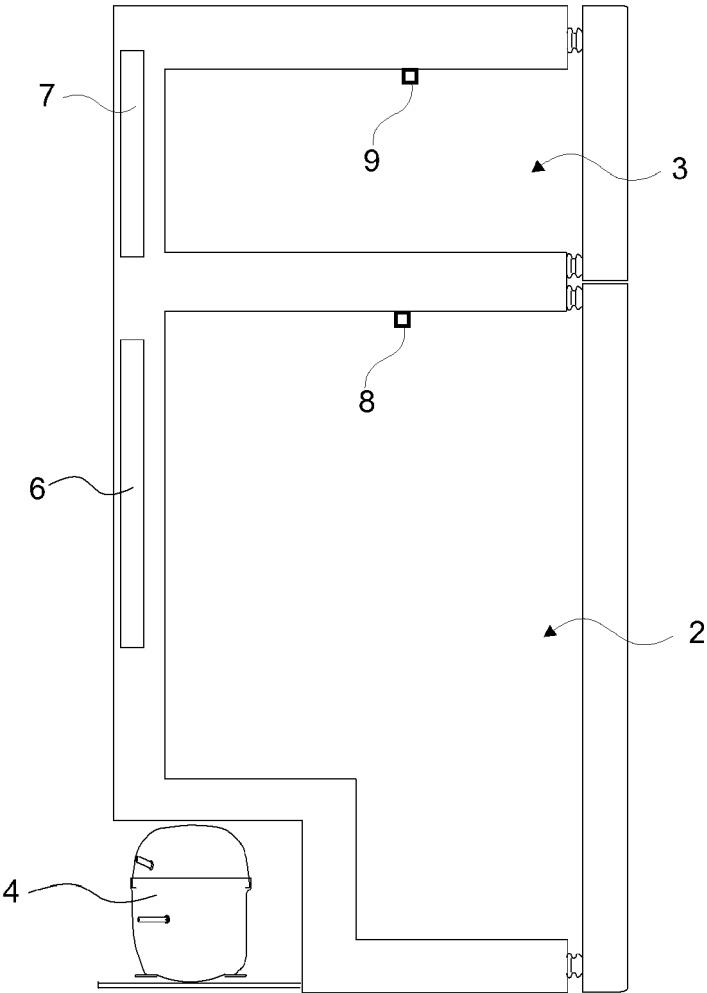
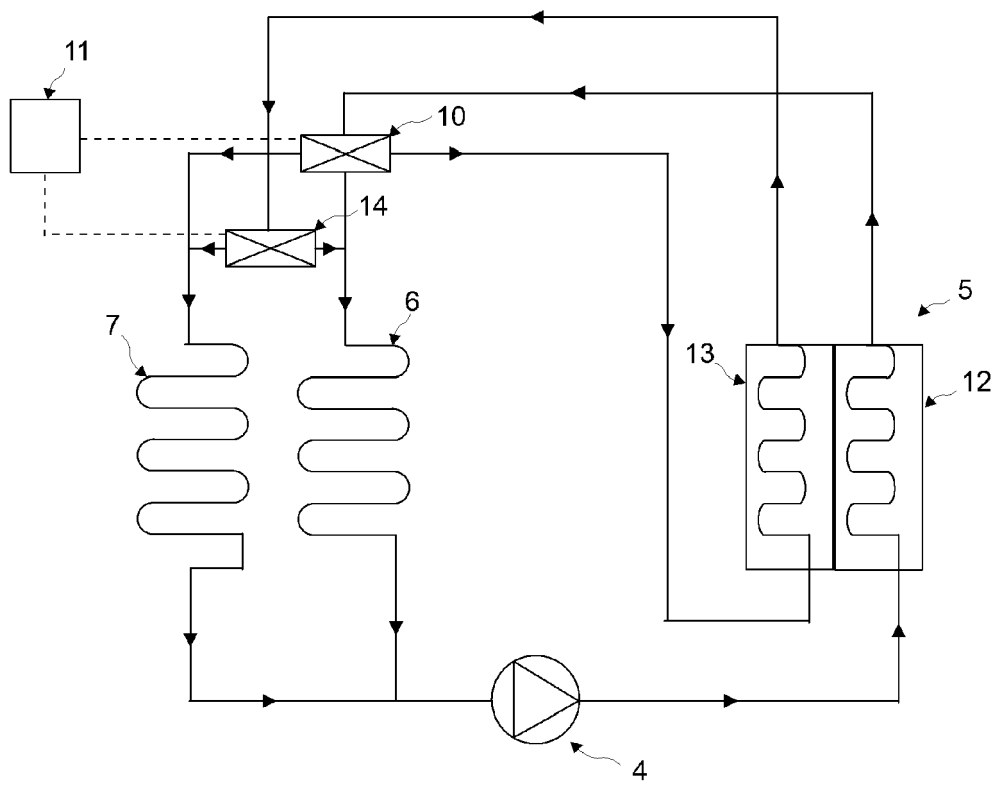


Figure 2





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Application Number
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**ANNEX TO THE EUROPEAN SEARCH REPORT
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