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(54) **CABINET FOR DISPLAY OF FOOD PRODUCTS AND METHOD FOR CONTROLLING THE TEMPERATURE IN SUCH A CABINET**

(57) A cabinet for displaying and storing food products (**P**, **P'**), comprising: a supporting frame (**2**) defining at least one heated compartment (**4**) with a predetermined temperature (**T₄**) and at least one refrigerated compartment (**3**) with a predetermined temperature (**T₃**) insulated from each other; a circuit (**6**) comprising at least one compressor (**8**), at least one main heat exchanger (**9**), at least one secondary heat exchanger (**10**), and at least one expansion valve (**11**); sensor means suited to measure the temperature (**T**) at the outlet (**16**) of the secondary heat exchanger (**10**); heat dissipation means (**21**) associated with the secondary heat exchanger (**10**); an electronic control unit operatively connected at least to the sensor means and to the heat dissipation means (**21**). The electronic control unit is suited to promote the selective activation/deactivation of the heat dissipation means (**21**) so as to maintain the temperature (**T**) of the fluid (**7**) at the outlet (**16**) of the secondary heat exchanger substantially constant at a predetermined reference value (**T_{REF}**). A method for controlling the temperature in the environments (**3**, **4**) intended to promote the display and storage of food products (**P**, **P'**).

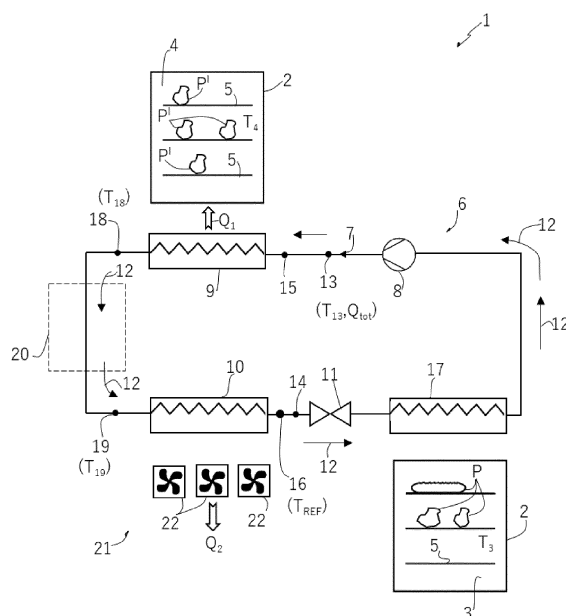


FIG. 1

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Description

Field of application of the invention

[0001] The present invention concerns the technical field of preservation of edible products, and the subject of the invention is a cabinet for displaying and storing food products.

[0002] The subject of the invention also includes a method for controlling the temperature inside the environments intended for displaying and storing food products.

State of the art

[0003] As is known, the display cabinets available on the market make it possible to store both food products that must be stored in cold environments and food products that must be stored in warm environments under optimal conditions.

[0004] More specifically, such assemblies are provided with a plurality of compartments, each of which is insulated from the external environment by means of a frame or window, in such a way as to maintain the temperature conditions inside them substantially constant.

[0005] These cabinets, therefore, are provided with at least one refrigerated compartment inside which it is possible to store food products subject to rapid deterioration such as, for example, vegetables, fruit, dairy products etc., and at least one heated compartment suited to store specific cooked or partially cooked food products at a temperature higher than the ambient temperature.

[0006] According to the regulations in force in many countries, the compartment of a display cabinet intended to reproduce a food counter must be set up in such a way that the food product is kept at a predetermined heating temperature which can vary within a predetermined and limited range of values.

[0007] For example, in Italy the storage temperature for cooked and perishable food to be consumed hot (ready meals, snacks, poultry etc.) is included between 60°C and 65°C.

[0008] The cabinets with refrigerated compartments and heated compartments are equipped with a thermal system that is suited to promote the extraction of heat from the refrigerated compartment and the introduction of heat into the heated compartment.

[0009] These systems exploit the thermal properties associated with the change of state of one or more fluids circulating inside a closed circuit.

[0010] In essence, the extraction of heat (and the generation of cold) from the refrigerated compartment is obtained by running a reverse Carnot cycle applied to a single carrier fluid, usually comprising carbon dioxide (CO₂) or gas mixtures containing mainly carbon dioxide.

[0011] However, normal refrigeration cycles using carbon dioxide as the carrier fluid are not suited to promote the heating and cooling of the respective compartments

in an energy-efficient manner.

[0012] Even the thermal efficiency of the entire cycle is rather low, as the refrigeration circuits using carbon dioxide (or other carrier fluids) can be easily optimized when it is necessary to promote only the heating or only the cooling, while they do not seem to be particularly suited to optimize thermal efficiency when it is necessary to promote both the heating and cooling of different compartments.

[0013] In the technical field of food preservation systems, there is therefore the need to develop a cycle control system operated by a single carrier fluid which makes it possible to maximize and optimize the efficiency of the heat exchange associated with both compartments (the heated compartment and the cooled compartment).

Presentation of the invention

[0014] The present invention intends to overcome the above-mentioned drawbacks by providing a particularly effective and efficient cabinet for displaying and storing food products.

[0015] More specifically, the main object of the present invention is to provide a cabinet for displaying and preserving food products which makes it possible to minimize losses and maximize thermal efficiency.

[0016] It is a further object of the present invention to provide a cabinet for displaying and preserving food products which is able to maintain the temperature in the two compartments substantially constant.

[0017] It is another object of the present invention to provide a cabinet for displaying and preserving food products which makes it possible to minimize the temperature fluctuations caused by losses/fluctuations in the refrigeration cycle to which the carrier fluid is subjected.

[0018] Lastly, it is not the least object of the present invention to provide a cabinet for displaying and preserving food products which makes it possible to optimize the energy associated with the carrier fluid in such a way as to reduce losses and improve the overall energy efficiency of the refrigeration cycle.

[0019] These objects are achieved by a method for controlling temperature in a cabinet for displaying and preserving food products according to claim 1.

[0020] Other objects that are described in greater detail below are achieved by a cabinet for displaying and preserving food products according to the dependent claims from 2 to 9.

[0021] According to a further aspect of the invention, the subject of the same is a method for controlling temperature in the environments intended to promote the display and storage of food products of the type according to claim 10.

[0022] Said method offers the same advantages as those already described with reference to the cabinet, and in particular makes it possible to optimize the efficiency of the refrigeration cycle to which the carrier fluid is subjected, in such a way as to maintain a substantially

uniform temperature inside the heated compartment and inside the refrigerated compartment, thus maximizing energy efficiency.

[0023] Further objects achieved by the cabinet can be deduced from the dependent claims from 11 to 15.

Brief description of the drawings

[0024] The advantages and characteristics of the present invention are clearly illustrated in the following detailed description of some preferred but not limiting configurations of a method for controlling the temperature of a heated compartment and a refrigerated compartment, and of a cabinet for displaying and storing food products, especially with reference to the following drawings:

- **Figure 1** shows a schematic view of a cabinet for displaying and storing food products according to the invention;
- **Figure 2** shows a state diagram of the carrier fluid used in the cabinet illustrated in Figure 1.

Detailed description of the invention

[0025] The present invention relates to a cabinet for displaying and storing food products, and a method for controlling the temperature in the environments intended to promote the display and storage of food products.

[0026] A cabinet according to the invention is schematically shown in **Figure 1** and is indicated here below by the reference number **1**.

[0027] Said cabinet **1** can mainly be installed in retail outlets and hypermarkets (shops, supermarkets etc.) to display and store packaged food products or food suited to be eaten immediately (or within a short time after the purchase) such as, for example, deli food, take-away products etc.).

[0028] The cabinet **1** that is the subject of the present invention is constituted by a supporting frame **2**, generally a self-bearing frame, defining a supporting base intended to come into contact with the floor (not illustrated in the figures), and a plurality of compartments **3**, **4** generally extending in the upper part of the frame **2**.

[0029] The food products **P** to be preserved are stored inside the compartments **3**, **4**.

[0030] More specifically, the frame **2** (and consequently the cabinet **1**) is such as to define at least one compartment **3** for the storage of refrigerated products **P** and at least one compartment **4** for the storage of heated products **P'**.

[0031] In the configuration of the cabinet **1** illustrated in **Figure 1** there is a single compartment **3** for storing cold products **P** (which hereinafter in this description is referred to as "refrigerated compartment") and a single compartment **4** for storing cooked or heated products **P'** (which hereinafter in this description is referred to as "heated compartment").

[0032] Such a configuration of the cabinet **1** is provided only by way of example, as the latter can be configured so as to define a plurality of refrigerated compartments **3** (insulated and distinct from each other) and/or a plurality of heated compartments **4** (insulated and distinct from each other).

[0033] The arrangement of the compartments **3**, **4** (in a multi-compartment cabinet **1**, that is, a cabinet provided with several compartments per each type) can be such as to form relatively large areas for displaying and storing the refrigerated products **P** and the heated products **P'**.

[0034] More specifically, it is possible to define a relatively large display area for all the refrigerated products **P** (made up, for example, of all the refrigerated compartments arranged side by side).

[0035] Similarly, it can also be envisaged a display area for the heated products **P'** (made up of all the heated compartments arranged side by side).

[0036] Furthermore, the subject of the present invention may include also a cabinet assembly **1** resulting from the union of several distinct cabinets (each of which comprising respective refrigerated compartments **3** and heated compartments **4**) served, however, by a single circuit providing for the forced circulation of a carrier fluid. In this case, the frame **2** can be defined as the union of all the frames making up the respective cabinets.

[0037] Obviously, each compartment **3**, **4** can be equipped with a plurality of shelves **5** suited to support the various food products **P**, **P'** thus facilitating their display.

[0038] The temperature **T₃** inside the refrigerated compartments **3** and the temperature **T₄** inside the heated compartments **4** can vary within a predetermined range that is defined by the user.

[0039] In fact, each refrigerated compartment **3** can have an internal temperature **T₃** ranging between -5°C and +10°C, while each heated compartment **4** can have an internal temperature **T₄** (except for defrosting periods) ranging between 60°C and 90°C.

[0040] The temperature **T₄** inside the heated compartment **4** can be selected in such a way as to meet the specifications provided by the national reference standards for the storage of cooked food.

[0041] For example, in Italy the storage temperature for cooked and perishable food to be consumed hot (ready meals, snacks, poultry etc.) is between 60°C and 65°C.

[0042] The cabinet **1** can also include a closed circuit **6** suited to allow the circulation of a carrier fluid **7**.

[0043] More specifically, the carrier fluid **7** can comprise carbon dioxide CO₂ or a mixture having a high content of carbon dioxide CO₂.

[0044] Carbon dioxide has good thermophysical properties within the range of pressures used in the cabinet **1** that is the subject of the present invention, which are specified more clearly below.

[0045] In addition, carbon dioxide is a fluid characterized by a low environmental impact, thus making it pos-

sible to limit the construction and disposal costs of a cabinet 1 using a heating/cooling system designed to contain said fluid.

[0046] In addition, differently from hydrocarbon-based carrier fluids (R290, R600 etc.), carbon dioxide is not flammable or explosive; the cabinets 1 using this fluid can therefore be located in a wide range of places in complete safety.

[0047] The circuit 6 is shaped in such a way as to define a closed loop and is constituted by piping sections and fluid-dynamic components suited to transform the carrier fluid 7 according to a reverse Carnot cycle, that is, according to a refrigeration cycle.

[0048] Conveniently, the circuit 6 containing the carrier fluid 7 can have respective portions fluidically and operatively associated with the refrigerated compartment 3 and the heated compartment 4, respectively.

[0049] The portions of the circuit 6 associated with the compartments 3, 4 make it possible exchange thermal energy Q between the carrier fluid 7 and the air contained in the volumes defined by the compartments 3, 4 themselves, in such a way as to cool and/or heat the environments where the food products P, P' are stored.

[0050] The circuit provides for the use of a compressor 8, at least one main heat exchanger 9, at least one secondary heat exchanger 10 and at least one fluid expansion valve 11.

[0051] Conveniently, an evaporator 17 fluidically associated with the refrigerated compartment 3 so as to cool it down to the temperature T_3 defined by the user can be provided downstream of the expansion valve 11 (and upstream of the compressor 8).

[0052] Therefore, the evaporator 17 can be interposed between the expansion valve 11 and the compressor 8 and be provided with an inlet fluidically connected to the expansion valve 11 and an outlet fluidically connected to the compressor 8.

[0053] Obviously, the operation of the expansion valve 11 makes it possible to reduce the temperature and the pressure of the fluid 7; the latter, while flowing through the evaporator 17, heats up by absorbing heat from the refrigerated compartment 3. This heat exchange makes it possible to maintain the temperature T_3 inside the refrigerated compartment 3 at a substantially constant value or a value close to that set by the user.

[0054] Conveniently, the compressor 8 can be equipped with an inverter and can be of the type suited to promote the compression of the carrier fluid 7 under relatively high pressures.

[0055] The main heat exchanger 9 can be positioned downstream of the compressor 8 (with respect to the direction of circulation of the fluid 7 inside the circuit 6, indicated by the arrow 12 in the diagram in Figure 1).

[0056] Thus, the main heat exchanger 9 has an inlet 15 fluidically connected to the compressor 8 and an outlet 18 fluidically connected (or associated) with the secondary heat exchanger 10.

[0057] Conveniently, the main heat exchanger 9 is in-

stalled in the area of the circuit 6 located at the heated compartment 4 (or compartments).

[0058] In the case of a multi-compartment cabinet 1, a set of main heat exchangers 9 can be provided, each of which is directly placed in communication with a corresponding compartment 4 so as to heat it.

[0059] The secondary heat exchanger 10 can be positioned downstream of the main heat exchanger 9 (with respect to the direction of circulation 12 of the fluid 7).

[0060] Conveniently, the secondary heat exchanger 10 can comprise an inlet 19 connected (or associated) with the outlet 18 of the main heat exchanger 9 and an outlet 16 fluidically connected to the expansion valve 11.

[0061] The expansion valve 11 for the fluid 7 is installed, respectively, downstream of the secondary heat exchanger 10 and upstream of the evaporator 17.

[0062] During the activation of the compressor 8, the pressure of the carrier fluid 7 is raised to a predetermined value. The section of the circuit 6 included between the outlet 13 of the compressor 8 and the outlet 16 of the secondary heat exchanger 10 is characterized in that it promotes the circulation of the fluid 7 under high pressure and, for this reason, is called the "high pressure side".

[0063] The remaining part of the circuit (from the outlet of the expansion valve 11 to the inlet of the compressor 8) is characterized by a relatively low pressure of the carrier fluid 7, and for this reason it is called the "low pressure side".

[0064] In other words, the closed circuit 6 can be defined as the union of a high pressure side and a low pressure side.

[0065] As is better clarified below, for the purposes of the present invention it is possible to define an optimal pressure P_o of the carrier fluid 7 at the outlet 13 of the compressor 8 (and thus at the inlet 15 of the main heat exchanger 9).

[0066] The passage of the fluid 7 (under high pressure) through the main heat exchanger 9 makes it possible to transfer to the heated compartment 4 the thermal power Q_1 necessary to heat it up to the set temperature T_4 .

[0067] As is better clarified below, the optimal pressure P_o of the fluid 7 at the outlet 13 of the compressor 8 represents the pressure value that makes it possible to maximize the efficiency of the two heat exchanges: i) the heat exchange associated with the carrier fluid 7 when it flows through the main heat exchanger 9 and ii) the heat exchange of the fluid 7 when it flows through the evaporator 17.

[0068] For this reason, the setting of the optimal pressure P_o of the fluid 7 at the outlet 13 of the compressor 8 makes it possible to promote the operation of the circuit 6 in the condition of maximum efficiency (that is, with minimum losses) associated with the two heat exchanges described above (main heat exchanger 9 / evaporator 17).

[0069] Therefore, the main heat exchanger 9 makes it possible to transfer the thermal power Q_1 necessary to maintain the heating temperature T_4 to the compartment

4.

[0070] Subsequently, the fluid 7 under high pressure flows through the secondary heat exchanger 10 in such a way as to dissipate a predetermined amount of heat Q2 in the external environment.

[0071] Conveniently, the temperature of the fluid 7 at the outlet 16 of the secondary heat exchanger 10 (and thus at the inlet 14 of the expansion valve 11) can be equal to a predetermined reference value T_{REF} .

[0072] The reference value T_{REF} of the temperature of the fluid 7, measured at the outlet 16 of the secondary heat exchanger 10, can be defined according to the value of the temperature T_4 of the heated compartment 4 and to the value of the temperature T_3 of the refrigerated compartment 3.

[0073] In particular, the reference value T_{REF} can vary depending only on the temperature T_3 set in the refrigerated compartment 3. Thus, a change in the value of the temperature T_3 can cause a change in the value of the temperature T_{REF} , which must remain constant at the outlet 16 of the secondary heat exchanger 10.

[0074] In an alternative configuration of the invention, the reference value T_{REF} can vary depending only on the temperature T_4 set in the heated compartment 4, or T_{REF} can vary according to both the value of the temperature T_3 and the value of the temperature T_4 . Thus, a change in the value of the temperature T_4 (or of temperature T_3 and T_4) can cause a change in the value of the temperature T_{REF} which must remain constant at the outlet 16 of the secondary heat exchanger 10.

[0075] More specifically, the reference value T_{REF} of the temperature of the fluid 7 can vary within a range of values, delimited by a predetermined minimum value and a predetermined maximum value, suited to guarantee the operation of the system in transcritical mode in the "high pressure side", that is, in the side included between the outlet 13 of the compressor 8 and the inlet 14 of the expansion valve 11.

[0076] In particular, the reference value T_{REF} of the temperature of the fluid 7 can be a single value that remains constant during the circulation of the fluid 7 in the circuit 6, or it can always be constant but fall within a predetermined range of values. Alternatively, the reference temperature T_{REF} can present minimal oscillations, all falling within a small, predetermined temperature range.

[0077] For example, the reference temperature T_{REF} of the fluid 7 can vary within the range between 25°C and 45°C.

[0078] According to a specific aspect of the invention, the value of the reference temperature T_{REF} is kept substantially constant during the operation of the cabinet 1; that is, the value of the reference temperature T_{REF} is kept constant during the forced circulation of the fluid 7 inside the circuit 6 promoted when the compressor 8 is operated. In other words, the temperature T_{REF} remains substantially constant in the lapse of time during which the heated compartment 4 and the refrigerated compart-

ment 3 are maintained at their respective operating temperatures T_3 , T_4 (that is, during the lapse of time which does not include defrosting and the switching off of the circuit 6 and in which there is no circulation of the carrier fluid 7).

[0079] The sum of the thermal powers ($Q1 + Q2$) dissipated by the two heat exchangers 9, 10, therefore, is such as to allow the carrier fluid 7 to pass from an initial temperature T_{13} higher than the reference temperature T_{REF} (at the outlet 13 of the compressor 8) to a value equal to the reference temperature T_{REF} .

[0080] For example, the temperature T_{13} of the fluid 7 at the inlet 15 of the main heat exchanger 9 (and thus at the outlet 13 of the compressor 8) can be included between 80 °C and 110 °C.

[0081] After the heat exchange promoted at the level of the main heat exchanger 9 (transfer of the amount of heat Q1 to the heated compartment 4 in such a way as to maintain the latter at a temperature not lower than 65°C), the temperature T_{18} of the carrier fluid 8 at the outlet 18 of the main heat exchanger 9 itself can be included between 65°C and 90°C.

[0082] However, the value of the temperature T_{19} of the fluid 7 at the inlet 19 of the secondary heat exchanger 10 can be significantly lower than the value assumed at the outlet 18 of the main heat exchanger 9.

[0083] This occurs because the section of piping that connects the two heat exchangers 9, 10 can be used to promote the partial evaporation of the water collected after the melting of the ice formed on the set of evaporators associated with the refrigerated compartment 3 during normal operation of the cabinet 1.

[0084] More specifically, the frame 2 of the cabinet 1 can comprise a tank for collecting the water produced during the defrosting phases of the evaporator 17 associated with the compartment 3 (indicated by a broken line with the reference number 20 in Figure 1) formed at the evaporator 17 associated with the refrigerated compartment 3.

[0085] Said tank 20 can be traversed by the piping section (or a tube heat exchanger, not shown in the figures) which connects the heat exchangers 9, 10 with each other, which contains the carrier fluid 7 at a relatively high temperature.

[0086] In this way, part of the water contained in the tank 20 can be eliminated through evaporation.

[0087] While flowing through the tank 20, the fluid 7 is slightly cooled.

[0088] For example, if the temperature T_{18} of the carrier fluid 7 at the outlet 18 of the main heat exchanger 9 is included between 65°C and 90°C, after flowing through the collection tank 20 the same fluid may have a temperature T_{19} included between 50°C and 80°C at the inlet 19 of the secondary heat exchanger 10.

[0089] In this way, the amount of heat Q2 dissipated by the secondary heat exchanger 10 is selected in such a way as to lower the temperature of the fluid 7 from the higher value T_{19} (at the inlet 19 and included between

50°C and 80°C) to the value of the reference temperature T_{REF} (at the outlet 16 and included between 25°C and 40°C).

[0090] The temperature of the fluid 7 at the outlet 16 of the secondary heat exchanger 10 is substantially kept constant at the value T_{REF} during the entire activation time of the compressor 8. In other words, the temperature T of the fluid 7 at the outlet 16 of the secondary heat exchanger 10 remains fixed at the value T_{REF} (except for possible minimal fluctuations around this value) and is not subject to substantial increases/decreases with respect to the reference value T_{REF} .

[0091] The operation of the circuit 6 at the base of the cabinet 1 that is the subject of the present invention, therefore, differs from the known art in that:

- there is no maximum threshold temperature associated with the fluid 7 at the outlet 16 of the secondary heat exchanger 10;
- the thermal power Q_2 dissipated by the secondary heat exchanger 10 is not defined in such a way as to maintain the fluid 7, at the outlet 16 of the secondary heat exchanger 10, at any temperature below the maximum threshold value;
- the value of the temperature of the fluid 7 at the outlet 16 of the secondary heat exchanger 10 is fixed and not variable and, for this reason, it is not subject to deviations (in the systems known in the art, these deviations are all below the maximum threshold value).

[0092] To facilitate said heat dissipation, the cabinet 1 is provided with heat dissipation means 21 associated with the secondary heat exchanger 10.

[0093] Generally, the heat dissipation means 21 can comprise one or more fans, indicated by the reference number 22 in Figure 1, which are suited to extract the heat transferred to the secondary heat exchanger 10 by the carrier fluid 7 in order to dissipate such heat in the installation environment.

[0094] In this way, the selective activation of the fans 22 makes it possible to vary the overall thermal power Q_2 dissipated by the secondary heat exchanger 10 so as to substantially maintain the carrier fluid 7 at a constant reference temperature T_{REF} at the outlet 16 of the secondary heat exchanger 10.

[0095] Conveniently, the heat dissipation means 21 can be constituted by a plurality of fans 22 associated with the secondary heat exchanger 10 and suited to be activated selectively and independently of each other.

[0096] In this way, it is possible to vary the amount of heat extracted from the secondary heat exchanger 10 and, consequently, to obtain a change in Q_2 .

[0097] The fans 22 can be provided with an electronic control module, not shown in Figure 1, suited to vary the power supply voltage in order to vary the rotation speed of the fan itself.

[0098] The total heat Q_2 extracted from the secondary

heat exchanger due to the action of the fans 22 can, therefore, be the result of the synergic effect obtained by instantaneously varying the total number of fans 22 activated simultaneously and the rotation speed of each single fan.

[0099] Consequently, the activation of the fans 22, as described above, makes it possible to vary the thermal power Q_2 intended to be eliminated from the circuit 6 in the high pressure side. In this way, the temperature of the fluid 7 at the outlet 16 of the secondary heat exchanger 10 is maintained at a value substantially equal to the reference value T_{REF} (or close thereto).

[0100] Conveniently, the cabinet 1 can comprise sensor means, not illustrated in Figure 1, suited to measure the pressure and/or the temperature of the fluid 7 at various points of the circuit 6.

[0101] More specifically, the sensor means can be configured to measure the instant temperature T_3 , T_4 inside the refrigerated compartment 3 and the heated compartment 4, as well as the temperature and/or the pressure of the carrier fluid 7 at the inlet and/or outlet of the various components of the circuit 6.

[0102] Conveniently, the cabinet 1 can be provided with an electronic control unit, not shown in Figure 1, which is operatively connected to the compressor 8, the heat dissipation means 21 and the expansion valve 11.

[0103] In addition, the electronic control unit can be operatively connected also to the sensor means in such a way as to receive, at least, information on the instant temperature T_3 , T_4 in the refrigerated compartment 3 and the heated compartment 4 as well as information on the temperature T of the fluid at the outlet 16 of the secondary heat exchanger 10 so as to check that it corresponds to the reference value T_{REF} .

[0104] Conveniently, the electronic control unit can selectively activate/deactivate the heat dissipation means 21 according to the instant temperature T_3 , T_4 inside the compartments 3 and 4.

[0105] More specifically, when the temperature T_4 of the heated compartment 4 decreases, the amount of heat Q_2 dissipated by the secondary heat exchanger 10 and the heat dissipation means 21 increases (as the amount of heat Q_1 transferred from the main heat exchanger 9 to the heated compartment 4 decreases).

[0106] On the contrary, when the temperature T_4 of the heated compartment 4 increases, the amount of heat Q_2 dissipated by the secondary heat exchanger 10 and the heat dissipation means 21 decreases (as the amount of heat Q_1 transferred from the main heat exchanger 9 to the heated compartment 4 increases).

[0107] Similarly, even a change in the temperature T_3 associated with the refrigerated compartment 3 changes the value of the thermal energy associated with the fluid 7 in the low pressure side of the circuit 6 in such a way as to cause a change in the value of the thermal energy Q_2 dissipated by the secondary heat exchanger 10 and the heat dissipation means 21.

[0108] In essence, the electronic control unit can se-

lectively activate/deactivate one or more fans **22** (or vary their rotation speed) in such a way as to modulate the amount of heat **Q2** dissipated by the secondary heat exchanger **10** so as to: *i*) keep the temperature **T** of the fluid **7** substantially constant at the reference value **T_{REF}** at the outlet **16** of the heat exchanger itself, *ii*) keep the temperature **T₃**, **T₄** in the compartments **3**, **4** at a value corresponding to that previously set by the user.

[0109] The cabinet **1** that is the subject of the present invention is thus suited to heat and refrigerate the compartments **3**, **4** by means of a reverse Carnot cycle applied to a carrier fluid **7** with a constraint on the temperature of the fluid at the outlet of the high pressure side.

[0110] In addition, the circuit **6** is sized in such a way as to generate, under any operating condition, an amount of heat **Q_{tot}** associated with the carrier fluid **7** greater than the amount of heat **Q1** necessary to heat the heated compartment **4** (**Q_{tot} > Q1**).

[0111] It is possible to dissipate a part **Q2** of the excess heat associated with the carrier fluid **7** (compared to the heat **Q1** required to heat the compartment **4**) through the secondary heat exchanger **10** and the activation of the heat dissipation means **21**.

[0112] The value of **Q2** is always greater than zero and the selective activation of the heat dissipation means **21** makes it possible to vary the magnitude of said heat **Q2** in such a way as to obtain a value of the temperature of the fluid **7** at the outlet **16** of the secondary heat exchanger **10** which is substantially equal to the reference value **T_{REF}**.

[0113] It was possible to demonstrate experimentally that the setting up of a refrigeration cycle of the type described above (that is, suited to have a value of **Q2** greater than zero and a substantially constant temperature **T_{REF}** of the fluid **7** at the outlet of the secondary heat exchanger **10**) makes it possible to maximize the thermal efficiency of both the high pressure side and the low pressure side.

[0114] Conveniently, the circuit **6** associated with a cabinet **1** that is the subject of the present invention can be configured in such a way as to promote the circulation of the carrier fluid **7** in the transcritical region, where the term "transcritical" means the state of the fluid in which the liquid phase and the gaseous phase do not coexist any longer.

[0115] This operation region of the fluid **7** is highlighted in the enthalpy-pressure diagram in **Figure 2**.

[0116] In particular, the electronic control unit can be configured so as to keep the carrier fluid **7** in the transcritical operating region when it circulates in the high pressure side of the circuit **6**.

[0117] In particular, the electronic control unit can be configured so as to keep the carrier fluid **7** in the transcritical operating region exclusively in the high pressure part of the circuit **6**.

[0118] Furthermore, the provision of a refrigeration cycle of the type described above (that is, suited to feature a value of **Q2** greater than zero, a substantially constant temperature **T_{REF}** of the fluid **7** at the outlet of the sec-

ondary heat exchanger **10** and a transcritical phase of the fluid in the high pressure zone) makes it possible to maximize the thermal efficiency of the circuit **6** as it is easier to control the parameters of the fluid **7** at the high pressure side (and, consequently, also at the low pressure side).

[0119] The evaporation of the fluid **7**, that is, its partial transformation into the gaseous phase, takes place in the low pressure side of the circuit **6**.

[0120] Conveniently, each value of the reference temperature **T_{REF}** is associated with a certain optimal pressure **Po** of the fluid **7** measured at the outlet **13** of the compressor **8** (or, alternatively, at the inlet **15** of the main heat exchanger **9**).

[0121] As indicated above, the value of the optimal pressure **Po** of the fluid **7** falls within the transcritical region.

[0122] The optimal pressure **Po** represents the pressure value that makes it possible to optimize the efficiency of the heat exchange of the fluid **7** in *i*) the high pressure side and *ii*) the low pressure side.

[0123] It has been found experimentally that when carbon dioxide is used as carrier fluid the optimal pressure can be included between 75 bar and 90 bar (when the reference temperature **T_{REF}** of the fluid is between 30 °C and 40 °C).

[0124] In particular, as shown in greater detail in the diagram in **Figure 2**, as the reference temperature **T_{REF}** varies, the optimal pressure **Po** of the fluid **7** can follow a curve having a predetermined shape (for example, a straight line with an angular value smaller than one) whose points all fall within the transcritical region.

[0125] According to a further aspect of the invention, a method for controlling the temperature in the environments intended to contain and store food products is provided.

[0126] Said method can also be used to control the temperature **T₃**, **T₄** in the refrigerated compartments **3** and in the heated compartments **4** provided in a cabinet **1** for storing and displaying food products of the type previously described.

[0127] Said method includes a step **a**) of provision of at least one refrigerated compartment **3** and at least one heated compartment **4**. Obviously, both of these compartments **3**, **4** are intended to contain food products **P**, **P'** suited to be consumed by a user.

[0128] In step **b**) of the method, a closed circuit **6** is prepared, which is suited to promote the circulation of a carrier fluid **7**. In particular, the circuit **6** comprises at least one compressor **8**, at least one main heat exchanger **9**, at least one secondary heat exchanger **10** and at least one expansion valve **11**.

[0129] Furthermore, the circuit **6** can also include an evaporator **17** associated with the refrigerated compartment **3**.

[0130] The connection of the compressor **8**, the main heat exchanger **9**, the secondary heat exchanger **10** and the expansion valve **11** is the same as that previously

described with reference to the cabinet 1.

[0131] Conveniently, the main heat exchanger 9 is associated with the heated compartment 4 in such a way as to transfer to the latter a predetermined amount of heat Q_1 suited to heat said compartment 4 up to a predetermined temperature T_4 set by the user.

[0132] In addition, the secondary heat exchanger 10 is positioned downstream of the main heat exchanger 9 and upstream of the expansion valve 11. The latter, furthermore, is positioned upstream of the refrigerated compartment 3.

[0133] The purpose of the secondary heat exchanger 10 is to transfer a predetermined amount of heat, indicated by Q_2 , to the external environment (and thus to dissipate it from the circuit 6).

[0134] Conveniently, the fluidic connection between the main heat exchanger 9 and the secondary heat exchanger 10 can be obtained by means of one or more pipes inside which the carrier fluid 7 circulates.

[0135] Said pipes can pass through a tank 20 suited to collect the water produced at the evaporator 17 during the defrosting phase of the refrigerated compartment 3.

[0136] The temperature of the carrier fluid 7 flowing through the tank 20 (inside the relevant pipe) is relatively high and suited to promote the partial evaporation of the water contained inside said tank.

[0137] For this reason, the fluid 7, when it flows through the tank 20, is slightly cooled.

[0138] The circuit 6 described above can be divided into two portions according to the pressure associated with the carrier fluid.

[0139] In particular, it is possible to define a "high pressure side" of the circuit included between the inlet 15 of the main heat exchanger 9 (or the outlet 13 of the compressor 8) and the outlet 16 of the secondary heat exchanger 10 (or the inlet 14 of the expansion valve 11).

[0140] The high pressure side of the circuit 6 is therefore associated with the heated compartment 4.

[0141] The remaining portion of the circuit 6 can be defined as a "low pressure side"; this side is included between the inlet 14 of the expansion valve 11 (or the outlet 16 of the secondary heat exchanger 10) and the inlet of the compressor 8.

[0142] The low pressure side of the circuit 6 is therefore associated with the refrigerated compartment 3.

[0143] The entire circuit 6 can thus be defined as the union of the high pressure side with the low pressure side.

[0144] Obviously, the pressure of the fluid 7 in the side of the circuit 6 that includes the heat exchangers 9, 10 (high pressure) is significantly higher than the pressure of the same fluid 7 in the low pressure side.

[0145] Conveniently, the method includes a step c) of provision of sensor means suited to measure the temperature T (and possibly the pressure) of the carrier fluid 7 at the outlet 16 of the secondary heat exchanger 10.

[0146] There is also a step d) of provision of heat dissipation means 21. Said means 21 are associated with the secondary heat exchanger 10 and are configured to

be selectively activated in order to vary the amount of heat Q_2 extracted from the latter.

[0147] Generally, the heat dissipation means 21 can consist of one or more fans 22 (generally a set of fans) fluidically associated with the secondary heat exchanger 10, each of which can be selectively activated.

[0148] To vary the amount of heat Q_2 extracted from the secondary heat exchanger 10, it is possible to selectively and independently activate the number of fans 22 active at the same instant of time and/or the rotation speed associated with them.

[0149] The method also includes the step e) of provision of an electronic control unit operatively connected at least to the sensor means and to the heat dissipation means 21.

[0150] The electronic control unit is also suited to promote the selective activation/deactivation of said heat dissipation means 21 in such a way as to maintain the temperature T of the carrier fluid 7 at a predetermined value.

[0151] There is also a step f) of determination (or setting) of a heating temperature T_4 inside the heated compartment 4. In an alternative form of the method, the step f) can be such as to determine both the heating temperature T_4 inside the heated compartment 4 and the cooling temperature T_3 inside the refrigerated compartment 3. The step f) must be performed by the user so as to determine the correct temperature T_4 (or T_3) for the storage and display of the heated food products P' (or refrigerated food products P).

[0152] For example, in Italy, the temperature T_4 that must be maintained inside the heated compartment 4 cannot be lower than 65 °C.

[0153] The method includes a step g) of activation/deactivation of said heat dissipation means 21 in such a way as to dissipate the heat Q_2 and maintain the temperature T of the fluid 7 (at the outlet 16 of said secondary heat exchanger 10) at a substantially constant value over time, equal to a predetermined reference value T_{REF} .

[0154] Conveniently, the reference temperature T_{REF} is a function of the temperature T_4 of the heated compartment 4 and is suitable for determining an optimal value of the pressure P_0 of the carrier fluid 7 at the outlet 13 of the compressor 8 where said carrier fluid 7 is within the transcritical region.

[0155] Conveniently, the method includes a step h) of calculation of a reference temperature T_{REF} of the carrier fluid 7 at the outlet 16 of the secondary heat exchanger 10.

[0156] More specifically, the reference temperature T_{REF} of the carrier fluid 7 at the outlet 16 of the secondary heat exchanger 10 (or at the inlet 14 of the expansion valve 11) can be substantially a precise value (that is, have a single value that remains constant during the circulation of the fluid in the circuit), or it can be always constant but fall within a predetermined range of values. Alternatively, the reference temperature T_{REF} can have minimal fluctuations, all falling within a small, predeter-

mined temperature range.

[0157] In particular, the determination of the value of the reference temperature T_{REF} depends at least on the value of the heating temperature T_4 .

[0158] In an alternative embodiment of the invention, the determination of the reference temperature value T_{REF} can depend on the value of the heating temperature T_4 and on the value of the cooling temperature T_3 .

[0159] There is then a step i) of determination of an optimal pressure P_o of the carrier fluid 7 at the inlet 15 of the main heat exchanger 9 (or at the outlet 13 of the compressor 8).

[0160] In particular, as is better clarified below, the optimal pressure P_o of the fluid 7 (at the inlet 15 of the main heat exchanger 9) is selected in such a way as to maximize: i) the efficiency of the heat exchange associated with the carrier fluid 7 when the latter flows through the main heat exchanger 9, ii) the efficiency of the heat exchange associated with the carrier fluid 7 when the latter flows through the evaporator 17.

[0161] In addition, the method includes a step g) of activation/deactivation of the heat dissipation means 21 in such a way as to maintain substantially constant the reference temperature T_{REF} at the outlet 16 of the secondary heat exchanger 10, determined in step e).

[0162] The step i) of determination of the optimal pressure P_o can be performed by the electronic control unit; it is this component, in fact, that calculates the optimal pressure P_o .

[0163] Conveniently, as better described above, the optimal pressure P_o and the reference temperature T_{REF} are closely linked to each other, so that the calculation of one of them can affect the value of the other. For this reason, the electronic control unit can be configured either to calculate the reference temperature T_{REF} (and then determine the corresponding value of the optimal pressure P_o), or to calculate the optimal pressure P_o and then determine the corresponding value of the reference temperature T_{REF} .

[0164] In essence, the operation of the present method is based on the following principles:

- compressing the fluid 7 at the outlet 13 of the compressor 8 in such a way that the fluid has an amount of heat that is always greater than the value Q_1 required to heat the heated compartment 4;
- setting a reference temperature T_{REF} at the outlet of the high pressure side of the circuit (that is, at the outlet/inlet of the secondary heat exchanger/ expansion valve);
- dissipating an amount of heat Q_2 in the environment through the secondary heat exchanger 10, said amount of heat Q_2 being suited to ensure that the fluid 7 is maintained at the reference temperature T_{REF} (at the outlet 16 of the secondary heat exchanger 10).

[0165] Thus, there is a close relationship between the

heat Q_2 dissipated by the secondary heat exchanger 10 (through the selective activation/deactivation of the heat dissipation means 21) and the reference temperature T_{REF} .

[0166] In other words, the amount of heat Q_2 dissipated by the secondary heat exchanger 10 can be varied in such a way that the temperature T of the fluid 7 at the outlet of the high pressure side is kept substantially constant over time and equal to the reference temperature T_{REF} .

[0167] The expression "keeping the temperature of the fluid substantially equal to the reference temperature" used in this context means the following:

- if the reference temperature T_{REF} is one precise value, the fluid 7 is substantially maintained at the value of this precise temperature;
- if the reference temperature T_{REF} is selected from within a range of temperatures, the temperature of the fluid 7 associated with the outlet 16 of the high pressure side is always within that range (that is, it will never be lower than the minimum value of the range and will never be higher than the maximum value of the range).

[0168] Conveniently, the reference temperature value T_{REF} can generally be included between 25 °C and 45 °C.

[0169] Conveniently, the sensor means are configured to measure the temperature and/or the pressure of the carrier fluid along said circuit 6.

[0170] In particular, the execution of step g) of activation/deactivation of the heat dissipation means 21 can vary according to (that is, depend on) the temperatures and/or pressures measured by the sensor means.

[0171] Generally, the sensor means are suited to measure at least the following temperatures and pressures:

- the instant temperature T_4 inside the heated compartment 4;
- the instant temperature T_3 inside the refrigerated compartment 3;
- the instant temperature T_{13} of the carrier fluid 7 measured at the inlet 15 of the main heat exchanger 9;
- the instant temperature of the carrier fluid 7 at the outlet of the expansion valve 11;
- the instant temperature of the fluid 7 at the outlet 16 of the secondary heat exchanger 10 (that is, at the outlet of the high pressure side).

[0172] In addition, if necessary, the sensor means can also be configured to measure the pressure of the carrier fluid 7 along the circuit at the following points:

- at the inlet 15 of the main heat exchanger 9 (optimal pressure P_o);
- at the outlet 18 of the main heat exchanger 9 (or at

- the inlet **19** of the secondary heat exchanger **10**;
- at the outlet **16** of the secondary heat exchanger **10** (or at the inlet **14** of the expansion valve **11**);
- at the outlet of the expansion valve **11**.

[0173] The electronic control unit can be connected to the compressor **8**, the expansion valve **11** and the heat dissipation means **21**, respectively.

[0174] In particular, the electronic control unit can selectively activate the compressor **8** in such a way as to increase the pressure of the fluid **7** to the value of the optimal pressure **P_o**.

[0175] Furthermore, the electronic control unit can selectively activate the heat dissipation means **21** (generally constituted by a plurality of fans **22**) so as to extract from the fluid an amount of heat **Q2** selected in such a way as to maintain the temperature of the fluid **7**, at the outlet **16** of the high pressure side, substantially constant at the reference value **T_{REF}** (or variable within the range defined by the reference value **T_{REF}**).

[0176] Conveniently, the electronic control unit can be configured to promote the controlled opening and closing of the expansion valve **11** in order to vary the pressures and the temperatures of the fluid **7** circulating in the low pressure side.

[0177] Furthermore, the electronic control unit can be operatively connected to the sensor means (if present).

[0178] In this way, all the components of the circuit (compressor **8**, heat dissipation means **21** and expansion valve **11**) can be activated by the control unit according to the pressures/temperatures of the fluid **7** measured by the sensor means along the circuit.

[0179] In particular, the activation/deactivation of the heat dissipation means **21** (that is, the dissipation of the amount of heat **Q2** in the environment) can be controlled by the processing unit according to the instant temperature values measured in the heated compartment **4** and possibly measured in the refrigerated compartment **3**.

[0180] In this way, the control unit will be suited to selectively activate the heat dissipation means **21** in such a way as to keep the temperature of the fluid at the outlet **16** of the secondary heat exchanger **10** substantially constant (at the reference temperature **T_{REF}**), while maintaining the temperatures **T₃**, **T₄** inside the compartments at the operating values set by the user.

[0181] Advantageously, the value of the optimal pressure **P_o** of the fluid **7** at the outlet **16** of the secondary heat exchanger **10** and obtained during the execution of step **g**), is variable according to the value selected for the reference temperature **T_{REF}**.

[0182] Furthermore, the optimal pressure **P_o** of the carrier fluid **7** is selected from within the transcritical region of the fluid itself.

[0183] In particular, the trend followed by the optimal pressure **P_o**, whatever the set reference temperature **T_{REF}**, varies along a predetermined geometric curve that extends entirely within the transcritical region of the fluid.

[0184] The optimal pressure represents the pressure

value that makes it possible to optimize the efficiency of the heat exchange of the fluid **7** in *i*) the high pressure side and *ii*) the low pressure side.

[0185] It has been found experimentally that when carbon dioxide is used as carrier fluid, the optimal pressure can be included between 75 bar and 90 bar (when the reference temperature **T_{REF}** of the fluid is between 30 °C and 40 °C).

[0186] More specifically, as shown in greater detail in the diagram in **Figure 2**, as the reference temperature **T_{REF}** varies, the optimal pressure **P_o** of the fluid **7** can follow a curve with a predetermined shape which, for example, can be represented by a straight line with an angular value lower than one.

[0187] All the points of this curve, however, fall within the transcritical region of the carrier fluid **7**.

[0188] Conveniently, the fluid may remain in the transcritical region of the curve, at least when circulating in the high pressure side of the circuit **6**.

[0189] The method described above makes it possible to promote the execution of a refrigeration cycle with a value **Q2** greater than zero, a substantially constant temperature **T_{REF}** of the fluid **7** at the outlet of the secondary heat exchanger **10** and a transcritical fluid phase in the high pressure side.

[0190] This method, therefore, makes it possible to maximize the thermal efficiency of the circuit **6** as it is easier to control the parameters of the fluid **7** at the high pressure side (and, consequently, also at the low pressure side).

[0191] The present invention can be carried out in other variants, all falling within the scope of the inventive features claimed and described herein; these technical features can be replaced by different technically equivalent elements and materials; the shapes and dimensions of the invention can be any, provided that they are compatible with its use.

[0192] The numbers and reference signs included in the claims and in the description are only intended to increase the clarity of the text and must not be considered as elements limiting the technical interpretation of the objects or processes identified by them.

45 Claims

1. A cabinet for displaying and storing food products (**P**, **P'**), comprising:

- a supporting frame (**2**) defining at least one heated compartment (**4**) having a predetermined temperature (**T₄**) and at least one refrigerated compartment (**3**) having a predetermined temperature (**T₃**), said compartments (**3**, **4**) being insulated from each other and configured to contain the food products (**P**, **P'**) to be displayed and/or stored;
- a closed circuit (**6**) in which a carrier fluid (**7**)

circulates, said circuit (6) comprising:

- at least one compressor (8);
- at least one main heat exchanger (9) positioned downstream of said compressor (8) and fluidically associated with said heated compartment (4);
- at least one secondary heat exchanger (10) positioned downstream of said main heat exchanger (9);
- at least one expansion valve (11) for the carrier fluid (7) positioned, respectively, downstream of said secondary heat exchanger (10) and upstream of said refrigerated compartment (3);

- sensor means suited to measure the temperature (T) of said carrier fluid (7) at the outlet (16) of said at least one secondary heat exchanger (10);

- heat dissipation means (21) associated with said secondary heat exchanger (10);

- an electronic control unit operatively connected at least to said sensor means and to said heat dissipation means (21);

wherein said electronic control unit is suited to promote the selective activation/deactivation of said heat dissipation means (21) so as to maintain the temperature of the carrier fluid at a predetermined value;

characterized in that:

- the carrier fluid (7) is selected from among the mixtures containing carbon dioxide (CO₂);
- the electronic control unit is suited to promote the selective activation/deactivation of said heat dissipation means (21) in such a way as to maintain the temperature (T) of said carrier fluid (7) at the outlet (16) of said at least one secondary heat exchanger (10) at a reference value (T_{REF}) substantially constant over time;
- said reference temperature (T_{REF}) is variable as a function of the temperature of the heated compartment (T₄) and suited to determine an optimal pressure value (Po) for the fluid at the outlet (13) of the compressor (8) where said carrier fluid (7) is within the transcritical region.

2. Cabinet according to claim 1, **characterized in that** said reference temperature (T_{REF}) is between 25 °C and 45 °C.
3. Cabinet according to claim 1 or 2, **characterized in that** said heat dissipation means (21) comprise one or more fans (22) associated with said secondary

heat exchanger (10) and suited to extract from the latter an amount of heat (Q₂) suited to maintain the temperature (T) of the carrier fluid (7) at the outlet (16) of said secondary heat exchanger (10) at the predetermined reference value (T_{REF}).

4. Cabinet according to claim 3, **characterized in that** said heat dissipation means (21) comprise a plurality of fans (22), said electronic control unit being suited to selectively activate/deactivate each of said fans (22) independently of the others.

5. Cabinet according to one or more of the preceding claims, **characterized in that** said electronic control unit is suited to activate/deactivate said compressor (8) and said expansion valve (11) so as to maintain the pressure of the carrier fluid (7) at the outlet (13) of said compressor (8) at an optimal value (Po) within the transcritical region of said fluid (7).

6. Cabinet according to one or more of the preceding claims, **characterized in that** the reference temperature (T_{REF}) is included within a predetermined range of values suited to maintain the carrier fluid (7) within the transcritical region from the outlet (13) of the compressor (8) to the inlet (14) of said at least one expansion valve (11).

7. Cabinet according to one or more of the preceding claims, **characterized in that** the carrier fluid (7) circulating in said first heat exchanger (9) and said second heat exchanger (10) is within the transcritical region.

8. Cabinet according to one or more of the preceding claims, **characterized in that** the value of said optimal pressure (Po) is variable within the interval between 75 bar and 90 bar.

9. Cabinet according to one or more of the preceding claims, **characterized in that** the pressure of the carrier fluid (7) circulating in the section of the circuit included between the outlet (13) of said compressor (8) and the inlet (14) of said expansion valve (11) follows a predetermined trend entirely contained within the transcritical region of the fluid (7).

10. A method for controlling the temperature in the environments (3, 4) suited to display and store food products (P, P') of the type according to one or more of the preceding claims, said method comprising the following steps:

a) providing at least one refrigerated compartment (3) and at least one heated compartment (4) insulated from each other, said at least one refrigerated compartment (3) and said at least one heated compartment (4) being suited to con-

tain food products (**P**, **P'**);

b) providing a closed circuit (**6**) suited to promote the circulation of a carrier fluid (**7**) selected from within the group comprising carbon dioxide, said circuit (**6**) comprising:

- at least one compressor (**8**);
- at least one main heat exchanger (**9**) positioned downstream of said compressor (**8**) and fluidically associated with said heated compartment (**4**);
- at least one secondary heat exchanger (**10**) positioned downstream of said main heat exchanger (**9**);
- at least one expansion valve (**11**) of the carrier fluid (**7**) positioned, respectively, downstream of said secondary heat exchanger (**10**) and upstream of said refrigerated compartment (**3**);

c) providing sensor means suited to measure the temperature (**T**) of said carrier fluid (**7**) at the outlet (**16**) of said at least one secondary heat exchanger (**10**);

d) providing heat dissipation means (**21**) associated with said secondary heat exchanger (**10**), said heat dissipation means (**21**) being suited to be selectively activated to change the amount of heat (**Q2**) dissipated by said secondary heat exchanger (**10**);

e) providing an electronic control unit operatively connected at least to said sensor means and to said heat dissipation means (**21**), said electronic control unit is suited to promote the selective activation/deactivation of said heat dissipation means (**21**) in such a way as to maintain the temperature of the carrier fluid at a predetermined value;

f) setting a heating temperature (**T₄**) associated with the heated compartment (**4**);

g) activating/deactivating said heat dissipation means (**21**) in order to promote the dissipation of heat (**Q2**) and to maintain the temperature (**T**) of said fluid (**7**) at the outlet (**16**) of said secondary heat exchanger (**10**) at a value substantially constant over time and equal to a predetermined reference value (**T_{REF}**);

wherein said reference temperature (**T_{REF}**) is determined as a function of the temperature (**T₄**) of the heated compartment (**4**) and it is suited to determine an optimal value of the pressure (**Po**) of the carrier fluid (**7**) at the outlet (**13**) of the compressor (**8**) at which optimal pressure value (**Po**) said fluid (**7**) is within the transcritical region.

unit is suited to calculate the value of said reference temperature (**T_{REF}**), and a step **i**) in which said electronic control unit is suited to calculate the value of said optimal pressure (**Po**) of the carrier fluid (**7**) at the outlet (**13**) of said compressor (**8**).

12. Method according to claim 10 or 11, **characterized in that** the pressure of the carrier fluid (**7**) circulating in the section of the circuit (**6**) between the outlet (**13**) of said compressor (**8**) and the inlet (**14**) of said expansion valve (**11**) follows a predetermined trend entirely contained within the transcritical region of the fluid (**7**).

13. Method according to one or more of claims from 10 to 12, **characterized in that** the execution of step **g**) of activation/deactivation of the heat dissipation means (**21**) depends on the temperatures and/or pressures measured by said sensor means.

11. Method according to claim 10, **characterized in that** it comprises a step **h**) in which said electronic control

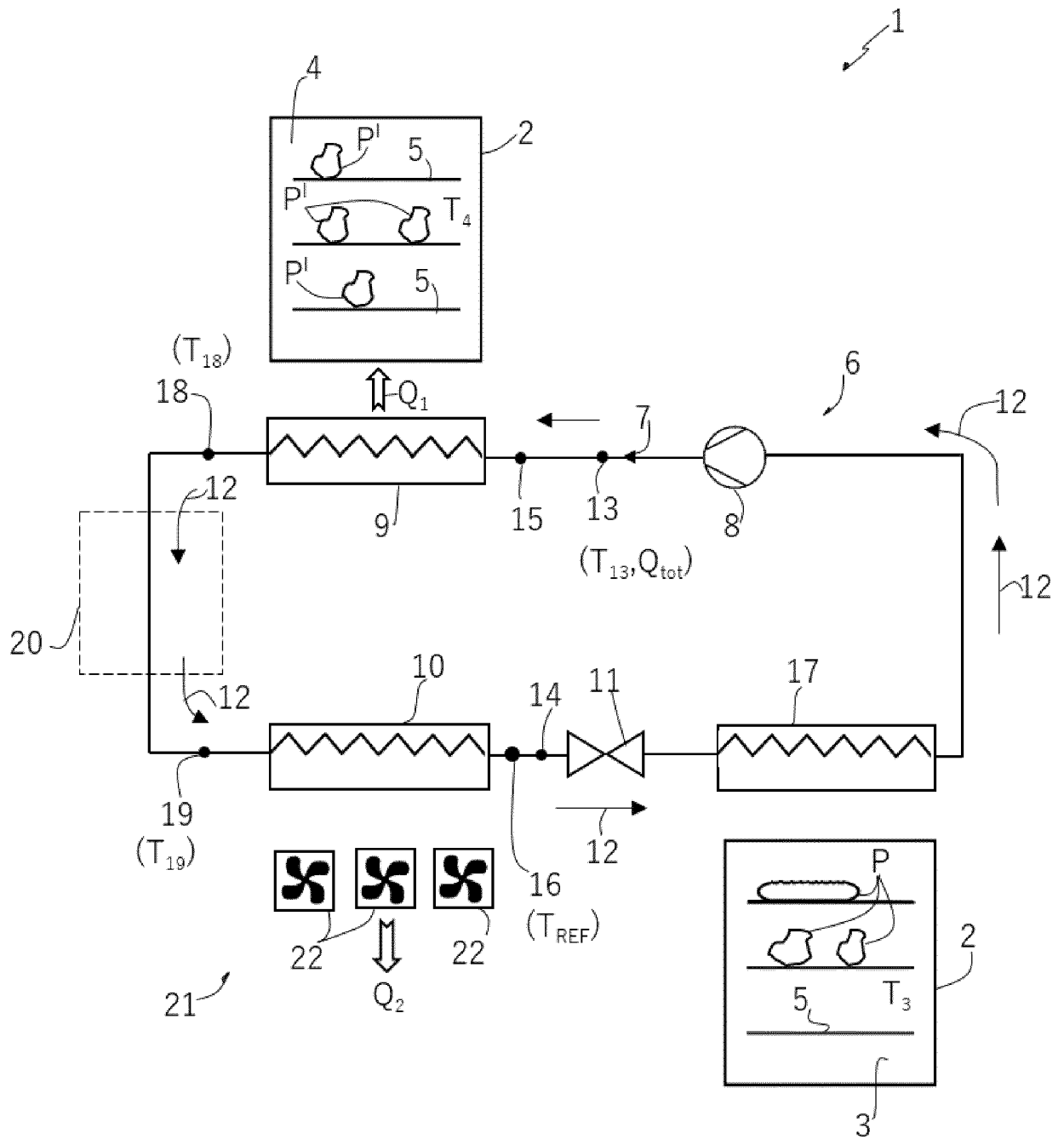


FIG. 1

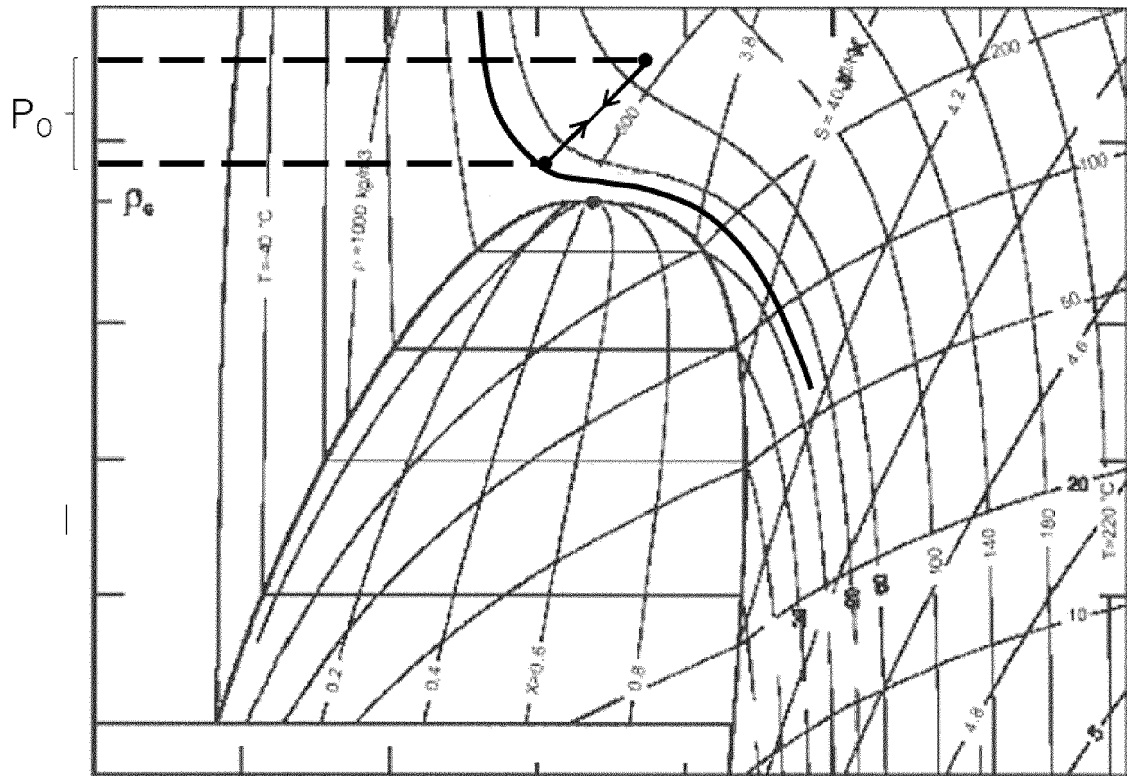


FIG. 2



EUROPEAN SEARCH REPORT

Application Number

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The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 12 October 2022	Examiner Yousufi, Stefanie
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