



(11)

EP 4 534 930 A1

(12)

EUROPEAN PATENT APPLICATION

(43) Date of publication:
09.04.2025 Bulletin 2025/15

(51) International Patent Classification (IPC):
F25D 17/06^(2006.01) F25D 19/04^(2006.01)

(21) Application number: **24204800.7**

(52) Cooperative Patent Classification (CPC):
F25D 17/06; F25D 19/04

(22) Date of filing: **04.10.2024**

(84) Designated Contracting States:
**AL AT BE BG CH CY CZ DE DK EE ES FI FR GB
GR HR HU IE IS IT LI LT LU LV MC ME MK MT NL
NO PL PT RO RS SE SI SK SM TR**
Designated Extension States:
BA
Designated Validation States:
GE KH MA MD TN

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(30) Priority: **06.10.2023 IT 202300020730**

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(54) **REFRIGERATING MACHINE FOR FOOD PRODUCTS AND RELATED OPERATING METHOD**

(57) A refrigerating machine (1) for food products comprising: an outer casing (2) internally provided with a large thermal-insulated compartment (3) adapted to contain the food product(s) to be preserved; an electrically-operated cooling assembly (5), which in turn comprises: a plurality of heatpump refrigeration circuits (8) separate and independent of one another, each of which is provided with a low-pressure heat exchanger (11) which is capable of cooling the inside of the thermal-insulated compartment (3); and an oblong-shaped forced-air heat exchange unit (15), which extends inside the thermal-insulated compartment (3) parallel to a given first direction (d_1), and is structured so as to accommodate said low-pressure heat exchangers (11) arranged so as to form at least two rows of low-pressure heat exchangers, which extend along said first direction (d_1) side by side and superimposed on one another; and a ventilation apparatus (9) is structured so as to generate a transversal airflow (f) that flows substantially perpendicular to said at least two rows of low-pressure heat exchangers (11) passing through said rows of low-pressure heat exchangers (11). (Figure 2)

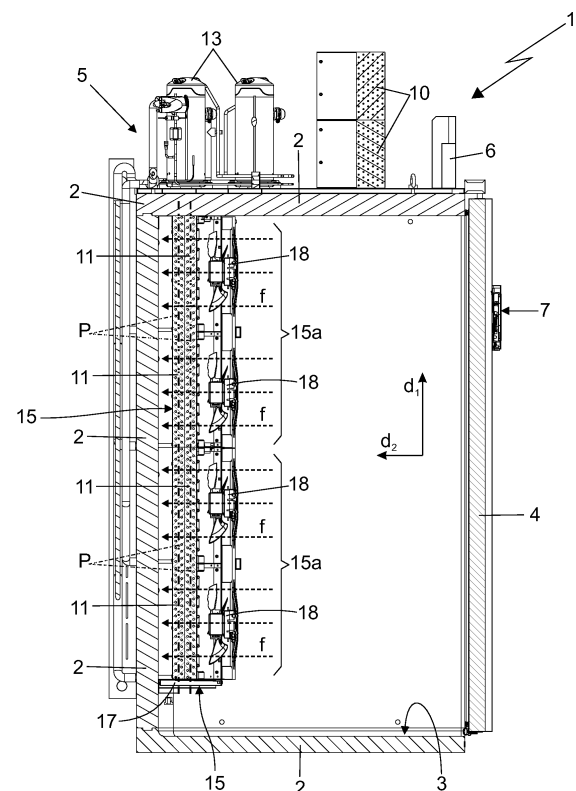


Fig. 2

Description

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This patent application claims priority from Italian patent application no. 102023000020730 filed on October 6, 2023, the entire disclosure of which is incorporated herein by reference.

TECHNICAL FIELD

[0002] The present invention relates to a refrigerating machine for food products and to its operation method.

[0003] In greater detail, the present invention relates to a professional blast chiller for food products, which is particularly suitable for use in restaurant kitchens, canteens, pastry shops, and the like. Apparatus to which the following description will make explicit reference without thereby losing generality.

STATE OF THE ART

[0004] As is well known, blast chillers for food products are apparatuses capable of quickly cooling and/or freezing foods and other food products, even when just taken out of the oven, while preserving their fragrance, consistency, colours and nutritional values, and more generally all their organoleptic properties.

[0005] Today's professional food-products blast chillers comprise: an outer box-like casing, generally substantially parallelepiped in shape and with a self-supporting structure, which is usually made of stainless steel and is internally provided with a large storage compartment substantially parallelepiped in shape, which is adapted to contain the food to be processed, is appropriately thermal-insulated so as to minimize heat exchange with the outside, and communicates with the outside through a large access opening located on the front face of the box-like casing; a door substantially rectangular in shape and with a thermal-insulated structure, which is flag hinged to the outer casing so as to be movable about a vertical axis to and from a closed position in which the door rests on the front face of the casing so as to close more or less hermetically the access opening to the thermal-insulated compartment; and an electrically-operated heat-pump cooling assembly, which is capable of cooling the content of the thermal-insulated compartment.

[0006] Unlike traditional refrigerators that are notoriously known to be structured to continuously maintain the food at a pre-set temperature, usually ranging between +3°C and +6°C, the food-products blast chillers are moreover provided with an electronic control unit that commands the heat-pump cooling assembly so as to bring, to a pre-set target temperature (generally between -20°C and +3°C) and within a pre-set and relatively short time interval, the usually hot food product placed inside the thermal-insulated compartment, following a pre-set cooling curve that depends on the type of food product

momentarily placed inside the thermal-insulated compartment.

[0007] The target temperatures of the cooling process and the related timing are determined by the current regulations on food hygiene and safety.

[0008] In addition, in the most modern and sophisticated blast chillers, the heat-pump cooling assembly is divided into a plurality of heat-pump refrigeration circuits, separate and independent of one another, each of which is capable of cooling the inside of the thermal-insulated compartment separately and independently of the other heat-pump refrigeration circuits.

[0009] This trick allows the cooling power supplied by the cooling assembly to be partialized, if necessary, while maintaining high efficiency.

[0010] The electronic control unit, in fact, is capable of selectively activating just a few heat-pump refrigeration circuits among those available, so as to partialize the cooling power supplied by the cooling assembly.

[0011] The reduced-power operation, for example, is used when the temperature of the content of the thermal-insulated compartment must be maintained substantially constant over time.

[0012] In greater detail, in the most sophisticated blast chillers, the low-pressure heat exchangers of the various heat-pump refrigeration circuits that make up the cooling assembly are placed in a vertical position, one above the other and substantially coplanar to one another, on a special oblong support framework, which is arranged in a vertical position inside the thermal-insulated compartment, nearly skimming the rear wall thereof, and which additionally supports a series of axial-flow electric fans, each of which is capable of generating a horizontal airflow passing through the facing low-pressure heat exchanger.

[0013] In other words, the oblong support framework is vertically divided into a series of consecutive sections, each of which accommodates a single, vertically-positioned low-pressure heat exchanger, and at least one axial-flow fan horizontally flanked to the low-pressure heat exchanger.

[0014] The arrangement of the low-pressure heat exchangers on the same/single vertical lying plane parallel to the rear wall of the thermal-insulated compartment allows to minimize the overall depth of the internal support framework and, consequently, to maximize the working volume of the thermal-insulated compartment.

[0015] Unfortunately, while ensuring an outstanding control of the cooling power supplied, the heat-pump cooling assembly described above is rarely operated at reduced power, because the deactivation of some heat-pump refrigeration circuits in order to partition the cooling power supplied produces, within the thermal-insulated compartment of the blast chiller, an uneven temperature distribution that in some cases can cause serious problems to the food products currently contained in the thermal-insulated compartment.

[0016] In fact, experimental tests have shown that the selective deactivation of some heat-pump refrigeration

circuits causes, in the areas of the thermal-insulated compartment in front of the temporarily deactivated low-pressure heat exchangers, slightly warmer airflows, which stratify inside the thermal-insulated compartment and affect only some limited areas of the internal volume, with evident problems for the food products that are located in these warmer areas and do not maintain the expected temperature.

SUMMARY OF THE INVENTION

[0017] Aim of the present invention is to provide a heat-pump cooling assembly which, with the same versatility and performance, can overcome the drawbacks described above.

[0018] In accordance with these aims, according to the present invention there is realized a refrigerating machine for food products as defined in claim 1 and preferably, though not necessarily, in any one of the claims dependent thereon.

[0019] In addition, according to the present invention there is provided an operation method off a refrigerating machine for food products as defined in claim 11 and preferably, though not necessarily, in any one of the claims dependent thereon.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020] The present invention will now be described with reference to the accompanying drawings, which illustrate a non-limiting embodiment thereof, wherein:

- Figure 1 is a perspective view of a refrigerating machine for food products realized according to the teachings of the present invention, with parts removed for clarity's sake;
- Figure 2 is a side view of the refrigerating machine in Figure 1, sectioned along the mid-plane and with parts removed for clarity's sake;
- Figure 3 is a perspective view of the forced-air heat exchange unit of the refrigerating machine illustrated in Figures 1 and 2, with parts removed for clarity's sake;
- Figure 4 is a partially exploded perspective view of the forced-air heat exchange unit illustrated in Figure 3, with parts removed for clarity's sake; whereas
- Figure 5 is a schematic view of the heat-pump cooling assembly partially illustrated in Figure 3.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0021] With reference to Figures 1 and 2, number 1 denotes, as a whole, a refrigerating machine for food products, which is capable of rapidly cooling and/or freezing foods and other food products, even still hot, preferably while preserving the fragrance, consistency, colours and, more generally, the organoleptic properties of the food product.

[0022] The refrigerating machine 1 therefore finds particularly advantageous use in restaurant kitchens, canteens, pastry shops, and the like.

[0023] In greater detail, the refrigerating machine 1 is preferably capable of bringing, within a pre-set and relatively short time interval (generally 90-240 minutes), food or other food products placed inside it to a pre-set target temperature advantageously ranging between -40°C and +40°C, preferably following a pre-set cooling curve that depends on the temperature and/or the type of food momentarily contained within the same refrigerating machine 1.

[0024] In other words, the refrigerating machine 1 is preferably a professional blast chiller for food products, which can be advantageously used to rapidly freeze food and other food products, even if they are still hot, thereby counteracting bacterial growth and preventing formation of ice macro-crystals inside the product.

[0025] With particular reference to Figures 1 and 2, the refrigerating machine 1 firstly comprises: a rigid outer casing 2, preferably with a box-like and self-supporting structure, which is internally provided with a large storage compartment 3 suitably thermal-insulated so as to minimize heat exchange with the outside, which compartment is adapted to contain the food product(s) to be rapidly cooled and communicates with the outside through a large access opening preferably located on the front face of the same outer casing 2; and a door 4 preferably with a thermal-insulated and/or substantially plate-like structure, which is adapted to close, preferably in a substantially fluid-tight manner, the access opening to the thermal-insulated compartment 3.

[0026] In greater detail, the door 4 is preferably hinged to the outer casing 2 so as to freely rotate to and from a closed position (see Figures 1 and 2) in which the door 4 closes the access opening to the thermal-insulated compartment 3, preferably in a substantially fluid-tight manner.

[0027] In the example shown, in particular, the outer casing 2 is preferably substantially parallelepiped (rectangular parallelepiped) in shape.

[0028] The thermal-insulated compartment 3, in turn, preferably has a substantially parallelepiped shape complementary to that of the outer casing 2, and preferably communicates with the outside through a substantially rectangular, access opening that is conveniently realized on the vertical front wall of the outer casing 2.

[0029] The door 4, in turn, is preferably substantially rectangular, and is preferably flag hinged to the front face of the outer casing 2 so as to be able to rotate about an advantageously substantially vertical rotation axis A, to and from a closed position (see Figures 1 and 2) in which the door 4 rests on the front face of the outer casing 2 and closes, preferably substantially hermetically, the access opening to the thermal-insulated compartment 3.

[0030] With reference to Figures 1 to 5, the refrigerating machine 1 moreover comprises: an electrically-operated cooling assembly 5, which is at least partially

housed inside the thermal-insulated compartment 3 and is adapted to cool, on command, the content of the same thermal-insulated compartment 3; and an electronic control unit 6, which is preferably located outside the outer casing 2, and is adapted to command the cooling assembly 5, preferably in accordance with the signals coming from one or more temperature sensors (not shown in the figures), which are capable of detecting, continuously or at regular intervals, the temperature inside the thermal-insulated compartment 3.

[0031] In addition or alternatively, the electronic control unit 6 is preferably also adapted to command the cooling assembly 5 according to signals coming from one or more portable temperature probes (not shown in the figures), which are adapted to detect, continuously or at regular intervals, the temperature inside the food or other food product momentarily located inside the thermal-insulated compartment 3.

[0032] In greater detail, the electronic control unit 6 is adapted to command the cooling assembly 5 so that the temperature measured inside the thermal-insulated compartment 3 is brought to a pre-set target value preferably ranging between -40°C and $+40^{\circ}\text{C}$, within a pre-set time interval preferably, though not necessarily, ranging between 60 and 240 minutes.

[0033] Moreover, the electronic control unit 6 is preferably also adapted to command the cooling assembly 5 so that the temperature measured inside the thermal-insulated compartment 3 and/or the temperature of the food product(s) momentarily present inside the thermal-insulated compartment 3 reaches the target temperature following a predetermined cooling curve.

[0034] Clearly, the target temperature and the cooling curve depend on the type of food product present in the thermal-insulated compartment 3 and on the food-product initial temperature, and are preferably suitable for preserving the organoleptic properties of the same food product.

[0035] Preferably, the value of the target temperature and/or the timing to reach the target temperature and/or the cooling curve up to the target temperature is/are moreover manually selected/selectable by the user via a control panel 7 located on the outside of the refrigerating machine, preferably on the outer face of door 4. Clearly, the control panel 7 may also be placed on the outside of the outer casing 2.

[0036] In greater detail, in the example shown the electronic control unit 6 is preferably equipped with a non-volatile memory, which stores a series of target temperatures, the timing to reach the same target temperature, and a series of cooling curves up to the target temperature, each of which is uniquely associated with a type of food. The user can thus select the desired target temperature and the timing to reach the same target temperature via the control panel 7.

[0037] With reference to Figures 1 to 5, the cooling assembly 5, on the other hand, comprises a plurality of electrically-operated heat-pump refrigeration circuits 8,

separate and independent of one another, each of which is capable of cooling, on command, the content of the thermal-insulated compartment 3, separately and independently of the other heat-pump refrigeration circuits 8.

[0038] In greater detail, each heat-pump refrigeration circuit 8 is provided with a low-pressure air/refrigerant-fluid heat exchanger, traditionally called evaporator, which is located inside the thermal-insulated compartment 3 and is structured so as to allow the low-temperature refrigerant fluid flowing through it to remove heat from the air inside the same thermal-insulated compartment 3.

[0039] In addition, the cooling assembly 5 further comprises an advantageously electrically-operated, internal ventilation apparatus 9, which is likewise located inside the thermal-insulated compartment 3 and is capable of generating, on command, an air flow that passes through the low-pressure heat exchangers of the various heat-pump refrigeration circuits 8.

[0040] The electronic control unit 6, in turn, is adapted to control the individual heat-pump refrigeration circuits 8 and advantageously also the internal ventilation apparatus 9.

[0041] With particular reference to Figures 2 and 5, in particular each heat-pump refrigeration circuit 8 comprises: a first heat exchanger 10, traditionally called the high-pressure heat exchanger or condenser, which is placed outside the casing 2 and structured so as to allow the high-pressure, high-temperature refrigerant fluid flowing through it to release heat to the outside air; and a second heat exchanger 11, traditionally called the low-pressure heat exchanger or evaporator, which is located inside the thermal-insulated compartment 3 and structured so as to allow the low-pressure, low-temperature refrigerant fluid flowing through it to remove heat from the air inside the thermal-insulated compartment 3.

[0042] Each heat-pump refrigeration circuit 8 additionally comprises: a preferably electrically- or thermostatically-operated, gas expansion device 12 which is interposed between the outlet of the high-pressure heat exchanger 10 and the inlet of the low-pressure heat exchanger 11 and is adapted to cause the rapid and irreversible expansion of the refrigerant fluid flowing from the outlet of the heat exchanger 10 towards the inlet of the heat exchanger 11, so that the refrigerant fluid entering the heat exchanger 11 has a pressure and temperature significantly lower than those of the refrigerant fluid exiting the heat exchanger 10; and an electrically-operated compressor 13, which is interposed between the heat exchangers 10 and 11 and is adapted to compress the refrigerant fluid exiting the heat exchanger 11 and going back to the heat exchanger 10, so that the refrigerant fluid coming out of compressor 13 has a higher temperature and pressure than the refrigerant fluid entering the same compressor 13.

[0043] Similar to the heat exchanger 10, also the compressor 13 is preferably located outside the outer casing 2.

[0044] The electronic control unit 6, in turn, is preferably adapted to command the compressor 13 and, advantageously, also the gas expansion device 12 of each heat-pump refrigeration circuit 8.

[0045] In addition, each heat-pump refrigeration circuit 8 preferably also comprises a dehydrator filter 14, which is advantageously located immediately upstream of the gas expansion device 12, i.e. between the outlet of the high-pressure heat exchanger 10 and the gas expansion device 12, and is adapted to dehumidify the refrigerant fluid directed towards the gas expansion device 12, optionally also retaining any solid particles.

[0046] Preferably, the low-pressure heat exchanger 11 of each heat-pump refrigeration circuit 8 is moreover a finned pack heat exchanger, advantageously with a substantially flat structure.

[0047] Similarly, the high-pressure heat exchanger 10 of each heat-pump refrigeration circuit 8 is preferably a finned pack heat exchanger.

[0048] Clearly, the internal ventilation apparatus 9 is adapted to generate, on command, an air flow that flows through the low-pressure heat exchangers 11 of the various heat-pump refrigeration circuits 8.

[0049] With reference to Figure 5, preferably the cooling assembly 5 furthermore comprises an external ventilation apparatus, still advantageously electrically-operated, which is instead located outside the box-like casing 2 and is adapted to generate, on command, an air flow that passes through the high-pressure heat exchangers 10 of the various heat-pump refrigeration circuits 8.

[0050] The electronic control unit 6, in turn, is preferably also adapted to control the external ventilation apparatus.

[0051] Moreover, with reference to Figures 1 to 5, the low-pressure heat exchangers 11 of the heat-pump refrigeration circuits 8 and the internal ventilation apparatus 9 are incorporated into a large forced-air heat exchange unit 15, which is oblong in shape and extends inside the thermal-insulated compartment 3 parallel to a given first direction d_1 , which is advantageously substantially vertical.

[0052] In addition, the low-pressure heat exchangers 11 of cooling assembly 5 are arranged within the forced-air heat exchange unit 15 so as to form two distinct rows of heat exchangers, preferably substantially of equal length, which extend along direction d_1 side by side and superimposed on one another, advantageously substantially for the entire length/height of the heat exchange unit 15.

[0053] Preferably, the two rows of low-pressure heat exchangers 11 moreover have substantially the same length and/or are formed by an equal number of low-pressure heat exchangers 11.

[0054] In addition, the two rows of low-pressure heat exchangers 11 are preferably also arranged adjoined/-contiguous to one another.

[0055] The internal ventilation apparatus 9, on the other hand, is preferably placed beside one of the two

rows of low-pressure heat exchangers 11, and is structured so as to generate a transversal airflow f , which flows substantially perpendicular to said rows of low-pressure heat exchangers 11 and passes through both rows of low-pressure heat exchangers 11 in succession.

[0056] In other words, the transversal airflow f flows in a second direction d_2 locally substantially perpendicular to direction d_1 . Preferably, direction d_2 is therefore substantially horizontal.

[0057] In greater detail, the forced-air heat exchange unit 15 is preferably longitudinally divided (along direction d_1), or rather vertically, into a number of consecutive longitudinal segments 15a, each of which comprises a pair of low-pressure heat exchangers 11, which belong to two different and distinct heat-pump refrigeration circuits 8 and are arranged one in front of the other, aligned along direction d_2 , so as to be both lapped/passed through by a same transversal airflow f that flows in direction d_2 through the same longitudinal segment 15a of heat exchange unit 15.

[0058] Preferably, on the other hand, the internal ventilation apparatus 9 comprises, per each longitudinal segment 15a of the heat exchange unit 15, a respective electrically-operated ventilation device 16, which is located in front of one of the two low-pressure heat exchangers 11 of the same longitudinal segment 15a, and is adapted to generate an airflow f that passes in succession through both the low-pressure heat exchangers 11 of the longitudinal segment 15a.

[0059] The electronic control unit 6, in turn, is preferably adapted to command the ventilation device 16 of each longitudinal segment 15a of the heat exchange unit 15, advantageously separately and independently of the ventilation devices 16 of the other longitudinal segment(s) 15a of the same heat exchange unit 15.

[0060] Preferably, the two low-pressure heat exchangers 11 of each longitudinal segment 15a of the same heat exchange unit 15 are moreover arranged in direct contact with each other, so that heat can flow by conduction from one heat exchanger to the other.

[0061] In other words, the two low-pressure heat exchangers 11 of each longitudinal segment 15a are adjoined/contiguous to one another.

[0062] With particular reference to Figures 2 and 4, in addition, the two low-pressure heat exchangers 11 of each longitudinal segment 15a of heat exchange unit 15 have a substantially plate-like and advantageously also substantially rectangular structure, and are arranged adjacent to each other with their respective lying planes P locally substantially parallel to each other and substantially perpendicular to direction d_2 .

[0063] Preferably, the two low-pressure heat exchangers 11 are also closely flanked to each other.

[0064] In other words, the two low-pressure heat exchangers 11 of each longitudinal segment 15a of the heat exchange unit 15 are preferably arranged in a substantially vertical position, one flush with the other in a pack or double-layer configuration.

[0065] In greater detail, the two low-pressure heat exchangers 11 of each longitudinal segment 15a are preferably finned pack heat exchangers that are substantially flat and also advantageously rectangular. In addition, the finned bodies of the two low-pressure heat exchangers 11 are preferably made in one piece.

[0066] In other words, the low-pressure heat exchangers 11 belonging to a same longitudinal segment 15a of the forced-air heat exchange unit 15 share the same finned body.

[0067] The ventilation device 16 of each longitudinal segment 15a of the heat exchange unit 15, in turn, is adapted to generate an airflow f substantially perpendicular to the two major faces of both heat exchangers 11 of the longitudinal segment 15a.

[0068] Preferably, the two low-pressure heat exchangers 11 of each longitudinal segment 15a of the heat exchange unit 15 are moreover substantially coplanar each with a respective low-pressure heat exchanger 11 of the immediately adjacent longitudinal segment(s) 15a.

[0069] With reference to Figures 1 to 5, in particular, the forced-air heat exchange unit 15 preferably is substantially oblong parallelepiped (rectangular parallelepiped) in shape and preferably extends inside the thermal-insulated compartment 3 advantageously in a substantially vertical direction, while remaining locally almost flush with the rear wall of the same thermal-insulated compartment 3.

[0070] In other words, the forced-air heat exchange unit 15 extends inside the thermal-insulated compartment 3 while remaining locally substantially parallel to the rear wall of the thermal-insulated compartment 3, at a distance from the same rear wall advantageously less than 30-40 cm (centimetres).

[0071] In greater detail, the distance between the forced-air heat exchange unit 15 and the rear wall of the thermal-insulated compartment 3 advantageously ranges between 5 and 20 cm (centimetres).

[0072] With reference to Figures 3 and 4, in particular, the heat exchange unit 15 preferably comprises a rigid and oblong support framework 17, which extends rectilinearly in direction d_1 and is adapted to be rigidly fixed to the box-like casing 2, inside the thermal-insulated compartment 3, advantageously in a substantially vertical position and/or almost flush with the rear wall of the thermal-insulated compartment 3.

[0073] In greater detail, the forced-air heat exchange unit 15, or rather its support framework 17, is preferably adapted to be butt-fixed/anchored to the upper wall of the thermal-insulated compartment 3, so as to hang inside the thermal-insulated compartment 3 in a substantially vertical position.

[0074] In addition, the support framework 17 is preferably provided with a plurality of pass-through housing seats 17a, advantageously substantially rectangular in shape, which are arranged one after the other along the length of the support framework 17, and are adapted to accommodate each a respective pair of low-pressure

heat exchangers 11 preferably of the finned-pack type, advantageously together with the related ventilation device 16.

[0075] In other words, each housing seat 17a is adapted to accommodate the low-pressure heat exchangers 11 and advantageously also the ventilation device 16, which concur in forming one longitudinal segment 15a of the forced-air heat exchange unit 15.

[0076] Preferably, the forced-air heat exchange unit 15, or rather the support framework 17, is moreover arranged inside the thermal-insulated compartment 3 so that the lying planes P of the two low-pressure heat exchangers 11 of each longitudinal segment 15a of the heat exchange unit 15 are substantially parallel to the rear wall of the thermal-insulated compartment 3.

[0077] In other words, direction d_2 is preferably locally substantially perpendicular to the rear wall of the thermal-insulated compartment 3.

[0078] The ventilation device 16 of each longitudinal segment 15a of heat exchange unit 15, on the other hand, is preferably arranged flush with one of the two low-pressure heat exchangers 11, advantageously on the other side with respect to the rear wall of the thermal-insulated compartment 3.

[0079] In greater detail, the/each ventilation device 16 preferably comprises at least one electrically-operated axial-flow fan 18, which is advantageously arranged flush with one of the major faces of one of the two low-pressure heat exchangers 11 belonging to the longitudinal segment 15a.

[0080] Preferably, the axial-flow fan 18 is moreover a variable-speed fan, and the electronic control unit 6 is preferably adapted to control/vary the rotation speed of the fan.

[0081] With reference to Figures 1 to 5, in the example shown, in particular, the forced-air heat exchange unit 15 is preferably vertically divided into two longitudinal sections 15a, each of which is provided with a pair of low-pressure heat exchangers 11, advantageously of the finned-pack type, which are arranged vertically adjacent to each other.

[0082] The cooling assembly 5 therefore comprises four electrically-operated heat-pump refrigeration circuits 8 separate and independent of one another.

[0083] Preferably, the finned bodies of each pair of low-pressure finned-pack heat exchangers 11 are also made in one piece.

[0084] Additionally, the/each ventilation device 16 preferably comprises a pair of electrically-operated axial-flow fans 18, which are arranged side by side, substantially coplanar with each other, and are substantially grazing one of the major faces of one of the two low-pressure heat exchangers 11 of the longitudinal segment 15a.

[0085] Preferably, the electronic control unit 6 is moreover programmed/configured to simultaneously activate and deactivate both axial-flow fans 18.

[0086] Finally, in the example shown the high-pressure

heat exchangers 10 and the compressors 13 of the various heat-pump refrigeration circuits 8 are preferably located on the top of the box-like casing 2, clearly outside of the same casing.

[0087] The operation of refrigerating machine 1 includes a maximum-power operating mode in which the cooling assembly 5 must supply the maximum cooling power, and a reduced-power operating mode in which the cooling assembly 5 must supply a cooling power substantially equal to half of the maximum power.

[0088] The maximum-power operating mode is typically used when the content inside the thermal-insulated compartment 3 needs to be cooled as quickly as possible.

[0089] The reduced-power operating mode, on the other hand, is advantageously used when thermostating the content of the thermal-insulated compartment 3, i.e. to keep the temperature of the content of the thermal-insulated compartment 3 substantially constant over time. Clearly, the reduced-power operating mode can also be used in other steps of the cooling cycle.

[0090] Similarly to what occurs in the blast chillers currently on the market, in the maximum-power operating mode, the electronic control unit 6 activates the internal ventilation apparatus 9, or rather all the ventilation devices 16, and all the low-pressure heat exchangers 11 present in the heat exchange unit 15.

[0091] Clearly, the activation of a low-pressure heat exchanger 11 implies the activation of the corresponding heat-pump refrigeration circuit 8, or rather the activation of the compressor 13 of the corresponding heat-pump refrigeration circuit 8.

[0092] In the reduced-power operating mode, on the other hand, the electronic control unit 6 activates the internal ventilation apparatus 9, or rather all the ventilation devices 16, and a subgroup of low-pressure heat exchangers 11 that, however, is distributed substantially seamlessly along the (full) length of the heat exchange unit 15. Clearly, the low-pressure heat exchangers 11 that do not belong to this subgroup remain inactive.

[0093] In other words, the electronic control unit 6 is programmed/configured so as to selectively activate a subgroup of low-pressure heat exchangers 11 distributed substantially seamlessly along the (full) length of the forced-air heat exchange unit 15.

[0094] Clearly, this subgroup of low-pressure heat exchangers 11 comprises a total number of low-pressure heat exchangers 11 equal to that forming a single row of heat exchangers 11.

[0095] In other words, this subgroup of low-pressure heat exchangers 11 comprises half of the low-pressure heat exchangers 11 occurring in the forced-air heat exchange unit 15.

[0096] With reference to Figure 4, in the example shown, in particular, said subgroup of low-pressure heat exchangers 11 consists of the heat exchangers 11 marked with the Roman numerals I and III, or the heat exchangers 11 marked with the Roman numerals II and IV, or the heat exchangers 11 marked with the Roman

numerals I and IV, or the heat exchangers 11 marked with the Roman numerals II and III.

[0097] In this way, even when the cooling power is partialized, the airflow *f* flowing out of each longitudinal segment 15a of the heat exchange unit 15 has previously passed through an active/working low-pressure heat exchanger 11, i.e. a heat exchanger passed through by a low-temperature refrigerant fluid that can remove heat from the airflow *f*.

[0098] The airflow *f* flowing out of the forced-air heat exchange unit 15 therefore has substantially the same temperature along the full length of the same heat exchange unit 15.

[0099] Furthermore, the electronic control unit 6 is preferably programmed/configured to keep all the ventilation devices 16 of the internal ventilation apparatus 9 active, both in the maximum-power operating mode and in the reduced-power operating mode.

[0100] In greater detail, the electronic control unit 6 is preferably programmed/configured to activate, in the reduced-power operating mode, only one/single low-pressure heat exchanger 11 per each longitudinal segment 15a of the heat exchange unit 15, or rather only one heat-pump refrigeration circuit 8 per each longitudinal segment 15a of the heat exchange unit 15.

[0101] Preferably, said subgroup of low-pressure heat exchangers furthermore consists of any one of the two rows of low-pressure heat exchangers 11 occurring in the heat exchange unit 15.

[0102] In other words, in the reduced-power operating mode, the electronic control unit 6 is preferably programmed/ configured to activate all the low-pressure heat exchangers 11 belonging to only one of the two rows of low-pressure heat exchangers 11 occurring in the forced-air heat exchange unit 15.

[0103] In addition, the electronic control unit 6 is preferably also programmed/configured so as to periodically change, during the reduced-power operating mode, the low-pressure heat exchangers 11 belonging to said subgroup of low-pressure heat exchangers 11.

[0104] In other words, during the reduced-power operating mode, the electronic control unit 6 is preferably programmed/ configured to change, advantageously at more or less regular intervals, the composition of said subgroup of low-pressure heat exchangers 11, clearly keeping the number of heat exchangers 11 unchanged.

[0105] In greater detail, the electronic control unit 6 is preferably programmed/configured to change periodically and by turns the row of low-pressure heat exchangers 11 of the forced-air heat exchange unit 15, which remains active during the reduced-power operating mode.

[0106] In other words, during the reduced-power operating mode, the electronic control unit 6 is preferably programmed/ configured to alternately activate the two rows of low-pressure heat exchangers 11 of the forced-air heat exchange unit 15.

[0107] The advantages resulting from the particular

structure of the cooling assembly 5, or rather of the forced-air heat exchange unit 15, are remarkable.

[0108] Firstly, the distribution of the low-pressure heat exchangers 11 along two overlapping rows allows for an extremely homogeneous temperature distribution during the reduced-power operating mode.

[0109] In addition, the periodic switching from one row of heat exchangers 11 to the other during the reduced-power operating mode minimizes the on and off cycles of the compressors 13 of the various heat-pump refrigeration circuits 8, thereby increasing the average lifespan of these components.

[0110] In addition, by sharing the finned pack with another heat exchanger 11, each low-pressure heat exchanger 11 is able to offer a much larger heat-exchange surface area, resulting in increased efficiency and effectiveness.

[0111] Moreover, due to the larger heat exchange surface area, the cooling assembly 5 allows for a higher and more uniform moisture content inside the thermal-insulated compartment 3 during the reduced-power operating mode.

[0112] Finally, in the event of a failure of one or more heat-pump refrigeration circuits 8, the cooling assembly 5 is still able to ensure optimum operation at least in the reduced-power operating mode.

[0113] Finally, it is clear that modifications and variations may be made to the above-described refrigerating machine 1 without however departing from the scope of the present invention.

[0114] For example, the low-pressure heat exchangers 11 of the cooling assembly 5 could be arranged inside the forced-air heat exchange unit 15 so as to form three or more rows of low-pressure heat exchangers 11, which extend in direction d_1 , one overlapped and advantageously also leaned against the other.

[0115] In greater detail, each longitudinal segment 15a of the forced-air heat exchange unit 15 may include three or more low-pressure heat exchangers 11, which are arranged side by side and overlapped on one another so that all are lapped/ passed through by the airflow f that flows in direction d_2 through the same longitudinal segment 15a of the heat exchange unit 15.

[0116] In the reduced-power operating mode, moreover, the electronic control unit 6 may also activate just one of the three or more rows of low-pressure heat exchangers 11 present in the heat exchange unit 15, or in any case a subgroup of low-pressure heat exchangers 11 distributed substantially seamlessly along the full length of the heat exchange unit 15.

[0117] Of course, the subgroup of low-pressure heat exchangers 11 is equal to a submultiple of the total low-pressure heat exchangers 11, or rather of the heat-pump refrigeration circuits 8 belonging to the cooling assembly 5.

[0118] Clearly, since the forced-air heat exchange unit 15 is provided with three or more rows of low-pressure heat exchangers 11, the minimum cooling power sup-

plied by the cooling assembly 5 is equal to an integer submultiple of the maximum power that can be supplied.

5 Claims

1. A refrigerating machine (1) for food products comprising: an outer casing (2) internally provided with a large thermal-insulated compartment (3) adapted to contain the food product or products to be preserved; an electrically-operated cooling assembly (5) adapted to cool the content of the thermal-insulated compartment (3); and an electronic control unit (6) that controls the cooling assembly (5);

said cooling assembly (5) comprising: a plurality of heat-pump refrigeration circuits (8) separate and independent of one another, each of which is provided with a low-pressure heat exchanger (11) which is capable of cooling the inside of the thermal-insulated compartment (3); and an oblong-shaped forced-air heat exchange unit (15), which extends inside the thermal-insulated compartment (3) parallel to a given first direction (d_1), and is structured so as to accommodate said low-pressure heat exchangers (11) and a ventilation apparatus (9) adapted to generate a transversal airflow (f) that passes through said low-pressure heat exchangers (11);

said refrigerating machine (1) being **characterized in that** the low-pressure heat exchangers (11) are arranged in the forced-air heat-exchange unit (15) so as to form at least two rows of low-pressure heat exchangers (11), which extend in said first direction (d_1) side by side and superimposed on one another; **and in that** said ventilation apparatus (9) is structured so as to generate a transversal airflow (f) that flows substantially perpendicular to said at least two rows of low-pressure heat exchangers (11) passing through said rows of low-pressure heat exchangers (11).

2. The refrigerating machine according to claim 1, wherein the electronic control unit (6) is programmed/configured so as to selectively activate a subgroup of low-pressure heat exchangers (11) distributed substantially seamlessly along the length of the forced-air heat-exchange unit (15).
3. The refrigerating machine according to claim 1 or 2, wherein the ventilation apparatus (9) is located beside one of said at least two rows of low-pressure heat exchangers (11).
4. The refrigerating machine according to any one of the preceding claims, wherein said rows of low-pressure heat exchangers (11) are adjoined/contig-

uous to one another.

5. The refrigerating machine according to any one of the preceding claims, wherein said forced-air heat-exchange unit (15) is longitudinally divided into a number of consecutive longitudinal segments (15a), each of which comprises at least two low-pressure heat exchangers (11) that are arranged one in front of the other aligned along a second direction (d_2) substantially perpendicular to said first direction (d_1); said ventilation apparatus (9) being adapted to generate a transversal airflow (f) that flows through the longitudinal segment (15a) in said second direction (d_2).

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 6. The refrigerating machine according to claim 5, wherein said ventilation apparatus (9) comprises, for each longitudinal segment (15a) of said forced-air heat-exchange unit (15), a respective electrically-operated ventilation device (16), which is located in front of one of the low-pressure heat exchangers (11) of the same longitudinal segment (15a) and is adapted to generate an airflow (f) that passes in succession through all the low-pressure heat exchangers (11) of the same longitudinal segment (15a).

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 7. The refrigerating machine according to claim 5 or 6, wherein the electronic control unit (6) is programmed/configured so as to selectively activate a single low-pressure heat exchanger (11) for each longitudinal segment (15a) of said forced-air heat-exchange unit (15).

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 8. The refrigerating machine according to any one of the preceding claims, wherein the low-pressure heat exchangers (11) are finned pack heat exchangers.

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 9. The refrigerating machine according to claim 8, wherein the low-pressure heat exchangers (11) belonging to a same longitudinal segment (15a) of the forced-air heat-exchange unit (15) share the same finned body.

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 10. The refrigerating machine according to any one of the preceding claims, wherein said forced-air heat-exchange unit (15) is arranged inside the thermal-insulated compartment (3) in a substantially vertical position, nearly skimming the rear wall of the thermal-insulated compartment (3).

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 11. Operating method of a refrigerating machine (1) for food products comprising: an outer casing (2) internally provided with a large thermal-insulated compartment (3) adapted to contain the food product or products; and an electrically-operated cooling assembly (5) adapted to cool what's contained inside the thermal-insulated compartment (3);

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- said cooling assembly (5) including an oblong-shaped forced-air heat-exchange unit (15), which extends inside the thermal-insulated compartment (3) parallel to a given first direction (d_1), and accommodates: a plurality of independent low-pressure heat exchangers (11) that are arranged so as to form at least two rows of low-pressure heat exchangers (11), which extend along said first direction (d_1) side by side and superimposed on one another; and a ventilation apparatus (9) adapted to generate a transversal airflow (f) that flows substantially perpendicular to said at least two rows of low-pressure heat exchangers (11) passing through said rows of low-pressure heat exchangers (11); said operating method being **characterized by** comprising a reduced-power operating mode, in which a subgroup of low-pressure heat exchangers (11) distributed substantially seamlessly along the length of the forced-air heat-exchange unit (15) is activated.
12. The operating method of a refrigerating machine for food products according to claim 11, wherein the composition of said subgroup of low-pressure heat exchangers (11) is periodically changed.
 13. The operating method of a refrigerating machine for food products according to claim 11 or 12, wherein said subgroup of low-pressure heat exchangers (11) comprises all of the low-pressure heat exchangers (11) that form a single row of low-pressure heat exchangers (11) of the forced-air heat-exchange unit (15).

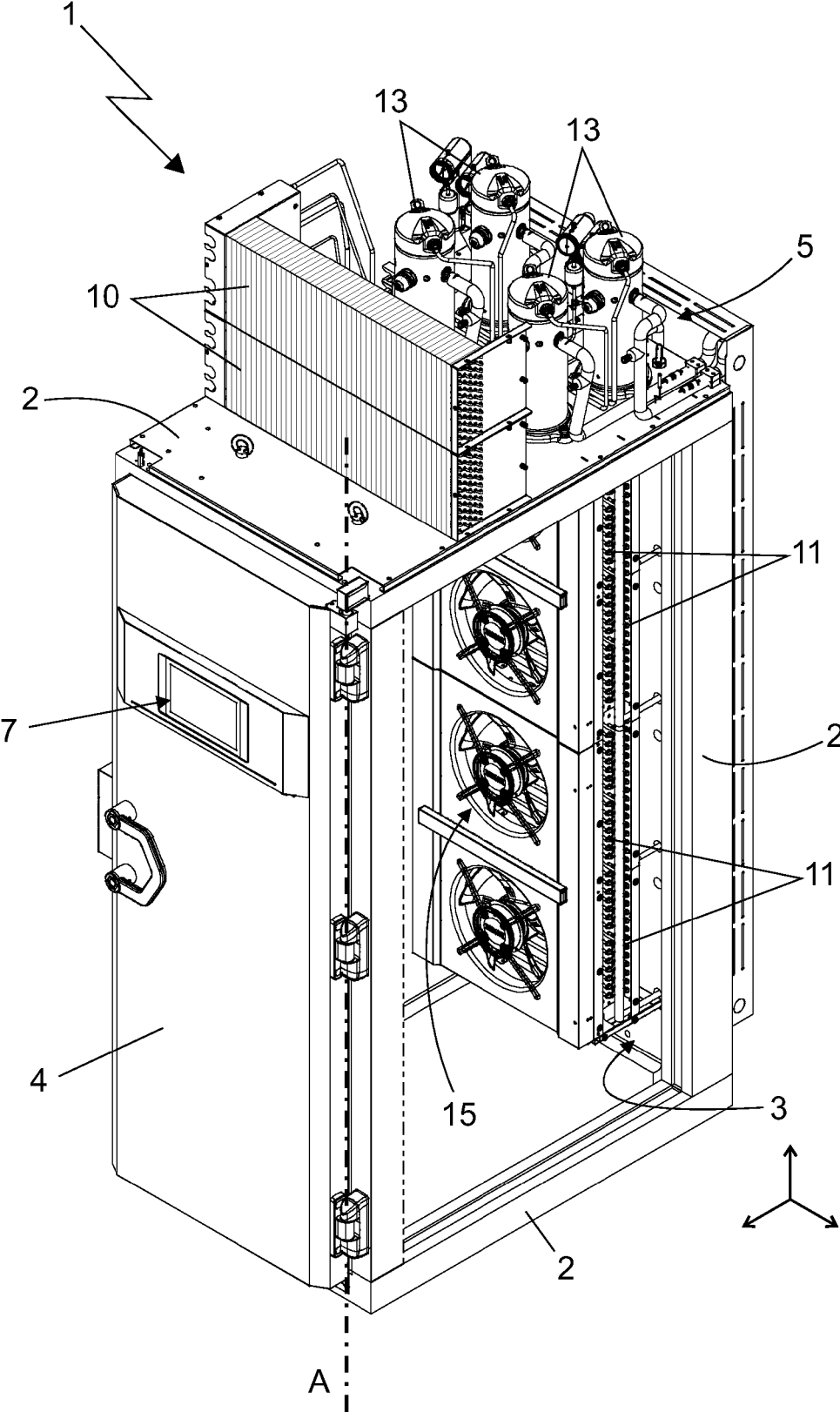


Fig. 1

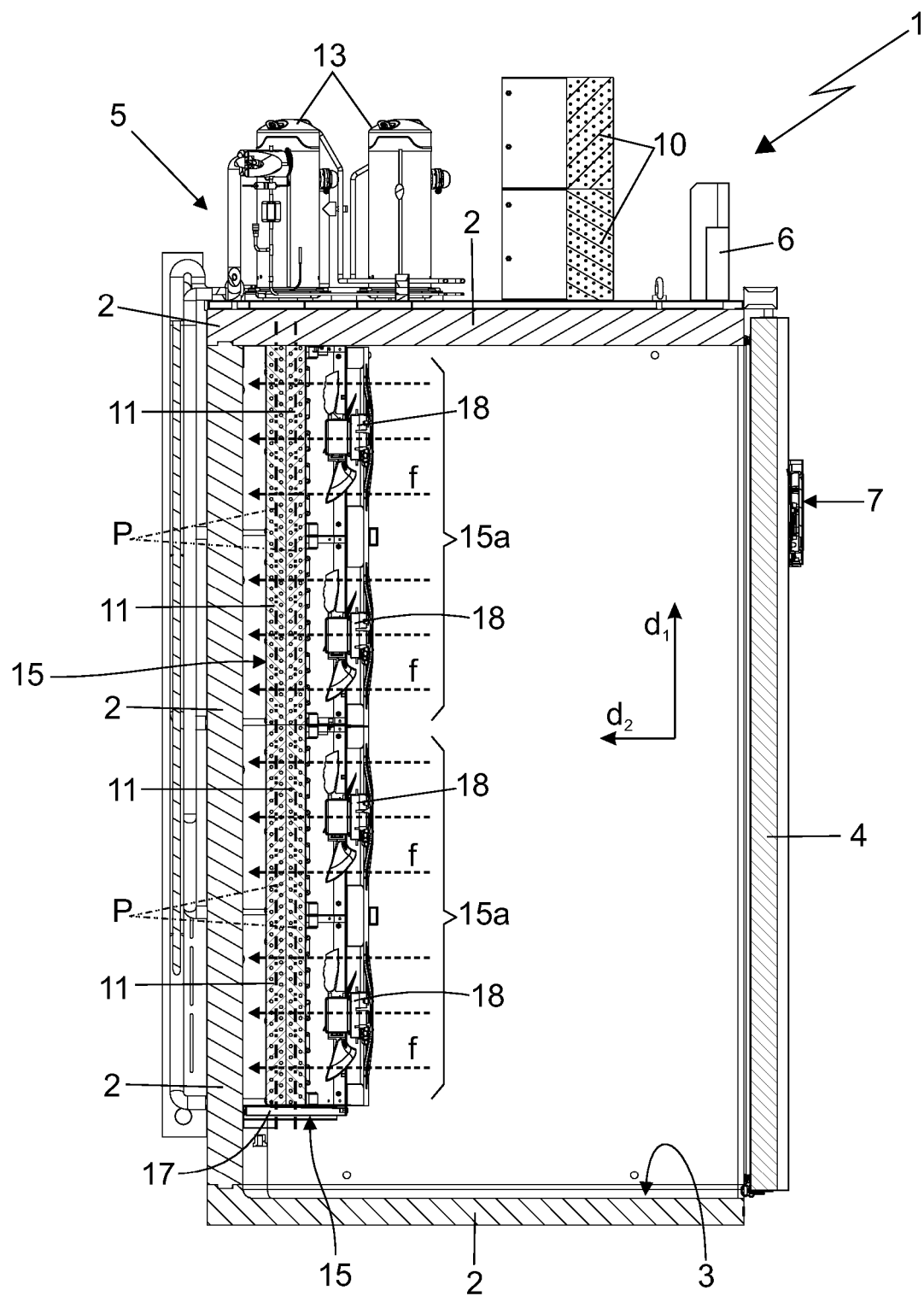


Fig. 2

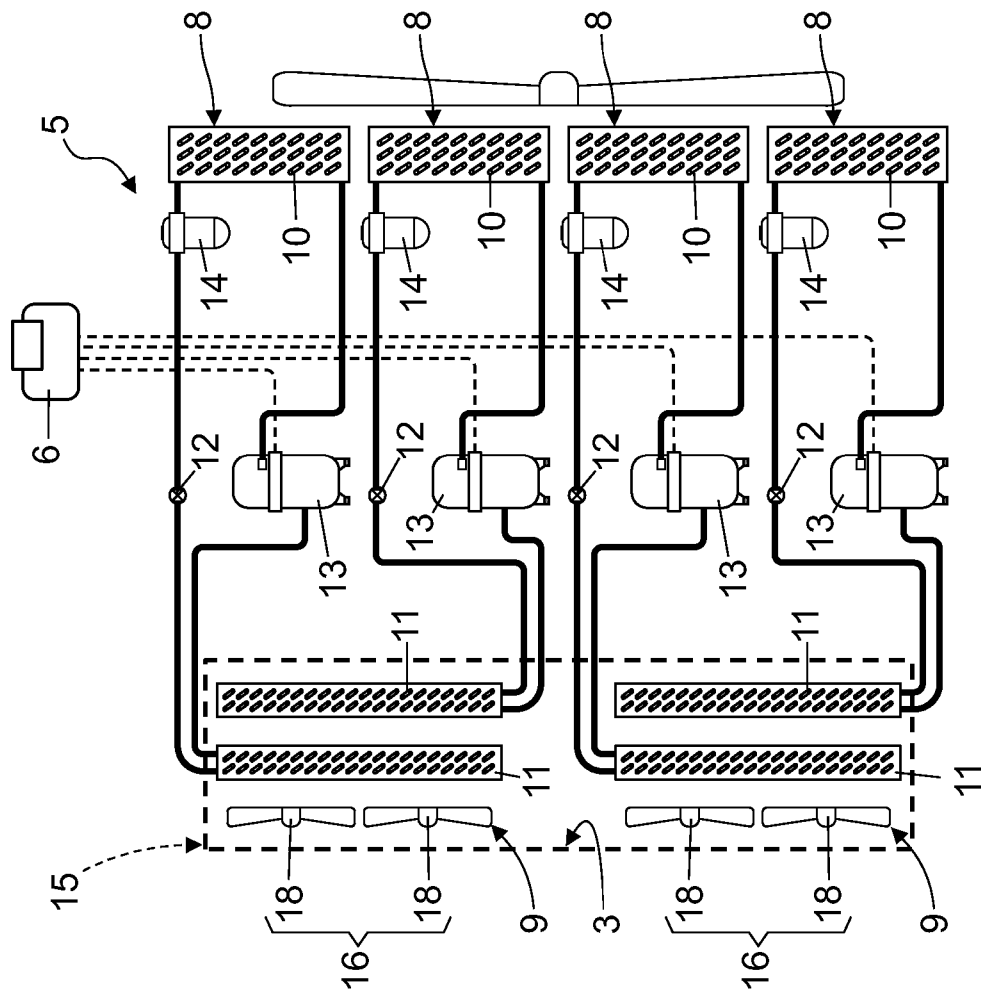


Fig. 5

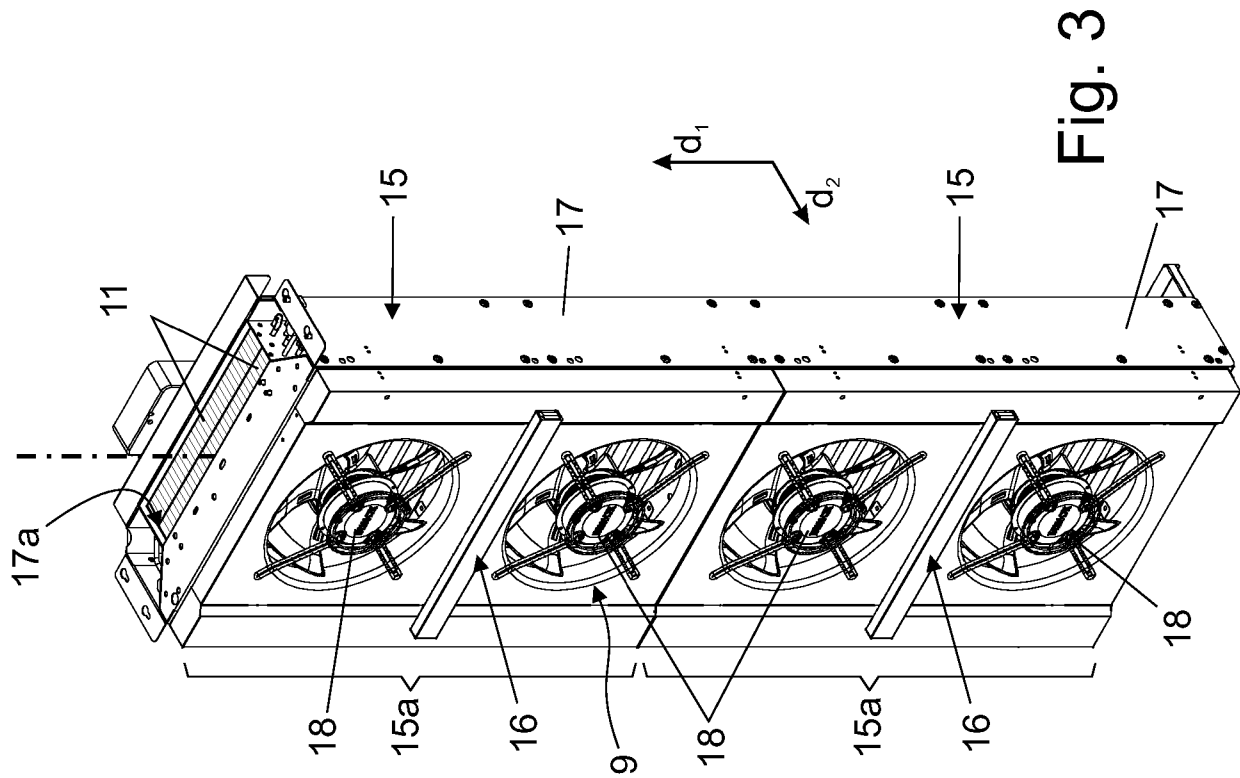


Fig. 3

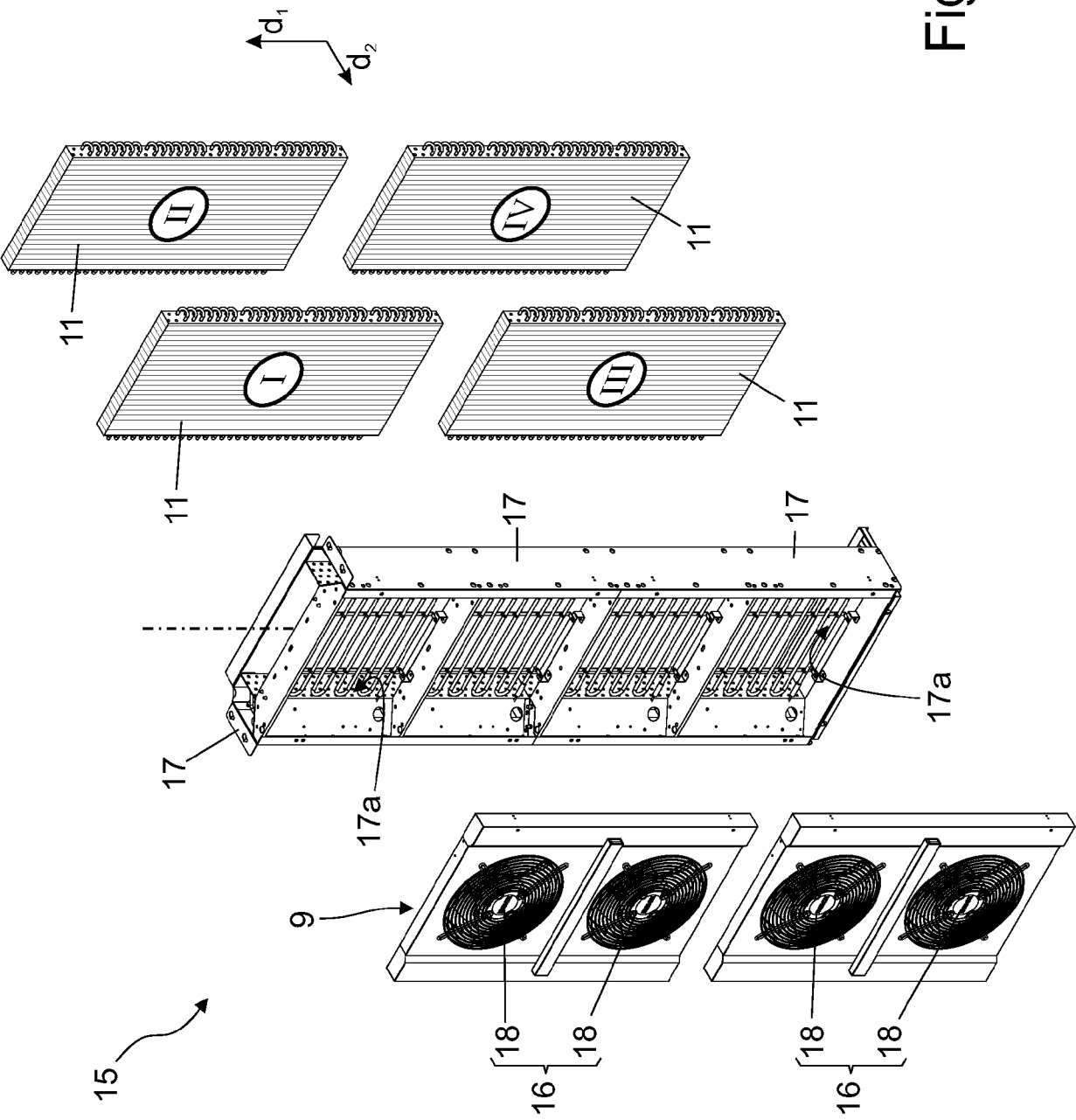


Fig. 4



EUROPEAN SEARCH REPORT

Application Number

EP 24 20 4800

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