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(54) **Multi-compartment refrigerating apparatus for storing fresh food at different temperatures**

(57) A refrigerating apparatus **(100),** particularly for home use, is proposed. The refrigerating apparatus comprises a first fresh-food sub-compartment **(120)** for storing fresh foods at a first range of temperatures, at least a second fresh-food sub-compartment **(125)** for storing fresh foods at a second range of temperatures lower than the first range of temperatures, a panel **(130)** separating the first and second fresh-food sub-compartments, an evaporator **(145)** for commonly refrigerating both the first and second fresh-food sub-compartments - the evaporator is mounted at the rear of the refrigerating apparatus and separated from the fresh-food sub-compartments by a rear panel **(160)** -, a main fan **(135),** provided in a rear wall **(140)** and passing through the rear panel, for sucking air from the first fresh-food sub-compartment and to blow the same in an interspace **(165)** and through the evaporator to be cooled down; said air returns into the first fresh-food sub-compartment and reaches the second fresh-food sub-compartment through apertures **(170, 175)** formed by the rear panel. The refrigerating apparatus further comprises a secondary fan **(155)** adapted to suck air from the first fresh-food sub-compartment and to blow it into the second fresh-food sub-compartment in order to raise the temperature thereof.

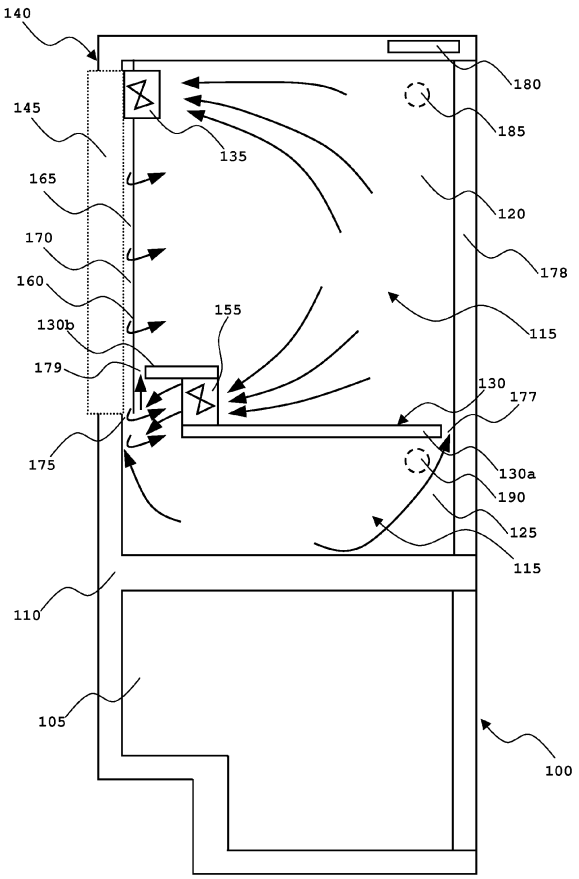

FIG.2

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Description

[0001] The present invention relates to refrigerating apparatuses, particularly refrigerators, for example for domestic use. In particular, the present invention relates to refrigerators provided with two (or more) fresh-food sub-compartments, designed to operate at different ranges of temperatures.

[0002] It is widely known that fresh foods have to be properly stored not to be spoiled and preserving their nutritional qualities. It is also widely known that different foods have different storing requirements; as an example vegetables can be better and longer preserved if they are kept at temperature near zero Celsius degrees, while cheese can be stored for relatively long periods of time at temperatures near ambient temperature (at least in a cold or temperate climate).

[0003] It is also known that most foods loose, partly or fully, their nutritional qualities if they froze (an example are, again, the vegetables) preventing the possibility of storing them in a freezer. Thus, the foods are to be stored in a fresh-food compartment of a refrigerator.

[0004] Refrigerators with two (or more) fresh-food compartments operating at different temperature have been developed, achieving an enhanced storing capability, thanks to the different storage temperature ranges, allowing for store different kinds of food in an optimal way.

[0005] Several refrigerator types with fresh-food compartments kept at different ranges of temperature have been developed. Usually, refrigerators with two fresh-food compartments have one compartment which operates in the range of temperatures typical of refrigerators (*e.g.*, from +3°C up to +7°C), and another compartment operating in a lower range of temperatures, typically near zero Celsius degrees, typically from 0°C to +3°C.

[0006] An easy way to obtain fresh-food compartments operating at different ranges of temperature is providing one evaporator for each compartment. This solution, though ensuring good performances, increases the cost of the refrigerator to a market uncompetitive extent. Another solution is to draw cold air from a freezer provided in the refrigerator (when the refrigerator is integral with a freezer in a so-called combined refrigerator structure) and feed it to the low-temperature fresh-food compartment. This solution, using air at very low temperatures (typically from-18°C to -27°C), may damage the stored food if not properly designed and operated. A further solution may be to use one evaporator shared with the other compartment(s).

[0007] Purpose of the present invention is to provide a cost-effective refrigerator with one or more low temperature compartments, for storing food safely for relative long periods of time.

[0008] One aspect of the present invention relates to a refrigerating apparatus, particularly for home use. The refrigerator comprises a first fresh-food sub-compartment for storing fresh foods at a first range of temperatures, at least a second fresh-food sub-compartment for storing fresh foods at a second range of temperatures lower than the first range of temperatures, a panel separating the first and second fresh-food sub-compartments, an evaporator for commonly refrigerating both the first and second fresh-food sub-compartments - the evaporator being mounted at the rear of the refrigerator and being separated from the fresh-food sub-compartments by a rear panel - and a main fan, provided in a rear wall and passing through the rear panel, for sucking air from the first fresh-food sub-compartment and blowing the same in an interspace and through the evaporator to be cooled down; said air returns into the first fresh-food sub-compartment and reaches the second fresh-food sub-compartment through apertures formed by the rear panel. The refrigerating apparatus further comprises a secondary fan adapted to suck air from the first fresh-food sub-compartment and to blow it into the second fresh-food sub-compartment in order to raise the temperature thereof.

[0009] Preferred features of the method are set forth in the dependent claims.

[0010] The separation panel has a substantially step-like shape, and comprises a first horizontal portion, a second horizontal portion at a higher level compared to the first horizontal portion, and an upright portion joining the first and second horizontal portions; the secondary fan is mounted on the separation panel in correspondence of the upright portion thereof.

[0011] The separation panel comprises or is made of a thermal insulating material for thermally insulating the first fresh-food sub-compartment from the second fresh-food sub-compartment.

[0012] The rear panel has lateral apertures into the first fresh-food sub-compartment and a bottom aperture into the second fresh-food sub-compartment.

[0013] The panel is formed so as to leave at least a frontal gap and/or a rear gap between the separation panel and a refrigerating compartment door, and between the separation panel and the rear panel, respectively.

[0014] The refrigerating apparatus further comprises a control unit for activating the main fan on a regular basis, with a first frequency depending on a prescribed maximum temperature selectable by a user.

[0015] The refrigerating apparatus further comprises a first temperature sensor for detecting a temperature in the first fresh-food sub-compartment, a control unit being configured for activating the main fan upon the detection, by the first temperature sensor, of a temperature higher than a prescribed maximum temperature, selectable by a user.

[0016] The refrigerating apparatus further comprises a second temperature sensor for detecting a temperature in the second fresh-food sub-compartment, the control unit being configured for activating the secondary fan upon the detection, by the second temperature sensor, of a temperature lower than a minimum temperature.

[0017] The control unit is configured for activating the

secondary fan on a regular basis, with a second frequency depending on the minimum temperature.

[0018] The control unit is configured for activating the secondary fan when a difference, sensed by the first temperature sensor between the prescribed maximum temperature and a predetermined temperature difference is equal to, or lower than the minimum temperature.

[0019] The secondary fan is so oriented that the air blown by the secondary fan at least partly stops the air blown by the main fan and out-coming from the apertures of the rear panel into the second fresh-food compartment.

[0020] The prescribed maximum temperature in the first fresh-food sub-compartment ranges from +3°C to +7°C.

[0021] The minimum temperature in the second fresh-food sub-compartment ranges from 0°C to +3°C.

[0022] A method of storing fresh foods, comprising the steps of providing a refrigerator compartment, comprising a first and a second fresh-food sub-compartments; providing a panel for separating the first and the second fresh-food sub-compartments; providing an evaporator; providing a rear panel for separating the evaporator from the first and the second fresh-food sub-compartments; providing apertures in the rear panel for allowing fluid communication between the evaporator and the first and the second fresh-food sub-compartments; providing a main fan communicating with the evaporator and the first fresh-food sub-compartment; providing a secondary fan communicating with the first fresh-food sub-compartment and the second fresh-food sub-compartments; activating the main fan for keeping the temperature of the first fresh-food sub-compartment beneath a maximum temperature, and activating the secondary fan for keeping the temperature of the second fresh-food sub-compartment above a minimum temperature.

[0023] These, and others, features and advantages of the solution according to the present invention will be better understood with reference to the following detailed description of some embodiments thereof, provided for illustrative and not restrictive purposes, to be read in conjunction with the attached drawings. In this regard, it is expressly intended that the drawings are not necessarily to scale and that, unless specified otherwise, they simply aim to conceptually illustrate the structures and procedures. In particular:

Figure 1 shows schematically a front view of a refrigerator, shown without doors, according to an embodiment of the present invention.

Figure 2 shows schematically a sectional view of the refrigerator of **Figure 1** along line **II-II.**

[0024] With reference to the drawings, in **Figure 1** there is shown a frontal view of a refrigerator **100**, without doors, according to an embodiment of the present invention. In particular, the refrigerator **100** is a so-called combined refrigerator, being provided with a freezer compartment **105** in a same casing **110** that comprises a fresh-food compartment **115.** The fresh-food compartment **115** is divided in a first fresh-food sub-compartment **120** and a second fresh-food sub-compartment **125,** separated by a panel **130,** preferably capable of providing thermal insulation. A main fan **135** is provided in the first fresh-food sub-compartment **120,** preferably, albeit not limitatively, near the top of a rear wall **140.** Embedded in the rear wall **140** and in correspondence with the main fan **135** an evaporator **145** (shown with dotted line) is provided. The evaporator **145** extends vertically for most of the height of the first fresh-food sub-compartment **120** and has a lower portion **150** located in correspondence with the second fresh-food sub-compartment **125.** A secondary fan **155** is associated with the panel **130.** Preferably, the panel **130** has a substantially step-like shape, with a first horizontal portion 130a, of prevalent extension, a second horizontal portion **130b,** closer to the rear wall **140** and at a higher level with respect to the first panel portion **130a,** and an upright portion **130c** joining the first and second horizontal portions **130a** and **130b.** The secondary fan **155** is mounted on the panel **130** in correspondence of the upright portion **130c** thereof. In alternative embodiments of the invention, not shown, the panel separating the first and second fresh-food sub-compartments may be shaped differently, for example may be flat, and the secondary fan may be mounted horizontally on it.

[0025] **Figure 2** shows schematically a sectional (on an axis **II-II** shown in **Figure 1)** view of the refrigerator **100** of **Figure 1.** As can be seen, a rear panel **160** defines an interspace **165** with the rear wall **140** and separates the evaporator **145** from the fresh-food compartment **115.** The main fan **135** passes through the rear panel **160** and reaches the interspace **165.** Additionally, the rear panel **160** has a smaller width than the rear wall **140** leaving lateral apertures **170** running along the vertical sides of the rear wall **140** of the fresh-food compartment **115** for a length preferably, albeit not limitatively, corresponding to the length of the evaporator **145.** The panel **160** extends, in the vertical direction, for almost the entire height of the first fresh-food sub-compartment **120,** and also in an upper portion of the second fresh-food sub-compartment **125.** Therefore, the lateral apertures **170** extend, for a main part thereof, in the first fresh-food sub-compartment **120** and, in a shorter part thereof, in the second fresh-food sub-compartment **125.**

[0026] Another aperture **175** is defined at the lower end of the rear panel **160,** still between the panel **160** and the rear wall **140,** into the second fresh-food sub-compartment **125.** Thanks to the lateral apertures **170** and the bottom aperture **175,** a fluid communication between the evaporator **145** and the fresh-food compartment **115** is created. The aperture **175** is preferably placed in front of the secondary fan **155.**

[0027] In further embodiments of the invention, not shown, the rear panel **160** may be substituted by alternative rear panels provided with holes or with a grid-like structure for creating a fluid communication between the

evaporator and the fresh-food compartment **115.**

[0028] Moreover, the first horizontal portion **130a** of the panel **130** has such a length that leaves a frontal gap **177** between a front door **178** of the fresh-food compartment **115** and the panel **130** itself. Additionally or in alternative, a rear gap **179** can be provided between the rear panel **160** and the second horizontal portion **130b** of the panel **130.** Furthermore, additional apertures (not shown) may be provided in the first and second horizontal portions **130a, 130b** as well as in the upright portion **130c** of the panel **130.**

[0029] The operation of the refrigerator **100** is managed by a refrigerator control unit **180.** A first temperature sensor **185** and a second temperature sensor **190** can be provided in the first fresh-food sub-compartment **120** and in the second fresh-food sub-compartment **125,** respectively, for allowing the refrigerator control unit **180** to monitor the temperatures in both the fresh-food sub-compartments **120** and **125.**

[0030] Referring now to both **Figure 1** and **Figure 2,** the operation of the refrigerator **100** will be described. The main fan **135** and the evaporator **145** are actuated by the refrigerator control unit **180** to keep the first fresh-food sub-compartment **120** below a prescribed maximum temperature *T*, typically selected by a user; in more detail, the prescribed maximum temperature *T* is typically adjustable by means of, for example, a well known in the art thermostat (not shown in figures) in a range of temperatures that goes from +3°C to +7°C. During its operation, the main fan **135** sucks air from the first fresh-food sub-compartment **120** and blows it into the interspace **165,** where the air is cooled by the evaporator **145.** The cooled air then partly returns into the first fresh-food sub-compartment **120** through the apertures **170** extending in first fresh-food sub-compartment **120** and partly reaches the second fresh-food sub-compartment **125** through the aperture **175** and the apertures **170** extending in second fresh-food sub-compartment **125.** In this way, the temperature of the first fresh-food sub-compartment **120** is lowered until brought under the prescribed maximum temperature *T* selected by the user. Once such condition is reached, the evaporator **145** and the main fan **135** are the switched off.

[0031] At the same time, the temperature of the second fresh-food sub-compartment **125** is lowered. In particular, the temperature of the second fresh-food sub-compartment **125** is brought to a temperature lower than that of the first fresh-food compartment **120.** In more detail, thanks to the stratification tendency of the air (cold air, being denser, is heavier, and thus stays in a lower position than warmer air) cold air tends to remain confined in the second fresh-food sub-compartment **125;** in addition, cold air in the bottom of the first fresh-food sub-compartment **120** tends to fall into the second fresh-food compartment **125** through the frontal and rear gaps **177,179.**

[0032] Also, due to the structural design of the second fresh-food sub-compartment **125** (which is smaller than the first fresh-food sub-compartment **120** and thermally insulated therefrom by the panel **130,** the latter preferably comprising or being made of at least one high insulating material), when the refrigerator door is opened, the exchange of heat with the outside environment is smaller compared to that taking place in respect of the first fresh-food sub-compartment **120.**

[0033] Furthermore, the second fresh-food sub-compartment **125** is located above the freezer compartment **105,** which is at a very low temperature, so no heat enters into the sub-compartment **125** from the bottom thereof.

[0034] Nevertheless, the air reaching the second fresh-food sub-compartment **125** through aperture **175** and the lower part of apertures **170** is colder than the air reaching the first fresh-food sub-compartment **120** through the upper part of apertures **170** because the first runs along the whole evaporator **145** before leaving the interspace **165.** Even when the evaporator **145** and the main fan **135** are turned off, for the above-mentioned stratification tendency, colder air (as the evaporator remains at a low temperature for a relatively long period after it is turned off) tends to flow into the second fresh-food sub-compartment **125** through aperture **175** and through the apertures **170** extending in the bottom part of rear panel **160.**

[0035] The panel **130** prevents air from the two fresh-food sub-compartments **120** and **125** to mix to such an extent as to reach a common temperature (higher for the second fresh-food sub-compartment **125** and lower for the first fresh-food sub-compartment **120** than the selected values).

[0036] The refrigerator control unit **180** may also actuate the main fan **135** and the evaporator **145** periodically (*e.g.*, using cycles of activation of a predetermined duration with a frequency dependent on the temperature selected by the user), or by monitoring the temperature in the first fresh-food sub-compartment **120** by means of the first temperature sensor **185** provided inside thereof (*i.e.*, actuating the evaporator **145** and the main fan **135** whenever a temperature is detected that is above the prescribed maximum temperature *T*).

[0037] The secondary fan **155** is actuated by the refrigerator control unit **180** in such a way as to keep the temperature of the second fresh-food sub-compartment **125** within a prescribed temperature range and, in particular, above a predetermined minimum temperature *Tm*; in more detail, the minimum temperature *Tm* is typically comprised in a food-safety range of temperatures that goes from 0°C to +3°C. The secondary fan **155** sucks air from the first fresh-food sub-compartment **120** and blows it into the second fresh-food sub-compartment **125.** Such air has a higher temperature than the air in the second fresh-food sub-compartment **125,** for the reasons discussed above; therefore, blowing air from the first fresh-food compartment **120** into the second fresh-food compartment **125** allows raising the temperature in the second fresh-food sub-compartment **125** (to an extent that depends on the activation time of the secondary fan **155).** Additionally, airflow generated by the second-

ary fan **155** contrasts an opposite airflow generated by actuating the main fan **135** and entering into the second fresh-food compartment **125** through the apertures **170** (at the lower portion of panel **160)** and the aperture **175.** Advantageously, the secondary fan **155** may be designed for generating the airflow in such a way as to at least partly or fully stop the opposite airflow coming from the interspace **165,** preventing it to further cool down the second fresh-food sub-compartment **125,** until its temperature has risen above the minimum temperature. In such an operating condition (both the fans **135** and **155** turned on) the air exits from the second fresh-food sub-compartment **125** through the frontal and rear gaps **177, 179.** On the contrary, when the main fan **135** is off and the secondary fan **155** is actuated the air flows from the second fresh-food sub-compartment **125** into the first fresh-food sub-compartment **120** through the frontal and rear gaps **177, 179** and also through the apertures **170,** after being blown backward by the secondary fan 155 into the interspace **165** through aperture **175.**

[0038] The control unit may actuate the secondary fan **155** whenever a temperature equal to, or lower than the minimum temperature *Tm* is detected by means of the second temperature sensor **190** provided inside the second fresh-food sub-compartment **125.**

[0039] Alternatively, the second fresh-food sub-compartment **125** is designed to have a temperature lower than the prescribed maximum temperature *T* of the first fresh food sub-compartment **120** of a fixed temperature difference ΔT (*e.g.*, 4°C). Thus, the secondary fan can be activated periodically by the control unit **180** (*i.e.*, using cycles of fan activation of a predetermined duration with a frequency dependent on the prescribed maximum temperature *T*) to prevent the temperature in the second fresh-food sub-compartment **125** from dropping below 0°C, only when the prescribed maximum temperature *T* of the first fresh food sub-compartment **120** is set at relatively low values (*e.g.*, between +3 and +4°C) by the user. For example, when the prescribed maximum temperature *T* is set between +7 and +5°C, the temperature in the second fresh-food sub-compartment **125** stays in the range between +3 and +1°C, so the secondary fan **155** is always off. On the contrary when the prescribed maximum temperature *T* is set between +3 and +4°C the temperature in the second fresh-food sub-compartment **125** could drop in the range between -1 and 0°C, so the secondary fan **155** will be periodically actuated to keep it above 0°C. It should be appreciated that in this case there is no need of the second temperature sensor **190,** relative wiring and corresponding circuitry in the control unit **180** to manage said second temperature sensor **190,** leading to a cost reduction.

[0040] The present invention has been here described with reference to embodiments thereof, but it should be understood that various omissions, substitutions and changes in the form and details as well as other embodiments are possible without departing from the scope of the present invention; moreover, it is expressly intended that specific elements and/or method steps described in connection with any disclosed embodiment of the invention may be incorporated in any other embodiment as a general matter of design choice.

Claims

1. A refrigerating apparatus **(100),** particularly for home use, comprising a first fresh-food sub-compartment **(120)** for storing fresh foods at a first range of temperatures, at least a second fresh-food sub-compartment **(125)** for storing fresh foods at a second range of temperatures lower than the first range of temperatures, a separation panel **(130)** separating the first and second fresh-food sub-compartments, a rear panel **(160)** parallel to a rear wall **(140)** of the refrigerating apparatus and defining with the rear wall an interspace **(165),** an evaporator **(145)** positioned in the interspace for refrigerating both the first and second fresh-food sub-compartments, and a main fan **(135)** for sucking air from the first fresh-food sub-compartment and blowing it into the interspace so that it can flow through the evaporator, wherein the rear panel has apertures **(170,175)** allowing the air blown into the interspace to flow partly back into the first fresh-food sub-compartment and partly into the second fresh-food sub-compartment,
characterized in that,
the refrigerating apparatus further comprises a secondary fan **(155)** for sucking air from the first fresh-food sub-compartment and blowing it into the second fresh-food sub-compartment in order to raise the temperature thereof.

2. The refrigerating apparatus according to claim 1, in which the separation panel has a substantially step-like shape, comprising a first horizontal portion **(130a),** a second horizontal portion **(130b)** at a higher level compared to the first horizontal portion **(130a),** and an upright portion **(130c)** joining the first and second horizontal portions, the secondary fan being mounted on the separation panel in correspondence of the upright portion thereof.

3. The refrigerating apparatus according to claim 1 or 2, in which the separation panel comprises or is made of a thermal insulating material for thermally insulating the first fresh-food sub-compartment from the second fresh-food sub-compartment.

4. The refrigerating apparatus according to any of the preceding claims, wherein the rear panel has lateral apertures **(170)** into the first and second fresh-food sub-compartment and a bottom aperture **(175)** into the second fresh-food sub-compartment.

5. The refrigerating apparatus according to any of the

preceding claims, in which the panel is formed so as to leave at least a frontal gap **(177)** and/or a rear gap **(179)** between the separation panel and a refrigerating compartment door **(178),** and between the separation panel and the rear panel, respectively.

6. The refrigerating apparatus according to any of the preceding claims, further comprising a control unit **(180)** for activating the main fan on a regular basis, with a first frequency depending on a prescribed maximum temperature selectable by a user.

7. The refrigerating apparatus according to any of the preceding claims, further comprising a first temperature sensor **(185)** for detecting a temperature in the first fresh-food sub-compartment, a control unit being configured for activating the main fan upon the detection, by the first temperature sensor, of a temperature higher than a prescribed maximum temperature, selectable by a user.

8. The refrigerating apparatus according to claim 7, further comprising a second temperature sensor **(190)** for detecting a temperature in the second fresh-food sub-compartment, the control unit being configured for activating the secondary fan upon the detection, by the second temperature sensor, of a temperature lower than a minimum temperature.

9. The refrigerating apparatus according to claim 7 or 8, in which the control unit is configured for activating the secondary fan on a regular basis, with a second frequency depending on the minimum temperature.

10. The refrigerating apparatus according to claim 7,8 or 9, in which the control unit is configured for activating the secondary fan when a difference, sensed by the first temperature sensor between the prescribed maximum temperature and a predetermined temperature difference is equal to, or lower than the minimum temperature.

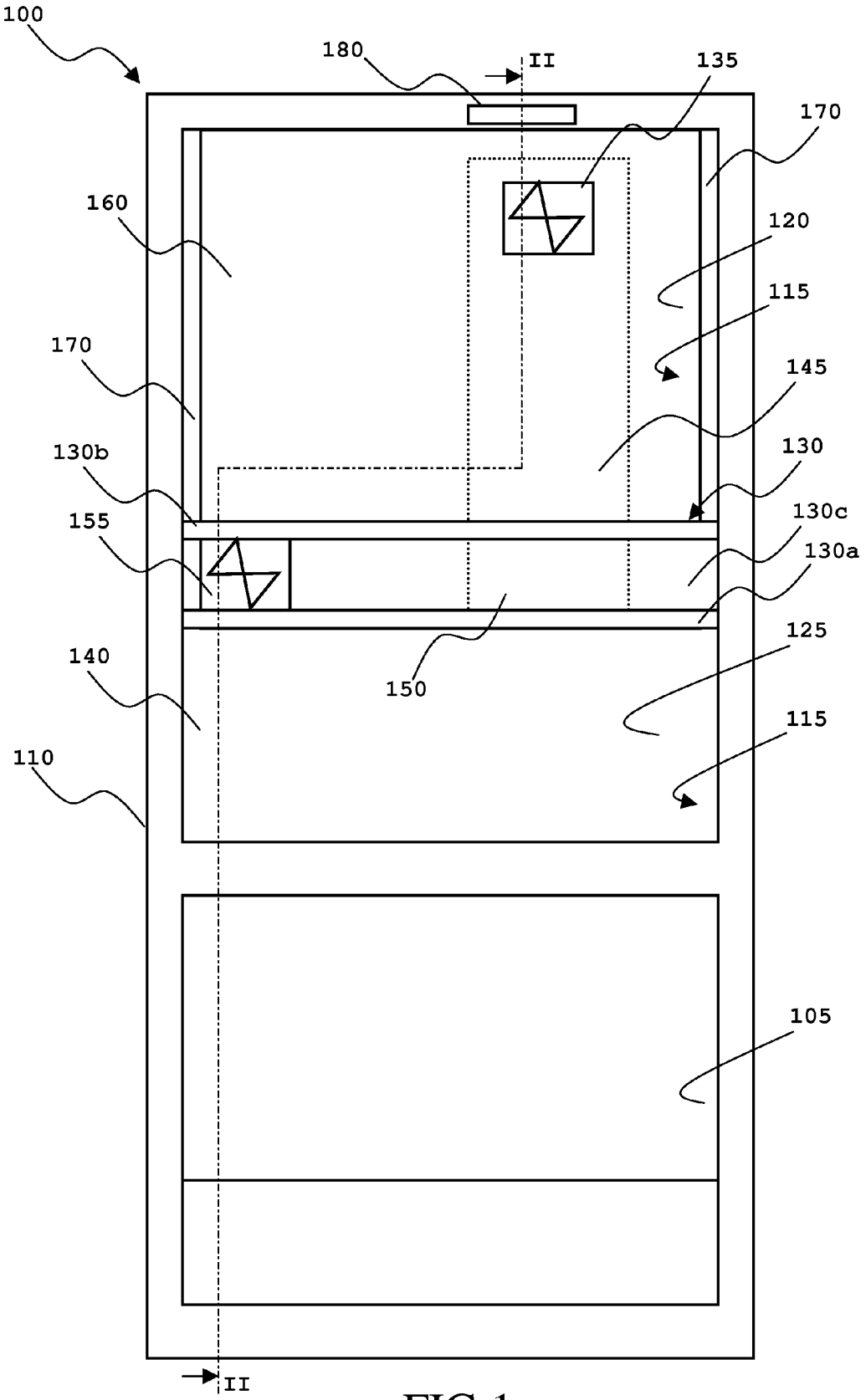
11. The refrigerating apparatus according to any of the preceding claims, wherein the secondary fan is so oriented that the air blown by the secondary fan at least partly stops the air blown by the main fan and out-coming from the apertures of the rear panel into the second fresh-food compartment.

12. The refrigerating apparatus according to any of the preceding claims, in which the prescribed maximum temperature in the first fresh-food sub-compartment ranges from +3°C to +7°C.

13. The refrigerating apparatus according to any of the preceding claims, in which the minimum temperature in the second fresh-food sub-compartment ranges from 0°C to +3°C.

14. A method of storing fresh foods, comprising the steps of:

- providing a refrigerator compartment, comprising a first and a second fresh-food sub-compartments;
- providing a panel for separating the first and the second fresh-food sub-compartments;
- providing an evaporator;
- providing a rear panel for separating the evaporator from the first and the second fresh-food sub-compartments;
- providing apertures in the rear panel for allowing fluid communication between the evaporator and the first and the second fresh-food sub-compartments;
- providing a main fan communicating with the evaporator and the first fresh-food sub-compartment;
- providing a secondary fan communicating with the first fresh-food sub-compartment and the second fresh-food sub-compartments;
- activating the main fan for keeping the temperature of the first fresh-food sub-compartment beneath a maximum temperature; and
- activating the secondary fan for keeping the temperature of the second fresh-food sub-compartment above a minimum temperature.


100
180
II
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170
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130b
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130c
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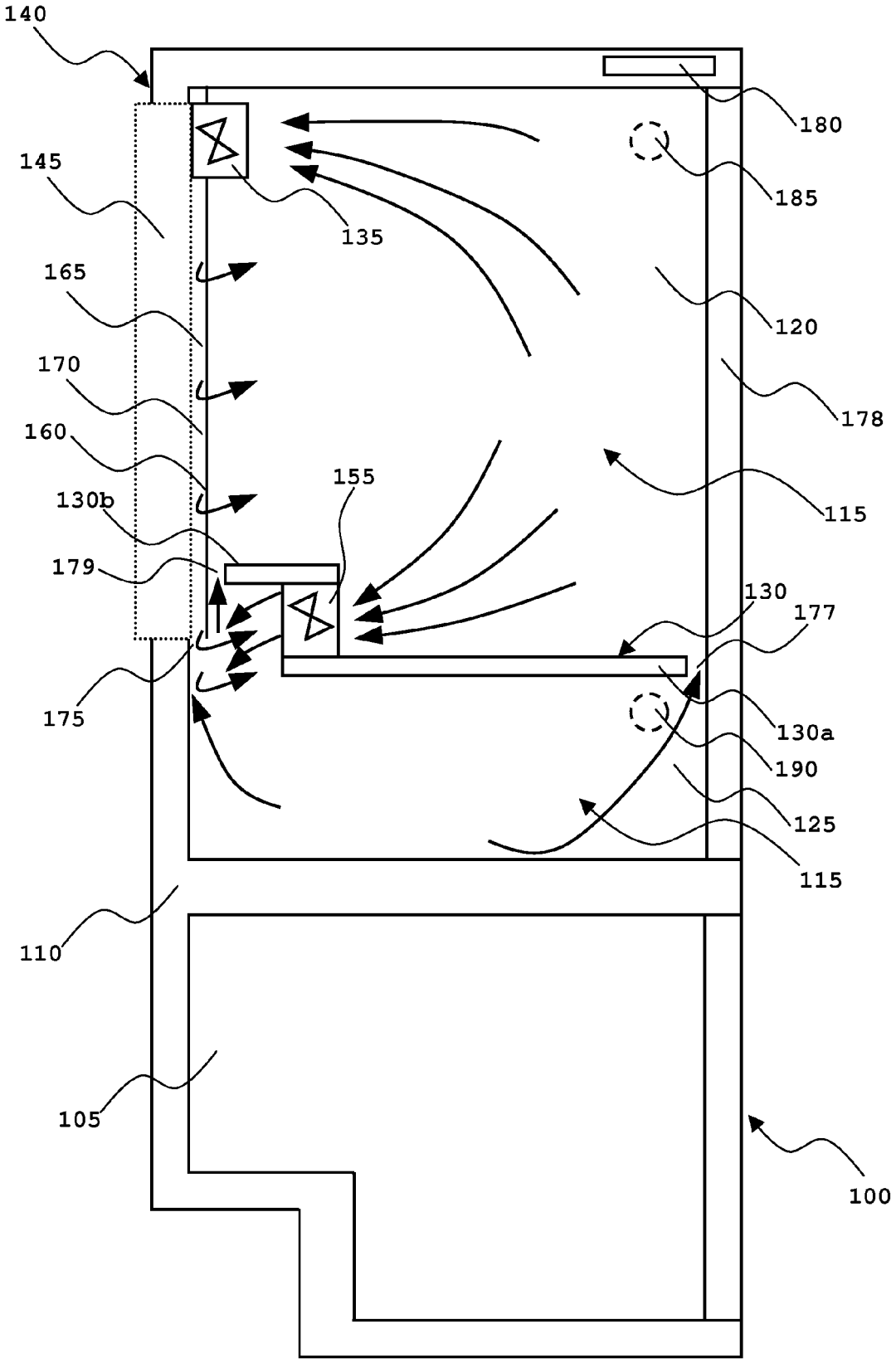
II

FIG.1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105
100

FIG.2

Europäisches Patentamt
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EUROPEAN SEARCH REPORT

Application Number
EP 10 17 0780

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	US 6 497 113 B1 (YAMADA HIROSHI [JP] ET AL) 24 December 2002 (2002-12-24) * column 16, line 50 - column 18, line 65; figures 7,8 *	1-14	INV. F25D17/06
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A	JP 11 311476 A (TOSHIBA CORP) 9 November 1999 (1999-11-09) * abstract; figure 4 *	1-14	

TECHNICAL FIELDS SEARCHED (IPC)
F25D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	2 December 2010	Lucic, Anita

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 10 17 0780

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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02-12-2010

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