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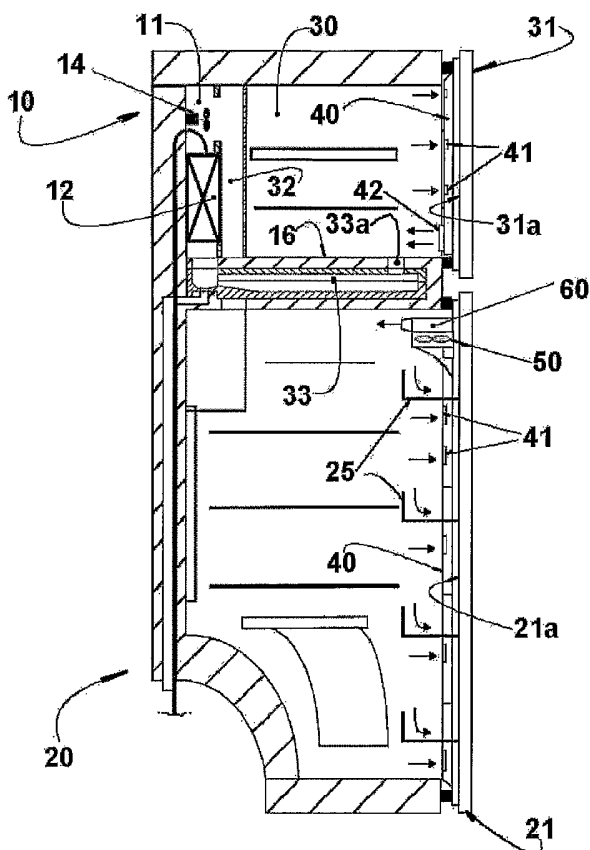
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(54) Title: ARRANGEMENT FOR THE FORCED AIR CIRCULATION IN REFRIGERATORS AND FREEZERS



(57) Abstract: An arrangement for the forced air circulation in refrigerators and freezers, whose cabinet (10) defines at least one compartment (20, 30), a respective door (21, 31), and an air-cooling chamber (11) lodging an evaporator (12) and from which the compartment is supplied with a forced cooling air-flow. The arrangement comprises: at least one suction duct (40), incorporated to the door (21, 31) and which is provided with air inlets (41), opened to the interior of the respective compartment (20, 30), and with at least one air outlet (42) turned to the interior of the cabinet (10). A return fan (50) is mounted so as to draw the air from different levels of the front part of the compartment, and to form inside the suction duct (40) a return airflow that is directed to the air outlet (42) of the suction duct (40).

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ARRANGEMENT FOR THE FORCED AIR CIRCULATION IN
REFRIGERATORS AND FREEZERS

Field of the Invention

The present invention refers to a constructive
5 arrangement to provide an additional forced air
circulation in the interior of the cabinet of
refrigerators and freezers, particularly to increase
air circulation in the internal regions of the cabinet
that are located close to the front door of each
10 compartment of said cabinet. The invention is intended
to be applied to refrigerators and freezers with a
simple cabinet, presenting a single compartment with a
respective front door, or two superposed compartments,
each being frontally closed by a door.

15 Prior Art

It is known from the state of art that, in the
cabinets of refrigerators and freezers, the highest
temperatures are found in the regions close to the
door, which in the refrigerators usually incorporates
20 different shelves on which the products to be
refrigerated are subject to said temperatures that are
higher than those in the remaining parts of the
refrigeration compartment of the cabinet.

The refrigeration deficiency mentioned above results
25 from several factors, such as: gain of additional heat
in the front regions of the cabinet through the door
sealing gaskets; difficulty in supplying cool air to
the front part of the cabinet or directly to the
internal panel of the door; poor distribution of the
30 forced airflow; low speed of the forced airflow when
reaching the regions close to the door. The existence
of this front region with a higher temperature has
been evidenced by thermodynamic tests.

The increase of the refrigerated airflow in the
35 interior of the cabinet, particularly the increase of

the refrigerated airflow directed to the cabinet region located adjacent to the front door, allows cooling more rapidly and intensively the load stored in the front region of the cabinet and thus reducing
5 the temperature inside the cabinet, with no additional energetic consumption being required from the refrigeration system, which thus becomes more efficient.

There are known different constructive solutions
10 aiming at providing a more efficient cooling of the front region of the cabinets of refrigerators and freezers with forced air circulation.

In some of these solutions, such as those described in patent documents US 5,946,934; US 5,979,174; US
15 5,584,191; US 6,041,606 and US 6,073,458, the supply of cool air to the front region of the refrigeration compartment or freezer compartment of a cabinet is achieved by conducting part of the forced airflow, coming from the air-cooling chamber within which is
20 lodged the evaporator, to the door region, through ducts incorporated to the cabinet structure and which communicate with at least one duct formed in the door structure and which is provided with a plurality of air outlets turned to the interior of the compartment.
25 In these prior art solutions, the cool airflow to be directed to a compartment, generally the refrigeration compartment, is derived to the front region of the cabinet through ducts provided in the structure of the latter, being then transferred to one or more ducts
30 provided on the door of the appliance.

Although in the constructive arrangements mentioned above the cool airflow is supplied to the compartment region adjacent to the door, and also to the region that is internal to the door shelves, it is still
35 difficult to reach an efficient, intense and uniform

cooling in said compartment region close to the door by means of a simple, durable and economically viable construction. Furthermore, these prior solutions do not promote a complete homogenization of the temperature in the compartment when it is loaded with food, since the central region does not receive the same cool airflow that reaches the marginal regions and those regions confronting the air outlets of the ducts. In some of these solutions, there is further provided a flexible connecting duct that couples the door duct with the cabinet duct, which connecting duct remains exposed to the movement of the door and thus susceptible to ruptures with time.

With the purpose of eliminating the disadvantages mentioned above, the solution object of patent US 5,826,437 has been proposed, according to which the refrigeration compartment door is provided with a duct, having a median air inlet opened to the refrigeration compartment, and two or more air outlets, provided in the upper and lower regions of the door duct and which are also opened to the interior of the respective compartment. A fan is mounted to the air inlet to draw the air from the inside of the central front region of the compartment and to return it to the latter, through the air outlets and at a more intense rate determined by the fan, whose operation depends on the closing of the door and on the temperature conditions inside the compartment that are detected by adequate sensors.

While eliminating the deficiencies of the solutions that use only cool airflow directional ducts, this solution of providing a fan in the door duct is somewhat limited in terms of refrigeration efficiency. In this prior solution, the fan draws the air from the median region of the respective compartment, returning

it in the form of a circulating airflow directed to different regions of the same compartment.

In this prior solution disclosed in patent US 5,826,437, the additional forced air circulation is effected by the air being drawn only from the central front region of the compartment and discharged in two opposite end regions of the same compartment. This suction from the central front region is insufficient to provide the displacement of the cooler air along the entire height of the compartment toward the front door. Only the cool air mass located in the central region of the compartment is forced to flow toward the front door. The lower and upper regions of the compartment close to the front door are not equally benefited with the forced cool airflow coming from the rear region of the compartment, said lower and upper regions frontally receiving, directly, only the airflow drawn from the central front region. In this prior solution, there is no displacement of cool air from the rear region to the front region of the compartment along practically the whole height thereof.

Objects of the Invention

As a function of the above, it is an object of the present invention to provide an arrangement for the forced air circulation in refrigerators and freezers, which overcomes the known constructive solutions, promoting an efficient homogenous refrigeration of the interior of the compartment close to the front door thereof.

It is a further object of the present invention to provide an arrangement as mentioned above, which promotes an adequate refrigeration of the compartment region close to the respective front door, producing a reduction in the average temperature of said

compartment.

It is another object of the present invention to provide an arrangement as mentioned above, which promotes an adequate refrigeration of the internal front region of the compartment at a relatively shorter time than that of the prior art solutions.

It is still a further object of the invention to provide an arrangement as mentioned above, which presents a simple construction, requiring no structural alterations in the cabinet design.

Summary of the Invention

Aiming at attaining the above-mentioned objects, the present invention is directed to refrigerators and freezers of the type comprising a cabinet, defining at least one compartment frontally closed by a door, and an air-cooling chamber lodging an evaporator, said compartment being supplied with a forced cooling airflow, coming from the air-cooling chamber, and provided with at least one air return duct directed to the air-cooling chamber.

According to the invention, the arrangement comprises at least one suction duct incorporated to the door, extending along at least part of the height of the latter and which is provided along the extension thereof with a plurality of air inlets opened to the interior of the respective compartment, and with at least one air outlet. A return fan is mounted to the suction duct, in order to draw the air from different levels of the front part of the compartment, in a closed door condition, through the air inlets of the suction duct, and to form inside the latter a return airflow directed to the air outlet turned to the interior of the cabinet.

In a preferred form of carrying out the invention, the air outlet of the suction duct is arranged so that,

upon the closing of the door, at least part of the return airflow is directed to the inside of the air return duct, to be conducted to the air-cooling chamber.

5 The arrangement proposed herein can be further provided with a directional duct, mounted to at least one of the parts defined by the door and the cabinet and which is provided with an inlet nozzle to receive the return airflow from the suction duct, and an
10 outlet nozzle which directs at least part of the return air to the inside of the air return duct of the compartment.

The present arrangement operates jointly with a means for sensing the operational condition of the door and
15 which allows the fan mounted to the latter to be automatically driven by a control module of the refrigeration appliance only when the door is closed, as it usually occurs with the fan operatively associated with the air-cooling chamber and which is
20 responsible for the forced cooling airflow which is caused to pass through the compartment to be refrigerated.

Brief Description of the Drawings

The present invention will be described below, with
25 reference to the enclosed drawings given by way of example of possible embodiments for the present arrangement, and in which:

Figure 1 is a schematic longitudinal vertical sectional view of a combined refrigerator, whose
30 cabinet defines an upper freezer compartment and a lower refrigeration compartment, which compartments are frontally closed by respective doors and with the refrigeration compartment being provided with the arrangement for the forced air circulation of the
35 present invention;

Figure 2 is a front elevational view of the internal face of the refrigeration compartment door of the cabinet illustrated in figure 1;

Figure 3 is an exploded perspective view of part of
5 the arrangement for the forced air circulation illustrated in figures 1 and 2;

Figure 4 is a view similar to that of figure 1, but illustrating the freezer compartment door also provided with the arrangement for the forced air
10 circulation of the present invention;

Figure 5 is a front elevational view of the internal face of the freezer compartment door of the cabinet illustrated in figure 4; and

Figure 6 is an enlarged vertical sectional view of the
15 fan used in the suction duct provided in the freezer compartment door, according to the arrangement for the forced air circulation illustrated in figure 4.

Detailed Description of the Invention

As illustrated in figures 1 and 4, the arrangement for
20 the forced air circulation of the present invention is directed to refrigeration appliances in the form of combined or not combined refrigerators and freezers, whose cabinet 10 forms at least one refrigeration compartment 20 or one freezer compartment 30, each
25 being frontally closed by a respective door 21, 31.

The cabinet 10 further defines an air-cooling chamber 11 lodging an evaporator 12 of a refrigeration system, whose compressor is mounted in the lower rear part of the cabinet 10. A refrigeration fan 14 is mounted
30 inside the cabinet 10, in order to draw the refrigerated air from the air-cooling chamber 11 and to form a forced cooling airflow, which is supplied to the refrigeration compartment 20, to the freezer compartment 30, or optionally to both the
35 refrigeration compartment 20 and the freezer

compartment 30 in the case of the combined cabinets, as illustrated in figures 1 and 4. The forced cooling airflow coming from the air-cooling chamber 11 and produced by the refrigeration fan 14 is conducted to
5 the single compartment or to both the refrigeration and freezer compartments 20, 30 of a combined cabinet 10, by means of supply ducts 22, 32, which can take different constructions such as that exemplarily illustrated.

10 Each refrigeration compartment 20 and freezer compartment 30 is further provided with at least one air return duct 23, 33 which is directed to the air-cooling chamber 11, so as to obtain a forced circulation of refrigerated air in a closed circuit
15 when the door or doors 21, 31 is/are closed, between the air-cooling chamber 11 and the compartments defined by the cabinet 10.

Considering the construction illustrated in figures 1, 2 and 3, the arrangement for the forced air
20 circulation according to the present invention comprises only one suction duct 40, which is incorporated to the door 21 of the refrigeration compartment 20 longitudinally in relation to said door 21 and extending along at least part of the height of
25 the latter. In case of being provided only one suction duct 40, it is preferably located in the median region of the door 21, in order to be totally or partially embedded or not embedded at all in the thickness of the latter. In the example of the illustrated
30 construction, the suction duct 40 is partially embedded in the door 21, so as to have a front face projecting outwardly from the internal face 21a of the door 21, as illustrated in figures 1 and 2.

In the illustrated construction, in which only one
35 suction duct 40 is provided projecting outwardly from

the median region of the door 21 of the refrigeration compartment 20, the shelves 25 of the door 21 are also medianly interrupted or at least narrowed in the region that is superposed to the width of the suction duct 40. Depending on the construction of the suction duct 40, the shelves 25 of the door 21 can be medianly interrupted.

The suction duct 40 is provided with a plurality of air inlets 41 which are opened to the inside of the refrigeration compartment 29 when the respective door 21 is in a closed condition, said air inlets 41 being provided along the width and the length of the suction duct 40, in order to maintain the interior of the latter in communication with the adjacent confronting front portion of the refrigeration compartment 20.

Still according to the illustrated construction, in which the refrigeration compartment 20 is the lower compartment of the cabinet 10, as shown in figure 1, the suction duct 40 presents an air outlet 42 positioned as a single air outlet at the upper end of the suction duct 40.

Since the door 21 of the refrigeration compartment 20 is provided with shelves 25, the air outlet 42 is defined at an end portion 43 with a widened depth of the suction duct 40 projecting outwardly from the front face of the latter, ending at a level that is above or below the level of the upper shelf 25 of the door 21.

Another component of the present arrangement is defined by a return fan 50, which is mounted to the suction duct 40 so as to draw the air from different levels of the front portion of the refrigeration compartment 20 in a closed condition of the door 21, through the air inlets 42 of the suction duct 40, and to form inside the latter a return airflow which is

directed to the air outlet 42 of the suction duct 40. The air outlet 42 of the suction duct 40 is preferably dimensioned and positioned in such a way as to conduct the return airflow to an internal region of the respective compartment 20, 30 located close to an inlet window 23a, 33a of the air return duct 23, 33 of the refrigeration compartment 20 or freezer compartment 30.

The constructive arrangement mentioned above allows the air drawn by the suction duct 40 to be at least partially returned to the air-cooling chamber 11 through the air return duct 23, 33 and not entirely returned to the respective compartment.

Regarding the refrigeration compartment 20, there can be further provided a directional duct 60, affixed to at least one of the parts defined by the door 21 and the cabinet 10 and which presents an inlet nozzle 61, which is arranged to receive the return airflow from the suction duct 40, and an outlet nozzle 62, which is turned to the inside of the refrigeration compartment 20.

In the construction illustrated in figures 1, 2 and 3, the return fan 50 comprises a rotor 51 mounted inside a tubular shell 55, which is coaxially coupled, by an open end, to the air outlet 42 of the suction duct 40 and with its also open opposite end being coupled to the inlet nozzle 61 of the directional duct 60. In this exemplificative construction, the directional duct 60 comprises an inlet portion 60a, coaxial to the air outlet 42 of the suction duct 40 and which carries the inlet nozzle 61, and an outlet portion 60b, constructed so as to define an outlet nozzle 62 in the form of a window with small height and having a width which can be quite larger than that of the suction duct 40. In this arrangement, the return fan 50 and

the air outlet 42 have the same axis which is parallel to the longitudinal axis of the suction duct, and the inlet nozzle 61 and the outlet nozzle 62 of the suction duct have their axes lying in distinct
5 directions, with the axis of the inlet nozzle 61 coinciding with the axis of the return fan 50 and of the air outlet 42 of the suction duct 40.

In order to allow the air drawn from the front portion of the refrigeration compartment 20 to be at least in
10 great part returned to the air-cooling chamber 11, the directional duct 60 is shaped so that its outlet nozzle 62 directs the return airflow to the inside of the respective inlet window 23a of the air return duct 23 of the refrigeration compartment 20, as better
15 illustrated in figure 1.

With this constructive arrangement, the air which is drawn from the front portion of the refrigeration compartment 20 close to the door 21, is returned at least in great part to the air return duct 23 and to
20 the air-cooling chamber 11, in order to have its temperature lowered by the evaporator 12, before being returned to the interior of the refrigeration compartment 20 through the supply duct 22.

It should be understood herein that in the combined
25 appliances in which the refrigeration compartment 20 is provided over the freezer compartment 30, the air outlet 42 of the suction duct 40 is preferably positioned at the lower end of the latter, adjacent to the dividing wall 16 of the cabinet 10 that separates
30 the compartments from each other. This arrangement allows the air outlet 42 of the suction duct 40 to be positioned closer to the air return duct 23 directed to the air-cooling chamber 11.

As illustrated in figures 4, 5 and 6, the present
35 arrangement for the forced air circulation can be also

applied to the freezer compartment 30. In this case, the door 31 of this compartment is provided with an internal face 31a from which projects a suction duct 40, similar to that of the door 21 of the refrigeration compartment 20 and which is provided with air inlets 41 that are turned to the inside of the freezer compartment 30, and with an air outlet 42 which is generally positioned, at the lower end of the suction duct 40, adjacent to the dividing wall 16 of the cabinet 10 in the refrigeration appliances of the combined type in which the freezer compartment 30 is provided over the refrigeration compartment 20.

The suction duct 40 provided in the door 31 of the freezer compartment 30 can have its air outlet 42 presenting an axis orthogonal to the plane of the door 31 and configured so as to receive and secure a tubular shell 55 of a return fan 50.

In this case, the return fan 50 can discharge the return airflow directly inside the freezer compartment 30 and preferably close to the inlet window 33a of the air return duct 33, with no need of providing a directional duct 60 similar to that provided in the refrigeration compartment 20. However, it should be understood that the freezer compartment 30 could be also provided with a directional duct 60, in case its existence is required as a function of the compartment design.

In this arrangement, the return fan 50 and the air outlet 42 have the same axis, which is orthogonal to the longitudinal axis of the suction duct 40.

As it can be noted, the arrangement of the present invention allows the air contained in the front region of any of the compartments 20, 30 of the cabinet 10 to be drawn by the return fan 50 mounted in the door 21, 31, and to be returned, at least in great part, to the

air-cooling chamber 11. In order to facilitate the conduction of the return airflow to the air-cooling chamber 11, it is preferred that the outlet 42 of the suction duct 40, provided or not with the directional duct 60, be positioned close to the air return duct 23, 33 already designed for the respective compartment 20, 30 and which in the case of the combined cabinets, is generally provided in the region of the dividing wall 16.

10 While only one embodiment of the invention has been illustrated, it should be understood that changes in the form and arrangements could be made without departing from the inventive concept defined in the appended claims.

CLAIMS

1. An arrangement for the forced air circulation in refrigerators and freezers of the type comprising a cabinet (10) defining at least one compartment (20, 30) frontally closed by a respective door (21, 31), and an air-cooling chamber (11) lodging an evaporator (12), said compartment being supplied with a forced cooling airflow coming from the air-cooling chamber (11) and provided with an air return duct (22, 33) directed to the air-cooling chamber, characterized in that it comprises:

- at least one suction duct (40) incorporated to the door (21, 31), extending along at least part of the height of the latter and being provided, along the extension thereof, with a plurality of air inlets (41) opened to the interior of the respective compartment (20, 30), and with at least one air outlet (42) turned to the interior of the cabinet (10); and

- a return fan (50) mounted to the suction duct (40), in order to draw the air from different levels of the front part of the compartment (20, 30) in a closed door condition, through the air inlets (41) of the suction duct (40), and to form inside the latter a return airflow directed to the air outlet (42) of the suction duct (40).

2. The arrangement as set forth in claim 1, characterized in that the air outlet (42) of the suction duct (40) is arranged so that, with the closing of the door (21, 31), at least part of the return airflow is directed to the inside of the air return duct (23, 33) of the compartment (20,30).

3. The arrangement as set forth in claim 1, characterized in that the return fan (50) is mounted close to the air outlet (42) of the suction duct (40).

4. The arrangement as set forth in claim 3,

characterized in that the return fan (50) presents a shell (55) having an end coupled to the air outlet (42) of the suction duct (40) and an opposite end opened to the inside of the respective compartment
5 (20, 30).

5. The arrangement as set forth in claim 4, characterized in that the return fan (50) and the air outlet (42) of the suction duct (40) have the same axis, which is parallel to the longitudinal axis of
10 the suction duct (40).

6. The arrangement as set forth in claim 3, characterized in that the return fan (50) and the air outlet (42) have the same axis, which is orthogonal to the longitudinal axis of the suction duct (40).

15 7. The arrangement as set forth in claim 1, characterized in that it further comprises a directional duct (60), mounted to at least one of the parts defined by the door (21, 31) and the cabinet (10) and which presents an inlet nozzle (61) receiving
20 the return airflow from the suction duct (40) and an outlet nozzle (62), which upon the closing of the door (21, 31) directs at least part of the return airflow to the inside of the air return duct (23, 33) of the respective compartment (20, 30).

25 8. The arrangement as set forth in claim 7, characterized in that the inlet nozzle (61) and the outlet nozzle (62) of the directional duct (60) have their axes lying in distinct directions, the inlet nozzle (61) having the axis coinciding with that of
30 the return fan (50) and of the air outlet (42) of the suction duct (40).

9. The arrangement as set forth in claim 1, characterized in that the suction duct (40) is located in the median region of the door (21, 31) and provided
35 with air inlets (41) along the width and length

thereof.

10. The arrangement as set forth in claim 1, characterized in that the suction duct (40) has its depth partially embedded in the thickness of the door (21, 31), in order to have a front face projecting outwardly from the internal face (21a, 31a) of the door (21, 31).

11. The arrangement as set forth in claim 1 and which is applied to a combined refrigerator provided with a refrigeration compartment (20) and a freezer compartment (30) which are superposed and separated from each other by a dividing wall (16), characterized in that the suction duct (40), which is provided in any of the doors (21, 31) of the two compartments, has the air outlet (41) positioned at an end portion (43) turned to said dividing wall (16).

12. The arrangement as set forth in claim 1, characterized in that the air outlet (42) of the suction duct (40) is defined at an end portion (43) of the latter, presenting a widened depth.

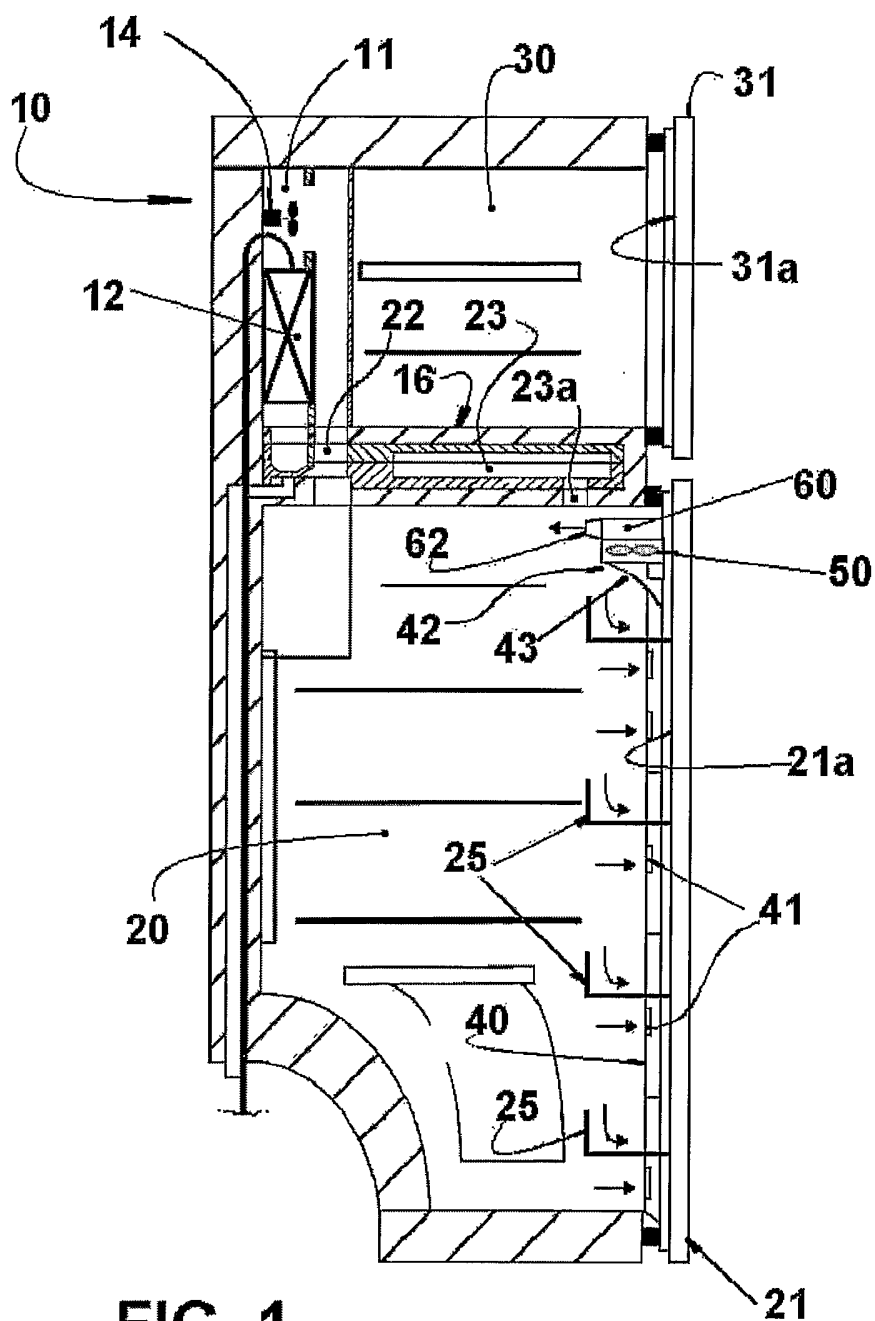
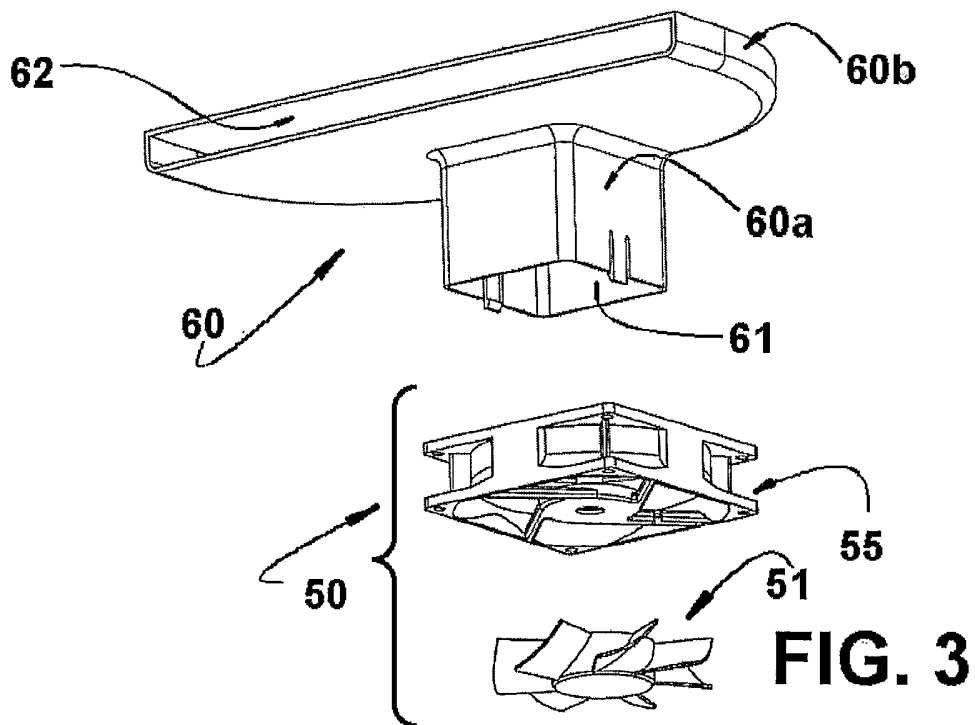
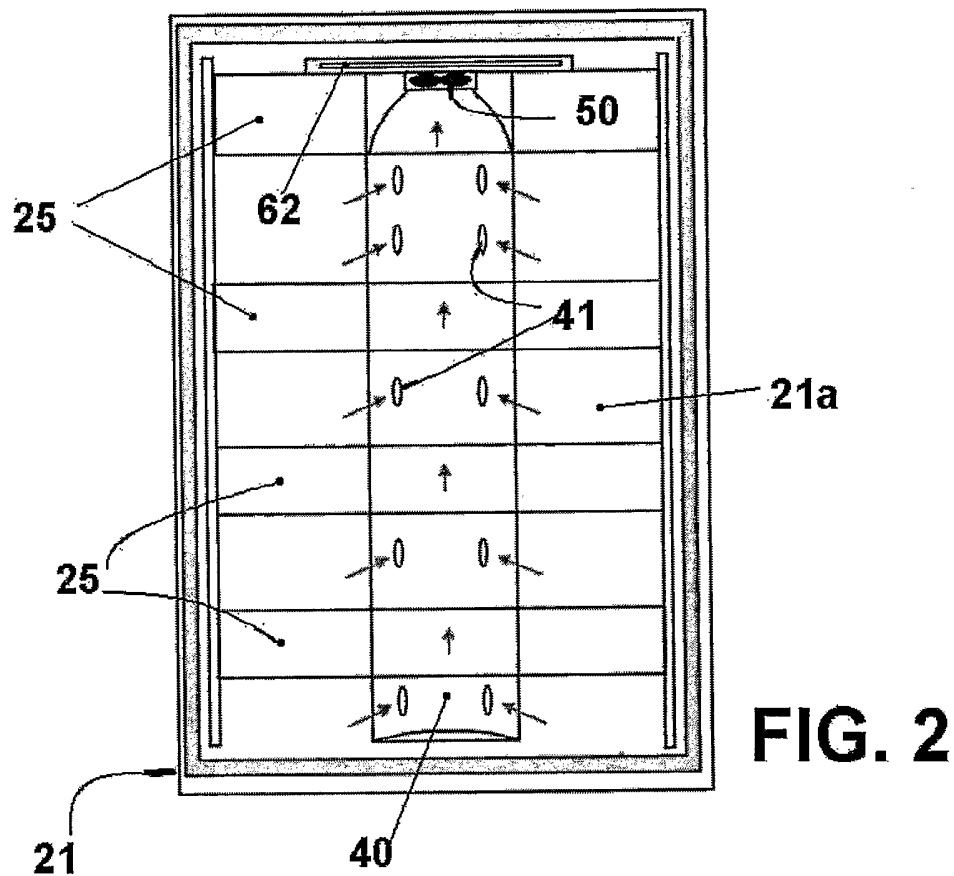


FIG. 1



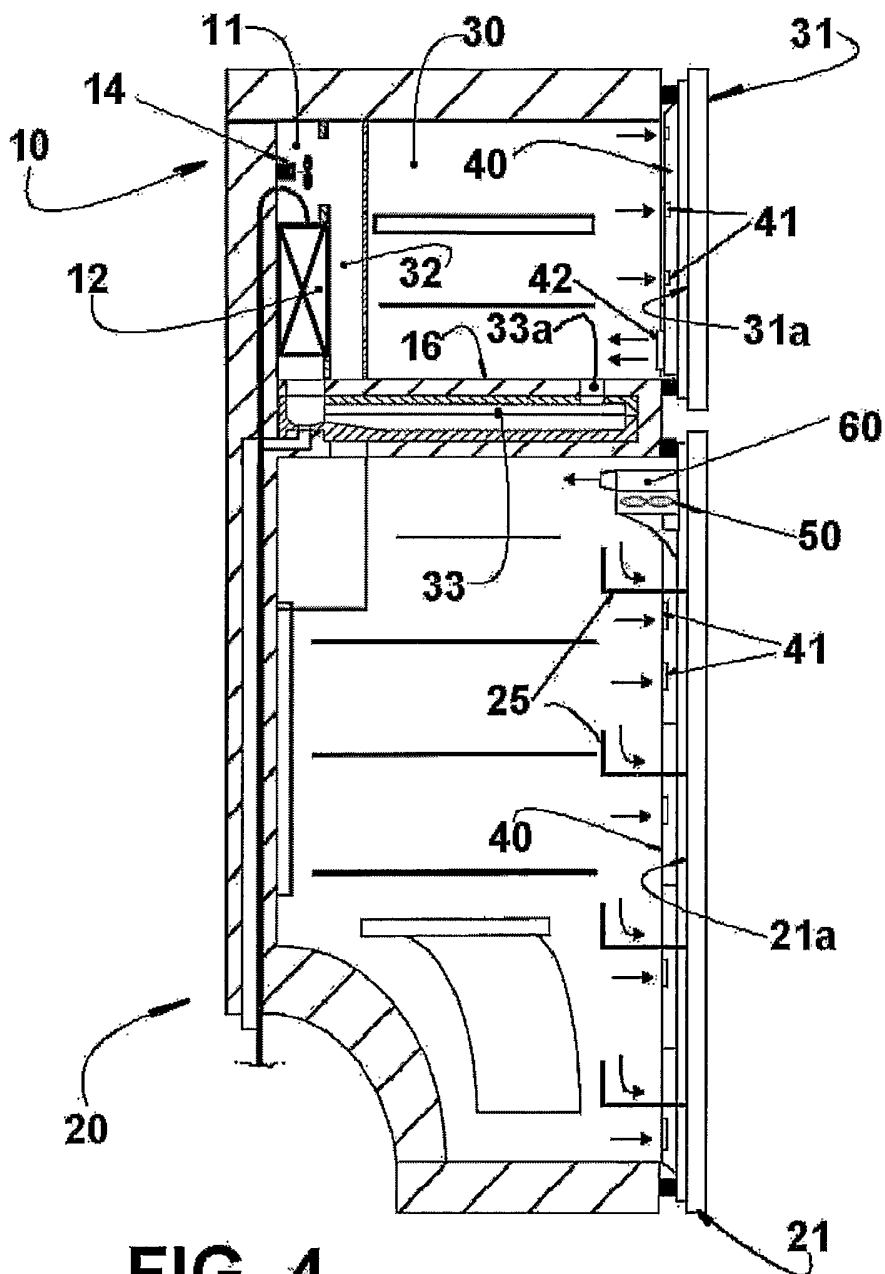
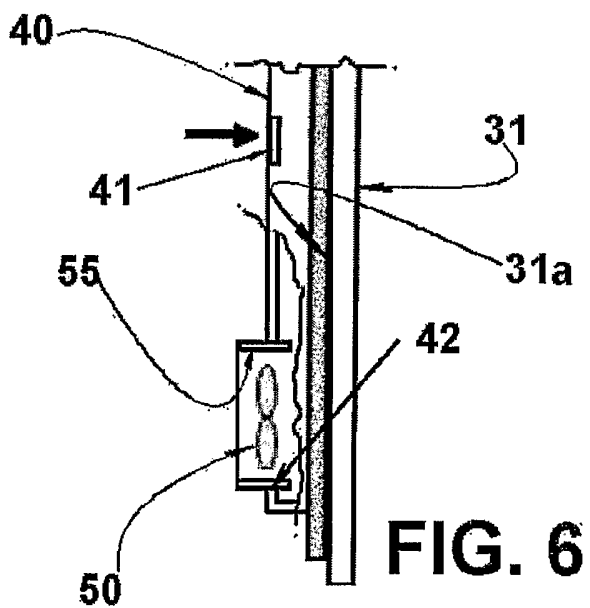
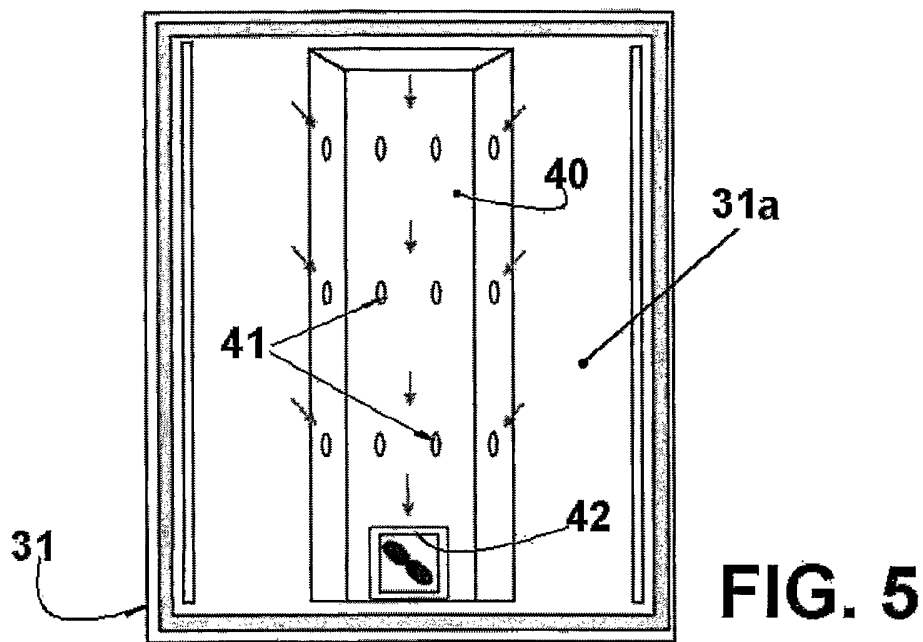


FIG. 4



INTERNATIONAL SEARCH REPORT

International Application No PCT/BR2004/000051
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A. CLASSIFICATION OF SUBJECT MATTER
 IPC 7 F25D17/08

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
 IPC 7 F25D A47F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
 EPO-Internal, PAJ, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 826 437 A (KIM HYUNG-KWAN) 27 October 1998 (1998-10-27)	1, 10
Y	column 1, line 63 - column 2, line 10; figures 2,3 column 4, lines 45-54 claim 1	2-9, 11, 12
Y	US 5 960 641 A (KIM SEOK RO ET AL) 5 October 1999 (1999-10-05) figures 2,5,7 claims 5,8,14-20 column 8, line 25 - column 9, line 5 column 5, line 49 - column 6, line 67	2,9,11
Y	US 5 899 083 A (LING LI GONG ET AL) 4 May 1999 (1999-05-04) figures 6,11,13,14	3-6
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Further documents are listed in the continuation of box C. Patent family members are listed in annex.

* Special categories of cited documents :

A document defining the general state of the art which is not considered to be of particular relevance *E* earlier document but published on or after the international filing date *L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) *O* document referring to an oral disclosure, use, exhibition or other means *P* document published prior to the international filing date but later than the priority date claimed	*T* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention *X* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone *Y* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art. *&* document member of the same patent family
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Date of the actual completion of the international search <h3 style="text-align: center;">20 July 2004</h3>	Date of mailing of the international search report <h3 style="text-align: center;">29/07/2004</h3>
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Name and mailing address of the ISA European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Authorized officer <h3 style="text-align: center;">Léandre, A</h3>
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INTERNATIONAL SEARCH REPORT

International Application No
PCI/BR2004/000051

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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