



**EUROPEAN PATENT APPLICATION**

(43) Date of publication:  
**18.06.2014 Bulletin 2014/25**

(51) Int Cl.:  
**F25D 23/00 (2006.01)**

(21) Application number: **12197386.1**

(22) Date of filing: **17.12.2012**

(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 MK MT NL NO  
PL PT RO RS SE SI SK SM TR**  
Designated Extension States:  
**BA ME**

(71) Applicant: **Electrolux Home Products Corporation  
N.V.**  
**1130 Brussel (BE)**

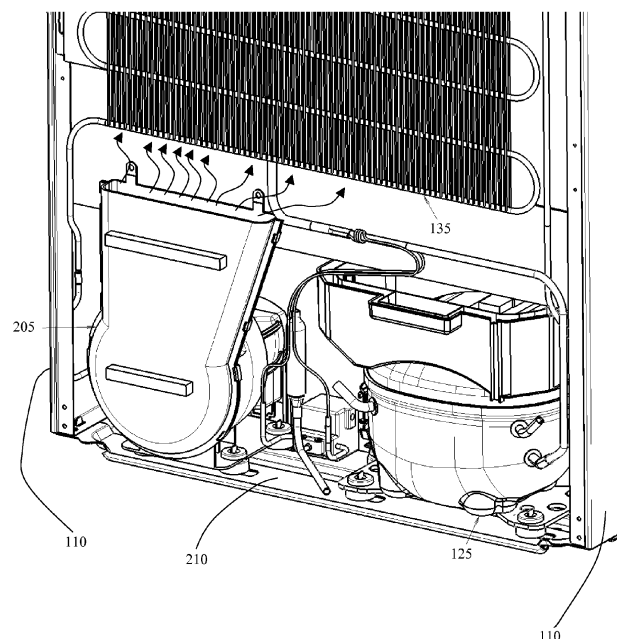
(72) Inventors:  
• **Buosi, Augusto**  
**33080 Porcia (PN) (IT)**  
• **Modolo, Diego**  
**33080 Porcia (PN) (IT)**  
• **Beni, Marco**  
**33080 Porcia (PN) (IT)**

(74) Representative: **Maccalli, Marco et al**  
**Maccalli & Pezzoli S.r.l.,**  
**Via Settembrini, 40**  
**20124 Milano (IT)**

(54) **Refrigerator for foods**

(57) A food refrigerator comprises a cabinet (105), a heat pump for submitting a refrigerant fluid to a thermodynamic cycle, wherein the heat pump comprises a refrigerant condenser (135) mounted on a back wall (120) of the cabinet and extending along said back wall, and a forced air ventilation system (140) for ventilating the con-

denser. The forced air ventilation system comprises at least one blower (305) for drawing in air from the outside environment, and an air conveyor (205) associated with the at least one blower for directing the ambient air drawn in and propelled by the at least one blower towards the refrigerant condenser.



**FIG. 2**

## Description

### Background of the invention

### Field of the invention

**[0001]** The present invention relates to appliances for food preservation, such as food refrigerators, particularly, although not limitatively, for domestic use.

### Overview of the related art

**[0002]** Food refrigerators essentially consist of a thermally-insulated compartment for the storage of food, and a heat pump that transfers heat from the inside of the refrigerator to its external environment so that the inside of the refrigerator is cooled to a temperature below the ambient temperature of the room (e.g., kitchen) where the appliance is located.

**[0003]** In the heat pump, a refrigerant fluid undergoes a thermodynamic cycle. The refrigerant enters a compressor as low-pressure vapor at or slightly above the temperature of the refrigerator interior. In the compressor, the vapor is compressed and exits the compressor as high-pressure superheated vapor. The superheated vapor flows under pressure through coils or tubes forming a condenser, which are cooled by exposure to air in the room. The condenser cools the vapor, which condenses (liquefies). As the refrigerant leaves the condenser, it is still under pressure but only slightly above room temperature. The liquid refrigerant is forced through a metering or throttling device, also known as an expansion valve, to an area of much lower pressure. The sudden decrease in pressure results in a flash evaporation of part of the liquid. The latent heat absorbed by this flash evaporation is drawn mostly from adjacent still-liquid refrigerant, a phenomenon known as auto-refrigeration. This cold and partially vaporized refrigerant continues through the coils or tubes of an evaporator unit. The food storage compartment is in heat-exchange relationship with the evaporator; in the evaporator, the refrigerant completely vaporizes, drawing further latent heat from the compartment, which is thereby kept cold. The refrigerant leaves the evaporator, fully vaporized and slightly heated, and returns to the compressor inlet to continue the cycle.

**[0004]** In household (domestic) refrigerators, two classes of refrigerant condensers are mainly used: static condensers or dynamic condensers.

**[0005]** Static condensers comprise external heat exchangers extending essentially along the whole vertical length of the food storage compartment at the rear of the refrigerator cabinet (i.e., opposite to the front door), or skin condensers attached to the cabinet side walls. Static condensers are cooled by a natural (non-forced) flow of ambient air that flows by convection from the bottom to the top of the refrigerator cabinet.

**[0006]** Dynamic condensers are usually box-shaped and placed in a recess at the bottom of the refrigerator

cabinet where the compressor is also accommodated, or in a "worm module" under the cabinet. Dynamic condensers are cooled by a forced flow of ambient air, taken in by means of a fan. Examples of refrigerators with dynamic condensers are given in DE 19933603, US 3,785,168, US 2,079,770, EP 1919973.

**[0007]** Refrigerators are often fully embedded (built-in or encased) in the furniture of the kitchen, and this makes the ventilation (natural or forced) of the condensers more difficult.

**[0008]** In refrigerators with dynamic condensers the path of ambient air cooling the condenser is typically "U"-shaped: ambient air is taken in through an opening at the bottom of the front of the kitchen furniture, caused to flow through the condenser, and expelled through another opening, which can also be at the bottom of the front of the kitchen furniture.

**[0009]** US 1,769,119 discloses a condensing system for household refrigerator using means for augmenting the draft passing over the compressor and condenser when the temperature of the environing atmosphere is such that the natural draft arrangement does not permit the refrigerating system to operate at its proper efficiency. A fan driven by a motor is provided, disposed in an apparatus compartment beneath the refrigerating chamber containing the compressor and its motor.

### Summary of the invention

**[0010]** A proper ventilation of the condenser is important for cooling it down; a condenser that is not properly ventilated and cooled reduces the efficiency of the heat pump, and the refrigerator does not operate properly.

**[0011]** Especially for built-in refrigerators to be encased in the kitchen furniture, but also for free-standing refrigerators, the solutions known in the art do not appear satisfactory.

**[0012]** Refrigerators with dynamic condensers are useful in some specific applications (e.g., for so-called "under-top" refrigerators, intended to be encased in the kitchen furniture below the kitchen worktop: in this case there is no possibility for the ambient air to escape from the refrigerator top). However, the box-shaped condenser used in dynamic condenser refrigerators costs more than a condenser of the type used in static condenser refrigerators. Also, a condenser for a static condenser refrigerator has a great heat exchange surface (the condenser can occupy the large area at the back of the cabinet), beneficial to the refrigerant cooling down. Refrigerators with condensers of the type used in static condenser refrigerators are thus preferable in some circumstances, and they are also traditionally preferred in some regions of the world.

**[0013]** The Applicant has observed that the solution disclosed in US 1,769,119 does not work properly, especially in a built-in refrigerator, encased within the kitchen furniture. The apparatus compartment where the compressor is disposed, and where, according to US

1,769,119, the fan is also disposed, is a closed compartment with very small openings at the bottom and the top. A free fan disposed in this compartment is not able to move air from the small apertures at the bottom and then to force the air up to the condenser, which is located out of the compartment, along the back of the refrigerator. In a built-in appliance a free fan positioned as described by US 1,769,119 is only able to recirculate air inside the compressor compartment; the compressor is still cooled by the natural air flow that moves by convection.

[0014] According to an embodiment of the present invention, a food refrigerator is provided, comprising a cabinet and a heat pump for submitting a refrigerant fluid to a thermodynamic cycle, wherein the heat pump comprises a refrigerant condenser mounted on a back wall of the cabinet and extending along said back wall.

[0015] The food refrigerator comprises a forced air ventilation system for ventilating the condenser. The forced air ventilation system comprises at least one blower for drawing in air from the outside environment, and an air conveyor associated with the at least one blower for directing the ambient air drawn in and propelled by the at least one blower towards the refrigerant condenser.

[0016] Advantageously, the at least one blower and the air conveyor are housed in a recess of the refrigerator cabinet at the bottom of the refrigerator cabinet, below the refrigerant condenser.

[0017] In an embodiment of the invention, the air conveyor may house the blower.

[0018] In an embodiment of the present invention, the air conveyor may comprise a first portion housing the blower, and a removable second portion configured to be mounted to the first portion for defining an air channel for the air expelled by the blower.

[0019] Preferably, the first and the second portions are configured so as to allow access to the blower when the second portion is removed.

[0020] In an embodiment of the present invention, the air conveyor may comprise a first portion housing the blower and at least part of a motor activating the blower, and a removable third portion configured to be mounted to the first portion to cover part of the motor.

[0021] Preferably, the first and the second portions are configured so as to allow access to the motor when the third portion is removed.

[0022] Advantageously, the air conveyor is provided with a plate for mounting it to a cross-plate at the bottom of a recess of the refrigerator cabinet where the air conveyor is housed.

[0023] The food refrigerator may advantageously comprise a control unit for selectively activating the blower.

#### Brief Description of the drawings

[0024] These and other features and advantages of the present invention will be made apparent by the following detailed description of an embodiment thereof.

The description is provided merely by way of non-limiting example, and makes reference to the annexed drawings, wherein:

**Figure 1** shows in isometric view from the back a refrigerator according to an embodiment of the present invention;

**Figure 2** shows in enlarged scale a detail of the bottom of the refrigerator shown in **Figure 1**;

**Figure 3** shows in exploded view a blower according to an embodiment of the present invention for the forced ventilation of the refrigerator condenser; and

**Figure 4** is a schematic cross-sectional view illustrating the operation of the refrigerator of **Figures 1** and **2**.

#### Detailed description of an embodiment of the invention

[0025] Referring to the drawings, in **Figure 1** there is shown in isometric view from behind a refrigerator according to an embodiment of the present invention.

[0026] The refrigerator comprises a refrigerator cabinet **105**, having two side walls (only one of which is visible, and is denoted **110**), a top wall **115**, a rear wall **120** and a bottom wall **415** (shown in **Figure 4**). Frontally, not visible in the drawing, the cabinet has an opening accessing the refrigerator inner compartment, where the food to be preserved can be stored, and a door, for closing the inner compartment opening.

[0027] The refrigerator comprises a heat pump having a refrigerant compressor, a refrigerant liquefier or condenser, a metering or throttling device, and a refrigerant evaporator, all in fluid communication by means of pipes. The compressor, denoted **125** in the drawing, is positioned in a recess **130** at the rear bottom of the cabinet **105**. The condenser, denoted **135** in the drawing, is an essentially flat external heat exchanger, with a winding piping for the refrigerant fluid, that is mounted onto the cabinet **105** (e.g. by means of brackets and screws) so as to extend along the cabinet rear wall **120**, preferably along a significant length thereof, so as to feature a large heat exchange area. This is a typical arrangement for a static condenser (on the contrary, the refrigerators with dynamic condensers typically have box-shaped condensers that are relatively small in outer dimensions and are placed in the recess **130** where the compressor **125** is also placed).

[0028] In a refrigerator with a static condenser, ambient air usually flows by natural convection over the condenser **135**, from the bottom to the top of the cabinet **105**, exiting from an opening at the rear top of the cabinet. However, when the refrigerator is encased, built-in the kitchen furniture, the natural flow of ambient air over the condenser is difficult.

[0029] According to a preferred embodiment, the refrigerator of the present invention comprises an air ventilation system **140** for augmenting the draft of ambient air over the condenser **135**.

[0030] Referring also to **Figures 2 and 3**, the air ventilation system **140** advantageously comprises a fan or blower **305** and an air conveyor **205** conveying the air generated by the fan **305**. In the preferred embodiment here described, the air conveyor **205** houses the fan **305**. The fan **305** draws ambient air in from the outside environment (i.e., the kitchen) and the air conveyor **205** conveys the air taken in by the blower towards the condenser **135**. Advantageously, the fan **305** and the associated air conveyor **205** are positioned in the recess **130**, preferably aside the compressor **125**, as visible in enlarged scale in **Figure 2**.

[0031] **Figure 3** shows in exploded view the exemplary constitution of the air ventilation system **140** according to an embodiment of the present invention.

[0032] The air conveyor **205** is advantageously provided with a fixing plate **315** for mounting it, by means of screws or bolts, onto a cross-plate **210** at the bottom of the recess **130** (to which the compressor **125** is also mounted). The fan **305** is preferably driven by an own motor **320** with horizontal axis, preferably coupled to the fan **305** through motor vibration absorbers **325**, to damp vibrations. Preferably, the air conveyor **205** is mounted onto the cross-plate **210** by interposition of further vibration absorbers **335**, e.g. made of rubber, for further dumping vibrations.

[0033] Preferably, as shown in **Figure 4**, the air conveyor **205** defines an air conveying duct or channel **406** for conveying the air blown by the fan **305**, and a motor chamber **407** housing the motor **320**.

[0034] With reference to **Figure 3**, the air conveyor **205** is preferably an assembly of three portions removably coupled to each other:

- a main hollow body **340** housing the fan **305** and partly the motor **320**,
- a front cover **330**, coupled to the main body **340** by means of screws and giving access to the motor **320** when removed, and
- a back cover **345**, coupled to the main body **340** by means of snap fits and giving access to the fan **305** when removed.

[0035] It is clear that other kind of coupling means can be used as well to couple the three portions.

[0036] The main hollow body **340** and the back cover **345** are shaped substantially as two half-shells to form together the air conveying duct **406** receiving and conveying the air blown by the fan **305**.

[0037] In particular:

- the main hollow body **340** has a lower cylindrical portion **340a** with horizontal axis defining a chamber hosting the fan **305** and an upper vertical wall **340b** extending upwards from the back end of the cylindrical portion **340a**, and
- the back cover **345** is a substantially planar body having a lower circular portion **345a** matching with

the perimeter of the cylindrical portion **340a** of the main hollow body **340**, and a vertical wall **345b** extending upwards from the lower circular portion **345a** and matching with the vertical wall **340b** of the main hollow body **340**.

[0038] Thus, as shown in **Figure 4**, the air conveying duct **406** has a first horizontal section **406a** (where the fan **305** is located) and a second vertical section **406b** directed upwards.

[0039] The motor chamber **407** is formed by the front part of the main hollow body **340** and the front cover **330**. The motor chamber **407** has, in its lower part, an opening defining an air inlet **409a** for the air conveyor **205**, to suck the air entering the recess **130** from the outside of the refrigerator cabinet **105**. Moreover, the refrigerator cabinet **105** has, in its bottom, in particular between the bottom wall **415** and the cross-plate **210**, an opening **420** to allow air to enter into the recess **130** from below the cabinet **105**. As air is sucked from the outside, air circulation in the whole recess **130** is improved, so that also the compressor **125** is better cooled, thus increasing its efficiency.

[0040] Accordingly, the air conveyor **205** is adapted to convey the air taken in by the fan **305** towards the top of the refrigerator cabinet **105**. An air outlet **409b** of the air conveyor **205** is located just below the condenser **135**.

[0041] Advantageously, hits absorbers **350** are attached to the outside of the back cover **345** for protecting the air conveyor **205** when the refrigerator **100** is installed in the kitchen, abutting the kitchen wall, and also dumps vibrations transmitted by the fan **305**.

[0042] The operations of the refrigerator of the present invention will be herein below described with reference to the schematic cross-sectional view **Figure 4**, illustrating the refrigerator encased in a kitchen furniture. In the drawing, **405** denotes the cross-sectioned walls of the kitchen furniture where the refrigerator is encased. When the refrigerator is encased in the kitchen furniture, an air gap **410** is left between the bottom wall **415** of the refrigerator cabinet **105** and a bottom wall **405-1** of the kitchen furniture **405**. Similarly, an air gap **420** is left between the rear wall of the refrigerator cabinet **105** and the rear wall **405-2** of the kitchen furniture **405**. When the kitchen furniture **405** does not have a rear wall, an air gap is similarly formed between the rear wall **120** of the refrigerator and the kitchen wall, laterally closed by the vertical side wall of the kitchen furniture where the refrigerator is encased.

[0043] Moreover, the refrigerator cabinet **105** has, in its bottom, in particular between the bottom wall **215** and the cross-plate **210**, an opening **420** to allow air within the air gap **410** to enter into the recess **130**.

[0044] When the fan **305** is operating, it draws in ambient air from the air gap **410** into the recess **130** through the opening **420**, and then into the air conveyor **205** through the air inlet **409a**, and thanks to the air conveyor **205** the air is then forced to flow up along the air gap **420**, thereby ventilating and cooling the condenser **135**. The

ambient air, after having cooled the condenser **135**, exits the air gap **420** and returns to the ambient through an opening provided at the top of the kitchen furniture where-in the refrigerator is encased.

[0045] If the refrigerator is not built-in but free-standing, the operations are exactly the same, and the walls **405-1** and **405-2** in **Figure 4** could represent the floor and the wall of the kitchen against which the refrigerator is positioned. Even in the absence of a wall **405-2**, the air conveyor **205** is able to properly direct the air blown by the fan **305** towards the condenser **135**.

[0046] The solution according to the present invention is very flexible. It allows improving the efficiency of existing refrigerators with static condenser in a way that does not impact their design, by simply adding, if desired, the air ventilation system **140**, which can be accommodated in the recess **130** at the bottom of the refrigerator cabinet where the compressor is placed. Thus, thanks to the solution of the present invention, a refrigerator with static condenser can easily be transformed into a refrigerator with forced-air condenser ventilation. This allows a manufacturer to have two distinct lines of product: one with static condenser ventilation and the other with forced condenser ventilation, but with a very small production cost (essentially just the cost of the fan **305** and associated air conveyor **205**).

[0047] Advantageously, the refrigerator control unit can be configured to selectively activate the fan **305**, for example in response to a user command. For example, the refrigerator control unit may be configured to cause the fan **305** to be activated only during the day and not at nighttime, so as to keep the noise level very low during the hours of sleep.

[0048] In the foregoing, an exemplary embodiment of the present invention has been described. Those skilled in the art will readily understand that several modifications to the described embodiments are possible. For example, in alternative embodiments the air conveyor can be a separate part with respect to the fan housing, coupled to the fan housing outlet so as to receive and guide towards the condenser the ambient air taken in by the fan. The fan, instead of being an axial fan as described above, can be a different type of fan, for example a centrifugal fan.

## Claims

1. A food refrigerator comprising a cabinet (**105**), a heat pump for submitting a refrigerant fluid to a thermodynamic cycle, wherein the heat pump comprises a refrigerant condenser (**135**) mounted on a back wall (**120**) of the cabinet and extending along said back wall, and a forced air ventilation system (**140**) for ventilating the condenser, **characterized in that** the forced air ventilation system comprises at least one blower (**305**) for drawing in air from the outside environment, and an air conveyor (**205**) associated with

the at least one blower for directing the ambient air drawn in and propelled by the at least one blower towards the refrigerant condenser.

2. The food refrigerator according to claim 1, wherein the at least one blower and the air conveyor are housed in a recess (**130**) of the refrigerator cabinet at the bottom of the refrigerator cabinet, below the refrigerant condenser.
3. The food refrigerator of claim 1 or 2, wherein the air conveyor houses the blower.
4. The food refrigerator of any of the preceding claims, wherein the air conveyor comprises a first portion (**340**) housing the blower, and a removable second portion (**345**) configured to be mounted to the first portion for defining an air channel for the air expelled by the blower.
5. The food refrigerator of claim 4, wherein the first and the second portions are configured so as to allow access to the blower when the second portion is removed.
6. The food refrigerator of any of the preceding claims, wherein the air conveyor comprises a first portion (**340**) housing the blower and at least part of a motor activating the blower, and a removable third portion (**345**) configured to be mounted to the first portion to cover part of the motor.
7. The food refrigerator of claim 6, wherein the first and the second portions are configured so as to allow access to the motor when the third portion is removed.
8. The food refrigerator of any of the preceding claims, wherein the air conveyor is provided with a plate (**315**) for mounting it to a cross-plate (**210**) at the bottom of a recess (**130**) of the refrigerator cabinet where the air conveyor is housed.
9. The food refrigerator of any one of the preceding claims, comprising a control unit for selectively activating the blower.

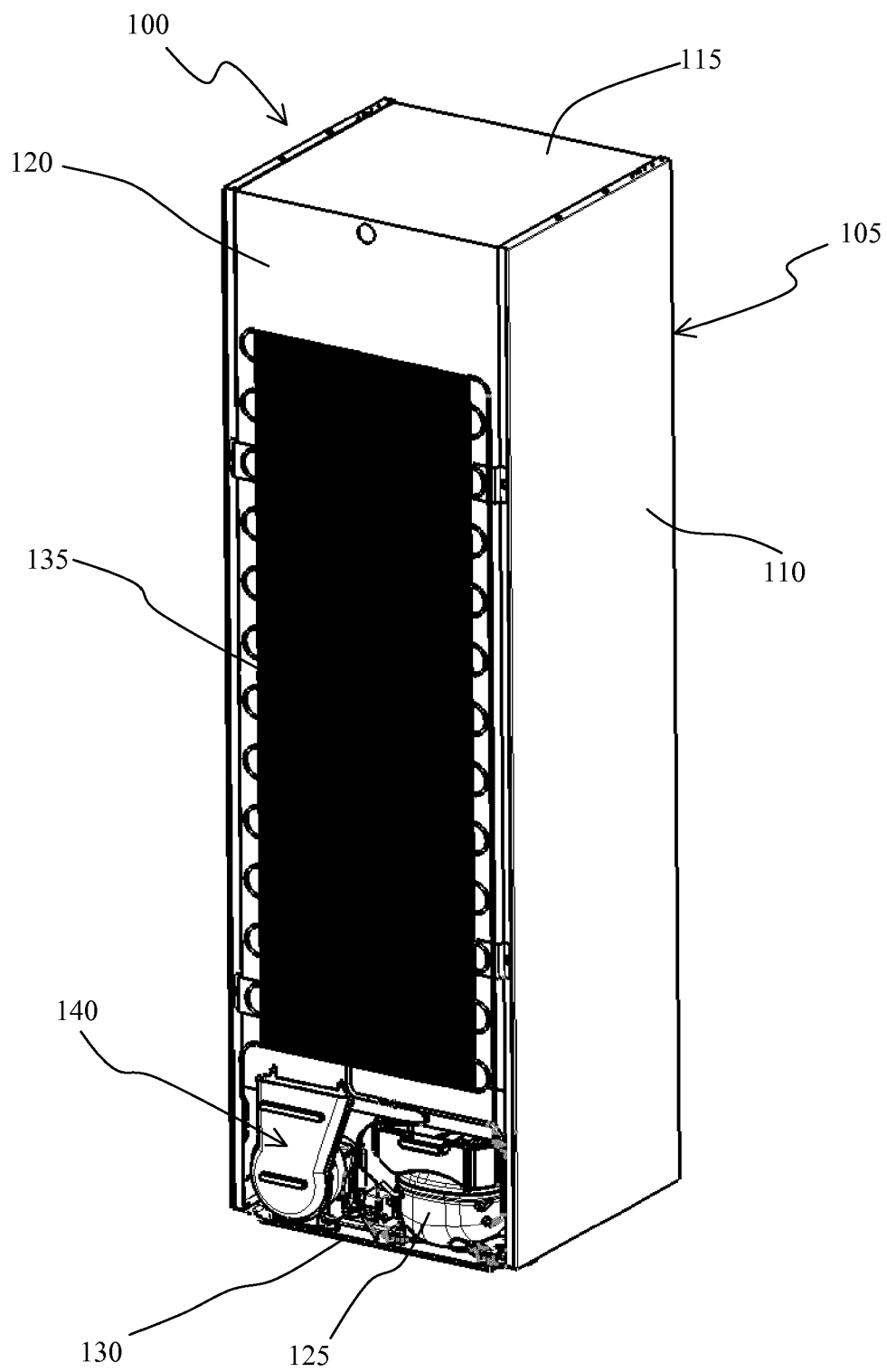


FIG. 1

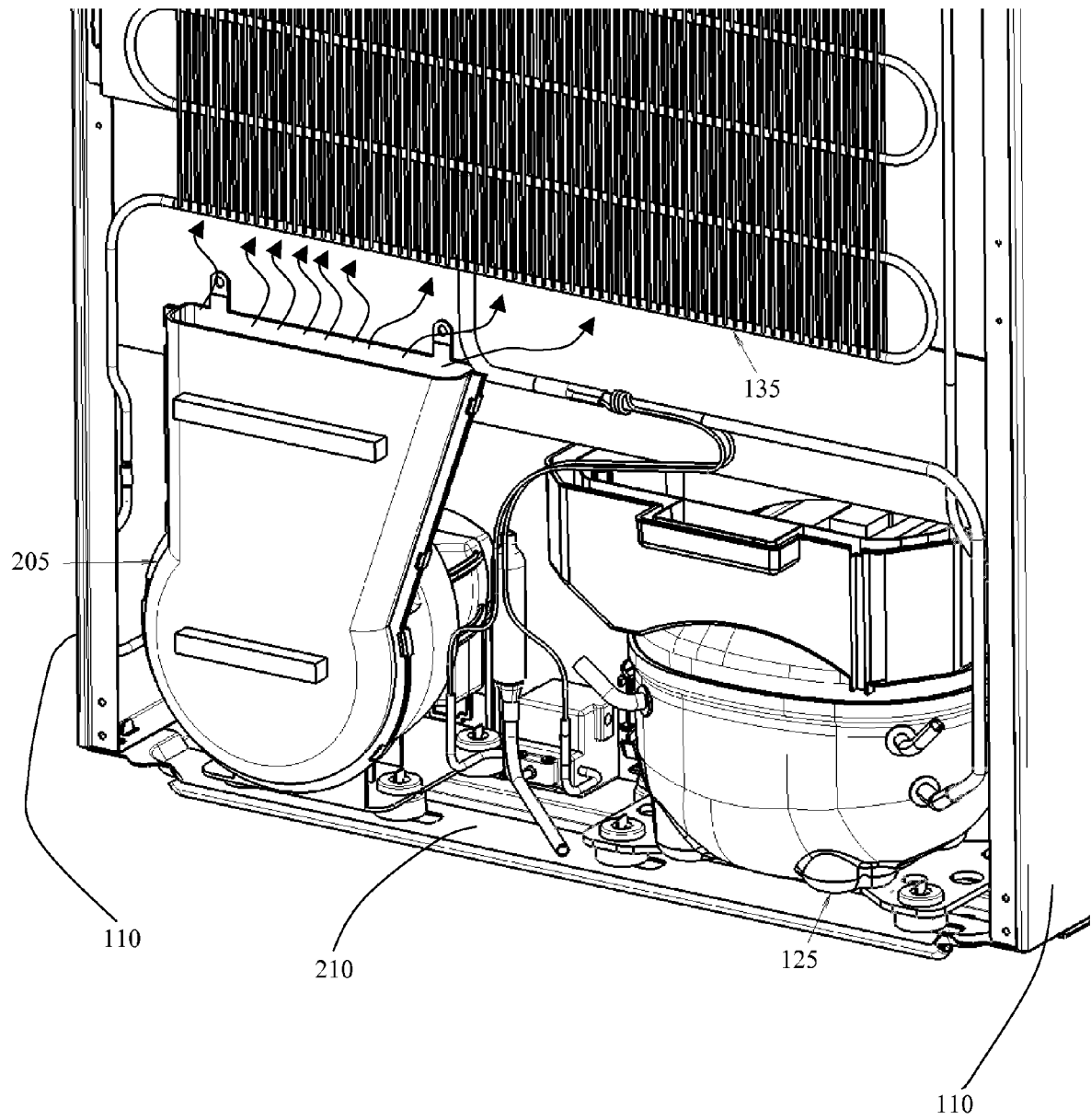
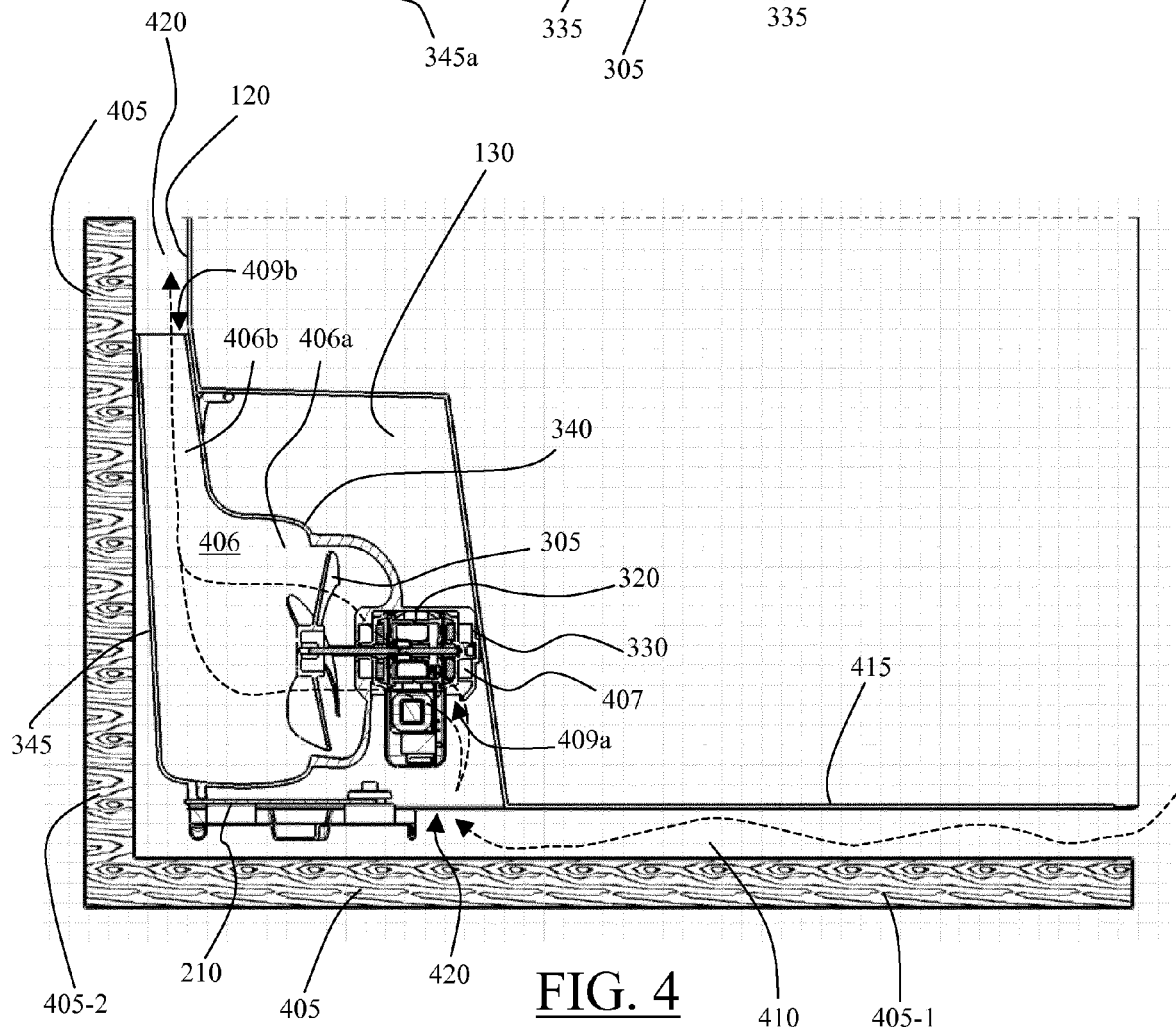
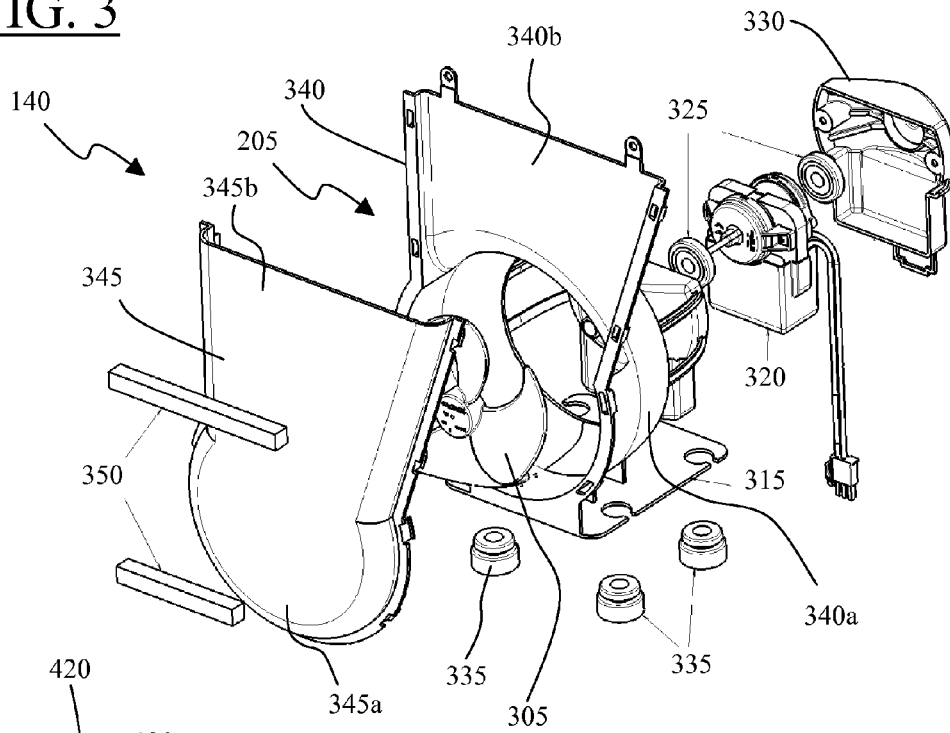


FIG. 2

**FIG. 3**



**FIG. 4**



## EUROPEAN SEARCH REPORT

Application Number  
EP 12 19 7386

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 5 743 109 A (SCHULAK EDWARD R [US]) 28 April 1998 (1998-04-28) * column 2, line 23 - column 3, line 48; figure 1 *	1-3,9	INV. F25D23/00
X	DE 199 06 742 A1 (FISCHER UDO [DE] AUSTRIA HAUSTECHNIK AG ROTTENM [AT]) 31 August 2000 (2000-08-31) * column 3, line 33 - page 4, line 10; figure 1 *	1,2	
X	US 4 089 187 A (SCHUMACHER FRANK A ET AL) 16 May 1978 (1978-05-16) * abstract; figure 1 *	1,2	
X,D	US 1 769 119 A (DAVENPORT RANSOM W) 1 July 1930 (1930-07-01) * page 1, line 78 - page 2, line 31; figure 1 *	1,2,9	
			TECHNICAL FIELDS SEARCHED (IPC)
			F25D
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 12 March 2013	Examiner Jessen, Flemming
<p>CATEGORY OF CITED DOCUMENTS</p> <p>X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document</p> <p>T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons &amp; : member of the same patent family, corresponding document</p>			

1  
EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT  
ON EUROPEAN PATENT APPLICATION NO.**

EP 12 19 7386

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  
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

12-03-2013

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
US 5743109	A	28-04-1998	NONE	
DE 19906742	A1	31-08-2000	NONE	
US 4089187	A	16-05-1978	NONE	
US 1769119	A	01-07-1930	NONE	

**REFERENCES CITED IN THE DESCRIPTION**

*This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.*

**Patent documents cited in the description**

- DE 19933603 [0006]
- US 3785168 A [0006]
- US 2079770 A [0006]
- EP 1919973 A [0006]
- US 1769119 A [0009] [0013]