



(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 153(4) EPC

(43) Date of publication:
03.05.2023 Bulletin 2023/18

(51) International Patent Classification (IPC):
F25D 17/06 ^(2006.01) **F25D 23/00** ^(2006.01)

(21) Application number: **21857476.2**

(52) Cooperative Patent Classification (CPC):
F25D 11/02; F25D 17/06; F25D 23/00

(22) Date of filing: **29.07.2021**

(86) International application number:
PCT/CN2021/109162

(87) International publication number:
WO 2022/037381 (24.02.2022 Gazette 2022/08)

(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
Designated Validation States:
KH MA MD TN

(30) Priority: **18.08.2020 CN 202010832824**

(71) Applicants:
• **Qingdao Haier Refrigerator Co., Ltd.**
Laoshan District
Qingdao
Shandong 266101 (CN)
• **Haier Smart Home Co., Ltd.**
Qingdao, Shandong 266101 (CN)

(72) Inventors:
• **MA, Jian**
Qingdao, Shandong 266101 (CN)
• **NODA, Toshinori**
Qingdao, Shandong 266101 (CN)
• **ZHU, Xiaobing**
Qingdao, Shandong 266101 (CN)
• **LI, Weijie**
Qingdao, Shandong 266101 (CN)
• **LIU, Lei**
Qingdao, Shandong 266101 (CN)

(74) Representative: **Ziebig Hengelhaupt Intellectual Property Attorneys**
Patentanwaltsanwaltskanzlei PartGmbB
Leipziger Straße 49
10117 Berlin (DE)

(54) **AIR-COOLED REFRIGERATOR**

(57) An air-cooled refrigerator, comprising a bottom liner, a plurality of upper liners, and a return air duct. The bottom of the bottom liner is provided with a refrigerating cavity for providing an evaporator of the refrigerator, and is provided with a side return air opening in communication with the refrigerating cavity; the plurality of upper liners are arranged in sequence above the bottom liner, and each upper liner is provided with an exhaust opening; the return air duct extends downwards to the side return air opening along the exhaust openings of the plurality of upper liners to introduce the return air flow of the plurality of upper liners into the refrigerating cavity. In the air-cooled refrigerator of the present invention, a single return air duct is used to divert the return air flow of the refrigerating cavity and a variable temperature cavity, thereby effectively saving the foaming space of the refrigerator, improving the heat preservation performance of the refrigerator, and reducing the cost of the refrigerator.

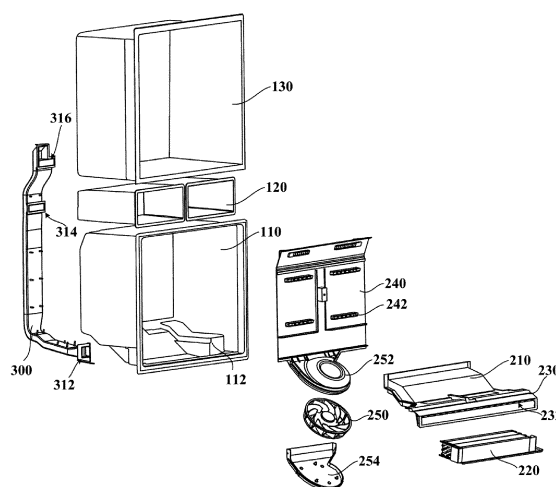


Fig. 3

Description

FIELD OF THE INVENTION

[0001] The present invention relates to refrigerating and freezing technologies, and particularly relates to an air-cooled refrigerator.

BACKGROUND OF THE INVENTION

[0002] As for a refrigerator with an evaporator at the bottom in the prior art, a return air duct is mainly configured to divert a return air flow of a variable temperature compartment into a cooling chamber at the lowest portion of the refrigerator, while a refrigerating compartment at the uppermost portion of the refrigerator adopts an independent air supply system. There are certain defects in this design. For example, the return air duct can only ensure variable temperature air return, which has a certain limitation; and two independent air supply systems inevitably occupy more spaces for foaming, which not only affects a heat load, but also increases the cost of the refrigerator.

BRIEF DESCRIPTION OF THE INVENTION

[0003] An objective of the present invention is to overcome at least one defect in the prior art and to provide an air-cooled refrigerator.

[0004] A further objective of the present invention is that as for an air-cooled refrigerator with a cooling chamber at the bottom, a single return air duct is adopted to divert return air flows of the upper liners into the cooling chamber.

[0005] Another further objective of the present invention is to improve heat exchange efficiency of the refrigerator.

[0006] Particularly, the present invention provides an air-cooled refrigerator, including:

a bottom liner, the bottom of which is provided with a cooling chamber for arranging an evaporator of the refrigerator, and is provided with a side return air inlet in communication with the cooling chamber;
a plurality of upper liners, arranged in sequence above the bottom liner, an exhaust outlet being formed in each upper liner; and
a return air duct, extending downwards to the side return air inlet along the exhaust outlets of the plurality of upper liners to introduce return air flows of the plurality of upper liners into the cooling chamber.

[0007] Further, the plurality of exhaust outlets are all provided in positions of rear walls of the corresponding upper liners close to edges of one side.

[0008] Further, the upper liners include a first upper liner located above the bottom liner, and a second upper liner located above the first upper liner; wherein

a space of the bottom liner above the cooling chamber is configured as a freezing compartment;
an internal space of the first upper liner is configured as a variable temperature compartment; and
an internal space of the second upper liner is configured as a refrigerating compartment.

[0009] Further, a segment of the return air duct between the second upper liner and the first upper liner is gradually bent, so as to extend from the position of the exhaust outlet of the second upper liner to the position of the exhaust outlet of the first upper liner.

[0010] Further, the air-cooled refrigerator also includes:

a separation cover plate, transversely provided inside the bottom liner for separating the cooling chamber and the freezing compartment; and
areas of a bottom face of the bottom liner close to two sides protrude upwards to form supporting parts to support the separation cover plate, and
the evaporator is provided in a sunken area between the supporting parts.

[0011] Further, the air-cooled refrigerator also includes:

a return air cover, provided on a front portion of the cooling chamber, at least one forward return air inlet that makes the cooling chamber communicate with the freezing compartment being formed in the return air cover;
there is a set gap between a front end of the supporting part on one side and the return air cover, and
the side return air inlet is provided in the front end of the supporting part, so as to make air from the return air duct enter the cooling chamber via the gap between the front end of the supporting part and the return air cover.

[0012] Further, after extending from an outer side of a rear wall of the bottom liner to an outer side of a bottom wall of the bottom liner, the return air duct extends along the outer side of the bottom wall of the bottom liner until being connected with the side return air inlet.

[0013] Further, the evaporator is a finned evaporator, which includes:

a set of fins, parallelly arranged in the front-back direction of the refrigerator;
an evaporation tube, penetrating through the fins; and
supporting end plates, provided on the two sides of the fins, a front end of the supporting end plate close to the side of the side return air inlet being bent towards the corresponding supporting part to form a shielding part, so as to avoid an air flow from passing through a gap between the evaporator and the cor-

responding supporting part by using the shielding part.

[0014] Further, the air-cooled refrigerator also includes:

a centrifugal fan, obliquely provided behind the evaporator, with a suction inlet thereof facing a front lower portion and an air outlet thereof facing a rear portion; and
an air supply duct, communicating with the air outlet of the centrifugal fan and extending upwards, and configured to convey an air flow discharged by the centrifugal fan to the freezing compartment and/or the variable temperature compartment and/or the refrigerating compartment.

[0015] Further, the return air duct is a flat square duct, and a wider face of the return air duct nestles against the bottom liner and the plurality of upper liners.

[0016] In the air-cooled refrigerator of the present invention, the cooling chamber is provided at the bottom of the bottom liner, the upper liners are located above the bottom liner, and an exhaust outlet is provided in each upper liner. The side return air inlet communicating with the cooling chamber is provided in the bottom liner, the return air duct extends downwards to the side return air inlet along the exhaust outlets of the plurality of upper liners, so as to introduce return air flows of the plurality of upper liners into the cooling chamber to continue the heat exchange with the evaporator and form a circulating air flow.

[0017] Further, in the air-cooled refrigerator of the present invention, the plurality of exhaust outlets are all provided in the positions of the rear walls of the corresponding upper liners close to the edges of one side, and the segment of the return air duct between the second upper liner and the first upper liner is gradually bent, which may avoid the situation that when the return air duct has a vertical shape and there are both the return air flow of the refrigerating compartment and the return air flow of the variable temperature compartment in the duct, the return air flow of the refrigerating compartment enters the variable temperature compartment via a first exhaust outlet, and counteract or inhibit the trend of the return air flow of the variable temperature compartment upwards entering the refrigerating compartment via a second exhaust outlet, thereby reducing the pressure loss of the return air duct and improving the heat exchange efficiency of the refrigerator.

[0018] These and other objectives, advantages and features of the present invention will be better understood by those skilled in the art in the light of the detailed description of specific embodiments of the present invention in conjunction with the accompanying drawings below.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] Some specific embodiments of the present invention will be described below in detail in an exemplary and non-limiting manner with reference to the accompanying drawings. Identical reference numerals in the accompanying drawings indicate identical or similar components or parts. It should be understood by those skilled in the art that these accompanying drawings are not necessarily drawn to scale. In the accompanying drawings,

Fig. 1 is a schematic diagram of a refrigerator according to an embodiment of the present invention; Fig. 2 is a longitudinal sectional view of a refrigerator according to an embodiment of the present invention, with upper liners being hidden;

Fig. 3 is an exploded view of a refrigerator according to an embodiment of the present invention, with a housing being hidden;

Fig. 4 is a schematic diagram of position relationships between a bottom liner, a first upper liner and a second upper liner in a refrigerator according to an embodiment of the present invention;

Fig. 5 is a rear view of a refrigerator according to an embodiment of the present invention, with a housing being hidden;

Fig. 6 is a left view of a refrigerator according to an embodiment of the present invention, with a housing being hidden; and

Fig. 7 is a transverse sectional view of a bottom liner of a refrigerator according to an embodiment of the present invention.

DETAILED DESCRIPTION

[0020] In the description of the embodiment, it should be understood that, orientation or position relationships indicated by terms "longitudinal", "transverse", "length", "width", "thickness", "upper", "lower", "front", "rear", "left", "right", "vertical", "horizontal", "top", "bottom", "depth", etc. are based on orientations of a refrigerator in normal use as a reference, and can be determined with reference to orientation or position relationships as shown in the accompanying drawings. For example, "front" for indicating an orientation refers to a side of the refrigerator facing a user. It is merely for ease of describing the present invention and simplifying the description, and not for indicating or implying the device or component referred to should have a specific orientation and be constructed and operated in the specific orientation, and thus it cannot be interpreted as a limitation on the present invention.

[0021] See Fig. 1, a refrigerator 1 of the embodiment may generally include a refrigerator body 10. The refrigerator body 10 may be composed of a housing, a liner, a heat insulation layer and other accessories. The housing is an outer layer structure of the refrigerator 1, and protects the whole refrigerator 1. In order to isolate heat conduction from the outside, the heat insulation layer is

additionally disposed between the housing and the liner of the refrigerator body 10, and the heat insulation layer is generally made by means of a foaming process. There may be one or more liners, which may be arbitrarily divided into a refrigerating liner, a variable temperature liner, a freezing liner and the like according to functions. The specific number and functions of the liners may be configured according to usage demands of the refrigerator. In the embodiment, the liner at least includes a bottom liner 110, which may generally be a freezing liner.

[0022] See Fig. 2, a cooling chamber 140 is provided at the bottom of the bottom liner 110 of the refrigerator 1 of the embodiment, and an evaporator 220 is provided inside the cooling chamber 140 and supplies cold to the refrigerator 1. Specifically, a separation cover plate 210 is provided on the lower portion of the bottom liner 110, and transversely provided inside the bottom liner 110 to separate the bottom liner 110 into the cooling chamber 140 and a freezing compartment 160 located above the cooling chamber 140.

[0023] That is, in the embodiment, the evaporator 220 is provided on the lower portion of the bottom liner 110. Such arrangement may avoid the reduction of depth of the freezing compartment due to the occupation of a rear space of the freezing compartment by an evaporator in a traditional refrigerator. Especially for a side-by-side refrigerator, it is especially important to increase the depth dimension of the freezing compartment when the transverse dimension of the freezing compartment is small. Thus, the space utilization rate of the refrigerator 1 is improved, and objects that are large and difficult to be divided are stored advantageously.

[0024] Additionally, in the traditional refrigerator, the freezing compartment on the lowest portion has a low position, a user needs to bend down significantly or squat down to pick up and place objects in the freezing compartment. Thus, it is inconvenient for the user to use, especially for the elderly. However, in the embodiment, since the lower space of the bottom liner 110 is occupied by the cooling chamber 140, the height of the freezing compartment 160 above the cooling chamber 140 is raised, and thus the degree of bending down is reduced when the user picks up and places the objects in the freezing compartment 160, thereby improving the user experience of the user.

[0025] See Fig. 3, in the embodiment, the evaporator 220 may have an overall flat cuboid shape, is arranged at a front portion of the cooling chamber 140, and is obliquely provided in the cooling chamber 140. This manner breaks through the technical shackle that, in the prior art, an evaporator needs to be placed horizontally to reduce the depth dimension. Although oblique placement of the flat cuboid evaporator 220 may increase the length in the front-back direction, it makes other components inside the cooling chamber 140 arranged more reasonably, and it is verified from actual analysis of an air flow field that air circulation efficiency is higher, and water drainage is smoother. The layout of oblique placement of the evap-

orator 220 is one of the main technical improvements made in the embodiment. In some specific embodiments, an oblique angle of the evaporator 220 is set within a range from 7 to 8 degrees, e.g., 7 degrees, 7.5 degrees and 8 degrees, preferably 7.5 degrees.

[0026] See Figs. 2 and 3, in the embodiment, the refrigerator 1 may also include an air supply assembly. The air supply assembly is provided behind the evaporator 220. The air supply assembly may include a centrifugal fan and an air supply duct 150. The centrifugal fan is obliquely provided behind the evaporator 220, with its suction inlet facing a front lower portion and its air outlet facing a rear portion, and is configured to prompt the formation of a refrigeration air flow supplied towards the freezing compartment 160 via the evaporator 220. The air supply duct 150 communicates with the air outlet of the centrifugal fan and extends upwards, and is configured to convey an air flow discharged by the centrifugal fan to the freezing compartment 160. A proportion of a horizontal distance between a front end of the centrifugal fan and the evaporator 220 to the depth dimension of the refrigerator body 10 in the front-back direction is less than 4.5%. For example, the proportion is set to 4.3%.

[0027] See Figs. 2 and 3, the refrigerator 1 may also include an air duct back plate 240. The air duct back plate 240 is provided in front of a rear wall of the bottom liner 110 and may be roughly parallel to the rear wall of the bottom liner 110, so as to define the air supply duct 150 together with the rear wall of the bottom liner 110. The air supply duct 150 communicates with the air outlet of the centrifugal fan and extends upwards. At least one air supply outlet 242 is formed in the air duct back plate 240. The air supply outlet 242 is configured to make the air supply duct 150 communicate with the freezing compartment 160. The air supply duct 150 communicates with the cooling chamber 140, and the separation cover plate 210 serves as a separation part of the cooling chamber 140, thus the air duct back plate 240 may be connected with separation cover plate 210 in an abutting manner, so as to play a role in sealing a gap between the cooling chamber 140 and the air supply duct 150.

[0028] See Figs. 2 and 3, the centrifugal fan may also include fan blades 250, a fan upper cover 252 and a fan bottom shell 254. The fan upper cover 252 extends obliquely downwards into the cooling chamber 140 from a lower end of the air duct back plate 240. The fan bottom shell 254 covers the fan upper cover 252 and is fastened thereto. The fan blades 250 are provided inside a fan cavity (not shown in the figures) formed by the fan upper cover 252 and the fan bottom shell 254. The air duct back plate 240 and the fan upper cover 252 may also be configured as an integrally-formed piece, so as to simplify the installation procedure and reduce the cost, and it also enables the whole air duct structure to be more stable.

[0029] See Figs. 1 to 3, the refrigerator 1 may also include a return air cover 230. The return air cover 230 is provided at the front portion of the cooling chamber 140. At least one forward return air inlet 232 that makes

the cooling chamber 140 communicate with the freezing compartment 160 is formed in the return air cover 230.

[0030] The evaporator 220 inside the cooling chamber 140 exchanges heat with surrounding air, so as to make its temperature reduced to form a refrigeration air flow. With the promotion of the centrifugal fan, the refrigeration air flow is discharged from the cooling chamber 140 to the air supply duct 150, and then enters the freezing compartment 160 from the air supply outlet 242 in the air duct back plate 240, so as to exchange heat with air in the freezing compartment 160 to reduce the temperature of the freezing compartment 160. The refrigeration air flow may flow back to the cooling chamber 140 via the forward return air inlet 232 in the return air cover 230 after heat exchange to continue to conduct heat exchange with the evaporator 220, thereby forming a circulating air flow path.

[0031] See Figs. 3 to 6, in some embodiments of the present invention, the bottom liner 110 is provided with a side return air inlet 114 in communication with the cooling chamber 140. The refrigerator 1 may also include a plurality of upper liners and one return air duct 300. The plurality of upper liners are arranged in sequence above the bottom liner 110, and an exhaust outlet is formed in each upper liner 110. The return air duct 300 extends downwards to the side return air inlet 114 along the exhaust outlets of the plurality of upper liners to introduce return air flows of the plurality of upper liners into the cooling chamber 140.

[0032] The side return air inlet 114 may be located on one side of the cooling chamber 140, so as to enable return air flows of the upper liners to be discharged to a side of the evaporator 220 via the side return air inlet 114, so that a contact path of the return air flows of the upper liners with the evaporator 220 is extended, improving heat exchange efficiency.

[0033] In the embodiment, each upper line is configured to be independent of the bottom liner 110, such that the upper liners no longer occupy the space of the bottom liner 110, which may increase the volume of the freezing compartment 160 defined by the bottom liner 110.

[0034] See Figs. 3 and 4, specifically, the upper liners include a first upper liner 120 located above the bottom liner 110 and a second upper liner 130 located above the first upper liner 120. A first exhaust outlet 122 is provided on a rear wall of the first upper liner 120, and a second exhaust outlet 132 is provided on a rear wall of the second upper liner 130. The return air duct 300 has a lower end duct opening 312 connected with the side return air inlet 114, a middle duct opening 314 connected with the first exhaust outlet 122 and an upper end duct opening 316 connected with the second exhaust outlet 132. That is, the return air duct 300 overall extends along and is provided on the rear walls of the bottom liner 110, the first upper liner 120 and the second upper liner 130.

[0035] See Fig. 5, the rear wall of the first upper liner 120 is also provided with a first upper air supply duct 256 communicating with the air supply duct 150 of the bottom

liner 110, and a second upper air supply duct 258 communicating with the first upper air supply duct 256. That is, the air supply duct 150 and the first upper air supply duct 256 communicate with each other, or the air supply duct 150, the first upper air supply duct 256 and the second upper air supply duct 258 communicate with one another, so that the refrigeration air flow inside the air supply duct 150 enters the first upper air supply duct 256 and the second upper air supply duct 258 under the action of the centrifugal fan, and then the refrigeration air flow can be discharged into the upper liners via the upper air supply ducts and exchange heat with air of the upper liners, to reduce the temperature of the upper liners. Since the cooling chamber 140 of the refrigerator 1 is located at the bottom of the bottom liner 110, i.e., the lowest portion of the refrigerator 1, the return air flows in the upper liners are discharged into the cooling chamber 140 via the return air duct 300 to conduct heat exchange with the evaporator 200 for cooling to form a circulating air flow.

[0036] In some preferable embodiments, the interior of the first upper liner 120 may be divided into a left storage zone and a right storage zone, and the two storage zones may also be configured as variable temperature compartments, and for example, are arranged as variable temperature drawers, respectively. The second upper liner 130 is located above the first upper liner 120, and inner space of the second upper liner 130 may also be configured as a refrigerating compartment. Specifically, as is well known to those skilled in the art, the temperature inside the refrigerating compartment may also be set to be within a range from 2°C to 10°C, preferably 4°C to 7°C; and the temperatures of the variable temperature compartment may be randomly adjusted to be within a range from -18°C to 8°C. Different kinds of objects have different optimal storage temperatures and different positions suitable for storage. For example, fruit and vegetable foods are suitable for storage in the refrigerating compartment.

[0037] As mentioned in the background art, as for a refrigerator with an evaporator at the bottom in the prior art, a return air duct is mainly configured to divert a return air flow of a variable temperature compartment into a cooling chamber at the lowest portion of the refrigerator, while a refrigerating compartment at the uppermost portion of the refrigerator adopts an independent air supply system. There are certain defects in this design. For example, the return air duct can only ensure variable temperature air return, which has a certain limitation; and two independent air supply systems inevitably occupy more spaces for foaming, which not only affects a heat load, but also increases the cost of the refrigerator.

[0038] In the air-cooled refrigerator 1 of the embodiment, a single return air duct 300 is adopted to divert return air flows of the refrigerating compartment and the variable temperature compartment, which can effectively save foaming space of the refrigerator 1, reduce the obstruction to foaming layers, ensure the foaming thick-

ness, improve heat preservation performance of the refrigerator 1, and reduce the cost of the refrigerator 1.

[0039] Additionally, as is well known to those skilled in the art, the temperature of the refrigerating compartment is higher than the temperatures of the variable temperature compartment and the freezing compartment, thus the air pressure of the return air flow of the refrigerating compartment is relatively large. When the air-cooled refrigerator 1 adopts the single return air duct 300 to divert both the return air flow of the refrigerating compartment and the return air flow of the variable temperature compartment into the cooling chamber 140, the return air flow of the refrigerating compartment can increase the air pressure of the whole return air duct 300, so as to make the flow rate of the return air flow of the return air duct 300 increased and to make air return efficiency improved, which further improves the refrigeration effect of the refrigerator 1. The inventor also verifies the technical effect on a trial product.

[0040] See Figs. 5 and 6, in some embodiments of the present invention, the plurality of exhaust outlets are all arranged in the positions of the rear walls of the corresponding upper liners close to edges of one side. The arrangement of the plurality of exhaust outlets in the positions close to the edges of one side may also make the return air duct 300 kept in a roughly vertical state, so as to ensure the beauty of the refrigerator body 10.

[0041] A segment of the return air duct 300 between the second upper liner 130 and the first upper liner 120 is gradually bent, so as to extend from the position of the second exhaust outlet 132 of the second upper liner 130 to the position of the first exhaust outlet 122 of the first upper liner 120.

[0042] See Fig. 5, in the embodiment, a certain distance may be kept between the first exhaust outlet 122 and the second exhaust outlet 132 in a transverse horizontal direction, such that there are segments of the return air duct 300 bent in the transverse horizontal direction generated at the position of the second upper liner 130 and the position of the first upper liner 120.

[0043] And also, see Fig. 6, a certain distance may be kept between the first exhaust outlet 122 and the second exhaust outlet 132 in a depth horizontal direction, such that there are segments of the return air duct 300 bent in the depth horizontal direction generated at the position of the second upper liner 130 and the position of the first upper liner 120.

[0044] Through experiments, the inventor found that when both the return air flow of the refrigerating compartment and the return air flow of the variable temperature compartment are diverted in the return air duct 300, an optimal shape of the return air duct 300 is not completely vertical. When the return air duct 300 has a vertical shape and there are both the return air flow of the refrigerating compartment and the return air flow of the variable temperature compartment in the duct, the return air flow of the refrigerating compartment may enter the variable temperature compartment via the first exhaust outlet 122,

and the return air flow of the variable temperature compartment also tends to upwardly enter the refrigerating compartment via the second exhaust outlet 132, which makes the flow rate of the return air flow in the return air duct 300 overall reduced, and further reduces the heat exchange efficiency.

[0045] In the embodiment, the segment of the return air duct 300 between the second upper liner 130 and the first upper liner 120 is simultaneously bent in the depth and transverse directions, which may counteract or inhibit the trend of the above return air flow, so as to avoid mutual interference between the return air flow of the refrigerating compartment and the return air flow of the variable temperature compartment when both of them exist in the return air duct 300, thereby effectively reducing the pressure loss of the return air duct 300 and improving the heat exchange efficiency. The above technical effect is also verified by the trial product, with significant progress.

[0046] See Figs. 3 and 4, in some embodiments of the present invention, areas of a bottom face of the bottom liner 110 close to two sides protrude upwards to form supporting parts 112 to support the separation cover plate 210. The evaporator 220 is provided in a sunken area between the supporting parts 112.

[0047] In the embodiment, the areas of the bottom face of the bottom liner 110 close to the two sides protrude upwards to form the supporting parts 112, which may also be understood as the two sides of an intersection area of the rear wall and the bottom wall of the bottom liner 110 protruding inwards and upwards to form the supporting parts 112. The upper surfaces of the supporting parts 112 may be configured to support the separation cover plate 210, and an area between the two supporting parts 112 forms the sunken area relative to the two supporting parts to dispose the evaporator 220.

[0048] Optionally, a bottom face of the sunken area may also be provided as an oblique plate inclining downward from back to front, so as to enable the evaporator 220 to be obliquely arranged inside the cooling chamber 140 to achieve the technical effect of oblique arrangement of the evaporator 220 in the above embodiment.

[0049] Additionally, the inwards-sunken supporting parts 112 also allow for more spaces to be avoided for a compressor compartment located below the cooling chamber 140, making the whole refrigerator body 10 arranged more reasonably.

[0050] See Fig. 7, in some embodiments of the present invention, there is a set gap between a front end of the supporting part 112 on one side and the return air cover 230, and the side return air inlet 114 is provided in the front end of this supporting part 112, so as to make air from the return air duct 300 enter the cooling chamber 140 via the gap between the front end of this supporting part 112 and the return air cover 230.

[0051] In the embodiment, the evaporator 220 is provided in the sunken area formed by the supporting parts 112 on the two sides and located in the center of the

cooling chamber 140. The side return air inlet 114 is provided in the front end of one of the supporting parts 112. In other words, the side return air inlet 114 is located at a side of the evaporator 220, while the return air cover 230 is located in front of the evaporator 220, there is the set gap between the return air cover 230 and the front end of said supporting part 112, which allows a return air area to be formed between the side return air inlet 114 and the return air cover 230, and the return air area is located on a side-front position relative to the evaporator 220. That is, the return air flow entering the cooling chamber 140 can be discharged to the side-front position relative to the evaporator 220, which may play a role in extending a contact path of the return air flow with the evaporator 220, so as to improve the heat exchange efficiency.

[0052] The value of the set gap may also be configured as any numerical value within a range from 20 mm to 60 mm, e.g., 20 mm, 30 mm, 50 mm and 60 mm, so as to ensure that normal air return of the bottom liner 110 is not affected while the air return efficiency of the upper liners is improved.

[0053] See Fig. 7, further, the evaporator 220 may also be a finned evaporator, which includes a set of fins 222, an evaporation tube 224 and supporting end plates 226. The fins 222 are parallelly arranged in the front-back direction of the refrigerator 1. The evaporation tube 224 is internally provided with a refrigerant to supply cold to the refrigerator 1, and penetrates through the fins 222. The supporting end plates 226 are provided on two sides of the fins 222, and a front end of the supporting end plate 226 close to the side of the side return air inlet 114 is bent towards the corresponding supporting part to form a shielding part, so as to avoid the air flow from passing through the gap between the evaporator 220 and the corresponding supporting part 112 by using the shielding part.

[0054] In the embodiment, the evaporator 220 is provided in the sunken area formed by the supporting parts 112 on the two sides, and there is a certain gap between the evaporator 220 and the supporting part 112 on one of the two sides. The supporting end plates 226 play a role in blocking the gap, which avoids the situation that the air flow directly passes through the evaporator 220 via the gap under the action of the centrifugal fan without exchanging heat with the evaporator 220, thereby further improving refrigeration efficiency of the refrigerator 1.

[0055] See Figs. 3, 5 and 6, in some embodiments of the present invention, after extending from the outer side of the rear wall of the bottom liner 110 to the outer side of the bottom wall of the bottom liner 110, the return air duct 300 extends along the outer side of the bottom wall of the bottom liner 110 until being connected with the side return air inlet 114.

[0056] That is, in the embodiment, an upper end of the return air duct 300 extends downwards from the second exhaust outlet 132 to the first exhaust outlet 122, then extends from the first exhaust outlet 122 to the outer side

of the rear wall of the bottom liner 110, and finally extends roughly in the transverse direction until being connected with the side return air inlet 114. In other words, in the embodiment, the return air duct 300 is overall arranged behind the liner. Such an arrangement manner may reduce the transverse dimension of the refrigerator body 10 to make the refrigerator body 10 more reasonable and beautiful, as compared with a side return air duct.

[0057] Further, the return air duct 300 may also be provided as a flat square duct, and a wider face of the return air duct nestles against the bottom liner 110 and the plurality of upper liners, which may not only meet the normal air return demand, but also reduce the transverse dimension occupied by the return air duct 300, while improving the stability of the return air duct 300.

[0058] At this point, it should be recognized by those skilled in the art that, although multiple exemplary embodiments of the present invention have been exhaustively shown and described herein, many other variations or modifications in accordance with the principles of the present invention may still be directly determined or derived from the disclosure of the present invention without departing from the spirit and scope of the present invention. Therefore, the scope of the present invention should be understood and recognized as covering all these other variations or modifications.

Claims

1. An air-cooled refrigerator, comprising:

a bottom liner, a bottom of which is provided with a cooling chamber for arranging an evaporator of the refrigerator, and is provided with a side return air inlet in communication with the cooling chamber;
a plurality of upper liners, arranged in sequence above the bottom liner, an exhaust outlet being formed in each upper liner; and
a return air duct, extending downwards to the side return air inlet along the exhaust outlets of the plurality of upper liners to introduce return air flows of the plurality of upper liners into the cooling chamber.

2. The air-cooled refrigerator according to claim 1, wherein
the plurality of exhaust outlets are all provided in positions of rear walls of the corresponding upper liners close to edges of one side.

3. The air-cooled refrigerator according to claim 2, wherein

the upper liners comprise a first upper liner located above the bottom liner, and a second upper liner located above the first upper liner;

- wherein
 a space of the bottom liner above the cooling chamber is configured as a freezing compartment;
 an internal space of the first upper liner is configured as a variable temperature compartment;
 and
 an internal space of the second upper liner is configured as a refrigerating compartment.
4. The air-cooled refrigerator according to claim 3, wherein
 a segment of the return air duct between the second upper liner and the first upper liner is gradually bent, so as to extend from the position of the exhaust outlet of the second upper liner to the position of the exhaust outlet of the first upper liner.
5. The air-cooled refrigerator according to claim 3, further comprising:
 a separation cover plate, transversely provided inside the bottom liner for separating the cooling chamber and the freezing compartment; and
 areas of a bottom face of the bottom liner close to two sides protrude upwards to form supporting parts to support the separation cover plate, and
 the evaporator is provided in a sunken area between the supporting parts.
6. The air-cooled refrigerator according to claim 5, further comprising:
 a return air cover, provided on a front portion of the cooling chamber, at least one forward return air inlet that makes the cooling chamber communicate with the freezing compartment being formed in the return air cover; wherein
 there is a set gap between a front end of the supporting part on one side and the return air cover, and
 the side return air inlet is provided in the front end of the supporting part, so as to make air from the return air duct enter the cooling chamber via the gap between the front end of the supporting part and the return air cover.
7. The air-cooled refrigerator according to claim 6, wherein
 after extending from an outer side of a rear wall of the bottom liner to an outer side of a bottom wall of the bottom liner, the return air duct extends along the outer side of the bottom wall of the bottom liner until being connected with the side return air inlet.
8. The air-cooled refrigerator according to claim 6, wherein

the evaporator is a finned evaporator, comprising:

- a set of fins, parallelly arranged in the front-back direction of the refrigerator;
 an evaporation tube, penetrating through the fins; and
 supporting end plates, provided on the two sides of the fins, a front end of the supporting end plate close to the side of the side return air inlet being bent towards the corresponding supporting part to form a shielding part, so as to avoid an air flow from passing through a gap between the evaporator and the corresponding supporting part by using the shielding part.
9. The air-cooled refrigerator according to claim 8, further comprising:
 a centrifugal fan, obliquely provided behind the evaporator, with a suction inlet thereof facing a front lower portion and an air outlet thereof facing a rear portion; and
 an air supply duct, communicating with the air outlet of the centrifugal fan and extending upwards, and configured to convey an air flow discharged by the centrifugal fan to the freezing compartment and/or the variable temperature compartment and/or the refrigerating compartment.
10. The air-cooled refrigerator according to claim 1, wherein
 the return air duct is a flat square duct, and a wider face of the return air duct nestles against the bottom liner and the plurality of upper liners.

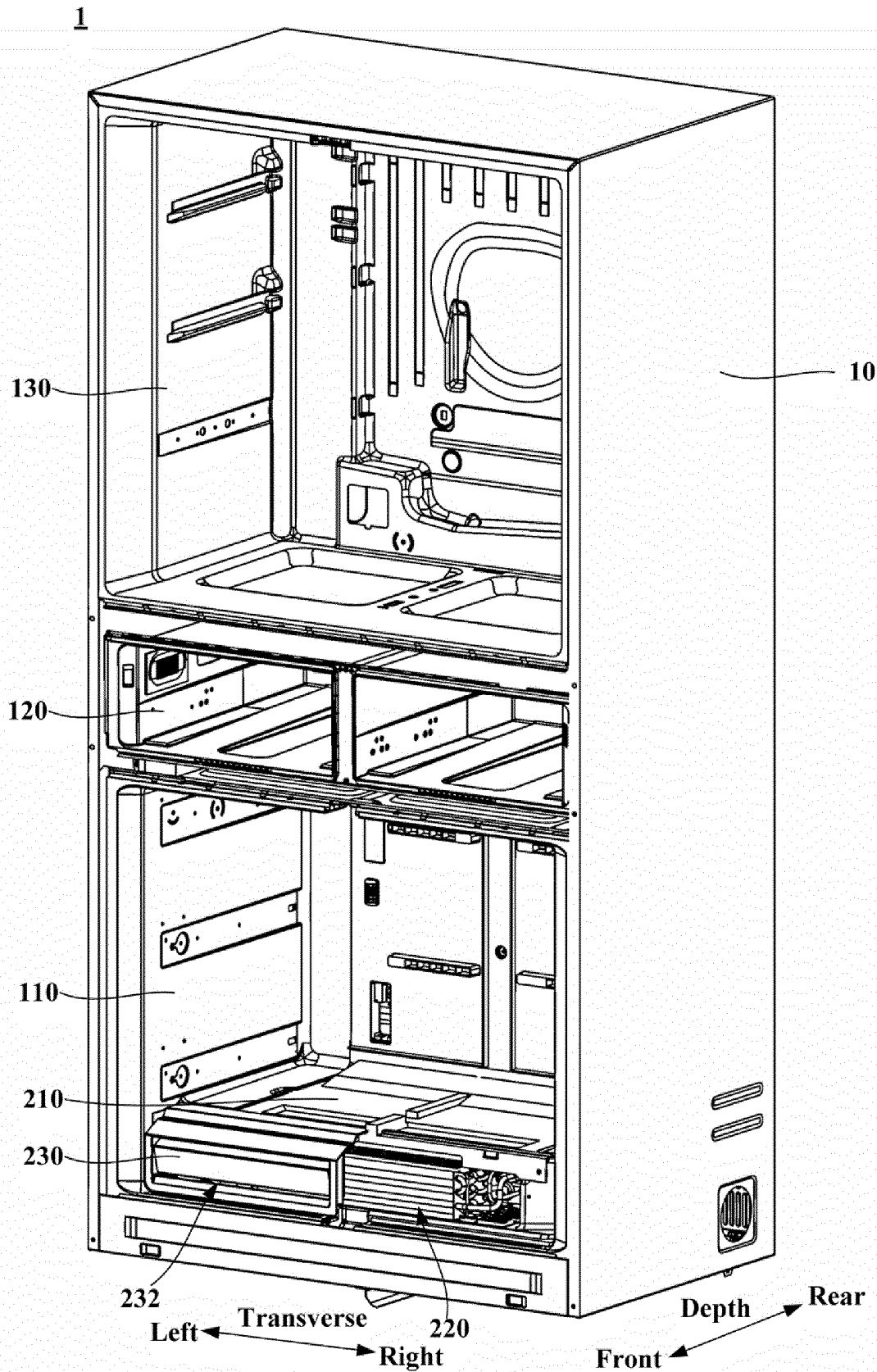


Fig. 1

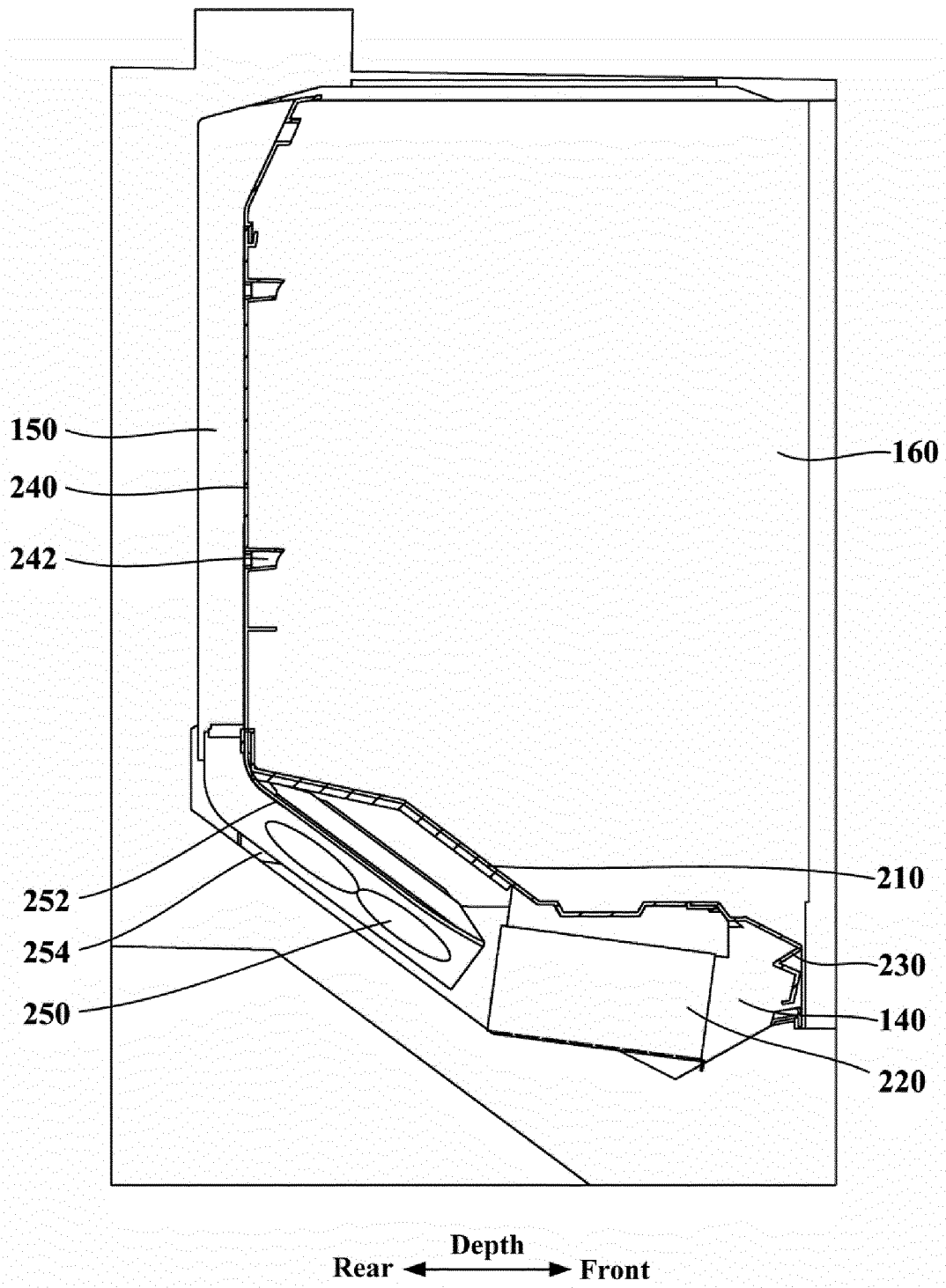


Fig. 2

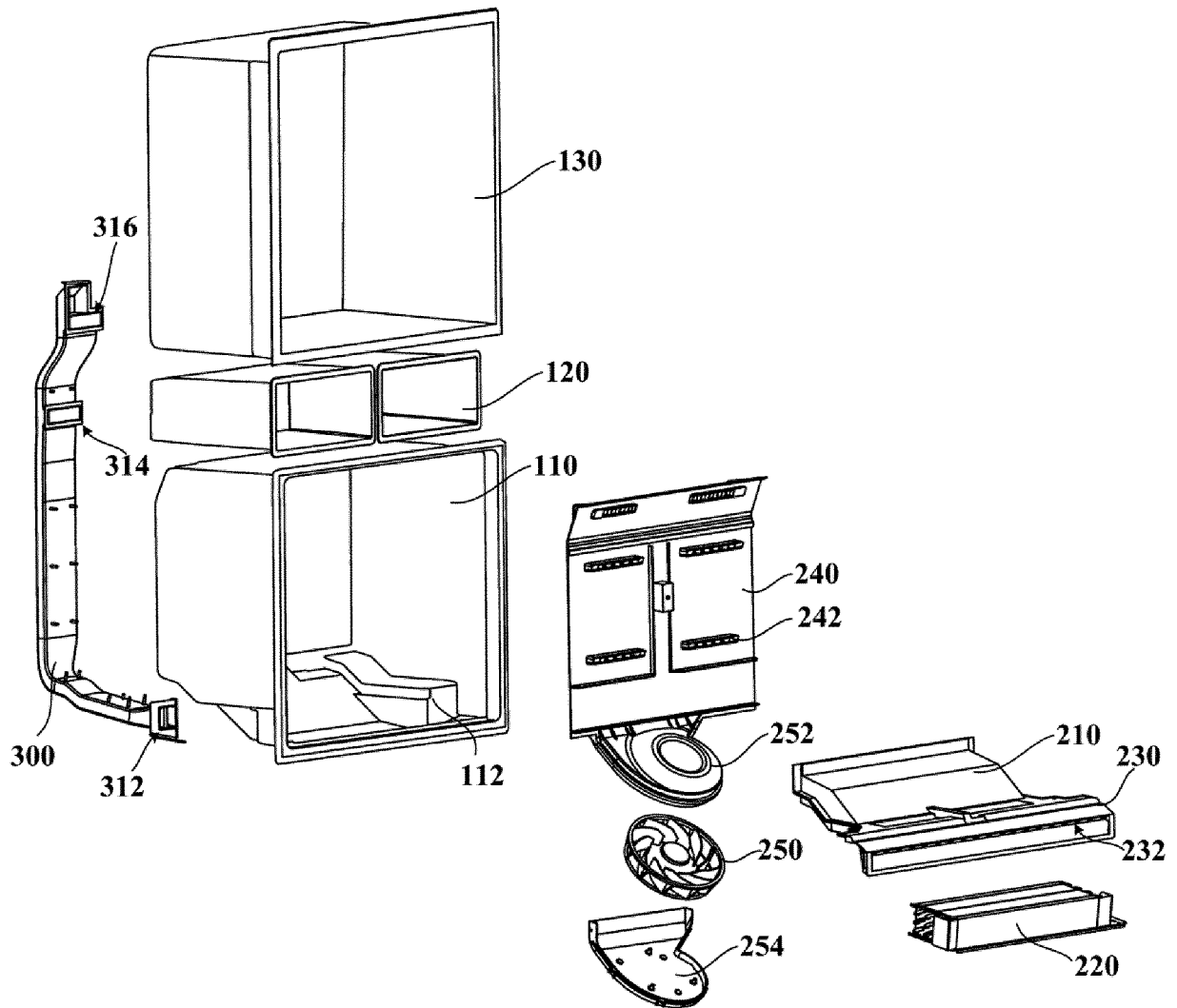


Fig. 3

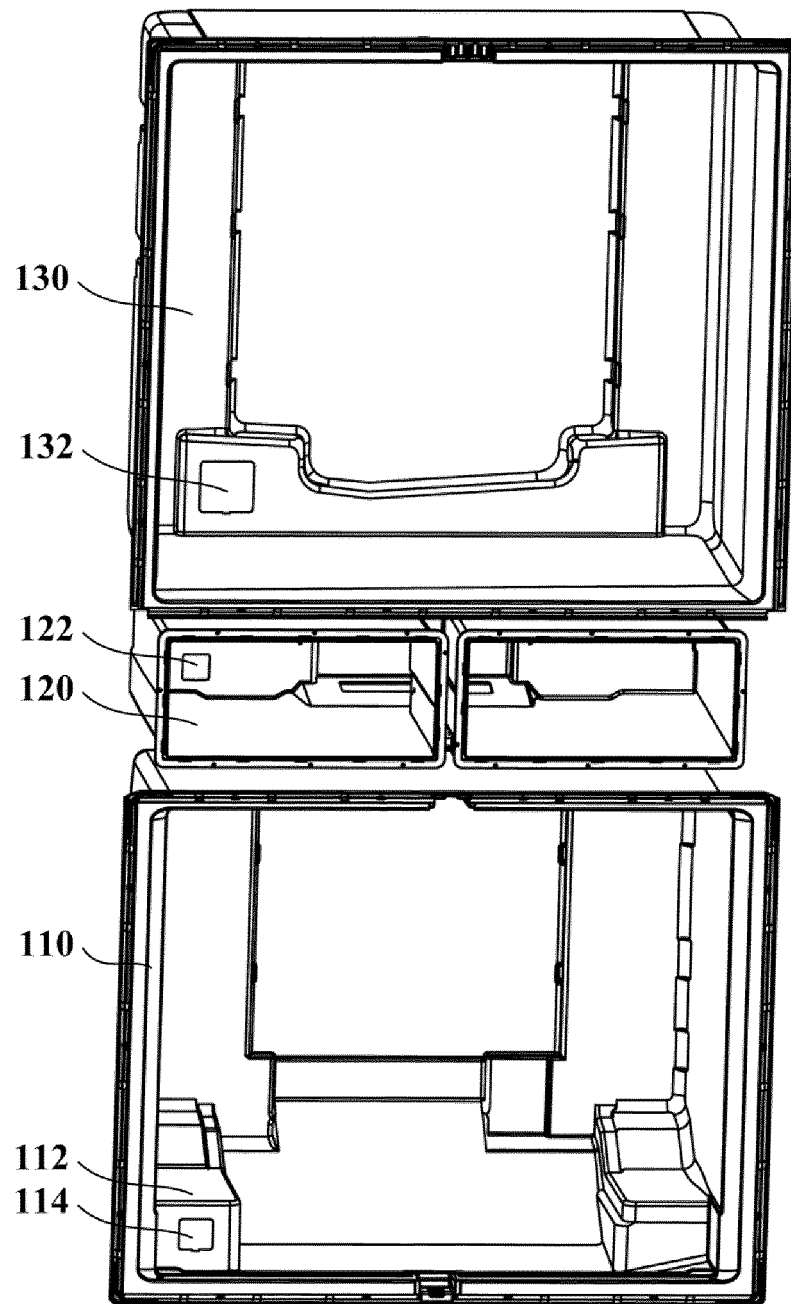


Fig. 4

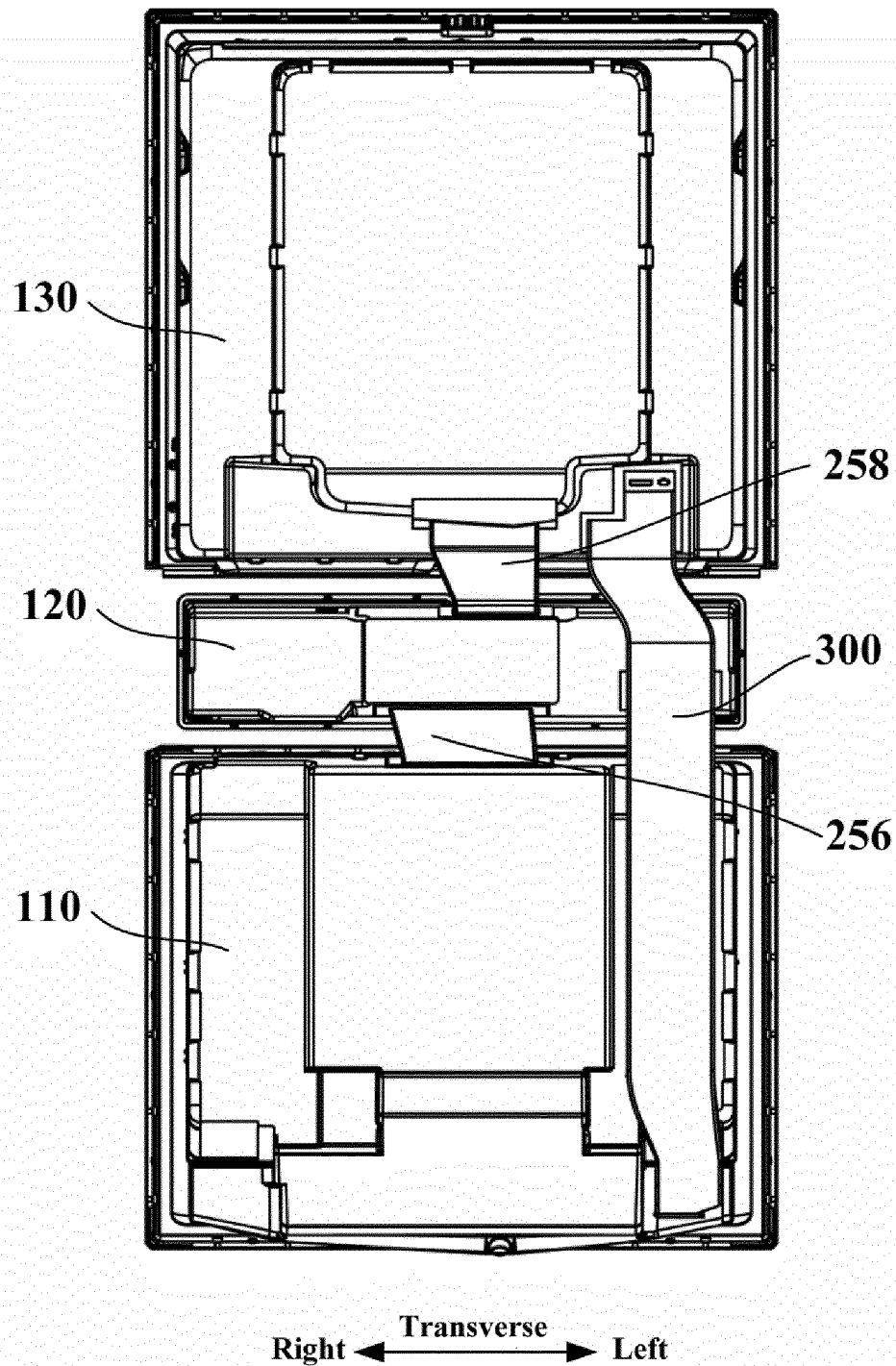


Fig. 5

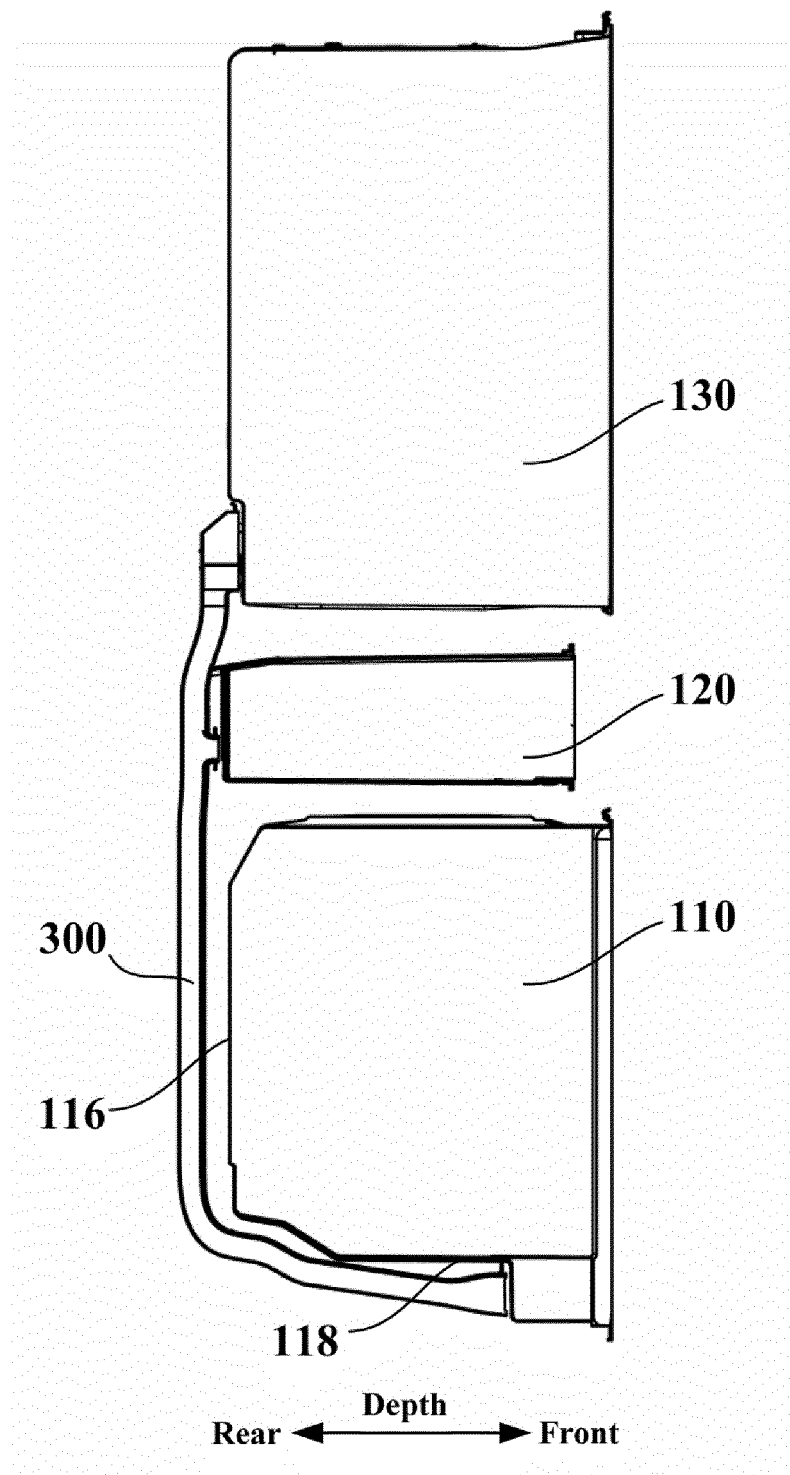


Fig. 6

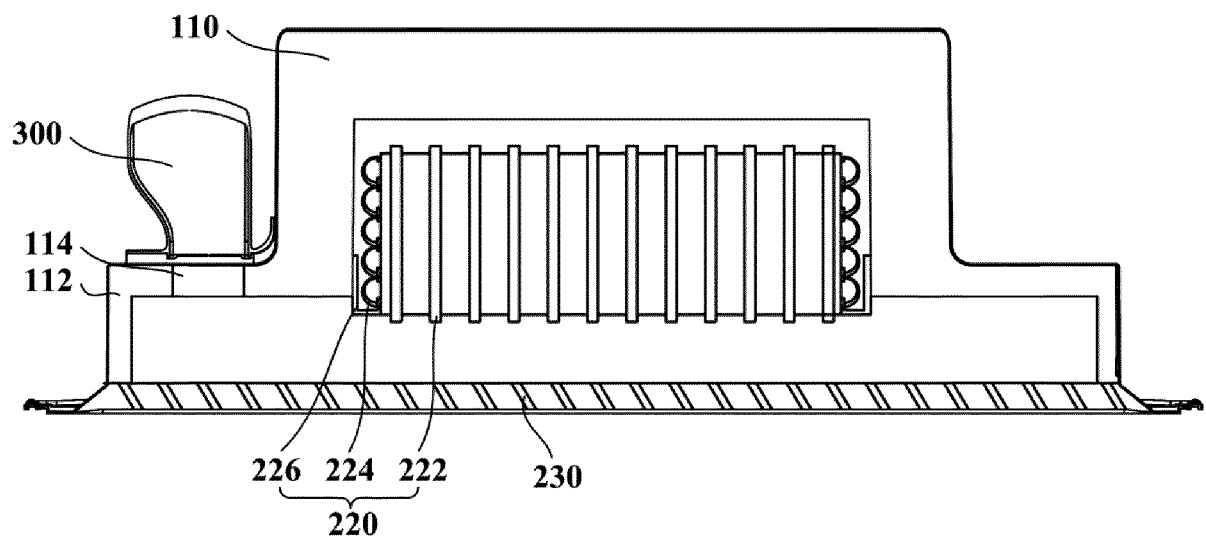


Fig. 7

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2021/109162

A. CLASSIFICATION OF SUBJECT MATTER F25D 17/06(2006.01)i; F25D 23/00(2006.01)i 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) F25D11 F25D17 F25D23 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 practicable, search terms used) CNABS, CNTXT, CNKI, DWPI: 蒸发器 底 冷藏室 变温室 回风 evaporator bottom below lower refrigerat+ temperature chamber return+																								
C. DOCUMENTS CONSIDERED TO BE RELEVANT <table border="1"> <thead> <tr> <th>Category*</th> <th>Citation of document, with indication, where appropriate, of the relevant passages</th> <th>Relevant to claim No.</th> </tr> </thead> <tbody> <tr> <td>Y</td> <td>CN 210220343 U (QINDAO HAIER REFRIGERATOR CO., LTD. et al.) 31 March 2020 (2020-03-31) description, paragraphs [0069]-[0074] and figures 3, 4</td> <td>1-10</td> </tr> <tr> <td>Y</td> <td>CN 111207558 A (CHANGHONG MEILING CO., LTD.) 29 May 2020 (2020-05-29) description paragraph [0047] and figures 4-6</td> <td>1-10</td> </tr> <tr> <td>A</td> <td>CN 110285629 A (QINGDAO HAIER CO., LTD.) 27 September 2019 (2019-09-27) entire document</td> <td>1-10</td> </tr> <tr> <td>A</td> <td>CN 105091457 A (HEFEI MIDEA REFRIGERATOR CO., LTD. et al.) 25 November 2015 (2015-11-25) entire document</td> <td>1-10</td> </tr> <tr> <td>A</td> <td>CN 106288606 A (HEFEI HUALING CO., LTD. et al.) 04 January 2017 (2017-01-04) entire document</td> <td>1-10</td> </tr> <tr> <td>A</td> <td>US 5678421 A (HABCO BEVERAGE SYSTEMS INC) 21 October 1997 (1997-10-21) entire document</td> <td>1-10</td> </tr> <tr> <td>A</td> <td>JP 2005233525 A (SHARP K. K.) 02 September 2005 (2005-09-02) entire document</td> <td>1-10</td> </tr> </tbody> </table>	Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.	Y	CN 210220343 U (QINDAO HAIER REFRIGERATOR CO., LTD. et al.) 31 March 2020 (2020-03-31) description, paragraphs [0069]-[0074] and figures 3, 4	1-10	Y	CN 111207558 A (CHANGHONG MEILING CO., LTD.) 29 May 2020 (2020-05-29) description paragraph [0047] and figures 4-6	1-10	A	CN 110285629 A (QINGDAO HAIER CO., LTD.) 27 September 2019 (2019-09-27) entire document	1-10	A	CN 105091457 A (HEFEI MIDEA REFRIGERATOR CO., LTD. et al.) 25 November 2015 (2015-11-25) entire document	1-10	A	CN 106288606 A (HEFEI HUALING CO., LTD. et al.) 04 January 2017 (2017-01-04) entire document	1-10	A	US 5678421 A (HABCO BEVERAGE SYSTEMS INC) 21 October 1997 (1997-10-21) entire document	1-10	A	JP 2005233525 A (SHARP K. K.) 02 September 2005 (2005-09-02) entire document	1-10
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.																						
Y	CN 210220343 U (QINDAO HAIER REFRIGERATOR CO., LTD. et al.) 31 March 2020 (2020-03-31) description, paragraphs [0069]-[0074] and figures 3, 4	1-10																						
Y	CN 111207558 A (CHANGHONG MEILING CO., LTD.) 29 May 2020 (2020-05-29) description paragraph [0047] and figures 4-6	1-10																						
A	CN 110285629 A (QINGDAO HAIER CO., LTD.) 27 September 2019 (2019-09-27) entire document	1-10																						
A	CN 105091457 A (HEFEI MIDEA REFRIGERATOR CO., LTD. et al.) 25 November 2015 (2015-11-25) entire document	1-10																						
A	CN 106288606 A (HEFEI HUALING CO., LTD. et al.) 04 January 2017 (2017-01-04) entire document	1-10																						
A	US 5678421 A (HABCO BEVERAGE SYSTEMS INC) 21 October 1997 (1997-10-21) entire document	1-10																						
A	JP 2005233525 A (SHARP K. K.) 02 September 2005 (2005-09-02) entire document	1-10																						
☐ Further documents are listed in the continuation of Box C. ☒ See patent family 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 application or patent 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																								
Date of the actual completion of the international search 29 September 2021	Date of mailing of the international search report 20 October 2021																							
Name and mailing address of the ISA/CN China National Intellectual Property Administration (ISA/ CN) No. 6, Xitucheng Road, Jimenqiao, Haidian District, Beijing 100088 China Facsimile No. (86-10)62019451	Authorized officer Telephone No.																							

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/CN2021/109162

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)		Publication date (day/month/year)
CN	210220343	U	31 March 2020	None		
CN	111207558	A	29 May 2020	None		
CN	110285629	A	27 September 2019	None		
CN	105091457	A	25 November 2015	CN	105091457	B 17 November 2017
CN	106288606	A	04 January 2017	None		
US	5678421	A	21 October 1997	None		
JP	2005233525	A	02 September 2005	None		

Form PCT/ISA/210 (patent family annex) (January 2015)