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(54) REFRIGERATOR

(57) The present invention provides a refrigerator which shortens the time of passing through a maximum ice crystal generation zone by efficiently blowing cold air to an object to be frozen. With respect to the refrigerator 1 according to the present invention, the upper portion of the upper freezing compartment 5 is provided with: a first supply air duct 24 for supplying cold air during normal cooling operation; and a second supply air duct 25 for supplying cold air during rapid cooling operation. During rapid cooling operation, the blower 23 is operated, and the cold air supplied from the supply air duct 14 is supplied to the upper freezing compartment 5 via the second supply air duct 25 and the air outlet 28.

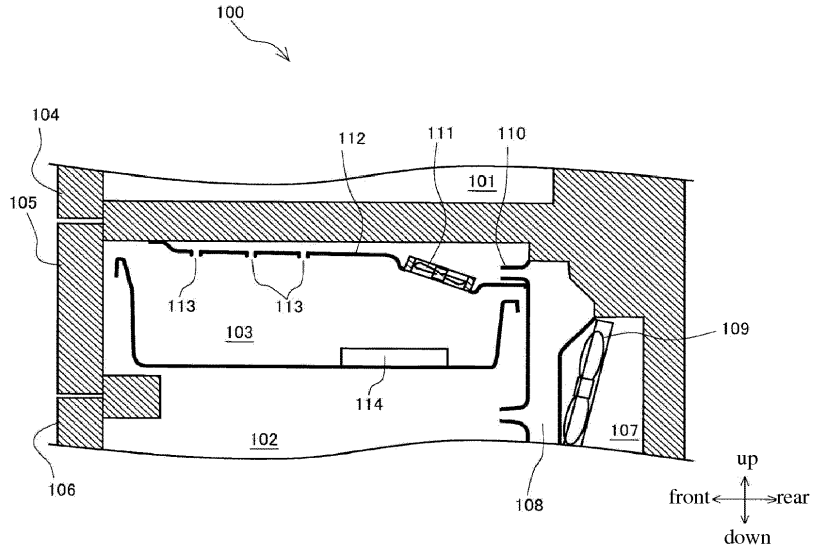

Fig. 9

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Description

[0001] The present application claims priority to Chinese Patent Application No. 201610878087.1, filed on October 8, 2016 and tiled "Refrigerator", which is incorporated herein by reference in its entirety.

FIELD OF THE INVENTION

[0002] The present invention relates to a refrigerator for refrigerating and preserving food in a storing compartment, and in particular, to a refrigerator having such functions as rapidly freezing the food within a freezing compartment.

BACKGROUND OF THE INVENTION

[0003] Among the well-known conventional refrigerators, there is a refrigerator, which is provided with a blower for rapidly freezing the food within the freezing compartment in addition to a main blower responsible for the circulation of cold air in the entire refrigerator. For example, such a refrigerator is described in Japanese Patent Laid-Open Publication No. 1988-46362 and Japanese Patent Laid-Open Publication No. 2002-267318.

[0004] Further, Japanese Patent Laid-Open Publication No. 2015-1331 describes a refrigerator, which is capable of rapidly freezing food without affecting the storage performance of the freezing compartment. Fig. 9 shows a refrigerator 100 described in Patent Document 3. In the refrigerator 100 shown in this figure, a refrigerating compartment 101, an upper freezing compartment 103, and a lower freezing compartment 102 are provided from top to bottom. An upper portion of the upper freezing compartment 103 is separated by a partition body 112, and a blower 111 is provided on the partition body 112 for blowing cold air during rapid cooling operation. Further, an air delivery duct 108 is provided behind the upper freezing compartment 103 for blowing cold air, and a cooling compartment 107 is provided behind the air delivery duct 108 for accommodating a cooler not shown in the drawing. A blower 109 for blowing cold air is provided on a partition wall which separates the cooling compartment 107 and the air delivery duct 108. Further, an air outlet 113 for supplying cold air to the upper freezing compartment 103 is provided on the partition body 112.

[0005] According to the refrigerator 100 having the above structure, the normal cooling operation thereof is as follows. First, the blower 109 is rotated according to the instruction of a control unit not shown in the drawing, and the air inside the cooling compartment 107, which is cooled in the cooler not shown in the drawing, is blown into the air delivery duct 108. The cold air blown into the air delivery duct 108 is supplied to the refrigerating compartment 101, the upper freezing compartment 103, and the lower freezing compartment 102 via a blowing air duct not shown in the drawing. Further, the cold air supplied to the upper freezing compartment 103 passes through the air outlet 113 located on the partition body 112 and an air outlet 110. Here, the blower 111 provided in the upper freezing compartment 103 is not operated during normal cooling operation.

[0006] According to the refrigerator 100 having the above structure, the rapid cooling operation thereof is as follows. The cold air blown to the air delivery duct 108 is supplied to the upper portion of the partition body 112 via the air outlet 110, and then is blown toward an object to be frozen 114 by the rotated blower 111, so that the object to be frozen 114 is quickly frozen, and the object to be frozen 114 retains its freshness while being frozen. Further, since the blower 111 for blowing cold air to the object to be frozen 114 is provided in the upper portion of the upper freezing compartment 103, it is possible to ensure that the upper freezing compartment 103 has a larger depth.

[0007] However, from the viewpoint of improving the cooling efficiency, the refrigerator described in Japanese Patent Laid-Open Publication No. 2015-1331 may be further improved. Specifically, in order that the object to be frozen 114 such as food retains its freshness while being frozen, it is necessary to shorten the time of passing through a maximum ice crystal generation zone. Here, the maximum ice crystal generation zone refers to a temperature zone during which the temperature of the object to be frozen 114 is lowered from -1°C to -5°C. On the other hand, referring to Fig. 9, the cold air blown to the upper freezing compartment 103 is blown via the air outlet 113 during a normal cooling process, but is blown via the blower 111 during rapid cooling operation. In either case, however, the cold air is supplied from the same air outlet 110, which is not an optimized structure for a rapid cooling process, and is disadvantageous for increasing the wind speed and shortening the time of passing through the maximum ice crystal generation zone during rapid cooling operation.

[0008] Further, the refrigerator described in Japanese Patent Laid-Open Publication No. 2015-1331 also has a problem in that the upper portion of the upper freezing compartment 103 thereof is provided with the blower 111 as an axial fan, since the blower 111 occupies the layer height of the upper freezing compartment 103, this makes it difficult for the upper freezing compartment 103 to have a large volume.

SUMMARY OF THE INVENTION

[0009] To solve at least one of the technical problems described above, an object of the present invention is to provide a refrigerator, which shortens the time of passing through a maximum ice crystal generation zone by efficiently blowing cold air to an object to be frozen.

[0010] In order to achieve one of the objects of the present invention, an embodiment of the present invention provides a refrigerator, including: a storing compartment for accommodating an object to be frozen; a cooler for cooling air supplied to the storing compartment; a

cooling compartment for accommodating the cooler; a supply air duct for flowing the air cooled by the cooler from the cooling compartment to the storing compartment; a first supply air duct disposed near a top surface of the storing compartment, wherein the cold air supplied from the supply air duct to the storing compartment passes through the first supply air duct during normal cooling operation; and a second supply air duct disposed near the top surface of the storing compartment and disposed separately from the first supply air duct, wherein the cold air supplied from the supply air duct and blown toward the object to be frozen passes through the second supply air duct during rapid cooling operation.

[0011] As an improvement of the embodiment of the present invention, the refrigerator includes a blower for rapid freezing, which is used for blowing cold air to the second supply air duct during rapid cooling operation.

[0012] As a further improvement of the embodiment of the present invention, the blower for rapid freezing is disposed at a rear end portion of the second supply air duct.

[0013] As a further improvement of the embodiment of the present invention, the blower for rapid freezing blows the air from the cooling compartment to the second supply air duct, and circulates the air in the storing compartment via the first supply air duct.

[0014] As a further improvement of the embodiment of the present invention, the first supply air duct and the second supply air duct are located at an upper portion of the storing compartment, and are separated by a partition wall extending in the vertical direction.

[0015] As a further improvement of the embodiment of the present invention, an indoor blower is disposed inside the storing compartment for blowing cold air to the object to be frozen via the second supply air duct.

[0016] As a further improvement of the embodiment of the present invention, an air door is disposed between the first supply air duct and the supply air duct, and the air door is in a closed state during rapid cooling operation to supply the air supplied from the supply air duct to the second supply air duct.

[0017] As a further improvement of the embodiment of the present invention, the supply air duct extends toward the side of the first supply air duct close to the first supply air duct and the second supply air duct.

[0018] Compared with the prior art, the present invention has the following beneficial technical effects:

the refrigerator according to the present invention, includes: a storing compartment for accommodating an object to be frozen; a cooler for cooling air supplied to the storing compartment; a cooling compartment for accommodating the cooler; a supply air duct for flowing the air cooled by the cooler from the cooling compartment to the storing compartment; a first supply air duct disposed near a top surface of the storing compartment, wherein the cold air supplied from the supply air duct to the storing compartment passes through the first supply air duct during normal cooling operation; and a second supply air duct disposed near the top surface of the storing compartment and disposed separately from the first supply air duct, wherein the cold air supplied from the supply air duct passes through the second supply air duct and is blown toward the object to be frozen during rapid cooling operation. Therefore, when the object to be frozen is rapidly frozen, the cold air is supplied to the storing compartment from the second supply air duct which is independent of the air duct for circulation of the cold air during normal cooling operation, namely, the first supply air duct, so that the cold air can be blown at a certain speed or higher speed. Thereby, the time of passing through the maximum ice crystal generation temperature zone can be shortened, so that the object to be frozen such as food retains its freshness while being frozen.

[0019] Further, the present invention provides a refrigerator, including a blower for rapid freezing, which is used for blowing cold air to the second supply air duct during rapid cooling operation. Therefore, it is possible to rapidly blow cold air from the second supply air duct to the object to be frozen by using the blower for rapid freezing, thereby further shortening the time required for freezing the object to be frozen, and effectively maintaining the freshness of the food.

[0020] Further, the present invention provides a refrigerator, wherein the blower for rapid freezing is disposed at a rear end portion of the second supply air duct, closer to the side of the cooler described above. Therefore, the blower for rapid freezing is not exposed to the side of the storing compartment, which can ensure that the storing compartment has a larger volume.

[0021] Further, the present invention provides a refrigerator, wherein the blower for rapid freezing circulates the air in the storing compartment via the first supply air duct while blowing the air from the cooling compartment to the second supply air duct. Therefore, it is possible to blow the cold air supplied from the cooling compartment together with the cold air in the storing compartment to the object to be frozen, so that more cold air concentrates on the object to be frozen.

[0022] Further, the present invention provides a refrigerator, wherein the first supply air duct and the second supply air duct are located at an upper portion of the storing compartment, and are separated by a partition wall extending in the vertical direction. Therefore, the first supply air duct and the second supply air duct can be arranged in the horizontal direction in the upper portion of the storing compartment along the partition wall extending in the vertical direction, thereby preventing the arrangement of the first supply air duct and the second supply air duct from occupying the volume of the storing compartment.

[0023] Further, the present invention provides a refrigerator, wherein an indoor blower is disposed inside the storing compartment for blowing cold air to the object to be frozen via the second supply air duct. Therefore, it is possible to blow the cold air to the object to be frozen nearby by using the indoor blower, thereby achieving a more efficient cooling of the object to be frozen.

[0024] Further, the present invention provides a refrigerator, wherein an air door is disposed between the first supply air duct and the supply air duct, and the air door is in a closed state during rapid cooling operation to supply the air supplied from the supply air duct to the second supply air duct. Therefore, cold air cannot be supplied to the first supply air duct by closing the air door, so that a large amount of cold air can be blown to the object to be frozen via the second supply air duct.

[0025] Further, the present invention provides a refrigerator, wherein the supply air duct extends toward the side of the first supply air duct close to the first supply air duct and the second supply air duct. Therefore, during normal cooling operation, the air is preferentially supplied to the first supply air duct, and the amount of air supplied to the second supply air duct is reduced accordingly, and thus it is possible to avoid over-cooling of some individual places in the storing compartment.

BRIEF DESCRIPTION OF THE DRAWINGS

[0026]

Fig. 1 is a front external view of a refrigerator according to an embodiment of the present invention;

Fig. 2 is a side sectional view showing the schematic structure of the refrigerator according to an embodiment of the present invention;

Fig. 3 is a side sectional view showing the structure around an upper freezing compartment of the refrigerator according to an embodiment of the present invention;

Fig. 4 is an oblique view of a supply air duct leading to the upper freezing compartment of the refrigerator according to an embodiment of the present invention;

Fig. 5 is a rear structural view of the air duct of the refrigerator according to an embodiment of the present invention;

Fig. 6 is a structural view showing the structure around an upper freezing compartment of a refrigerator according to another embodiment of the present invention, wherein (A) is a side sectional view, and (B) is an oblique view of a supply air duct leading to the upper freezing compartment;

Fig. 7 is a structural view showing the structure around the upper freezing compartment of the refrigerator according to another embodiment of the present invention, wherein (A) is a side sectional view, (B) is an oblique view of the supply air duct leading to the upper freezing compartment, and (C) is a rear structural view of the air duct;

Fig. 8 is a side sectional view showing the structure around the upper freezing compartment of the refrigerator according to another embodiment of the present invention; and

Fig. 9 is a longitudinal sectional view showing a portion of a rapid freezing compartment according to an example of a refrigerator in the "background of the invention".

DETAILED DESCRIPTION FO THE EMBODIMENTS

[0027] A refrigerator 1 according to an embodiment of the present invention will be described in detail below with reference to the accompanying drawing. In the following description, the description will be made in the up, down, front, rear, left, and right directions as appropriate. The left and right directions refer to the left and the right when viewed from the front of the refrigerator 1.

[0028] Fig. 1 is a front external view showing the schematic structure of the refrigerator 1 according to this embodiment. Referring to this figure, the refrigerator 1 takes a heat insulation cabinet 2 as the main body, and a storing compartment for storing food is formed inside the heat insulation cabinet 2. The storing compartment includes a topmost refrigerating compartment 3, an ice making compartment 4 on the left side of the next layer of the topmost refrigerating compartment 3, an upper freezing compartment 5 on the right side of the ice making compartment 4, a lower freezing compartment 6 in the next layer of the ice making compartment 4 and the upper freezing compartment 5, and a bottommost fruit and vegetable compartment 7. Here, the ice making compartment 4, the upper freezing compartment 5, and the lower freezing compartment 6 are small freezing compartments formed by dividing a freezing compartment, and sometimes these may be collectively referred to as a freezing compartment.

[0029] An opening portion is provided in front of the heat insulation cabinet 2, and the opening portion of the heat insulation cabinet 2 is provided with heat insulation doors 8 to 12 which may be freely opened and closed. Specifically, the opening portion of the refrigerating compartment 3 is closed by the heat insulation door 8; the ice making compartment 4 is closed by the heat insulation door 9; the upper freezing compartment 5 is closed by the heat insulation door 10; the lower freezing compartment 6 is closed by the heat insulation door 11; and the fruit and vegetable compartment 7 is closed by the heat insulation door 12. Here, the upper right side and the lower right side of the heat insulation door 8 are installed on the heat insulation cabinet 2, and the heat insulation door 8 can be freely rotated. Further, the heat insulation doors 9 to 12 are installed on the heat insulation cabinet 2, and can be freely pulled out from the front of the refrigerator 1.

[0030] As shown in Fig. 2, as the main body of the refrigerator 1, the heat insulation cabinet 2 includes: an

outer casing 2a made of steel plate and having an opening portion at the front thereof; and an inner casing 2b made of synthetic resin and having an opening portion at the front thereof, and disposed at an inner side of the outer casing 2a so that a gap is left between the outer casing 2a and the inner casing 2b. Further, the gap between the outer casing 2a and the inner casing 2b is filled with a heat insulation material 2c made of urethane foam. In addition, the above-mentioned heat insulation doors 8 to 12 have the same heat insulation structure as the heat insulation cabinet 2.

[0031] The refrigerating compartment 3 is separated from the ice making compartment 4 and the upper freezing compartment 5 located in the lower layer thereof by a heat insulation partition wall 36.

[0032] Further, the ice making compartment 4 is separated from the upper freezing compartment 5 by a partition wall not shown in the drawing. In addition, the ice making compartment 4 and the upper freezing compartment 5 are communicated with the lower freezing compartment 6 disposed in the lower layer thereof, and the cold air can freely pass therebetween. Then, the lower freezing compartment 6 is separated from the fruit and vegetable compartment 7 by a heat insulation partition wall 37.

[0033] Further, the back surface and the top surface of the refrigerating compartment 3 inside the inner casing 2b is provided with a supply air duct 15 for flowing the cooled air to the refrigerating compartment 3. Likewise, the depth side of the ice making compartment 4 and the upper freezing compartment 5 is provided with a supply air duct 14 which is separated and formed by a partition member 38 made of synthetic resin.

[0034] An air door 41 as an air duct switching unit is provided in the passage of the supply air duct 14. The air door 41 is in an open state during normal cooling operation and is in a closed state during rapid cooling operation. When the air door 41 is in the open state, the cold air blown by the blower 32 is supplied to the upper freezing compartment 5 and the lower freezing compartment 6. On the other hand, when the air door 41 is in the closed state, the cold air blown by the blower 32 is only supplied concentratively to the upper freezing compartment 5 to promote rapid freezing in the upper freezing compartment 5.

[0035] Here, an air door of the blower may be provided to block a blower 23 from the front, instead of the air door 41. In this case, the air door of the blower does not turn off the blower 32 during normal cooling operation, and the cold air blown by the blower 32 is supplied to the upper freezing compartment 5 and the lower freezing compartment 6 from different directions. On the other hand, during rapid cooling operation, the air door of the blower turns off the blower 32, and the cold air blown by the blower 32 is only supplied concentratively to the upper freezing compartment 5.

[0036] The upper portion of the upper freezing compartment 5 is separated by a partition member 20 made of synthetic resin, and is communicated with the second supply air duct 25 of the supply air duct 14, and is independent of the first supply air duct 24 described later. Further, a blower 23 is provided behind the second supply air duct 25 for blowing cold air to the upper freezing compartment 5 via the second supply air duct 25. The blower 23 is a blower for rapid freezing used during rapid cooling operation, and detailed description related thereto will be described later with reference to Fig. 3 and the like.

[0037] A cooling compartment 13 is provided at a greater depth of the supply air duct 14 inside the inner casing 2b, and is separated by a partition member 39. The partition member 39 in the upper portion of the cooling compartment 13 is provided with a blowing port 13a for connecting the cooling compartment 13 and the supply air duct 14; and the blowing port 13a is provided with the blower 32 for circulating air. An opening 13b is provided below the cooling compartment 13 for sucking the return cold air from the storing compartment into the inside of the cooling compartment 13.

[0038] Then, the inside of the cooling compartment 13 is provided with a cooler 16 as an evaporator for cooling the circulating air. The cooler 16 is connected to a compressor 42, a heat sink not shown in the drawing and a capillary not shown in the drawing through a refrigerant pipe, so as to constitute a vapor compression refrigeration circulation loop.

[0039] Further, the refrigerator 1 has a control unit not shown in the drawing; an indoor temperature in each of the storing compartments is measured by a thermometer not shown in the drawing; and an electrical signal indicating the indoor temperature is input to the control unit. Further, the control unit controls the compressor 42, the blower 32, the blower 23, the air door 41, a defrost heater not shown in the drawing, and the like based on the electrical signal inputted by the thermometer and the like.

[0040] Next, the basic cooling operation of the refrigerator 1 having the above structure will be described.

[0041] First, the air in the cooling compartment 13 is cooled by the cooler 16 in the vapor compression refrigeration circulation loop described above according to an instruction from the control unit. Then, the control unit rotates the blower 32 to blow the air cooled by the cooler 16 from the blowing port 13a of the cooling compartment 13 to the supply air duct 14.

[0042] A part of the cooled air blown to the supply air duct 14 is adjusted to have an appropriate flow rate by the air door 18 controlled by the control unit, and flows to the supply air duct 15 to be supplied to the refrigerating compartment 3. In this way, it is possible to ensure that the food accommodated inside the refrigerating compartment 3 is cooled and stored at a suitable temperature.

[0043] The cold air supplied to the inside of the refrigerating compartment 3 is supplied to the fruit and vegetable compartment 7 via a connecting air duct not shown in the drawing. Then, the cold air circulated in the fruit and vegetable compartment 7 is returned to the inside of the cooling compartment 13 via the return air duct 17

and the opening 13b of the cooling compartment 13. At there, it is cooled again by the cooler 16.

[0044] Further, a part of the cooled air blown to the supply air duct 14 is supplied to the ice making compartment 4 and the lower freezing compartment 6, and a part thereof is supplied to the upper freezing compartment 5 at the same time. Then, the air inside the ice making compartment 4 and the upper freezing compartment 5 flows toward the lower freezing compartment 6 communicated therewith, and the air inside the lower freezing compartment 6 then flows below the lower freezing compartment 6, and flows to the inside of the cooling compartment 13 through the opening 13b of the cooling compartment 13. At this time, the control unit enables the air door 41 to be in an open state, and the cold air is supplied to the lower freezing compartment 6 via the air door 41.

[0045] As described above, the air cooled by the cooler 16 is circulated in the storing compartment to freeze as well as cool and store the food.

[0046] Next, a structure for rapidly freezing an object to be frozen 19 accommodated in the upper freezing compartment 5 will be described with reference to Figs. 3 to 8.

[0047] Fig. 3 is a sectional view taken along line A-A of Fig. 1, which is a side sectional view showing the structure around the upper freezing compartment 5. Fig. 4 is an oblique view showing the structure of the partition member 20 and the like; Fig. 5 is a rear view of the partition member 20; and Figs. 6 to 8 show other embodiments of the second supply air duct 25.

[0048] Referring to Fig. 3, the upper portion of the upper freezing compartment 5 is provided with the second supply air duct 25 which is separated from the upper freezing compartment 5 by the partition member 20 made of synthetic resin. That is, the second supply air duct 25 is a space formed between the partition member 20 and the heat insulation partition wall 36, and is a circulation passage for cold air during rapid cooling operation.

[0049] A front end portion of the second supply air duct 25 extends above a shelf 22 on which the object to be frozen 19 is placed, and is provided with an opening downwards, namely, an air outlet 28. Further, a rear end portion of the second supply air duct 25 extends to a rear end of the upper freezing compartment 5, and a blower 23 is provided at the intersection between the rear end of the second supply air duct 25 and the supply air duct 14.

[0050] The blower 23 functions to rotate to blow cold air during rapid cooling operation, is preferably disposed at a rearward position compared with the rear end portion of the upper freezing compartment 5, namely, on the side of the cooling compartment 13. Since the blower 23 is provided at such a position, it does not occupy the space of the upper freezing compartment 5, which can ensure that the upper freezing compartment 5 has a larger volume.

[0051] The upper freezing compartment 5 is provided with a storage container 29 for accommodating the object to be frozen 19 such as food. The storage container 29 is made of synthetic resin and is an approximately cabinet-shaped container provided with an opening in the upper portion thereof. The storage container 29 is mounted on a frame not shown in the drawing, and the latter is fixed to the heat insulation door 10 and may be freely pulled forward together with the heat insulation door 10.

[0052] A shelf 22 is provided at the bottom of the storage container 29 for placing the object to be frozen 19. The shelf 22 is a metal plate made of aluminum or the like and is rectangular when viewed from above. The shelf 22 is provided on the bottom surface of the storage container 29, and the heat of the object to be frozen 19 placed on the shelf 22 may be drawn by the shelf 22, so that the object to be frozen 19 may be rapidly frozen. Further, a position at which the object to be frozen 19 may be placed may be marked at the bottom surface of the storage container 29.

[0053] Referring to the oblique view of Fig. 4, the structure of the partition member 20 for separating the air duct, which is located in the upper portion of the upper freezing compartment 5, will be described. The partition member 20 includes: a bottom surface portion 26 which is approximately rectangular when viewed from above, a side surface portion 27a which extends upward from a left side edge of the bottom surface portion 26; a side surface portion 27b which extends upward from a right side edge of the bottom surface portion 26; a side surface portion 27c which extends upward from a front side edge of the bottom surface portion 26; and a side surface portion 27d which extends upward from a rear side edge of the bottom surface portion 26.

[0054] The side surface portion 27d at the rear is opened to form opening portions 30 and 35. The opening portion 30 is provided with a blower 23 which is constituted by a fan 23a and a casing 23b for supporting. Further, the opening portion 35 is communicated with the supply air duct 14 described above.

[0055] The rear portion of the bottom surface portion 26 is an inclined surface that is inclined rearward and downward, which functions to introduce cold air into the air duct. Further, the front portion of the bottom surface portion 26 is provided with an elongated air outlet 21 that is opened in the horizontal direction, and during normal cooling operation, the cold air is blown to the upper freezing compartment 5 via the air outlet 21.

[0056] In this embodiment, the internal space of the partition member 20 is separated by a partition wall 31 to form the first supply air duct 24 and the second supply air duct 25.

[0057] The partition wall 31 is a wall-like member, which is arranged in such a manner that the right rear portion of the internal space of the partition member 20 is separated into a rectangular portion, the rear end portion thereof is connected to the side surface portion 27d, and the front end portion thereof is connected to the side surface portion 27b. Further, a region surrounded by the partition wall 31 in the bottom surface portion 26 is opened to form an air outlet 28.

[0058] The first supply air duct 24 is an air duct formed on the left side of the partition wall 31, and in the internal space of the partition member 20, refers to the air duct from the opening portion 35 to the air outlet 21. On the other hand, the second supply air duct 25 is an air duct formed on the right side of the partition wall 31, and in the internal space of the partition member 20, refers to the air duct from the opening portion 30 to the air outlet 28. The left-to-right width of the second supply air duct 25 is narrower than that of the first supply air duct 24, so that the cold air passing through the second supply air duct 25 may be accelerated and the object to be frozen 19 may be quickly frozen. The operation of blowing cold air via the first supply air duct 24 and the second supply air duct 25 will be described later.

[0059] Referring to Fig. 5, as seen from the rear, the partition member 20 having the above structure includes: an opening portion 35 connected to the first supply air duct 24, which is located on the left side of the partition member 20; and an opening portion 30 connected to the second supply air duct 25, which is located on the right side of the partition member 20. In the use state, the cold air is supplied to the first supply air duct 24 and the second supply air duct 25 via the supply air duct 14, but at a position close to the first supply air duct 24 and the second supply air duct 25, the supply air duct 14 extends toward the side of the first supply air duct 24. Here, the supply air duct 14 extends to the top left.

[0060] In this way, during normal cooling operation, it is possible to prevent the shelf 22 shown in Fig. 3 from flash cooling or over-cooling. Specifically, during normal cooling operation, the blower 23 disposed on the side of the second supply air duct 25 is in a stopped state, and the cold air blown by the blower 32 shown in Fig. 3 is supplied to the first supply air duct 24 via the supply air duct 14, and then is supplied to the upper freezing compartment 5 through the air outlet 21 shown in Fig 4. In Fig. 5, the passage for the cold air supplied to the first supply air duct 24 is indicated by a solid line arrow. In this embodiment, the supply air duct 14 extends toward the side of the first supply air duct 24, so most of the cold air blown via the supply air duct 14 is supplied to the first supply air duct 24, and the amount of the cold air supplied to the second supply air duct 25 is reduced accordingly. Therefore, referring to Fig. 3, during normal cooling operation, there wouldn't be a large amount of cold air from the air outlet 28 of the second supply air duct 25 to be blown to the inside of the upper freezing compartment 5, so that the vicinity of the shelf 22 can be prevented from being excessively cooled.

[0061] On the other hand, during rapid cooling operation, the control unit rotates the blower 23 on the side of the second supply air duct 25, so that most of the cold air supplied via the supply air duct 14 is blown toward the side of the second supply air duct 25. In this figure, the direction of flow of the cold air blown to the second supply air duct 25 is indicated by a broken line arrow.

[0062] Next, the operation of the upper freezing compartment 5 during normal cooling operation and during rapid cooling operation will be described with reference to the above figures.

[0063] Referring to Fig. 3, during normal cooling operation, the control unit operates the blower 32 to cause a part of the cold air blown from the cooling compartment 13 to the supply air duct 14 to flow into the first supply air duct 24 through the opening portion 35 shown in Fig. 4. In addition, as described above, during normal cooling operation, a part of the cold air in the supply air duct 14 is supplied to the ice making compartment 4 and the lower freezing compartment 6 shown in Fig. 2, and a part thereof is supplied to the refrigerating compartment 3 through the supply air duct 15.

[0064] The cold air flowing into the first supply air duct 24 from the supply air duct 14 flows into the upper freezing compartment 5 through the air outlet 21 located on the partition member 20. Further, a part of the cold air supplied from the supply air duct 14 is supplied to the upper freezing compartment 5 via the opening portion 30, the second supply air duct 25, and the air outlet 28.

[0065] The cold air supplied to the upper freezing compartment 5 flows outward beyond the top of the peripheral wall of the storage container 29. Then, the cold air passes between the peripheral wall and the inner wall of the upper freezing compartment 5, and flows into the lower freezing compartment 6 below. At this time, the air door 41 shown in Fig. 1 is in an open state, so the cold air is also supplied to the lower freezing compartment 6 via the supply air duct 14.

[0066] Next, the direction of flow of the cold air during rapid cooling operation will be described.

[0067] Referring to Fig. 4, the control unit operates the blower 23 during rapid cooling operation. As a result, most of the cold air in the supply air duct 14 is drawn by the blower 23 and flows toward the second supply air duct 25. In this way, the cold air flowing from the supply air duct 14 to the first supply air duct 24 is greatly reduced.

[0068] At this time, the control unit enables the air door 41 shown in Fig. 1 to be in the closed state, so that the cold air is not supplied to the lower freezing compartment 6, and is only supplied concentratively to the upper freezing compartment 5. In addition, at this time, in order to allow the cold air in the upper freezing compartment 5 to be more concentrated, the control unit may also enable the air door 18 connected to the refrigerating compartment 3 to be in the closed state.

[0069] Then, the cold air in the second supply air duct 25 is blown to the inside of the upper freezing compartment 5 by the blower 23. Here, since the cold air in the second supply air duct 25 is forcibly blown by the blower 23, almost all of the cold air supplied from the supply air duct 14 flows concentratively toward the air outlet 28. Referring to Fig. 3, the cold air blown from the air outlet 28 is blown toward the object to be frozen 19 placed on the shelf 22. Therefore, the sensible heat and the solidification latent heat of the object to be frozen 19 can be drawn away by the blown cold air, Thereby, the time of

passing through the maximum ice crystal generation temperature zone is shortened by, for example, about 25 minutes, so that the frozen product 19 such as food can retain its freshness while being frozen.

[0070] As described above, the control unit can supply more cold air to the upper freezing compartment 5 by operating the blower 23, thereby enhancing the freezing capacity in the upper freezing compartment 5. In particular, in this embodiment, since the cold air is supplied via the second supply air duct 25 for rapid freezing, the speed of the cold air supplied to the upper freezing compartment 5 by the air outlet 28 can be further increased, so that the freezing capacity can be further enhanced.

[0071] Further, referring to Fig. 4, in this embodiment, in addition to the cold air supplied from the supply air duct 14, the cold air in the upper freezing compartment 5 is circulated. In this figure, the passage for circulation of the cold air is indicated by a chain line arrow. That is, when the control unit rotates the blower 23, the cold air in the upper freezing compartment 5 is returned to the first supply air duct 24 via the air outlet 21. Thereafter, the cool air that has been returned to the first supply air duct 24 is blown from the air outlet 28 to the upper freezing compartment 5 via the opening portion 35, the supply air duct 14, the opening portion 30, and the second supply air duct 25. In this way, a larger amount of cold air may be supplied to the upper freezing compartment 5, so that the cooling capacity can be further improved.

[0072] Next, the control operation during rapid cooling operation will be described. In this embodiment, the rapid cooling operation is started according to a user's instruction. The use's instruction is issued by an input unit such as an operation button not shown in the drawing.

[0073] After the rapid cooling operation is started, as described above, the control unit operates the blower 23. At this time, the control unit causes the blower 32 and the compressor 42 to operate as during normal cooling operation. Here, it is also possible to use a control capable of enhancing the freezing capacity of the cooler 16 during rapid cooling operation. Specifically, the control unit may use controls such as increasing the operating frequency of the compressor 42, increasing the rotational speed of the fan for the radiator, and opening the expansion valve widely. In this way, the freezing capacity during rapid cooling operation can be further enhanced.

[0074] Then, after starting the rapid cooling operation for a certain period of time, the control unit stops the second blower 23 to end the rapid cooling operation; and the normal cooling operation is performed again. Here, the certain period of time refers to the time required to freeze the object to be frozen 19, and is preset. In addition, the control unit may determine whether or not to stop the rapid cooling operation based on the internal temperature of the upper freezing compartment 5 or the temperature of the object to be frozen 19 detected by a temperature detecting unit not shown in the drawing.

[0075] Referring to Fig. 6, a refrigerator 1 according to another embodiment of the present invention will be described. Fig. 6(A) is a side sectional view showing the structure in the vicinity of the upper freezing compartment 5 of the refrigerator 1 according to another embodiment, and Fig. 6(B) is an oblique view of the partitioning member 20. The structure and operation of the refrigerator 1 shown in this figure are substantially the same as those described above, except that an indoor blower for rapid freezing, i.e., the blower 43, is disposed in the upper portion of the upper freezing compartment 5.

[0076] Referring to Fig. 6(A), here, the blower 43 is disposed in the upper portion of the upper freezing compartment 5. For example, referring to Fig. 3, it can be seen that in the above embodiments, the blower 23 is disposed behind the second supply air duct 25, and here, the blower 43 is disposed in the passage of the second supply air duct 25. In this way, the blower 43 is disposed in the upper portion of the upper freezing compartment 5, which can shorten the distance between the object to be frozen 19 and the blower 43, so that the speed of the cold air blown toward the object to be frozen 19 can be increased. Here, the blower 43 is, for example, an air blower mounted on the partition member 20, and a thin air blower is used as the blower 43, which can ensure that the upper freezing compartment 5 has a large layer height.

[0077] Here, the second supply air duct 25 for circulation of the cold air during rapid cooling operation is a space surrounded by the partition member 20. The rear top surface of the second supply air duct 25 is provided with an opening portion 44 for sucking cold air; and the front bottom surface of the second supply air duct 25 is provided with an air outlet 28 for blowing cold air.

[0078] The operation during rapid cooling operation will be described with reference to Fig. 6(A) and Fig. 6(B). After the rapid cooling operation is started, the control unit not shown in the drawing rotates the blower 43, and the cold air supplied from the supply air duct 14 is blown to the second supply air duct 25 via the opening portion 35 and the opening portion 44 shown in Fig. 6(A). Thereafter, the cold air blown to the second supply air duct 25 is blown from the air outlet 28 to the object to be frozen 19 stored in the upper freezing compartment 5. On the other hand, during normal cooling operation, the blower 43 is not operated, and the cold air supplied from the supply air duct 14 is supplied from the air outlet 21 to the upper freezing compartment 5 via the first supply air duct 24.

[0079] Still another embodiment of the refrigerator 1 will be described with reference to Fig. 7. Fig. 7(A) is a side sectional view showing the refrigerator 1 according to another embodiment, Fig. 7(B) is an oblique view of the partition member 20, and Fig. 7(C) is a rear view of the partition member 20. The basic structure and operation of the refrigerator 1 shown here are the same as those described above, except that an air door 34 is provided.

[0080] Referring to Fig. 7 (A) and Fig. 7 (B), the blower 23 for rapid freezing shown in Fig. 4 is not provided here,

and the air door 34 is provided in the opening portion 35 on the side of the first supply air duct 24. That is, the air door 34 is provided at the intersection between the supply air duct 14 and the first supply air duct 24, and is provided at a rearward position compared with the rear end portion of the upper freezing compartment 5 in order to ensure that the upper freezing compartment 5 has a larger volume. On the other hand, the opening portion 30 on the side of the second supply air duct 25 is not provided with an air door.

[0081] The operation when the air door 34 is provided is as follows. First, during normal cooling operation, the control unit enables the air door 34 to be in the open state, and the cold air supplied from the supply air duct 14 is blown to the upper freezing compartment 5 via the air door 34, the second supply air duct 25, and the air outlet 21. Further, as shown in Fig. 7(C), the supply air duct 14 faces the side of the opening portion 35, namely, the side of the air door 34. If the air door 34 is in the open state, most of the cold air supplied along the supply air duct 14 is supplied to the first supply air duct 24 via the air door 34. In this figure, the cold air that travels toward the air door 34 is indicated by a solid arrow.

[0082] On the other hand, during rapid cooling operation, the control unit enables the air door 34 to be in the closed state. Therefore, referring to Fig. 7(C), the cold air supplied from the supply air duct 14 is not supplied to the first supply air duct 24, but travels toward the side of the opening portion 30, as indicated by a broken line arrow. Thereafter, referring to Fig. 7(B), the cold air is blown to the object to be frozen 19 stored in the upper freezing compartment 5 via the second supply air duct 25 and the air outlet 28.

[0083] In the case of the above-described refrigerator 1, it is possible to concentrate the cold air on the second supply air duct 25 without using the blower for rapid freezing, so that the refrigerating capacity can be improved with a compact structure.

[0084] Still another embodiment of the refrigerator 1 will be described with reference to a side sectional view of Fig. 8. The structure and operation of the refrigerator 1 shown in this figure are the same as those described above, except that a variable temperature compartment 5A is provided instead of the upper freezing compartment 5. That is, the partition member 20 shown in Fig. 4 and other figures is located above the variable temperature compartment 5A. Here, the variable temperature compartment 5A is a storing compartment that can change the indoor temperature from the refrigerating temperature zone to the freezing temperature zone depending on the intended use.

[0085] When the variable temperature compartment 5A is provided, a heat insulation partition wall 40 is provided between the variable temperature compartment 5A and the lower freezing compartment 6. Further, a heat insulation partition wall not shown in the drawing is also provided between the ice making compartment 4 and the variable temperature compartment 5A shown in Fig. 1.

[0086] A partition member 20 is provided above the variable temperature compartment 5A, and the first supply air duct 24 and the second supply air duct 25 as shown in Fig. 4 are formed between the partition member 20 and the heat insulation partition wall 36. During rapid cooling operation, a blower 23 is provided between the second supply air duct 25 and the supply air duct 14 for circulation of cold air. Further, an air door 45 is provided in the passage of the supply air duct 14 connected to the blower 23, is used as an air duct adjusting unit for adjusting the indoor temperature of the variable temperature compartment 5A. Here, the air door 45 may be replaced with a roller blind or the like. During rapid cooling operation, the air door 45 is in the open state.

[0087] When the variable temperature compartment 5A is used as the freezing compartment, the cold air is supplied to the object to be frozen 19 via the second supply air duct 25, so that the object to be frozen 19 can be quickly frozen, and can retain its freshness while being frozen.

[0088] On the other hand, when the variable temperature compartment 5A is used as the refrigerating compartment, the cold air blown by the blower 23 is supplied to the inside of the variable temperature compartment 5A via the second supply air duct 25, so that the inside of the variable temperature compartment 5A is quickly cooled.

[0089] In summary, the refrigerator 1 according to the embodiments of the present invention has been described, but the present invention is not limited to the above-described embodiments, and various other appropriate modifications can be made without departing from the spirit and scope of the present invention.

Claims

1. A refrigerator, comprising:

a storing compartment for accommodating an object to be frozen;
a cooler for cooling air supplied to the storing compartment;
a cooling compartment for accommodating the cooler;
a supply air duct for flowing the air cooled by the cooler from the cooling compartment to the storing compartment;
a first supply air duct disposed near a top surface of the storing compartment, wherein the cold air supplied from the supply air duct to the storing compartment passes through the first supply air duct during normal cooling operation; and
a second supply air duct disposed near the top surface of the storing compartment and disposed separately from the first supply air duct, wherein the cold air supplied from the supply air duct and blown toward the object to be frozen

passes through the second supply air duct during rapid cooling operation.

2. The refrigerator according to claim 1, comprising a blower for rapid freezing, wherein the blower is used for blowing cold air to the second supply air duct during rapid cooling operation.

3. The refrigerator according to claim 2, wherein the blower for rapid freezing is disposed at a rear end portion of the second supply air duct.

4. The refrigerator according to claim 2 or 3, wherein the blower for rapid freezing blows the air from the cooling compartment to the second supply air duct, and circulates the air in the storing compartment via the first supply air duct.

5. The refrigerator according to any of claims 1 to 4, wherein the first supply air duct and the second supply air duct are located at an upper portion of the storing compartment, and are separated by a partition wall extending in the vertical direction.

6. The refrigerator according to claim 1, wherein an indoor blower is disposed inside the storing compartment for blowing cold air to the object to be frozen via the second supply air duct.

7. The refrigerator according to claim 1, wherein an air door is disposed between the first supply air duct and the supply air duct, and the air door is in a closed state during rapid cooling operation to supply the air supplied from the supply air duct to the second supply air duct.

8. The refrigerator according to any of claims 1 to 7, wherein the supply air duct extends toward the side of the first supply air duct close to the first supply air duct and the second supply air duct.

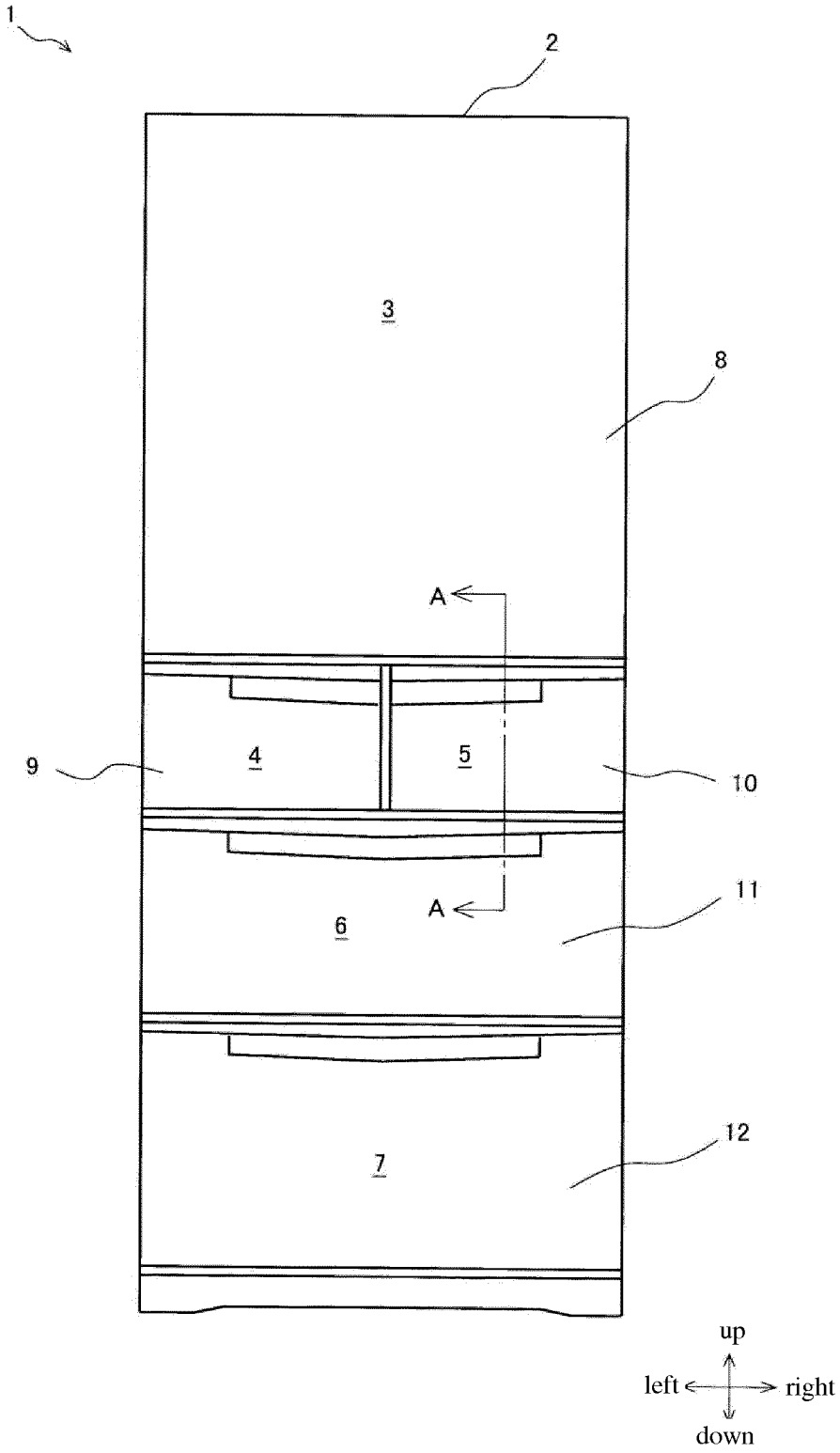

Fig. 1

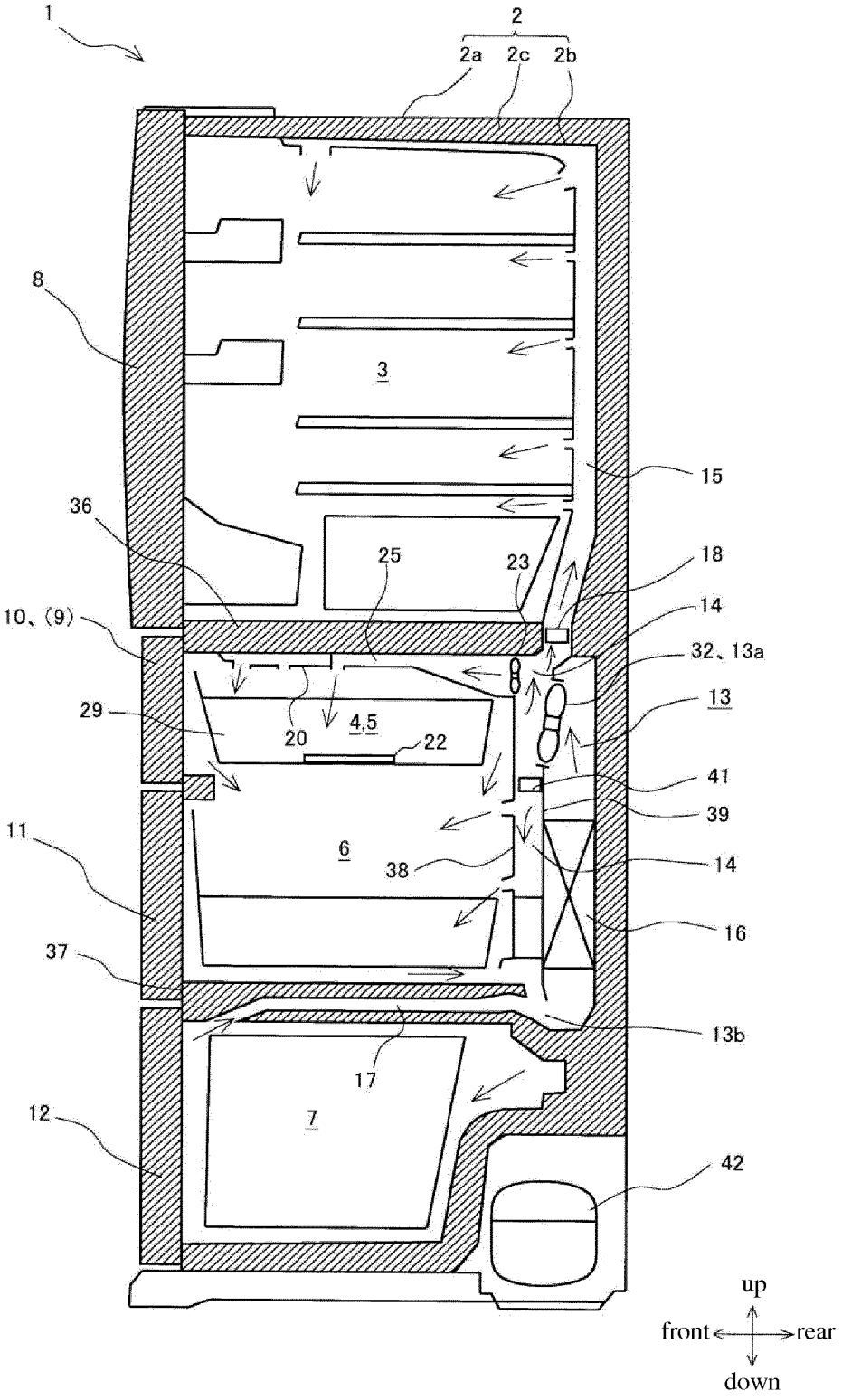
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Fig. 2

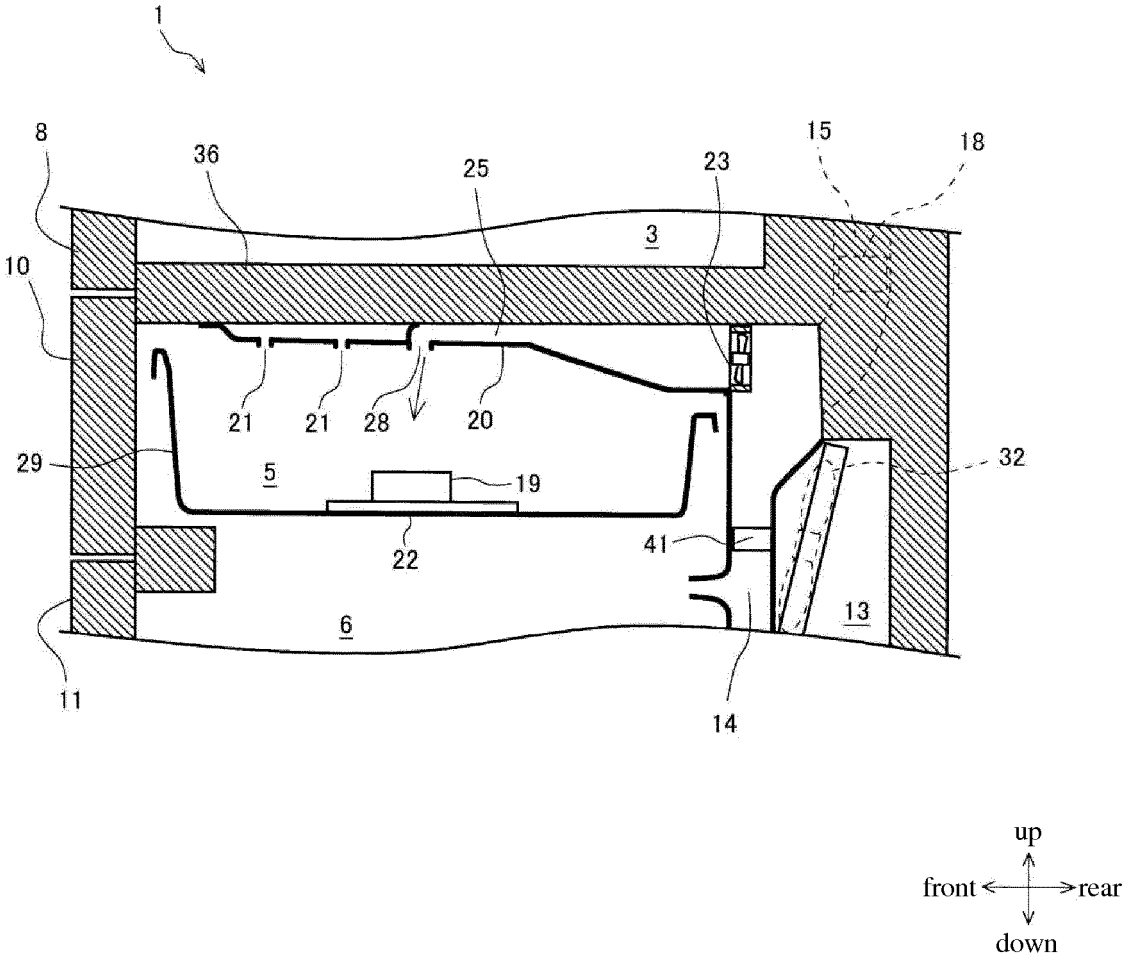
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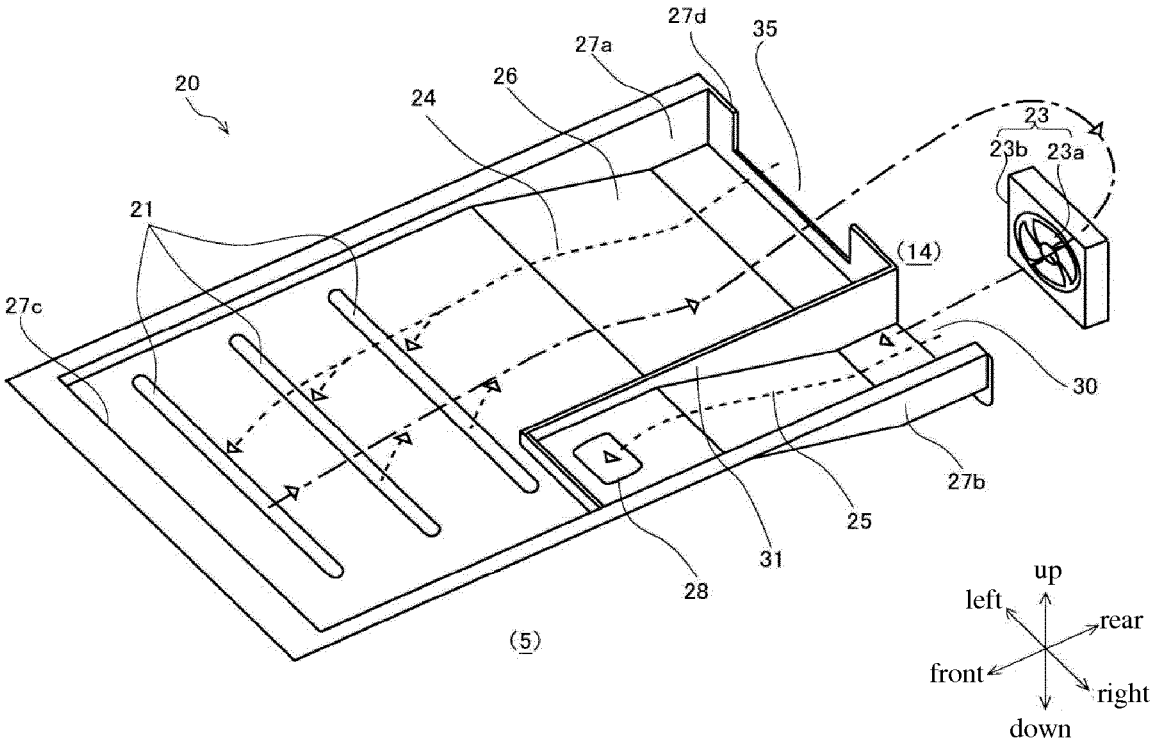
Fig. 3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rear
front
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down

Fig. 4

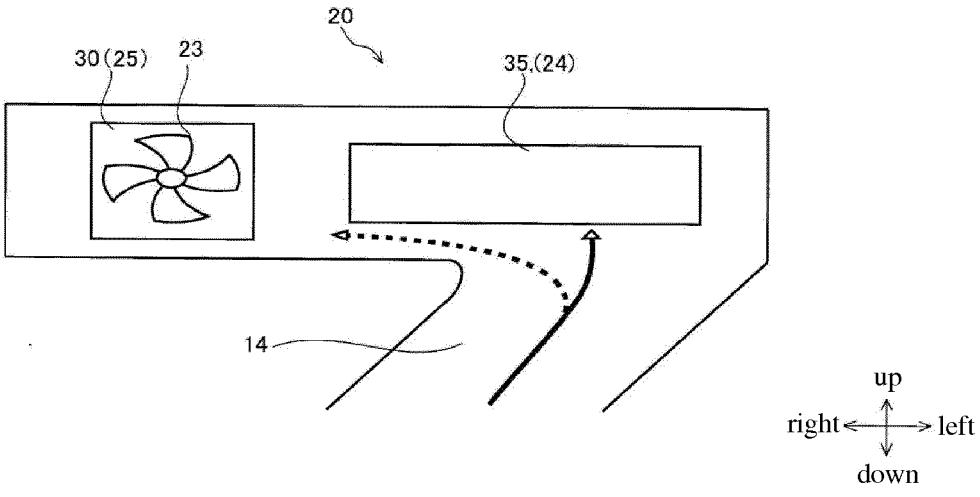
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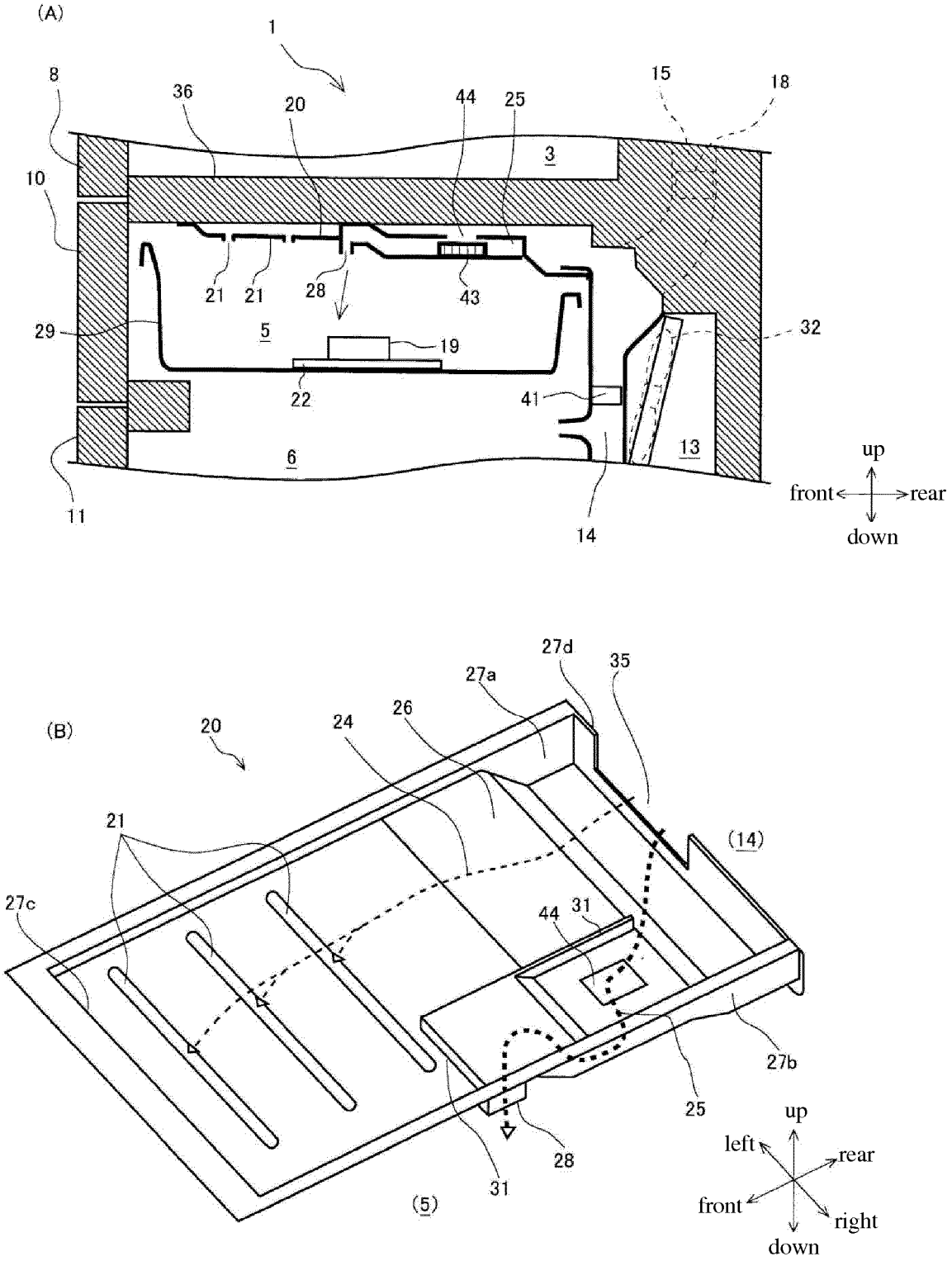
Fig. 5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(B)
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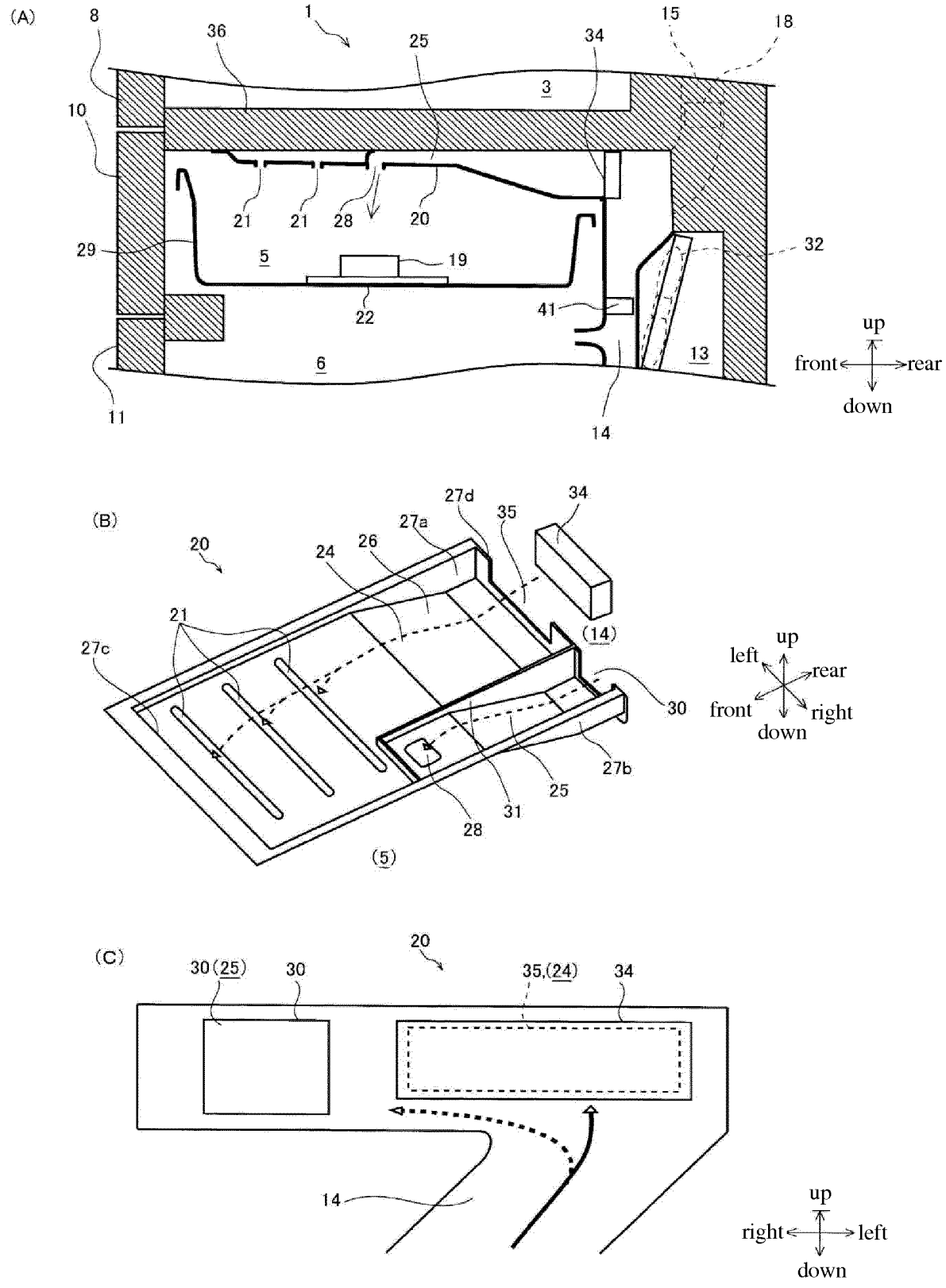
Fig. 6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27d
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(14)
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27b
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35,(24)
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Fig. 7

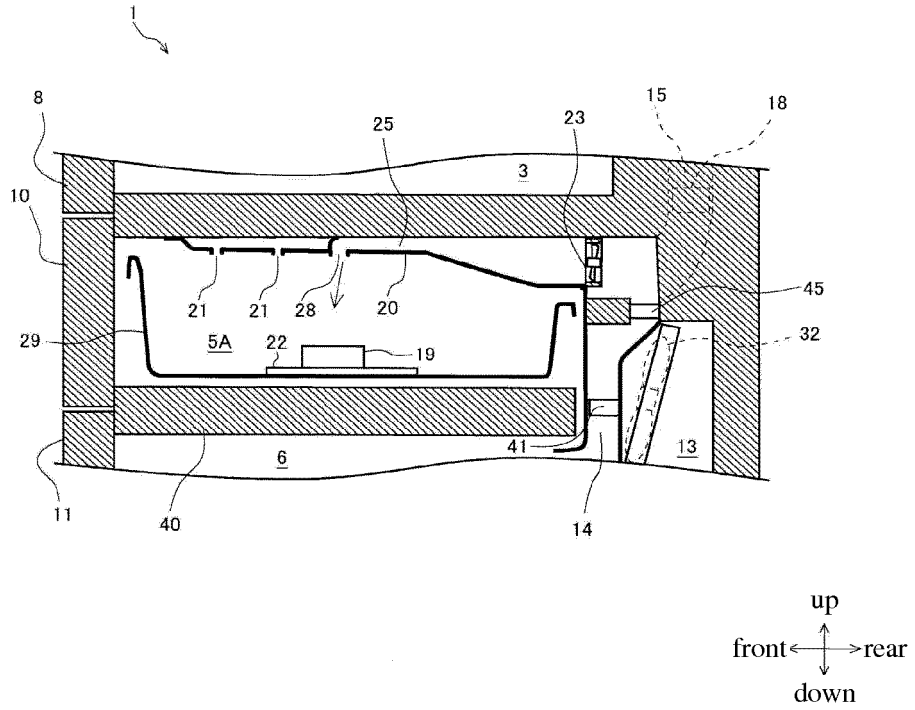
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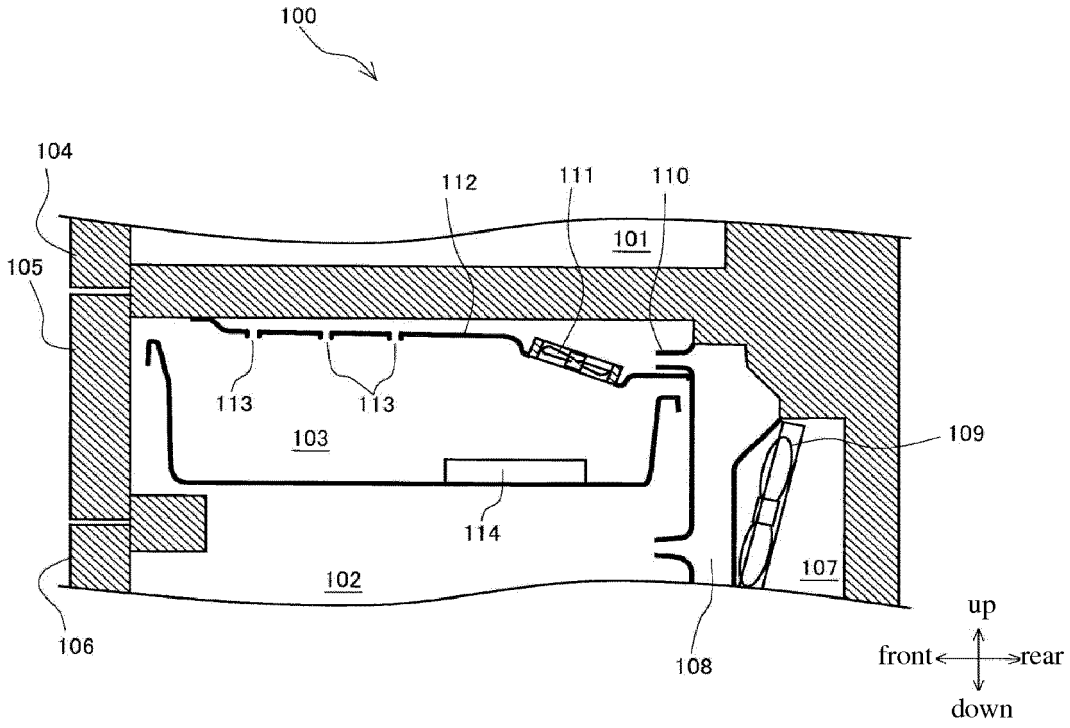
Fig. 8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up
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rear
down

Fig. 9

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2016/113467

A. CLASSIFICATION OF SUBJECT MATTER

F25D 17/06 (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)

F25D 17

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, DWPI, SIPOABS: 快速冷却, 快速冷冻, 速冻, 速冷, 风路, 风道, 流路, quick, freez+, frozen, rapidly, fast, cold, duct, path

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN 105157318 A (QINGDAO HAIER CO., LTD.), 16 December 2015 (16.12.2015), description, pages 4-7, and figures 2-11	1-8
X	CN 205002488 U (QINGDAO HAIER CO., LTD.), 27 January 2016 (27.01.5016), description, pages 4-7, and figures 2-11	1-8
X	KR 20030024399 A (LG ELECTRONICS INC.), 26 March 2003 (26.03.2003), description, pages 4-7, and figures 1-4	1-3, 6-8
PX	CN 106679269 A (QINGDAO HAIER CO., LTD. et al.), 17 May 2017 (17.05.2017), claims 1-8, and figures 1-9	1-8
A	KR 100780008 B1 (DAEWOO ELECTRONICS CORP.), 27 November 2007 (27.11.2007), entire document	1-8
A	JP 2015001331 A (HAIER ASIA INT CO., LTD.), 05 January 2015 (05.01.2015), entire document	1-8

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

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"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	Date of mailing of the international search report
20 June 2017	04 July 2017

Name and mailing address of the ISA	Authorized officer
State Intellectual Property Office of the P. R. China No. 6, Xitucheng Road, Jimenqiao Haidian District, Beijing 100088, China Facsimile No. (86-10) 62019451	GU, Xiaoyan Telephone No. (86-10) 62084873

Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2016/113467

Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
CN 105157318 A	16 December 2015	None	
CN 205002488 U	27 January 2016	None	
KR 20030024399 A	26 March 2003	KR 100505022 B1	01 August 2005
CN 106679269 A	17 May 2017	None	
KR 100780008 B1	27 November 2007	None	
JP 2015001331 A	05 January 2015	CN 104412052 A	11 March 2015
		CN 104412052 B	22 February 2017
		WO 2014198153 A1	18 December 2014

Form PCT/ISA/210 (patent family annex) (July 2009)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- CN 201610878087 **[0001]**
- JP 63046362 A **[0003]**
- JP 2002267318 A **[0003]**
- JP 2015001331 A **[0004] [0007] [0008]**