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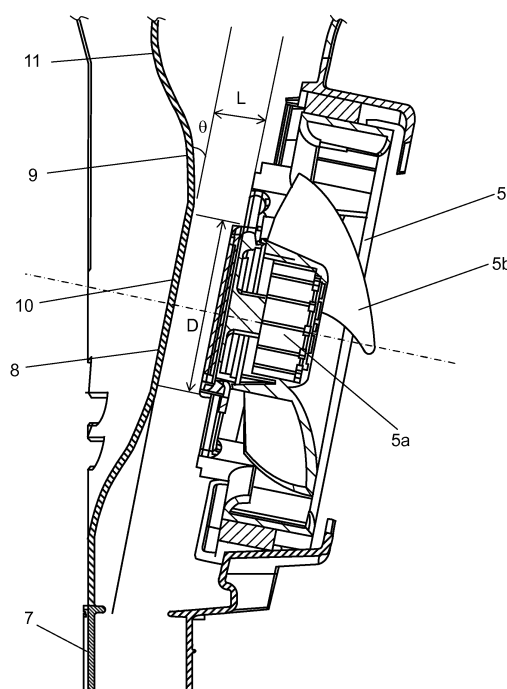
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(54) **REFRIGERATOR**

(57) The present invention includes a cooler stored on a back surface of a storage compartment, and a cooling fan (5) configured to circulate cool air generated by the cooler into the storage compartment, and further includes a duct (7) having a flow straightener (8) that protrudes toward the cooling fan (5) at such a position as to face the cooling fan (5). Furthermore, the flow straightener (8) is formed in a substantially truncated conical shape, the flow straightener (8) having an inclined part (9) and a plane part (10). Consequently, it is possible to reduce a pressure loss on a blowing side without increase in a pressure loss on a suction side of the cooling fan (5), while suppressing the depth dimension of the duct (7). Furthermore, it is possible to provide a refrigerator having high storage efficiency, high cooling efficiency, and low noise.

FIG. 3



Description

TECHNICAL FIELD

[0001] The present invention relates to a refrigerator, and more particularly to a structure of effectively circulating cool air of a cooling fan to the inside of a refrigerator, in the refrigerator in which an inside fan circulates cool air generated by a cooler to the inside of the refrigerator.

[0002] Additionally, the present invention relates to a refrigerator that forcibly circulates cool air generated by a cooler to cool a storage compartment.

[0003] Furthermore, the present invention relates to a refrigerator, and more particularly to a structure of effectively circulating cool air discharged from a cooling fan to the inside of a refrigerator, in the refrigerator in which the cooling fan circulates cool air generated by a cooler to the inside of the refrigerator.

BACKGROUND ART

[0004] FIG. 16 is a sectional view of the periphery of a cooling fan of a conventional refrigerator. FIG. 17 is an enlarged sectional view of the periphery of a flow straightener of the conventional refrigerator. In FIG. 16 and FIG. 17, refrigerator body 101 is configured by heat insulating walls, and includes at least one storage compartment 103 that is opened forward, and is closed by heat insulating door 102. On the back surface of storage compartment 103, cooler 104 is stored that is connected in series with a compressor (not shown), a condenser (not shown), and a decompressor (not shown), and configures a refrigerant circuit. Axial flow or diagonal flow cooling fan 105 that circulates cool air generated by cooler 104 into storage compartment 103 is provided on the upper part of cooler 104. On the side of cooler 104 closer to heat insulating door 102, duct 107 is provided at such a position as to face cooling fan 105. Duct 107 is provided with flow straightener 106 that protrudes toward cooling fan 105 so as to have a substantially truncated conical shape. This duct 107 separates storage compartment 103 and cooling compartment 108 that includes cooler 104 and cooling fan 105.

[0005] Slits 109 that communicate storage compartment 103 with cooling compartment 108 are provided in the plane part of duct 107. Slits 109 guide cool air discharged from cooling fan 105 into storage compartment 103.

[0006] During the operation of the refrigerator, cooling fan 105 is operated such that the cool air generated by cooler 104 is guided to storage compartment 103. Generally, in an axial flow, or diagonal flow fan, a flow in a direction opposite to a mainstream is generated at a central part near the cool air discharge side of the fan by reduction in the pressure of an inner side than blades near the fan, thereby generating a swirl. Consequently, there is a problem that a pressure loss is increased, and the noise of the fan becomes large, air volume reduces,

or the like (e.g., see PTL 1).

[0007] In the conventional refrigerator, in order to solve this problem, conically protruding flow straightener 6 is provided on a part facing cooling fan 105 of duct 107.

[0008] However, for example, in a refrigerator having a small depth, the rotary axis of cooling fan 105 is sometimes disposed to be inclined from a horizontal direction such that a suction direction of cooling fan 105 is directed to the cooler side in order to increase a space on the suction side of cooling fan 105. In this case, in the aforementioned conventional configuration, when the plane part of duct 107 is disposed in a vertical direction, the lower part of cooling fan 105 comes close to the plane part of the duct 107 as compared to the upper part thereof. Therefore, a lower clearance between flow straightener 106 and cooling fan 105 is small, and an upper clearance is large. As a result, there is a possibility that pressure loss reduction effect by flow straightener 106 reduces, and air volume reduces, or noise becomes large.

[0009] Additionally, in a case where the plane part of the duct 107 is disposed in a direction perpendicular to the rotary axis of cooling fan 105 in order to increase the pressure reduction effect by flow straightener 106, there is a possibility that the space on the cool air discharge side of the cooling fan 105 reduces, the pressure loss in duct 107 increases, the air volume reduces, or the noise becomes large.

[0010] The present invention provides a refrigerator that allows increase in the air volume of a cooling fan by effective arrangement of the cooling fan and a flow straightener in a cooling compartment, and has high cooling efficiency, and low noise.

[0011] Amid the increasingly severe condition of a request to energy saving, in a refrigerator that forcibly circulates cool air generated by a cooler, to cool a storage compartment, not only the refrigeration efficiency of the cooler, but also the air blowing efficiency of the cooling fan is important. Therefore, an air blowing technology of effectively conveying cool air discharged from the cooling fan is important. A configuration in which a flow straightener is provided on the discharge side of the cooling fan is heretofore used (e.g., see PTL 1).

[0012] Hereinafter, a conventional refrigerator is described with reference to the drawings.

[0013] FIG. 18 is a sectional plan view of the conventional refrigerator. In FIG. 18, cooling compartment 112 that generates cool air is disposed on the back surface of storage compartment 111, and cooling compartment 112 and other space are separated by cooling compartment cover 113. Cooler 114 is disposed in cooling compartment 112, and cooling fan 115 is connected to cooling fan motor 116 in the upper part of cooling compartment 112. Furthermore, on the front surface of the cooling compartment cover 113, partition plate 117 separates an air trunk through which cool air discharged from cooling fan 115 passes, and storage compartment 111. In partition plate 117, straightened flow guide plate 118 that has a conical shape at such a position as to face cooling fan

115, and discharge port 119 in the plane part are integrally formed.

[0014] The operation of a refrigerator configured as described above is hereinafter described.

[0015] When air in cooling compartment 112 is cooled by cooler 114 to become cool air, and cooling fan 115 discharges the cool air to straightened flow guide plate 118, the cool air radically flows out along the conical surface of straightened flow guide plate 118. Then, after radically diffusing, the cool air is sent to storage compartment 111 through discharge port 119.

[0016] As described above, in the conventional refrigerator, straightened flow guide plate 118 is integrally provided on partition plate 117 in front of cooling fan 115, so that the discharged cool air flows only radically. Consequently, it is possible to prevent a backward flow toward the center of cooling fan 115, and to simultaneously send straightened cool air to storage compartment 111 directly from discharge port 119. Furthermore, at the same time, it is possible to provide a refrigerator, in which the loss of cool air can be minimized, and a storage compartment can be effectively cooled.

[0017] However, in the configuration of the conventional refrigerator, when cool air is discharged from discharge port 119 provided in the plane part of partition plate 117, the cool air is radically straightened, and therefore has large force of expanding outward. Therefore, there is a problem that the front of cooling fan 115 being the center of storage compartment 111 having many stored goods therein is unlikely to be cooled.

[0018] Furthermore, the outwardly discharged cool air flows along the inner walls of storage compartment 111, and therefore there is a possibility of promoting heat exchange with outside air that passes through the wall of a refrigerator body, to increase power consumption.

[0019] The present invention provides a refrigerator, in which cool air discharged from a cooling fan can be delivered to the center of a storage compartment without a loss, and the storage compartment can be effectively cooled.

[0020] FIG. 19 is a sectional view of the periphery of a cooling fan of a conventional refrigerator. FIG. 20 is a front view of the periphery of the cooling fan of the conventional refrigerator.

[0021] In FIG. 19 and FIG. 20, refrigerator 121 is configured by heat insulating walls, and includes freezing compartment 123 that is opened forward and closed by freezing compartment door 122, and refrigerating compartment 125 closed by refrigerating compartment door 124. On the back surface of freezing compartment 123, cooler 126 is stored that is connected in series with a compressor (not shown), a condenser (not shown), and a decompressor (not shown), and configures a refrigerant circuit. Axial flow or diagonal flow cooling fan 127 that circulates cool air generated by cooler 126 is provided on the upper part of cooler 126. On the side of cooler 126 closer to freezing compartment door 122, duct 129 is provided at such a position as to face cooling fan 127.

Duct 129 is formed with flow straightener 128 that protrudes toward cooling fan 127 so as to have a substantially conical shape. Then, duct 129 separates freezing compartment 123 and cooling compartment 130 that includes cooler 126 and cooling fan 127.

[0022] Slits 131 that communicate freezing compartment 123 with cooling compartment 130 are provided in the plane part of duct 129. Cool air discharged from cooling fan 127 is guided into freezing compartment 123 through slits 131.

[0023] Additionally, refrigerating compartment air trunk 132 is provided on the heat insulating wall on the back surface of freezing compartment 123 such that freezing compartment 123 is communicated with refrigerating compartment 125, and cool air discharged from cooling fan 127 is guided into refrigerating compartment 125 through refrigerating compartment air trunk 132.

[0024] During the operation of the refrigerator, cooling fan 127 is operated such that the cool air generated by cooler 124 is guided to freezing compartment 123 and refrigerating compartment 125. Generally, in an axial flow, or diagonal flow fan, a flow in a direction opposite to a mainstream is generated at a central part near the cool air discharge side of the fan by reduction in the pressure of an inner side than blades near the fan, thereby generating a swirl. Consequently, there is a problem that a pressure loss increases, the noise of the fan becomes large, air volume reduces, or the like.

[0025] In the conventional refrigerator, in order to solve this problem, substantially conically protruding flow straightener 128 is provided on a part facing cooling fan 127 of duct 129. However, in the aforementioned conventional configuration, cool air discharged from cooling fan 127 is radially blown from cooling fan 127, and cool air that passes through slits 131 also radially flows. At this time, the cool air blown from slits 131 located above cooling fan 127 directly hits the heat insulating wall that separates freezing compartment 123 and refrigerating compartment 125, and the temperature of the heat insulating wall reduces. Consequently, there is a possibility that refrigerating compartment 125 is cooled by cool air which cools freezing compartment 123, and freezing compartment 123 cannot be effectively cooled due to heat conduction.

[0026] Additionally, refrigerating compartment air trunk 132 is opened at a position opposite to the blowing direction of cooling fan 127, and therefore there is a possibility that a flow direction is changed by 180 degrees, so that the pressure loss of the air trunk increases, and the air volume of cool air that flows to refrigerating compartment 125 reduces.

[0027] The present invention effectively arranges cooling fan 127, slits 131, and refrigerating compartment air trunk 132. Consequently, there is provided a refrigerator, in which the air volume of cooling fan 127 increases, heat transfer from refrigerating compartment 125 to freezing compartment 133 reduces, and cooling efficiency is high.

Citation List

Patent Literature

[0028] PTL 1: Japanese Patent No. 3631316

SUMMARY OF THE INVENTION

[0029] A refrigerator of the present invention includes: a storage compartment surrounded by a heat insulating wall and having an opening in a front surface thereof; a heat insulating door configured to close the opening; and a cooler stored on a back surface of the storage compartment. Furthermore, the refrigerator includes: a cooling fan configured to circulate cool air generated by the cooler into the storage compartment; and a duct having a flow straightener that protrudes toward the cooling fan at such a position as to face the cooling fan. Then, the flow straightener is formed in a substantially truncated conical shape having an inclined part and a plane part.

[0030] Consequently, it is possible to reduce a pressure loss on a blowing side without increase in a pressure loss on a suction side of the cooling fan, while the depth dimension of the duct is suppressed, and to provide a refrigerator having high storage efficiency, high cooling efficiency, and low noise.

[0031] A refrigerator of the present invention includes: a storage compartment; a cooler configured to generate cool air for cooling the storage compartment; a cooling fan configured to forcibly send the cool air generated by the cooler to the storage compartment; and a partition member located between the storage compartment and the cooling fan. The partition member has a discharge port configured to send the cool air to the storage compartment, and a cool air flow straightener configured such that a part facing the cooling fan protrudes toward the cooling fan, and at least a part of the discharge port is disposed in the cool air flow straightener. Consequently, the cool air discharged from cooling fan is radially straightened by cool air flow straightener, and discharged to the storage compartment with no change and no loss. At this time, force along cool air flow straightener acts on the cool air by Coanda effect, and therefore cool air to be discharged is discharged toward the front of cooling fan. Consequently, the cool air can be guided to the middle of the storage compartment in front of cooling fan, to which the cool air cannot be directly sent heretofore, and therefore it is possible to effectively cool stored goods.

[0032] A refrigerator of the present invention includes: a refrigerating compartment; a freezing compartment provided below the refrigerating compartment; a cooler provided inside the freezing compartment; a duct configured to separate the cooler and the freezing compartment; and a cooling fan configured to circulate cool air of the cooler. Furthermore, the refrigerator includes a flow straightener provided at such a position of the duct as to face the cooling fan; a freezing compartment side discharge port configured to discharge the cool air to the

freezing compartment; and a refrigerating compartment side discharge port configured to guide the cool air to the refrigerating compartment. In addition to this, the freezing compartment side discharge port is provided below the center of the cooling fan, and the refrigerating compartment side discharge port is provided above the center of the cooling fan.

[0033] Consequently, the cool air by the cooling fan is radially blown by the flow straightener, the cool air that blows upward above the cooling fan flows to the refrigerating compartment, and the cool air that blows downward below the cooling fan flows to the freezing compartment. Consequently, it is possible to effectively cool the cool air from the cooling fan to each compartment, and therefore it is possible to enhance coolability, and attain energy saving.

BRIEF DESCRIPTION OF DRAWINGS

[0034]

FIG. 1 is a sectional view of a refrigerator according to a first exemplary embodiment of the present invention.

FIG. 2 is a sectional view of the periphery of a cooling fan of the refrigerator according to the first exemplary embodiment of the present invention.

FIG. 3 is an enlarged sectional view of the periphery of a flow straightener of the refrigerator according to the first exemplary embodiment of the present invention.

FIG. 4 is a correlation diagram showing a relationship between a distance between the cooling fan and the flow straightener, and the air volume of the cooling fan, in the refrigerator according to the first exemplary embodiment of the present invention.

FIG. 5 is a correlation diagram showing a relationship between the angle of an inclined part of the flow straightener and the air volume of the cooling fan, in the refrigerator according to the first exemplary embodiment of the present invention.

FIG. 6 is a front view of a refrigerator according to a second exemplary embodiment of the present invention.

FIG. 7 is a longitudinal sectional view of the refrigerator according to the second exemplary embodiment of the present invention.

FIG. 8 is a front view of an essential part according to the second exemplary embodiment of the present invention.

FIG. 9 is an enlarged longitudinal sectional view of an essential part according to the second exemplary embodiment of the present invention.

FIG. 10 is a sectional plan view of an essential part according to the second exemplary embodiment of the present invention.

FIG. 11 is a perspective view of a storage compartment side partition member according to the second

exemplary embodiment of the present invention.

FIG. 12 is a longitudinal sectional view of a refrigerator according to a third exemplary embodiment of the present invention.

FIG. 13 is a sectional view of a refrigerator according to a fourth exemplary embodiment of the present invention.

FIG. 14 is a sectional view of the vicinity of a refrigerating compartment side discharge port of the refrigerator according to the fourth exemplary embodiment of the present invention.

FIG. 15 is a sectional view of the vicinity of an ice-making compartment side discharge port of the refrigerator according to the fourth exemplary embodiment of the present invention.

FIG. 16 is a sectional view of the periphery of a cooling fan of a conventional refrigerator.

FIG. 17 is an enlarged sectional view of the periphery of a flow straightener of the conventional refrigerator.

FIG. 18 is a sectional plan view of another conventional refrigerator.

FIG. 19 is an enlarged sectional view of the periphery of a flow straightener of yet another conventional refrigerator.

FIG. 20 is a front view of the inside of a freezing compartment of yet another conventional refrigerator.

DESCRIPTION OF EMBODIMENTS

[0035] Hereinafter, a refrigerator according to a first exemplary embodiment of the present invention is described with reference to the drawings. The present invention is not limited to this exemplary embodiment.

FIRST EXEMPLARY EMBODIMENT

[0036] FIG. 1 is a sectional view of the refrigerator according to the first exemplary embodiment of the present invention. FIG. 2 is a sectional view of the periphery of a cooling fan according to the first exemplary embodiment of the present invention. FIG. 3 is an enlarged sectional view of the periphery of a flow straightener according to the first exemplary embodiment. FIG. 4 is a correlation diagram showing a relationship between a distance between the cooling fan and the flow straightener, and the air volume of the cooling fan, according to the first exemplary embodiment. FIG. 5 is a correlation diagram showing a relationship between an angle of an inclined part of the flow straightener and the air volume of the cooling fan, according to the first exemplary embodiment.

[0037] As shown in FIG. 1 to FIG. 3, duct 7 separates cooling compartment 6 and storage compartment 3, and has flow straightener 8 at such a position as to face cooling fan 5.

[0038] Cooling fan 5 is a rectangular axial flow fan, and includes motor 5a and blades 5b. A rotary axis of cooling fan 5 is disposed to be inclined with respect to a horizontal

direction such that a lower end of cooling fan 5 is closer to heat insulating door 2, and an upper end thereof is far from heat insulating door 2.

[0039] Flow straightener 8 is formed in a substantially truncated conical shape, flow straightener 8 having inclined part 9 and plane part 10, and is smoothly connected to duct 7 by connection part 11.

[0040] A detailed configuration of flow straightener 8 is now described. Flow straightener 8 and cooling fan 5 are installed so as to have such a positional relationship that a distance between plane part 10 and a central part on the blowing side of cooling fan 5 is 20 mm or less, and preferably from about 10 mm to about 15 mm.

[0041] An angle formed by the surface of inclined part 9 and the surface of plane part 10 is 20 degrees or less, and preferably from about 10 degrees to about 15 degrees.

[0042] The central part of plane part 10 of flow straightener 8 and the rotary axis of cooling fan 5 are disposed substantially on the same line.

[0043] The maximum dimension of plane part 10 of flow straightener 8 is equal to or smaller than the dimension of motor 5a of cooling fan 5. Specifically, the diameter of plane part 10 is equal to or smaller than the diameter of motor 5a of cooling fan 5.

[0044] Operation of the refrigerator configured as described above is hereinafter described.

[0045] During the operation of the refrigerator, cooling fan 5 operates to guide cool air generated by cooler 4 to storage compartment 3. At this time, flow straightener 8 is provided at such a position as to face cooling fan 5 in order to suppress a swirl that is generated in the vicinity of the discharge side of the cool air of cooling fan 5. Consequently, it is possible to reduce a pressure loss, to increase the air volume of cooling fan 5, and to reduce noise.

[0046] When the air volume of cooling fan 5 increases, the cooling efficiency of cooler 4 is improved, and the inside of storage compartment 3 can be effectively cooled.

[0047] Herein, the rotary axis of cooling fan 5 is installed to be inclined with respect to the horizontal direction, so that the lower end of cooling fan 5 is located on the front side, and therefore a space on the suction side of cooling fan 5 can be ensured. Consequently, in a refrigerator having a small depth, for example, a refrigerator that cannot ensure a large space on the suction side of cooling fan 5, it is possible to reduce the pressure loss on the discharge side of cooling fan 5 while reducing the pressure loss on the suction side of cooling fan 5, and further it is possible to increase the air volume of cooling fan 5. On the other hand, flow straightener 8 can be configured while the basic plane of duct 7 is disposed in the vertical direction, and therefore it is possible to reduce a pressure loss on the discharge side of cooling fan 5 without increase in a pressure loss of the inside of duct 7, and further it is possible to increase the air volume of cooling fan 5.

[0048] Accordingly, it is possible to reduce a pressure loss of the whole of cooling compartment 6 and duct 7, and further it is possible to attain a refrigerator having high cooling efficiency and low noise.

[0049] Additionally, flow straightener 8 of duct 7 is formed in a substantially truncated conical shape, flow straightener 8 having plane part 10, and therefore the depth dimension of duct 7 can be reduced, thereby enabling the effective utilization of a space in storage compartment 3.

[0050] In the first exemplary embodiment, a distance between plane part 10 of flow straightener 8 and cooling fan 5 is set to 20 mm or less. According to study by the inventors of the present invention, as shown in FIG. 4, the result indicates that as to the specification of a representative cooling fan used in a refrigerator, when the distance between the plane part of the flow straightener and the cooling fan is too large, the effect of straightening cannot be obtained, and the effect of the increase of air volume appears from around 20 mm.

[0051] Accordingly, the distance between plane part 10 of flow straightener 8 and cooling fan 5 is set to 20 mm or less, so that it is possible to reduce a pressure loss, to further increase the air volume of cooling fan 5, and to reduce noise. Therefore, it is possible to obtain a refrigerator having higher cooling efficiency and low noise.

[0052] Additionally, in the first exemplary embodiment, an angle formed by inclined part 9 and plane part 10 of flow straightener 8 is set to 20 degrees or less. According to study by the inventors of the present invention, as shown in FIG. 5, the result indicates that as to the specification of a representative cooling fan used in a refrigerator, when the angle formed by the inclined part and the plane part of the flow straightener is too large, the effect of straightening cannot be obtained, and the effect of the increase of air volume appears from around 20 degrees.

[0053] Accordingly, an angle formed by inclined part 9 and plane part 10 of flow straightener 8 is set to 20 degrees or less, so that it is possible to reduce a pressure loss, to further increase the air volume of cooling fan 5, and to reduce noise. Therefore, it is possible to attain a refrigerator having higher cooling efficiency and low noise.

[0054] In an axial flow fan or a diagonal flow fan, a swirl generated on the discharge side is generated on a blade side rather than motor 5a. When the diameter of plane part 10 is larger than that of motor 5a, the pressure loss rather increases, and the air volume of cooling fan 5 is reduced. In the first exemplary embodiment, the diameter of plane part 10 of flow straightener 8 is equal to or smaller than the diameter of motor 5a of cooling fan 5, and therefore it is possible to reduce the pressure loss, to further increase the air volume of cooling fan 5, and to reduce noise. Therefore, it is possible to attain the refrigerator having higher cooling efficiency and low noise.

[0055] In the first exemplary embodiment, a joint be-

tween connection part 11 and duct 7 is smoothly joined by a curved line having a radius as large as possible, so that it is possible to further enhance a pressure loss reduction effect that is capable of minimizing the pressure loss due to rapid expansion or rapid reduction.

[0056] In the first exemplary embodiment, flow straightener 8 and duct 7 are integrally configured. However, also when flow straightener 8 is configured as another component, and thereafter is mounted on duct 7, a similar effect is obtained.

[0057] A depression by flow straightener 8 of duct 7 is covered by a decorative plate or the like, so that the uneven part on the inner back surface of storage compartment 3 disappears, and a refrigerator that is excellent in design can be attained.

[0058] In the first exemplary embodiment, cooling efficiency is enhanced by increase in the air volume of cooling fan 5. However, the number of revolutions of cooling fan 5 is reduced by the increase amount of air volume, and equal air volume is secured, so that it is possible to reduce the input of cooling fan 5, and further it is possible to attain a refrigerator having low power consumption.

[0059] In the first exemplary embodiment, the diameter of plane part 10 is not more than the diameter of motor 5a of cooling fan 5. However, for example, in a case where a component such as a safety guard having a larger diameter than that of motor 5a is mounted on motor 5a of cooling fan 5, the diameter of plane part 10 is set to be not more than the diameter of the safety guard, thereby obtaining a similar effect.

[0060] Second and third exemplary embodiments of the present invention are now described with reference to the drawings. The present invention is not limited to these exemplary embodiments.

SECOND EXEMPLARY EMBODIMENT

[0061] FIG. 6 is a front view of a refrigerator according to a second exemplary embodiment of the present invention, and FIG. 7 is a sectional view taken along line 7-7 in FIG. 6. FIG. 8 is a front view of an essential part according to the second exemplary embodiment, and FIG. 9 is an enlarged view of an essential part in FIG. 7. FIG. 10 is a sectional plan view of an essential part according to the second exemplary embodiment of the present invention, and FIG. 11 is a perspective view of a storage compartment side partition member.

[0062] As shown in FIG. 6 to FIG. 11, heat insulating box 21 that is a refrigerator body of refrigerator 20 has outer box 22 that mainly uses a steel plate, and inner box 23 molded by a resin such as ABS. Furthermore, heat insulating box 21 has a foamed heat insulating material such as hard foamed urethane that is foamed and filled in a space between outer box 22 and inner box 23, is thermally insulated from the surroundings, and is divided into a plurality of storage compartments.

[0063] Refrigerating compartment 24 as a first storage compartment is provided on the uppermost part of heat

insulating box 21, and second freezing compartment 25 as a fourth storage compartment, and ice-making compartment 26 as a fifth storage compartment are provided side by side below refrigerating compartment 24. First freezing compartment 27 as a second storage compartment is disposed below second freezing compartment 25 and ice-making compartment 26, and vegetable compartment 28 as a third storage compartment is disposed on the lowermost part of heat insulating box 21.

[0064] Refrigerating compartment 24 includes refrigerating compartment right door 24a and refrigerating compartment left door 24b that are revolving doors. Additionally, refrigerating compartment shelves 24c and refrigerating compartment case 24d are suitably disposed inside refrigerating compartment 24, so that storage spaces are configured to allow easy arrangement. On the other hand, other storage compartments have drawing type doors, and second freezing compartment door 25a and ice-making compartment door 26a store second freezing compartment case 25c and an ice-making compartment case (not shown), respectively. Upper freezing compartment case 27b and lower freezing compartment case 27c are placed on a frame (not shown) mounted on first freezing compartment door 27a. Additionally, upper vegetable compartment case 28b and lower vegetable compartment case 28c are placed on a frame (not shown) mounted on vegetable compartment door 28a.

[0065] The temperature of refrigerating compartment 24 is set in a refrigerating temperature zone that is such a temperature not as to be frozen for cold storage, and generally set to 1°C to 5°C. The temperature of vegetable compartment 28 is set in a refrigerating temperature zone that is equal to the set temperature of refrigerating compartment 24, or in a vegetable temperature zone that is set to a slightly higher temperature, namely, set to 2°C to 7°C. The temperature of first freezing compartment 27 is set in a freezing temperature zone, and generally set to -22°C to -15°C for freezing storage, but is sometimes set to a low temperature, for example, -30°C or -25°C in order to improve the state of freezing storage.

[0066] Second freezing compartment 25 is a first storage section whose set temperature is in the freezing temperature zone equal to the set temperature of first freezing compartment 27, or a slightly higher set temperature of -20°C to -12°C. In ice-making compartment 26, an automatic ice maker (not shown) provided in the upper part of the compartment makes ice with water sent from a water storage tank (not shown) in refrigerating compartment 24, and the ice is stored in ice-making compartment case 26b.

[0067] The top surface part of heat insulating box 21 is formed in a shape in which a recess is provided stepwise toward the back surface direction of the refrigerator, and machine compartment 21a is formed in this stepped recessed portion. Machine compartment 21a accommodates high pressure side components of a freezing cycle such as compressor 29 and a dryer (not shown) that removes moisture. That is, machine compartment 21a, in

which compressor 29 is disposed, is formed to encroach on a rear area of the uppermost part of the inside of refrigerating compartment 24.

[0068] Thus, machine compartment 21a is provided in the storage compartment rear area on the uppermost part, which a hand hardly reach and which is a dead space, of heat insulating box 21, and compressor 29 is disposed in machine compartment 21a, so that a space of a machine compartment which a user easily uses, and which is on the lowermost part of heat insulating box 21, in a conventional refrigerator can be effectively utilized as storage compartment capacity, and storage performance or usability can be greatly improved.

[0069] The freezing cycle is formed from a series of a refrigerant passage that sequentially includes compressor 29, a condenser, a capillary that is a decompressor, and cooler 32, and a hydrocarbon refrigerant, for example, isobutene is sealed as a refrigerant.

[0070] Compressor 29 is a reciprocating compressor that compresses a refrigerant by reciprocation of a piston in a cylinder. In the case of a freezing cycle using a three-way valve or a selector valve in heat insulating box 21, these functional components are sometimes disposed in machine compartment 21a.

[0071] In the second exemplary embodiment, a capillary is used as the decompressor that configures the freezing cycle. However, an electronic expansion valve may be used that is capable of freely controlling the flow rate of a refrigerant by driving with a pulse motor.

[0072] Matters as to an essential part of the present invention, described below, in the second exemplary embodiment may be applied to a conventionally general refrigerator, in which a machine compartment is provided in a storage compartment rear area on the lowermost part of heat insulating box 21, and compressor 29 is disposed in the machine compartment.

[0073] Cooling compartment 30 that generates cool air is provided on the back surface of first freezing compartment 27. Partition member 31 is configured to separate the storage compartments including second freezing compartment 25, ice-making compartment 26, and first freezing compartment 27, and cooling compartment 30. Cooler 32 is disposed in cooling compartment 30, and cool air is generated by heat exchange with air that is warmed by heat exchange with storage compartment. Partition member 31 is configured by storage compartment side partition member 31a and cooling compartment side partition member 31b. Cooling compartment side partition member 31b includes cooling fan 33. A space between storage compartment side partition member 31a and cooling compartment side partition member 31b is air supply duct 31c. Air supply duct 31c guides cool air forcibly sent out by cooling fan 33, to refrigerating compartment 24, second freezing compartment 25, ice-making compartment 26, first freezing compartment 27, and vegetable compartment 28.

[0074] Additionally, on a lower space of cooler 32, radiant heating means 34 is provided that is made of glass

and for defrosting frost or ice adhered to cooler 32 or the periphery of cooler 32 at the time of cooling. Drain pan 35 for receiving defrosting water generated at the time of defrosting is provided below radiant heating means 34. Drain tube 36 that penetrates from the deepest part of drain pan 35 to the outside of the refrigerator is provided, and evaporating dish 37 is provided outside the refrigerator on the downstream side of drain tube 36. Herein, cooling fan 33 is an axial flow fan that rotates clockwise as viewed from a discharge surface. Hereinafter, in a case where a position in the lateral direction of the refrigerator is designated, the rotation direction of cooling fan 33 is disposed in a reference. In a case where a cooling fan whose rotation direction is a counterclockwise direction is used, the right and the left are reversed, so that a similar effect can be obtained.

[0075] The discharge surface of cooling fan 33 is mounted to have an angle with respect to the front surface of refrigerator 20, and is disposed such that cool air blows obliquely upward. The center of cooling fan 33 is located on the left side with respect to a central perpendicular line in the lateral direction of first freezing compartment 27, and is located above the upper end of the back surface of upper freezing compartment case 27b, as viewed from the front of first freezing compartment 27.

[0076] A part, facing cooling fan 33, of storage compartment side partition member 31a configures cool air flow straightener 31d that protrudes toward cooling fan 33. Cool air flow straightener 31d is formed in a substantially truncated cone shape whose center is the rotary axis of cooling fan 33. The leading end of cool air flow straightener 31d is configured by a plane parallel to the discharge surface of cooling fan 33, and the diameter thereof is substantially the same as the boss diameter of cooling fan 33. A part except cool air flow straightener 31d of storage compartment side partition member 31a is configured by the substantial plane.

[0077] As shown in FIG. 8, storage compartment side partition member 31a includes discharge ports 31e that sends cool air to first freezing compartment 27. Discharge ports 31e are located below the center of cool air flow straightener 31d, above the upper end of the back surface of upper freezing compartment case 27b, below the lower surface of upper freezing compartment case 27b and above the upper end of the back surface of lower freezing compartment case 27c, at two locations. Additionally, at each location, oblong holes in a plurality of rows are provided in a single or a plurality of stages. At least a part of discharge ports 31e is formed to extend over cool air flow straightener 31d.

[0078] The upper central hole of discharge ports 31e passes the center of first freezing compartment 27 as viewed from the front, and has a wind direction raised portion 39 toward the storage compartments vertically to a side far from cool air flow straightener 31d.

[0079] An effective air trunk that matches the performance or the position of cooling fan 33, or the structure or the preset temperature of the storage compartment, or

the like can be attained by change in the position, the number, and the shape of discharge ports 31e. Additionally, a cool air guide part such as the wind direction raised portion is provided on not only the central hole, but also any hole, so that the wind direction can be more accurately controlled.

[0080] Upper discharge port 40 is interposed between partition wall 38 that separates between refrigerating compartment 24 and other storage compartments, and storage compartment side partition member 31a, so that cool air is sent to second freezing compartment 25 and ice-making compartment 26. Damper 41 is disposed on partition wall 38, and the cool air that passes damper 41 is further divided and flows to refrigerating compartment duct 42 and vegetable compartment duct (not shown), to be sent from the respective discharge ports to refrigerating compartment 24 and vegetable compartment 28.

[0081] Matters as to an essential part of the present invention, described below, in the second exemplary embodiment may be applied to a refrigerator that has a structure in which any storage compartment has a revolving door, and a storage case is placed in inner box 23.

[0082] Hereinafter, a description will be given of operation and action of refrigerator 20 of the second exemplary embodiment, which is configured as described above.

[0083] First, the operation of a freezing cycle is described. The freezing cycle is operated by a signal from a controller (not shown) in accordance with the preset temperature of the inside of the refrigerator, thereby performing cooling operation. A high-temperature and high-pressure refrigerant discharged by the operation of compressor 29 is condensed and liquefied to a certain extent by a condenser (not shown). Furthermore, the refrigerant is condensed and liquefied while preventing the condensation of heat insulating box 21, to reach a capillary tube (not shown) via a refrigerant pipe (not shown) disposed on the side surface or the back surface of heat insulating box 21 that is a refrigerator body, or the front surface of heat insulating box 21. Thereafter, in the capillary tube, the refrigerant becomes a low-temperature and low-pressure liquid refrigerant that is reduced in pressure while exchanging heat with a suction pipe (not shown) to compressor 29, to reach cooler 32.

[0084] Herein, in cooling compartment 30, air inside each storage compartment collected by the operation of cooling fan 33 exchanges heat with the liquid refrigerant by cooler 32, and the refrigerant inside cooler 32 is evaporated. At this time, the air returned from each storage compartment becomes cool air for cooling each storage compartment, in cooling compartment 30 again. The cool air having a low temperature passes air supply duct 31c from cooling fan 33, and is divided by using the air trunk or the damper, to cool refrigerating compartment 24, second freezing compartment 25, ice-making compartment 26, first freezing compartment 27, and vegetable compartment 28 to respective target temperature zones.

[0085] Since cooling fan 33 is an axial flow fan that

rotates clockwise, the discharged cool air conically flows so as to radially expand while turning clockwise. Accordingly, cool air flow straightener 31d is formed in such a shape as to match the flow of the discharged cool air, so that the cool air can be smoothly sent out into air supply duct 31c without the occurrence of a swirl. In the discharge side of the axial flow fan, airflow that returns toward the center is generated. However, the diameter of the upper surface of the truncated cone of cool air flow straightener 31d is set to be substantially the same as the boss diameter of the fan, thereby enabling the suppression of this return airflow. Therefore, energy given to the cool air by cooling fan 33 can be utilized for the blowing of air without any waste.

[0086] An angle formed by a conical surface produced by the discharged cool air and the rotary axis of cooling fan 33 varies depending on a flow rate sent by cooling fan 33 or the number of revolutions, and therefore the angle of the conical surface of cool air flow straightener 31d is changed, so that it is possible to perform optimum design according to a designed flow rate. For example, in a case where air volume of a range from 0.5 m³/min to 1.0 m³/min is obtained when cooling fan 33 whose diameter of the blades is in a range from 90 mm to 110 mm is rotated at a range from around 1200 rpm to around 3000 rpm, the angle formed by the rotary axis and the conical surface of cool air flow straightener 31d is desirably in a range from 50° to 85° according to an experiment. A distance between cooling fan 33 and cool air flow straightener 31d is increased as gradually radially expands, so that motion energy that discharged cool air has can be effectively retrieved as pressure energy, and therefore discharge pressure can be increased without increase of work of cooling fan 33. Like this exemplary embodiment, in the air trunk in which a large number of storage compartments are present, air supply circuits are various, and a large number of components that serves as air trunk resistance such as damper 41 are required, the work of cooling fan 33 increases, and therefore the role played by cool air flow straightener 31d is further increased.

[0087] Cool air that expands along cool air flow straightener 31d is partially discharged in first freezing compartment 27 from discharge ports 31e provided in cool air flow straightener 31d. At this time, force along cool air flow straightener 31d acts on cool air by Coanda effect. Accordingly, the cool air discharged from the discharge ports provided in cool air flow straightener 31d is smoothly discharged toward the front direction of cooling fan 33. Therefore, it is possible to send cool air also to the front of cooling fan 33, to which cool air is heretofore difficult to be sent directly.

[0088] Discharge ports 31e have oblong shapes, and therefore cool air is strongly influenced by cool air flow straightener 31d, and continuously changes from cool air that flows toward the front of cooling fan 33 to cool air that flows along the plane part of storage compartment side partition member 31a, and has a centrifugal com-

ponent with large velocity. Therefore, it is possible to obtain wide zonal cool air that expands from the front of cooling fan 33 to the inner wall of storage compartments, and to minimize temperature irregularity in the storage compartment.

[0089] Furthermore, discharge ports 31e are provided also at a position close to the side surface of inner box 23, or a position far from cooling fan 33 such as a position just above lower freezing compartment case 27c, so that cool air can be delivered in a wider range.

[0090] Additionally, discharge ports 31e are provided below cool air flow straightener 31d. Cool air discharged from cooling fan 33 is radially discharged along cool air flow straightener 31d. Accordingly, cool air having downward velocity is discharged from discharge ports 31e provided below cool air flow straightener 31d. The upper holes of discharge ports 31e are disposed above upper freezing compartment case 27b, and lower holes are disposed above lower freezing compartment case 27c, and therefore cool air discharged from discharge ports 31e is sent so as to blow down to the inside of each case. Accordingly, it is possible to directly cool the inside of each case, and therefore it is possible to rapidly cool stored goods.

[0091] Furthermore, the upper central hole of discharge ports 31e is located at the center of first freezing compartment 27 which is at the lower right of cooling fan 33. Since cooling fan 33 is an axial flow fan that rotates clockwise, and therefore cool air radially expands while turning clockwise. At this time, cooling fan 33 is located on the left side with respect to the center of first freezing compartment 27 as viewed from the front of refrigerator 20, and therefore cool air has large downward velocity in the vicinity of the center in the lateral direction of first freezing compartment 27, which is the right side of cooling fan 33. Accordingly, cool air that is blown from the upper central hole of discharge ports 31e located at the center of first freezing compartment 27, to upper freezing compartment case 27b is discharged so as to blow down toward the center of the case, so that stored goods can be effectively cooled.

[0092] The relationship between cooling fan 33 and the upper central hole of discharge ports 31e remains unchanged, a position with respect to first freezing compartment 27 is changed, so that an arbitrary location can be intensively cooled. In the second exemplary embodiment, the cool air discharged from the upper central hole of discharge ports 31e obtains an effect of discharging toward the front of cooling fan 33, and therefore the upper central hole of discharge ports 31e does not always need to pass the center of first freezing compartment 27, and can be disposed on the right side to such a degree not as to be completely out of a cool air straightening plate.

[0093] Additionally, the upper central hole of discharge ports 31e has wind direction raised portion 39 toward the storage compartment vertically to the side far from cool air flow straightener 31d, and therefore a component that radially expands, in the velocity of the cool air can be

directed toward the inside of storage compartment. Therefore, it is possible to increase cool air that flows toward the inside of upper freezing compartment case 27b, and to more rapidly cool the stored goods. Wind direction raised portion 39 can be molded integrally with storage compartment side partition member 31a without increase in the number of components, and therefore a structure, in which variation in the wind direction due to solid matters can be reduced, can be produced at a low cost.

[0094] Wind direction raised portion 39 is provided only vertically to the side far from cool air flow straightener 31d, and therefore even when condensation is generated in discharge ports 31e due to a difference in temperature, there is no possibility of accumulating the condensation to grow as ice. Therefore, it is possible to provide a refrigerator having a good quality. If, wind direction raised portion 39 is configured horizontally, condensation does not flow and drop, and there is a possibility of repeating a phenomenon that condensation is cooled by the discharged cool air to become ice, and closing discharge ports 31e.

[0095] Wind direction raised portion 39 is provided on the side of the storage compartment in the second exemplary embodiment, but may be provided on the side of cooling compartment. Additionally, the shape of the cool air guide part is not limited to a raised portion. Also when discharge port 31e is configured to protrude toward the storage compartments with respect to the plane part of partition member 31, or the air trunk shape to discharge ports 31e is formed in a streamline shape, a similar effect can be obtained. At this time, the cool air guide part is configured so as not to have a horizontal plane, or a partially low part, so that the growth of ice can be prevented.

[0096] As described above, in the second exemplary embodiment, at least a part of discharge ports 31e is disposed to extend over cool air flow straightener 31d, so that the cool air discharged from cooling fan 33 is radially straightened by cool air flow straightener 31d, and discharged to the storage compartment with no change and no loss. At this time, force along cool air flow straightener 31d acts on the cool air by the Coanda effect, and therefore cool air to be discharged is discharged toward the front of cooling fan 33, so that the cool air is guided to the middle of the storage compartment in front of cooling fan 33, to which the cool air cannot be directly sent heretofore, and therefore it is possible to effectively cool the stored goods.

[0097] Discharge port 31e has the cool air guide part configured by wind direction raised portion 39, so that the cool air can be reliably sent to the center of upper freezing compartment case 27b. At this time, the cool air guide part can be molded integrally with discharge ports 31e, and the number of components does not need to be increased, and therefore a structure, in which variation in the wind direction due to solid matters can be reduced, can be provided at a low cost. Furthermore, it is possible to attain a structure in which condensation likely to be

adhered to discharge ports 31e of refrigerator 20 is not accumulated, and therefore it is possible to provide a refrigerator having good quality.

[0098] First freezing compartment 27 includes upper freezing compartment case 27b and lower freezing compartment case 27c that store stored goods, and cooling fan 33 is disposed above the upper ends of the back surfaces of upper freezing compartment case 27b and lower freezing compartment case 27c. Furthermore, discharge ports 31e are provided lower the center of cool air flow straightener 31d, so that cool air discharged downward with respect to cooling fan 33 can be guided to first freezing compartment 27. Therefore, cool air can be blown in freezing compartment case from above the freezing compartment case, and therefore it is possible to effectively cool stored goods.

[0099] Discharge ports 31e is disposed at a position where the center of first freezing compartment 27 passes, and cooling fan 33 that is an axial flow fan which rotates clockwise is disposed on the left side with respect to the center of first freezing compartment 27, so that the cool air discharged from cooling fan 33 radially expands while turning clockwise. Therefore, discharge ports 31e are provided at a place where a turning component of the velocity which cool air has is downward, so that cool air can be more effectively blown downward to the inside of upper freezing compartment case 27b.

THIRD EXEMPLARY EMBODIMENT

[0100] FIG. 12 is a longitudinal sectional view of a refrigerator of a third exemplary embodiment of the present invention. Description of parts to which a configuration and a technical idea similar to those of the second exemplary embodiment of the present invention are applied is omitted. As long as there is no failure, a configuration obtained by combination of the configuration of the third exemplary embodiment with a configuration of the second exemplary embodiment of the present invention can be applied.

[0101] As shown in FIG. 12, refrigerating compartment duct 51 for conveying cool air generated in cooling compartment 30, to refrigerating compartment 24 is provided on the back surface of refrigerating compartment 24, and refrigerating compartment partition member 52 separates refrigerating compartment 24 and refrigerating compartment duct 51. Refrigerating compartment partition member 52 is configured by front partition member 52a and back partition member 52b, and refrigerating compartment duct 51 separates front duct 51a and back duct 51b. Front partition member 52a is often configured by a resin molded article such as polypropylene, and back partition member 52b is often configured by a foam resin molded article having high heat insulating properties.

[0102] Refrigerating compartment cooling fan 53 is disposed in back partition member 52b, assists the action of refrigerating compartment cooling fan 33 provided in cooling compartment 30, and circulates cool air in the

whole of refrigerating compartment 24. Herein, refrigerating compartment cooling fan 53 is an axial flow fan that rotates clockwise as viewed from a discharge surface.

[0103] A part, facing refrigerating compartment cooling fan 53, of front partition member 52a configures refrigerating compartment cool air flow straightener 52c that protrudes toward refrigerating compartment cooling fan 53. Refrigerating compartment cool air flow straightener 52c is formed in a substantially truncated cone shape whose center is a rotary axis of cooling fan 53. The leading end of refrigerating compartment cool air flow straightener 52c is configured by a surface parallel to the discharge surface of refrigerating compartment cooling fan 53, and the diameter thereof is substantially the same as the boss diameter of refrigerating compartment cooling fan 53. The upper part of inner box 23 that configures refrigerating compartment 24 has a projected portion on the inner side so as to match the shape of machine compartment 21a provided on the upper part of refrigerator 20. Accordingly, the upper end of front partition member 52a is curved so as to match the shape of inner box 23.

[0104] Front partition member 52a includes refrigerating compartment discharge ports 52d for sending cool air to refrigerating compartment 24. Refrigerating compartment discharge ports 52d are disposed at two of upper and lower locations in refrigerating compartment cool air flow straightener 52c. Refrigerating compartment shelves 24c are disposed so as to interpose two refrigerating compartment discharge ports 52d at suitable intervals therebetween.

[0105] An effective air trunk that matches the performance or the position of refrigerating compartment cooling fan 53, or the structure or the preset temperature of refrigerating compartment 24, or the like can be attained by change in the position, the number, and the shape of refrigerating compartment discharge ports 52d.

[0106] Hereinafter, a description will be given of operation of the refrigerator in the third exemplary embodiment of the present invention, which is configured as described above.

[0107] Cool air that is generated by heat exchange with heat cooler 32 is discharged to air supply duct 31c by cooling fan 33. The cool air is partially blown up, and passes damper 41, to flow in back duct 51b. The cool air that flows in back duct 51b is discharged to front duct 51a by the action of refrigerating compartment cooling fan 53. At this time, since refrigerating compartment cooling fan 53 is an axial flow fan that rotates clockwise, the discharged cool air conically flows so as to radially expand while turning clockwise. Accordingly, refrigerating compartment cool air flow straightener 52c is formed in such a shape as to match the flow of the discharged cool air, so that the cool air can be smoothly sent out into front duct 51a without the occurrence of a swirl. In the discharge side of the axial flow fan, airflow that returns toward the center is generated. However, the diameter of the upper surface of the truncated cone of refrigerating compartment cool air flow straightener 52c is set to be

substantially the same as the boss diameter of the fan. This enables the suppression of this return airflow, and therefore energy given to the cool air by refrigerating compartment cooling fan 53 can be utilized for the blowing of air without any waste.

[0108] Cool air that expands along refrigerating compartment cool air flow straightener 52c is partially discharged into refrigerating compartment 24 from refrigerating compartment discharge ports 52d provided in refrigerating compartment cool air flow straightener 52c. At this time, force along cool air flow straightener 52c acts on cool air by Coanda effect. Accordingly, the cool air discharged from the discharge ports provided in refrigerating compartment cool air flow straightener 52c is smoothly discharged toward the front direction of refrigerating compartment cooling fan 53. Therefore, it is possible to send cool air also to the front of refrigerating compartment cooling fan 53, to which cool air is heretofore difficult to be sent directly.

[0109] Since refrigerating compartment discharge ports 52d are disposed above and below refrigerating compartment cooling fan 53, and cool air that is radially discharged has a vertical velocity component in the vicinity of each discharge port. At this time, refrigerating compartment shelves 24c are disposed above and below each refrigerating compartment discharge port 52d, and therefore refrigerating compartment shelves 24c each can play a role of a cool air guide, and guide vertically discharged cool air in a front direction, to cool stored goods. Refrigerating compartment shelves 24c are generally configured such that a user can arbitrarily change the height. Also in this case, cool air is guided to a place where stored goods are placed in accordance with a usage state, and therefore a similar effect can be achieved in any state.

[0110] The shape of each refrigerating compartment discharge port 52d is vertically elongated from the inner part of refrigerating compartment cool air flow straightener 52c to the outer part, so that a vertical velocity distribution of cool air discharged from one discharge port becomes large. This is because cool air discharged from a part close to refrigerating compartment cool air flow straightener 52c flows toward the front of refrigerating compartment cooling fan 53 as described above, whereas a velocity component of cool air discharged from a part far from refrigerating compartment cool air flow straightener 52c becomes large in a radially expanding direction, namely in the vertical direction. Accordingly, the shape of each refrigerating compartment discharge port 52d is vertically elongated, so that a vertical discharge angle of the cool air can be expanded, and it is possible to uniformly cool the inside of the refrigerating compartment.

[0111] As described above, in the third exemplary embodiment, at least a part of refrigerating compartment discharge ports 52d is disposed inside refrigerating compartment cool air flow straightener 52c, so that cool air discharged by refrigerating compartment cooling fan 53

is radially straightened by refrigerating compartment cool air flow straightener 52c, and is discharged to refrigerating compartment 24 with no change and no loss. At this time, force along refrigerating compartment cool air flow straightener 52c acts on cool air by Coanda effect, and therefore cool air to be discharged is discharged toward the front of refrigerating compartment cooling fan 53. Consequently, the cool air is guided to the middle of the storage compartment in front of refrigerating compartment cooling fan 53, to which the cool air cannot be directly sent heretofore, and therefore it is possible to effectively cool stored goods.

[0112] Refrigerating compartment shelves 24c each can play a role of a cool air guide, and reliably send cool air forward.

[0113] Hereinafter, a fourth exemplary embodiment of the present invention is described with reference to the drawings. The present invention is not limited to this exemplary embodiment.

FOURTH EXEMPLARY EMBODIMENT

[0114] FIG. 13 is a sectional view of a refrigerator according to a fourth exemplary embodiment of the present invention. FIG. 14 is a sectional view of the vicinity of a refrigerating compartment side discharge port of the refrigerator according to the fourth exemplary embodiment. FIG. 15 is a sectional view of the vicinity of an ice-making compartment side discharge port of the refrigerator according to the fourth exemplary embodiment. Configurations identical to those of the embodiments that have been described above are denoted by the same reference numerals, and a detailed description thereof is omitted.

[0115] As shown in FIG. 13 to FIG. 15, refrigerator 61 includes freezing compartment 63 that is closed by drawer type freezing compartment door 62, includes freezing case 73, and is cooled at around minus 20 degrees. Refrigerating compartment 65 and ice-making compartment 76 are provided above freezing compartment 63. Refrigerating compartment 65 is closed by rotary refrigerating compartment door 64, and is cooled at around 5 degrees. Ice-making compartment 76 is closed by drawer type ice-making compartment door 74 between freezing compartment 63 and refrigerating compartment 65, and includes ice-making case 75. Herein, since ice-making compartment 76 stores ice whose melting point is 0 degrees, the temperature of the inside of ice-making compartment 76 is set to a relatively high temperature, around minus 15 degrees, as compared to a freezing compartment that stores stored goods such as ice cream whose melting point is minus 10 degrees or less.

[0116] Inside freezing compartment 63, cooling compartment 70 is configured that is separated from freezing compartment 63 by duct 77, and stores cooler 66 and cooling fan 67.

[0117] Duct 77 includes flow straightener 68 that protrudes in a substantially truncated conical shape at such

a position as to face cooling fan 67. Additionally, in duct 77, freezing compartment side discharge port 78 that communicates cooling compartment 70 with freezing compartment 63 is provided below the center of cooling fan 67, and ice-making compartment side discharge port 79 that communicates cooling compartment 70 with ice-making compartment 76 is provided above the center of cooling fan 67.

[0118] Partition wall 80 that separates ice-making compartment 76 and refrigerating compartment 65 is provided between both these compartments, and refrigerating compartment side discharge port 81 that communicates cooling compartment 70 with refrigerating compartment 65 is provided in cooling compartment 70 on partition wall 80. Damper 82 that selectively closes and opens refrigerating compartment side discharge port 81 is provided inside refrigerating compartment side discharge port 81.

[0119] Herein, ice-making compartment side discharge port 79 and refrigerating compartment side discharge port 81 are opened at positions shifted horizontally, as viewed from the front of the refrigerator.

[0120] Furthermore, ice-making compartment side discharge port 79 is provided on the front surface side of refrigerator 61 with respect to the basic plane of duct 77, and refrigerating compartment side discharge port 81 is provided on the back surface side. Duct 77 is inclined from flow straightener 68 to ice-making compartment side discharge port 79 and refrigerating compartment side discharge port 81, thereby allowing smooth connection.

[0121] On the side of ice-making compartment 76 of ice-making compartment side discharge port 79, wind-direction adjustment raised portion 83 is provided on the upper side of the opening at such an angle that cool air flows horizontally or downward.

[0122] Operation of the refrigerator configured as described above is hereinafter described.

[0123] During the operation of the refrigerator, cooling fan 67 is operated to guide cool air generated by cooler 66 to each compartment. At this time, flow straightener 68 is provided at such a position as to face cooling fan 67 to suppress a swirl that is generated in the vicinity of the discharge side of cooling fan 67. Consequently, it is possible to suppress the swirl that is generated on the discharge side of cooling fan 67, and to reduce a pressure loss. This allows increase in the air volume of cooling fan 67, and uniformly radial discharge of cool air by cooling fan 67.

[0124] Consequently, cool air below cooling fan 67 flows downward, and cool air above cooling fan 67 flows upward.

[0125] In refrigerator 61 according to the fourth exemplary embodiment, all the cool air below cooling fan 67 flows from freezing compartment side discharge port 78 to freezing compartment 63, and the cool air above cooling fan 67 flows from ice-making compartment side discharge port 79 to ice-making compartment 76, and flows

from refrigerating compartment side discharge port 81 to refrigerating compartment 65.

[0126] Accordingly, the cool air blown to freezing compartment 63 becomes a downward flow, and flows into freezing case 73, so that the cool air cools stored goods in freezing case 73 and does not directly cool partition wall 80.

[0127] The cool air blown to refrigerating compartment 65 is an upward flow, and therefore smoothly flows to refrigerating compartment 65, so that it is possible to reduce the loss of an air trunk.

[0128] Herein, the cool air blown to ice-making compartment 76 becomes an upward flow, and therefore there is a possibility that the cool air cools partition wall 80 and a heat loss is generated. However, ice-making compartment 76 is simply cooled at a higher temperature than freezing compartment 63. Additionally, the area of ice-making compartment side discharge port 79 is made smaller than that of freezing compartment side discharge port 78, thereby reducing the air volume of cool air. Accordingly, the temperature in the ice-making compartment is high, and a heat loss can be reduced as compared to a case where cool air hits inside freezing compartment 63, even when cool air directly hits partition wall 80. Furthermore, the flow of cool air is directed downward with respect to a horizontal line by wind-direction adjustment raised portion 83, so that the cool air is guided into ice-making case 75, and does not directly cool partition wall 80.

[0129] Accordingly, it is possible to reduce the heat losses of refrigerating compartment 65 and ice-making compartment 76, and it is possible to attain a refrigerator having high efficiency.

[0130] Distribution of cool air to ice-making compartment side discharge port 79 and refrigerating compartment side discharge port 81 is now described. During the operation of the refrigerator, the temperature of cooler 66 is in a range from minus 25 degrees to minus 30 degrees, and the temperature of cool air by cooling fan 67 is around minus 20 degrees. This cool air cools refrigerating compartment 65 at around 5 degrees, and therefore refrigerating compartment side discharge port 81 includes damper 82 that closes and opens refrigerating compartment side discharge port 81 in order to selectively flow cool air to refrigerating compartment 65. When damper 82 is closed, cool air discharged above cooling fan 67 flows only to ice-making compartment side discharge port 79. When damper 82 is opened, cool air discharged above cooling fan 67 is divided toward ice-making compartment side discharge port 79 and refrigerating compartment side discharge port 81.

[0131] In refrigerator 61 according to the fourth exemplary embodiment, ice-making compartment side discharge port 79 and refrigerating compartment side discharge port 81 are sifted in a lateral direction as viewed from the front surface of refrigerator 61, and shifted in a front and back direction as viewed from the side surface. Furthermore, duct 77 is inclined toward ice-making com-

partment side discharge port 79 and refrigerating compartment side discharge port 81, thereby allowing smooth connection.

[0132] Consequently, it is possible to reduce air trunk losses from cooling fan 67 to ice-making compartment side discharge port 79 and refrigerating compartment side discharge port 81.

[0133] Accordingly, it is possible to reduce the pressure loss of cooling fan 67, and it is possible to attain a refrigerator having high efficiency.

[0134] In the fourth exemplary embodiment, ice-making compartment 76 is interposed between freezing compartment 63 and refrigerating compartment 65. However, for example, a chiller compartment whose temperature is around 0 degree is provided, so that a larger effect can be obtained.

[0135] In the fourth exemplary embodiment, only ice-making compartment 76 is interposed between freezing compartment 63 and refrigerating compartment 65. However, a chiller compartment or the like is provided side by side with ice-making compartment 76, and discharge ports that respectively cool the compartments on the right and left of refrigerating compartment side discharge port 81 are provided, thereby enabling application to a multi-door refrigerator.

[0136] In the fourth exemplary embodiment, damper 82 is provided only in refrigerating compartment side discharge port 81. However, a damper is provided also in ice-making compartment side discharge port 79, so that it is possible to perform more accurate temperature control. Furthermore, the numbers of revolutions of cooling fan 67 and a compressor is controlled in accordance with the opening and closing of the damper, so that it is possible to eliminate the waste of cooling, and to attain a refrigerator having higher efficiency.

[0137] The present invention includes: a storage compartment surrounded by a heat insulating wall and having an opening in a front surface; and a heat insulating door configured to close the opening; a cooler stored on a back surface of the storage compartment; and a cooling fan configured to circulate cool air generated by the cooler into the storage compartment. Additionally, a duct having a flow straightener that protrudes toward the cooling fan is provided at such a position as to face the cooling fan. The flow straightener is formed in a substantially truncated conical shape having an inclined part and a plane part. With this configuration, the present invention is capable of reducing a pressure loss on a blowing side without increase in a pressure loss on a suction side of the cooling fan, while suppressing the depth dimension of the duct, and is capable of providing a refrigerator having high storage efficiency, high cooling efficiency, and low noise.

[0138] In the present invention, a basic plane of the duct is disposed in a substantially vertical direction, the cooling fan is disposed to be inclined with respect to the vertical direction, and the flow straightener is disposed to be inclined such that the flow straightener faces the

cooling fan. With this configuration, the present invention is capable of reducing a pressure loss on a blowing side without increase in a pressure loss on a suction side of the cooling fan, while suppressing the depth dimension of the cooling compartment, and further capable of providing a refrigerator having high storage efficiency, high cooling efficiency, and low noise.

[0139] In the present invention, a central part of the plane part of the flow straightener and a rotary axis of the cooling fan are disposed substantially on the same line. With this configuration, the present invention is capable of enhancing the straightening effect of the flow straightener while attaining the effective utilization of the space of the cooling compartment.

[0140] In the present invention, a distance between the plane part and a leading end surface of the cooling fan is 20 mm or less. With this configuration, the present invention is capable of effectively reducing a pressure loss, further increasing the air volume of the cooling fan, and reducing noise.

[0141] In the present invention, an angle between the inclined part of the flow straightener and a plane perpendicular to a rotary axis of the cooling fan is 20 degrees or less. With this configuration, the present invention is capable of effectively reducing a pressure loss, further increasing the air volume of the cooling fan, and reducing noise.

[0142] In the present invention, a maximum dimension of the plane part of the flow straightener is equal to or smaller than a dimension of a motor of the cooling fan. With this configuration, the present invention is capable of effectively reducing a pressure loss, further increasing the air volume of the cooling fan, and reducing noise.

[0143] Furthermore, a refrigerator of the present invention includes: a storage compartment; a cooler configured to generate cool air for cooling the storage compartment; a cooling fan configured to forcibly send the cool air generated by the cooler to the storage compartment; and a partition member located between the storage compartment and the cooling fan. The partition member has a discharge port configured to send the cool air to the storage compartment, and a cool air flow straightener configured such that a part facing the cooling fan protrudes toward the cooling fan, and at least a part of the discharge port is disposed in the cool air flow straightener. Consequently, the cool air discharged from cooling fan is radially straightened by the cool air flow straightener, and discharged to the storage compartment with no change and no loss. At this time, force along the cool air flow straightener acts on the cool air by Coanda effect, and therefore cool air to be discharged is discharged toward the front of cooling fan. Consequently, the cool air can be guided to the middle of the storage compartment in front of cooling fan, to which the cool air cannot be directly sent heretofore, and therefore it is possible to effectively cool stored goods.

[0144] In the present invention, the discharge port has a cool air guide part. With this configuration, the present

invention is capable of arbitrarily controlling the direction of cool air discharged from the discharge port.

[0145] In the present invention, the cool air guide part is a raised portion provided on the partition member. With this configuration, in the present invention, the cool air guide part can be molded integrally with the discharge port, and the number of components does not need to be increased, and therefore a structure, in which variation in the wind direction due to solid matters can be reduced, can be provided at a low cost. Additionally, it is possible to attain a structure in which condensation likely to be adhered to the discharge port of the refrigerator is not accumulated, and it is possible to provide a refrigerator having good quality.

[0146] In the present invention, the storage compartment includes a single or a plurality of storage cases that stores a stored good, and the cooling fan is disposed above an upper end of a back surface of at least one of the storage cases. Furthermore, the discharge port disposed in the cool air flow straightener is provided below the center of the cool air flow straightener, and above the upper end of the back surface of the storage case. With this configuration, the present invention is capable of guiding the cool air discharged downward from cooling fan to the storage compartment. Accordingly, the cool air can be blown into the storage case from above the storage case, and therefore it is possible to effectively cool stored goods.

[0147] In the present invention, the cooling fan is disposed on one side opposite to a rotation direction with respect to a central perpendicular line in a lateral direction of the storage compartment, as viewed from the front of the refrigerator. With this configuration, in the present invention, the cool air discharged from cooling fan radially expands while turning in the rotation direction of the cooling fan. Accordingly, a turning component of velocity which cool air has becomes downward on the central line of the storage compartment, and therefore the cool air can be effectively blown into the case.

[0148] Furthermore, a refrigerator of the present invention includes: a refrigerating compartment; a freezing compartment provided below the refrigerating compartment; a cooler provided inside the freezing compartment; a duct configured to separate the cooler and the freezing compartment; and a cooling fan configured to circulate cool air of the cooler. Then, the refrigerator includes a flow straightener provided at such a position of the duct as to face the cooling fan; a freezing compartment side discharge port configured to discharge the cool air to the freezing compartment; and a refrigerating compartment side discharge port configured to guide the cool air to the refrigerating compartment. Furthermore, the freezing compartment side discharge port is provided below the center of the cooling fan, and the refrigerating compartment side discharge port is provided above the center of the cooling fan. With this configuration, in the present invention, the cool air by the cooling fan does not hit the heat insulating wall between the refrigerating compart-

ment and the freezing compartment, so that it is possible to effectively blow the cool air to each compartment, and it is possible to provide a refrigerator having high cooling efficiency.

[0149] In the refrigerator of the present invention, an ice-making compartment is provided between the refrigerating compartment and the freezing compartment, and an ice-making compartment side discharge port configured to discharge the cool air to the ice-making compartment is provided. Then, the ice-making compartment side discharge port is provided on a front surface side, and the refrigerating compartment side discharge port is provided on a back surface side, above the center of the cooling fan, and the duct is configured such that a part in the vicinity of the refrigerating compartment side discharge port is inclined toward the back surface, and a part in the vicinity of the ice-making compartment side discharge port is inclined toward the front surface. With this configuration, the present invention is capable of effectively blowing the cool air by the cooling fan to each compartment, and it is possible to provide a refrigerator having higher cooling efficiency.

[0150] In the present invention, a wind direction adjuster is provided on an upper part of the ice-making compartment side discharge port such that the discharged cool air flows horizontally or downward. With this configuration, in the present invention, the cool air by the cooling fan does not hit the heat insulating wall provided between the refrigerating compartment and the ice-making compartment, so that it is possible to effectively blow the cool air to each compartment, and it is possible to provide a refrigerator having higher cooling efficiency.

INDUSTRIAL APPLICABILITY

[0151] The present invention is useful as refrigerators of various types and sizes for domestic use and commercial use, and the like. Additionally, the present invention is applicable to any cooling apparatuses having cooling fans.

REFERENCE MARKS IN THE DRAWINGS

[0152]

1 refrigerator
2 heat insulating door
3 storage compartment
4 cooler
5 cooling fan
5a motor
5b blade
6 cooling compartment
7 duct
8 flow straightener
9 inclined part
10 plane part
11 connection part

20 refrigerator
21 heat insulating box
21a machine compartment
22 outer box
5 23 inner box
24 refrigerating compartment
24a refrigerating compartment right door
24b refrigerating compartment left door
24c refrigerating compartment shelf
10 24d refrigerating compartment case
25 second freezing compartment
25a second freezing compartment door
26 ice-making compartment
26a ice-making compartment door
15 27 first freezing compartment
27a first freezing compartment door
27b upper freezing compartment case
27c lower freezing compartment case
28 vegetable compartment
20 28a vegetable compartment door
28b upper vegetable compartment case
28c lower vegetable compartment case
29 compressor
30 cooling compartment
25 31 partition member
31a storage compartment side partition member
31b cooling compartment side partition member
31c air supply duct
31d cool air flow straightener
30 31e discharge port
32 cooler
33 cooling fan
34 radiant heating means
35 drain pan
35 36 drain tube
37 evaporating dish
38 partition wall
39 wind direction raised portion (cool air guide)
40 40 discharge port
41 damper
42 refrigerating compartment duct
51 refrigerating compartment duct
51a front duct
51b back duct
45 52 refrigerating compartment partition member
52a front partition member
52b back partition member
52c refrigerating compartment cool air flow straightener
50 52d refrigerating compartment discharge port
53 refrigerating compartment cooling fan
202 refrigerating compartment partition member
61 refrigerator
63 freezing compartment
55 66 cooler
67 cooling fan
68 flow straightener
70 cooling compartment

73	freezing case			face the cooling fan,
74	ice-making compartment door			wherein the flow straightener is formed in a sub-
75	ice-making case			stantially truncated conical shape having an in-
76	ice-making compartment			clined part and a plane part.
77	duct	5		
78	freezing compartment side discharge port		2.	The refrigerator according to claim 1, wherein
79	ice-making compartment side discharge port			a basic plane of the duct is disposed in a substantially
80	partition wall			vertical direction,
81	refrigerating compartment side discharge port			the cooling fan is disposed to be inclined with respect
82	damper	10		to the vertical direction, and
83	wind-direction adjustment raised portion			the flow straightener is disposed to be inclined such
101	refrigerator			that the flow straightener faces the cooling fan.
102	heat insulating door			
103	storage compartment		3.	The refrigerator according to claim 2, wherein
104	cooler	15		a central part of the plane part of the flow straightener
105	cooling fan			and a rotary axis of the cooling fan are disposed sub-
106	flow straightener			stantially on the same line.
107	duct			
108	cooling compartment		4.	The refrigerator according to claim 1 or 2, wherein
109	slit	20		a distance between the plane part and a leading end
111	storage compartment			surface of the cooling fan is 20 mm or less.
112	cooling compartment			
113	cooling compartment cover		5.	The refrigerator according to claim 1 or 2, wherein
114	cooler			an angle between the inclined part of the flow
115	cooling fan	25		straightener and a plane perpendicular to a rotary
116	cooling fan motor			axis of the cooling fan is 20 degrees or less.
117	partition plate			
118	straightened flow guide plate		6.	The refrigerator according to claim 1 or 2, wherein
119	discharge port			a maximum dimension of the plane part of the flow
121	refrigerator	30		straightener is equal to or smaller than a dimension
123	freezing compartment			of a motor of the cooling fan.
124	cooler			
125	refrigerating compartment		7.	A refrigerator comprising:
126	cooler			
127	cooling fan	35		a storage compartment;
128	flow straightener			a cooler configured to generate cool air for cool-
129	duct			ing the storage compartment;
130	cooling compartment			a cooling fan configured to forcibly send the cool
131	slit			air generated by the cooler to the storage com-
132	refrigerating compartment air trunk	40		partment; and
				a partition member located between the storage
				compartment and the cooling fan,
				wherein the partition member has:

Claims

1. A refrigerator comprising:
 - a storage compartment surrounded by a heat insulating wall and having an opening in a front surface thereof;
 - a heat insulating door configured to close the opening;
 - a cooler stored on a back surface of the storage compartment;
 - a cooling fan configured to circulate cool air generated by the cooler into the storage compartment; and
 - a duct having a flow straightener that protrudes toward the cooling fan at such a position as to
- a discharge port configured to send the cool air to the storage compartment; and
 - a cool air flow straightener configured such that a part facing the cooling fan protrudes toward the cooling fan, and
 - at least a part of the discharge port is disposed in the cool air flow straightener.
8. The refrigerator according to claim 7, wherein the discharge port has a cool air guide part.
9. The refrigerator according to claim 8, wherein the cool air guide part is a raised portion provided

on the partition member.

10. The refrigerator according to claim 7 or 8, wherein the storage compartment includes a single or a plurality of storage cases that keeps an object being stored, the cooling fan is disposed above an upper end of a back surface of at least one of the storage cases, and the discharge port disposed in the cool air flow straightener is provided below a center of the cool air flow straightener, and above the upper end of the back surface of the at least one of the storage cases. 5
11. The refrigerator according to claim 7 or 8, wherein the cooling fan is disposed on one side opposite to a rotation direction with respect to a central perpendicular line in a lateral direction of the storage compartment, as viewed from a front of the refrigerator. 10
12. A refrigerator comprising: 15
a refrigerating compartment;
a freezing compartment provided below the refrigerating compartment;
a cooler provided inside the freezing compartment; 20
a duct configured to separate the cooler and the freezing compartment;
a cooling fan configured to circulate cool air of the cooler; 25
a flow straightener provided at such a position of the duct as to face the cooling fan;
a freezing compartment side discharge port configured to discharge the cool air to the freezing compartment; and 30
a refrigerating compartment side discharge port configured to guide the cool air to the refrigerating compartment, wherein
the freezing compartment side discharge port is provided below the center of the cooling fan, and 35
the refrigerating compartment side discharge port is provided above the center of the cooling fan. 40
13. The refrigerator according to claim 12 further comprising: 45
an ice-making compartment provided between the refrigerating compartment and the freezing compartment; and 50
an ice-making compartment side discharge port configured to discharge the cool air to the ice-making compartment, wherein 55
the ice-making compartment side discharge port is provided on a front surface side of the refrigerator, and the refrigerating compartment side

discharge port is provided on a back surface side of the refrigerator, above the center of the cooling fan, and
the duct is configured such that a part in a vicinity of the refrigerating compartment side discharge port is inclined toward the back surface, and a part in a vicinity of the ice-making compartment side discharge port is inclined toward the front surface.

14. The refrigerator according to claim 13, wherein a wind direction adjuster is provided on an upper part of the ice-making compartment side discharge port such that the discharged cool air flows horizontally or downward.

FIG. 1

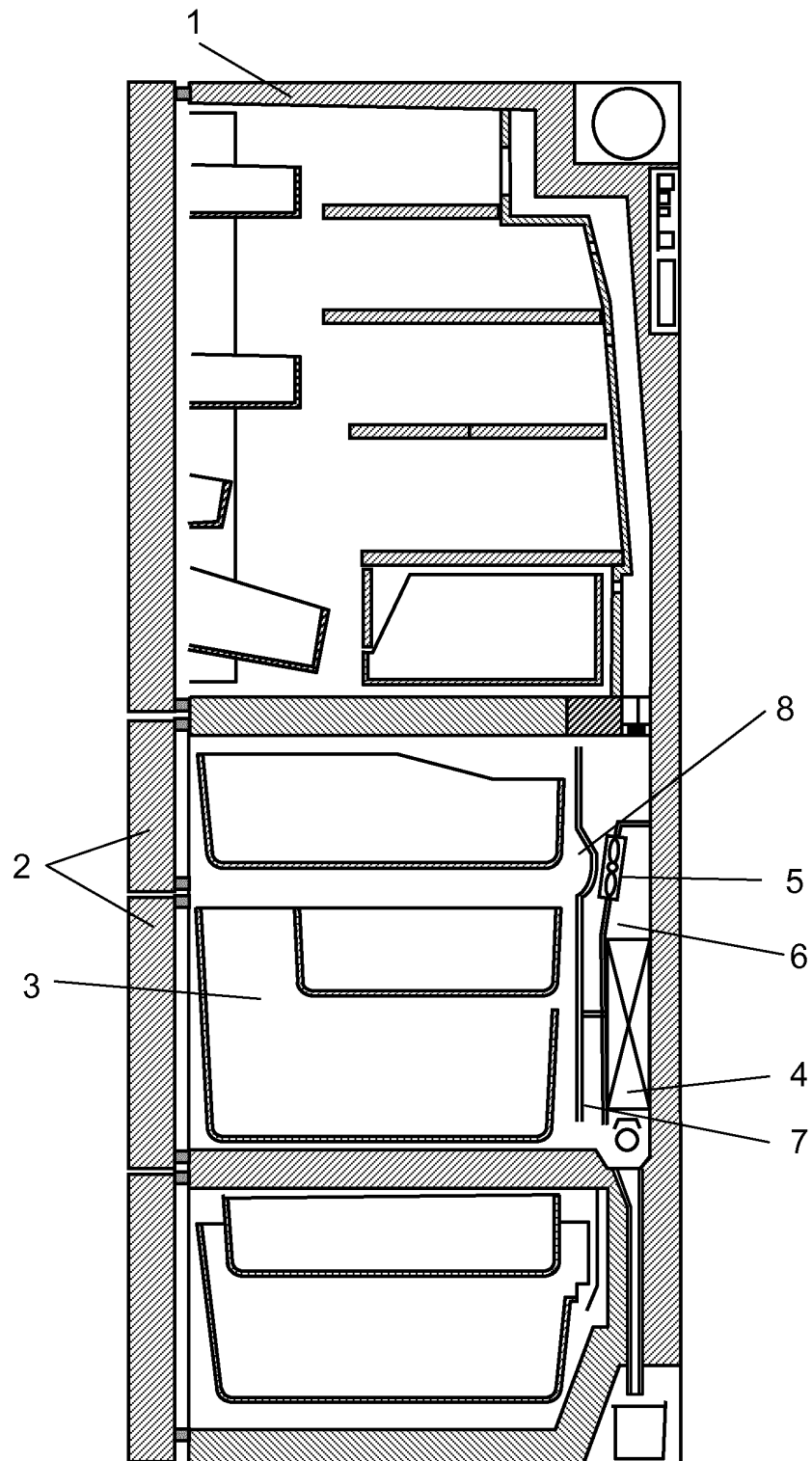


FIG. 2

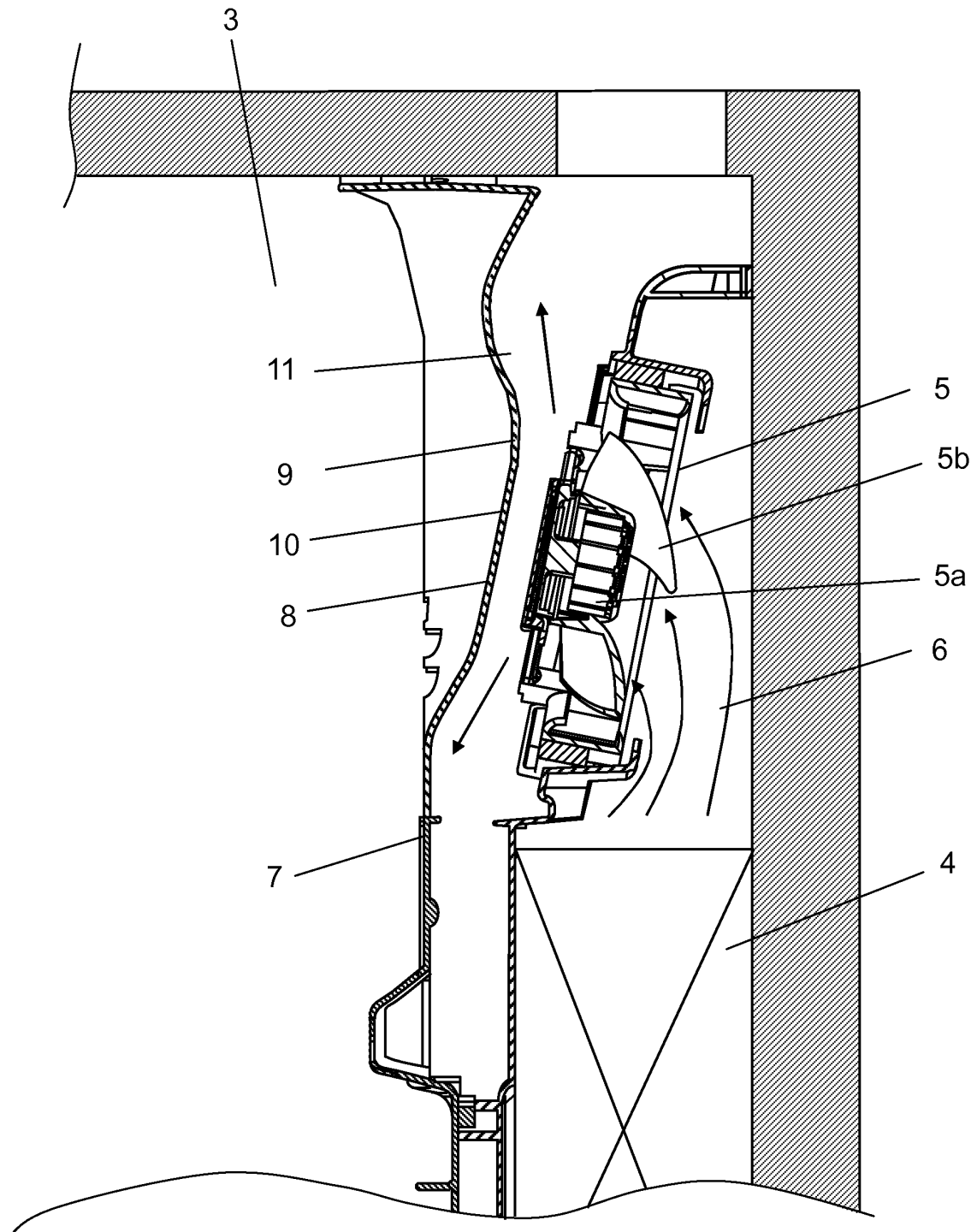


FIG. 3

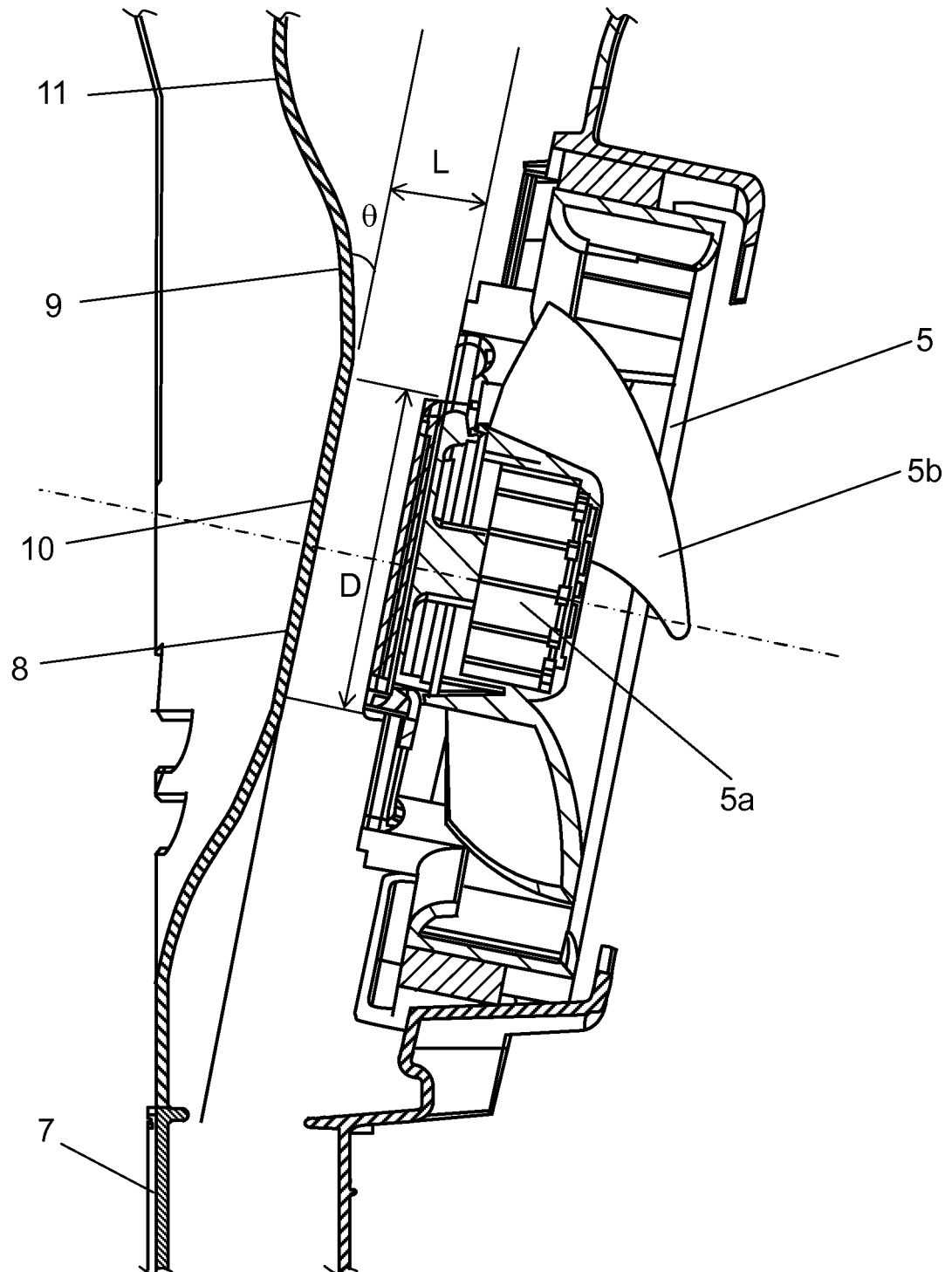


FIG. 4

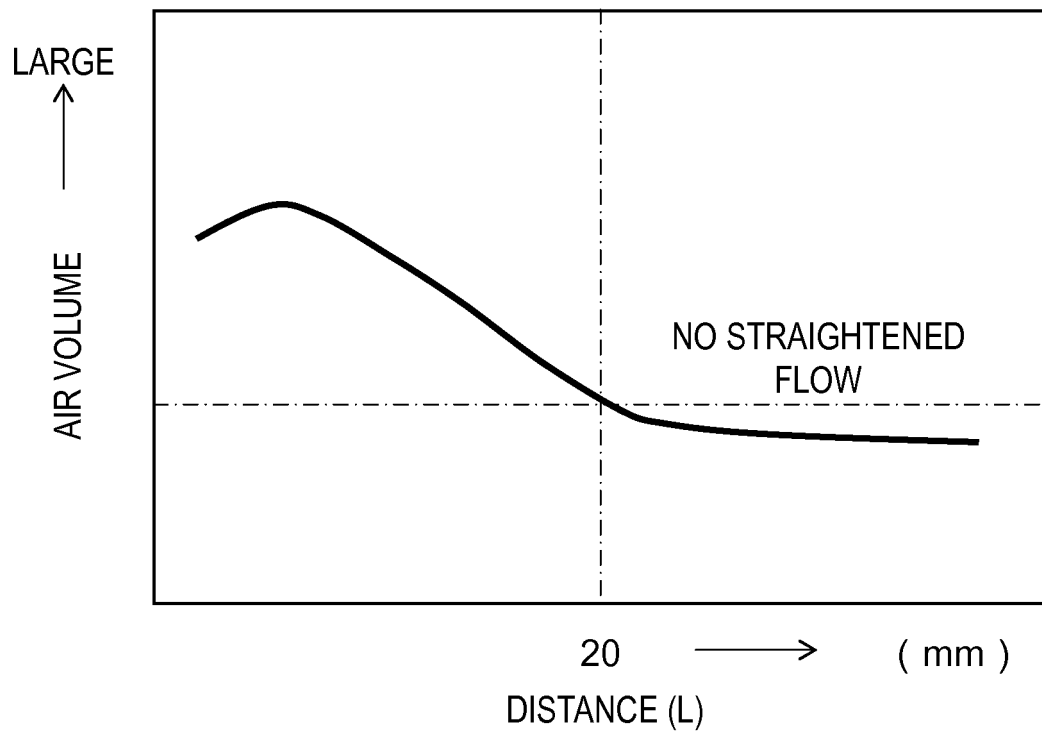


FIG. 5

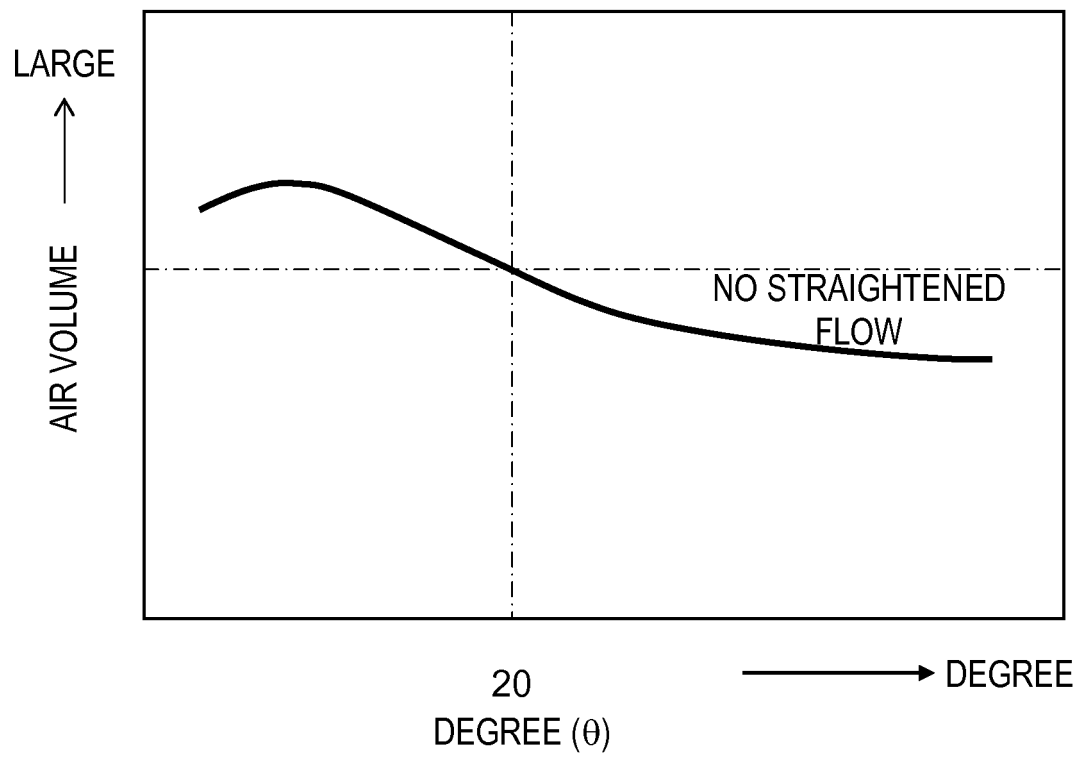


FIG. 6

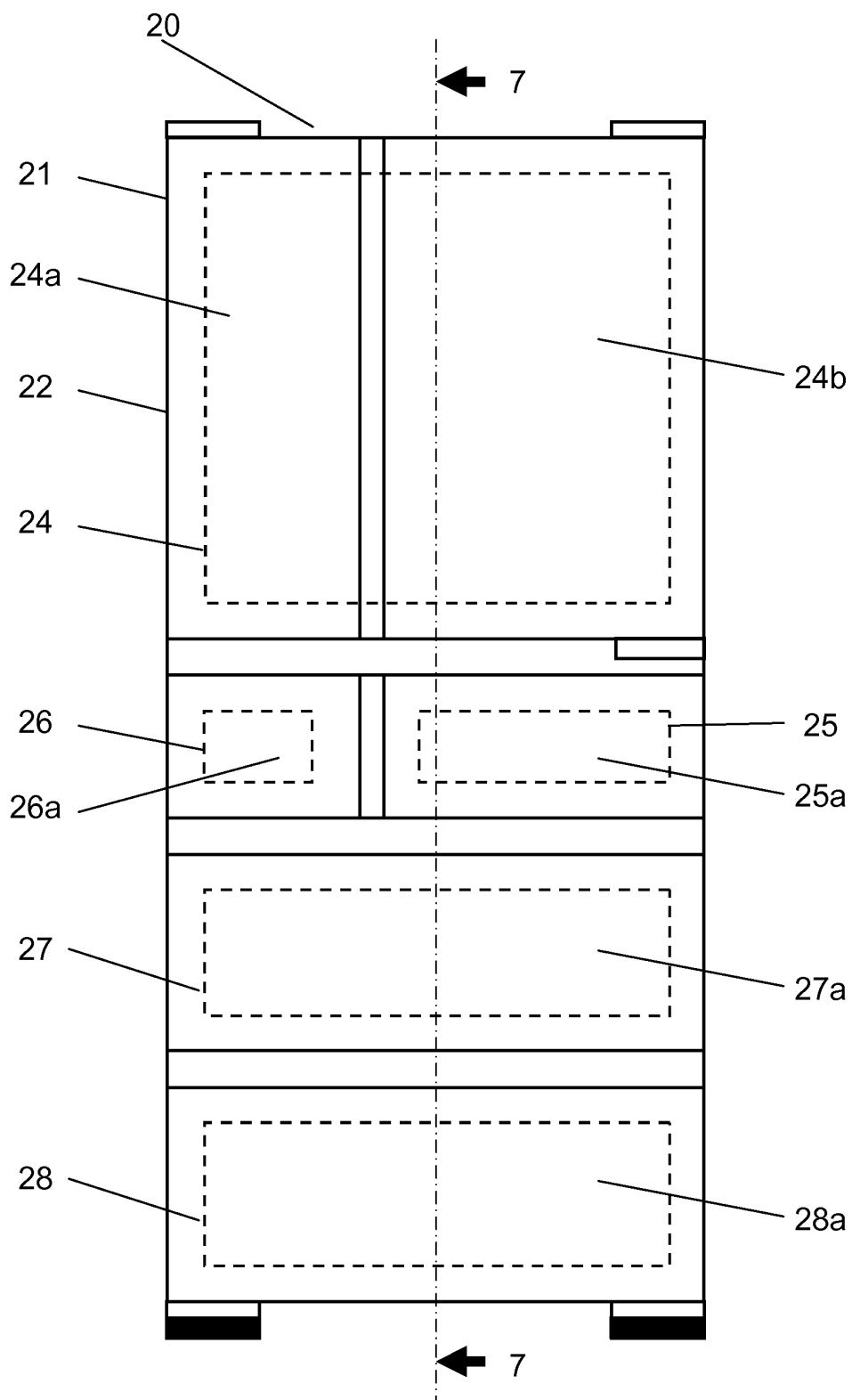


FIG. 7

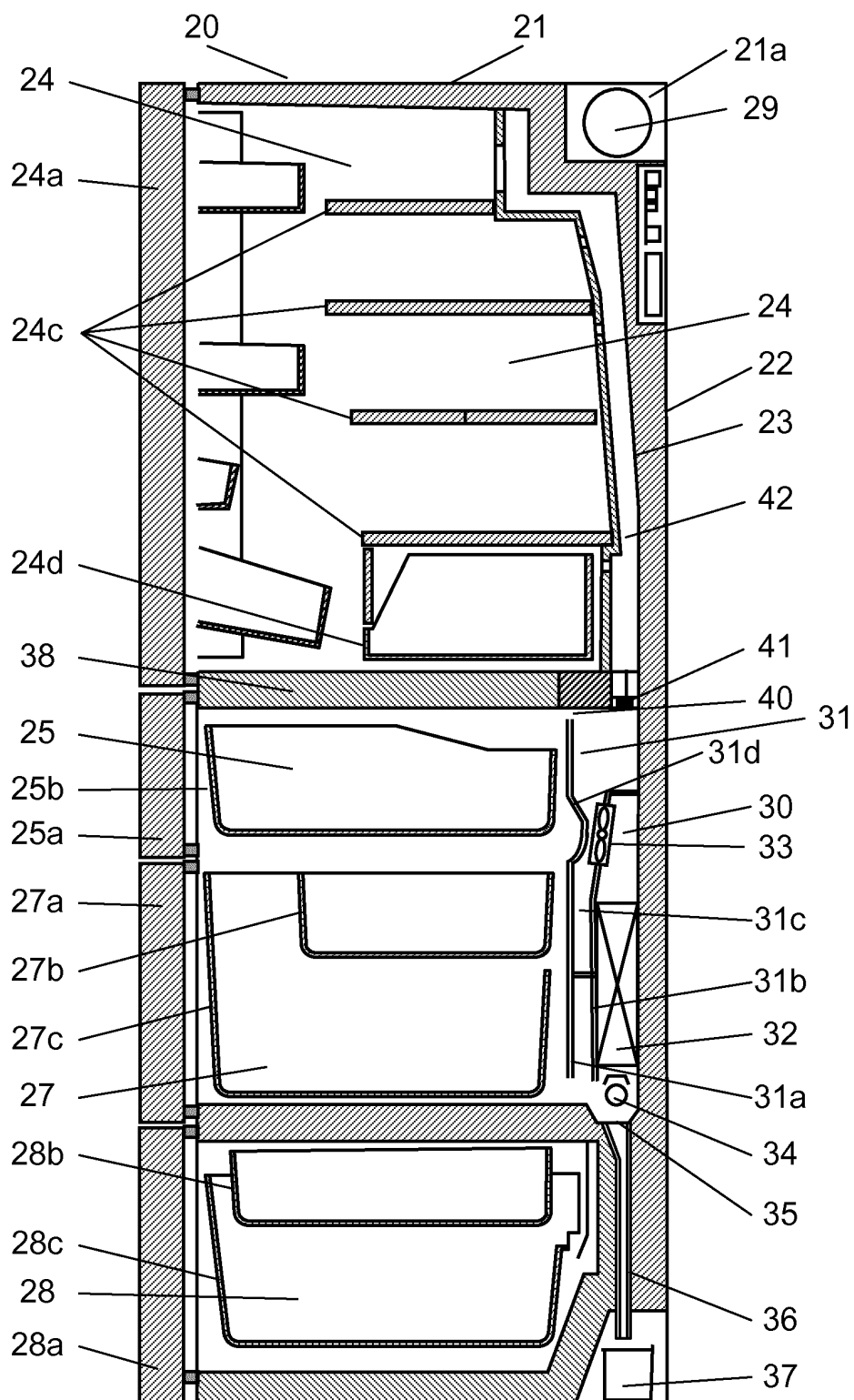


FIG. 8

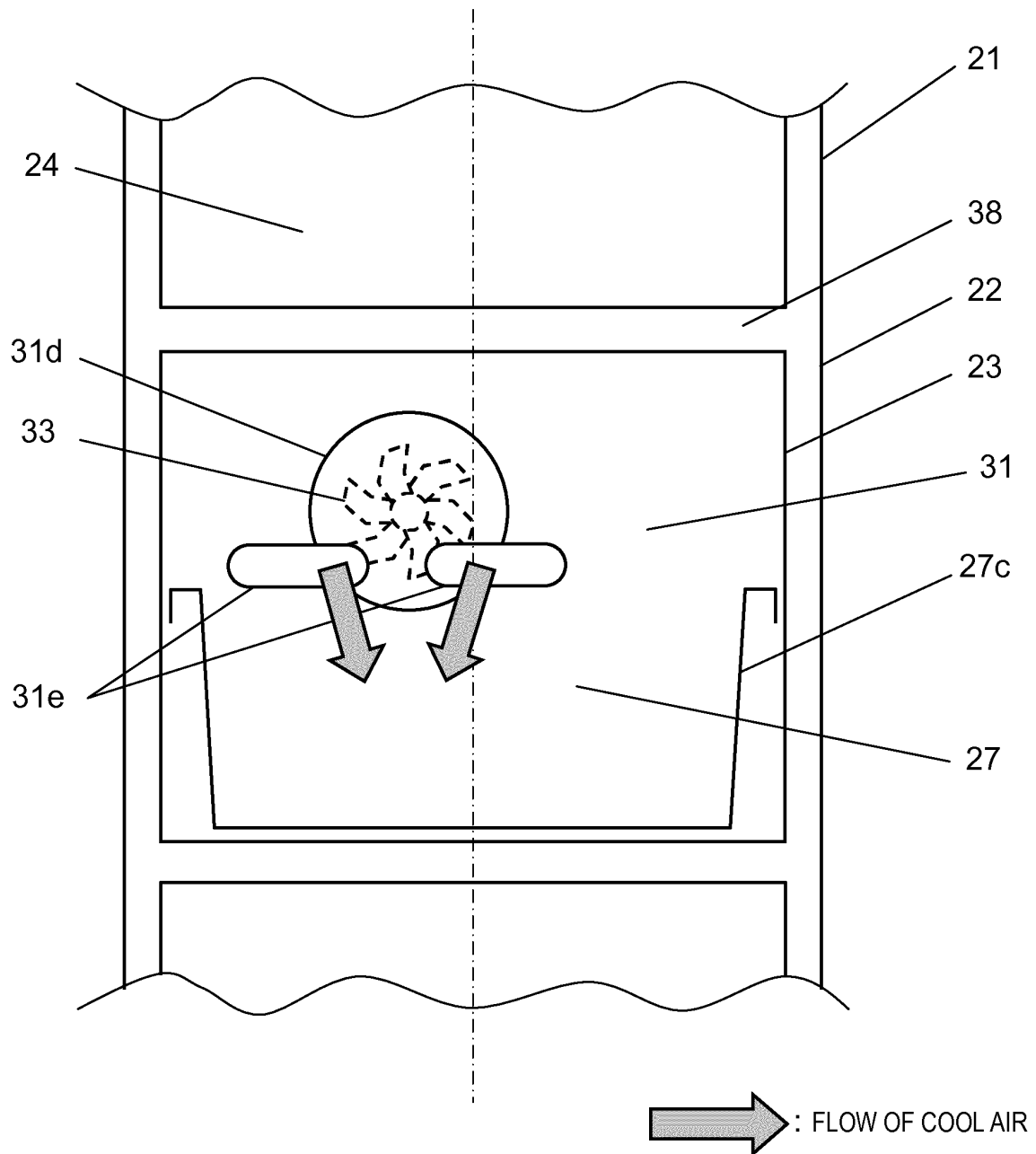


FIG. 9

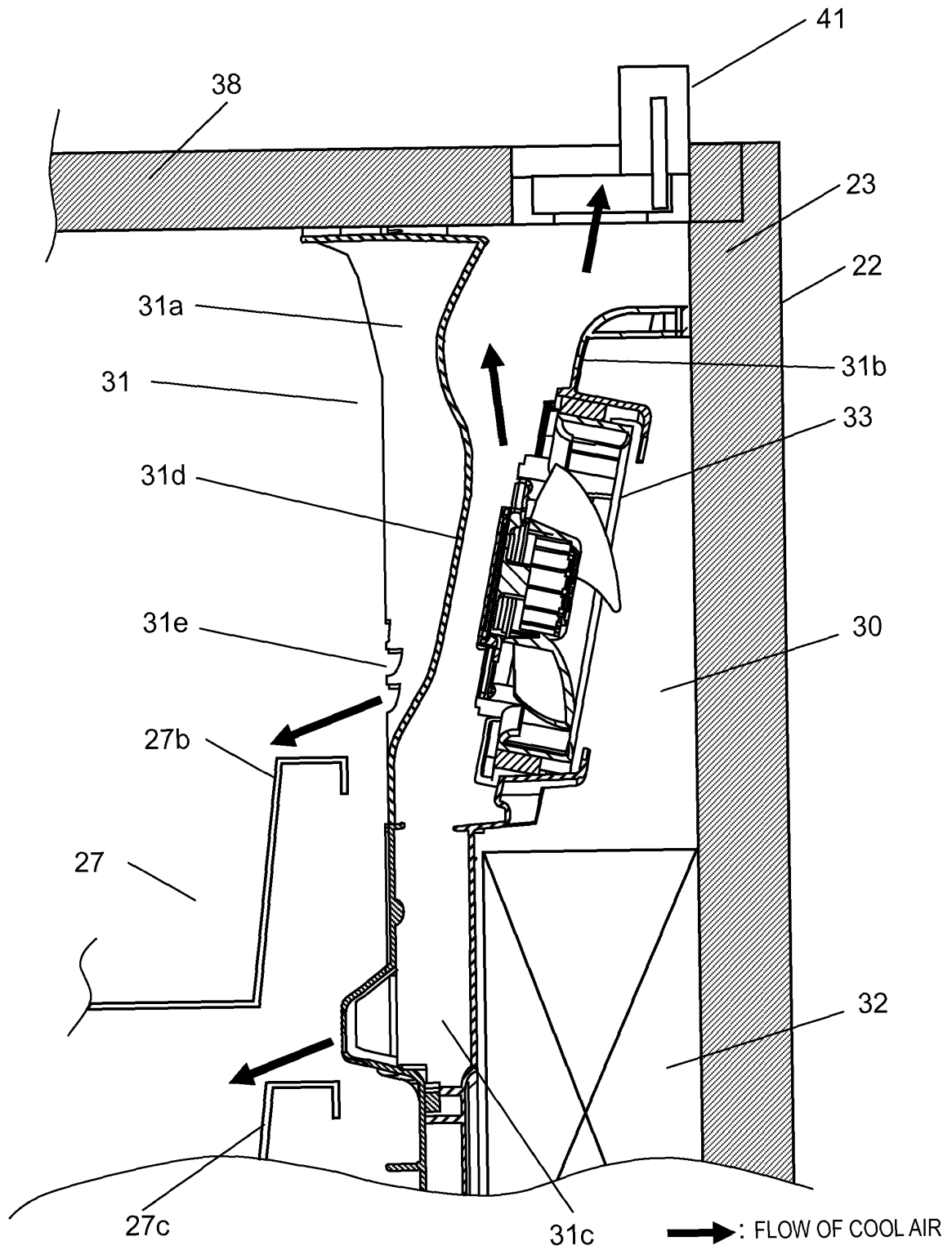


FIG. 10

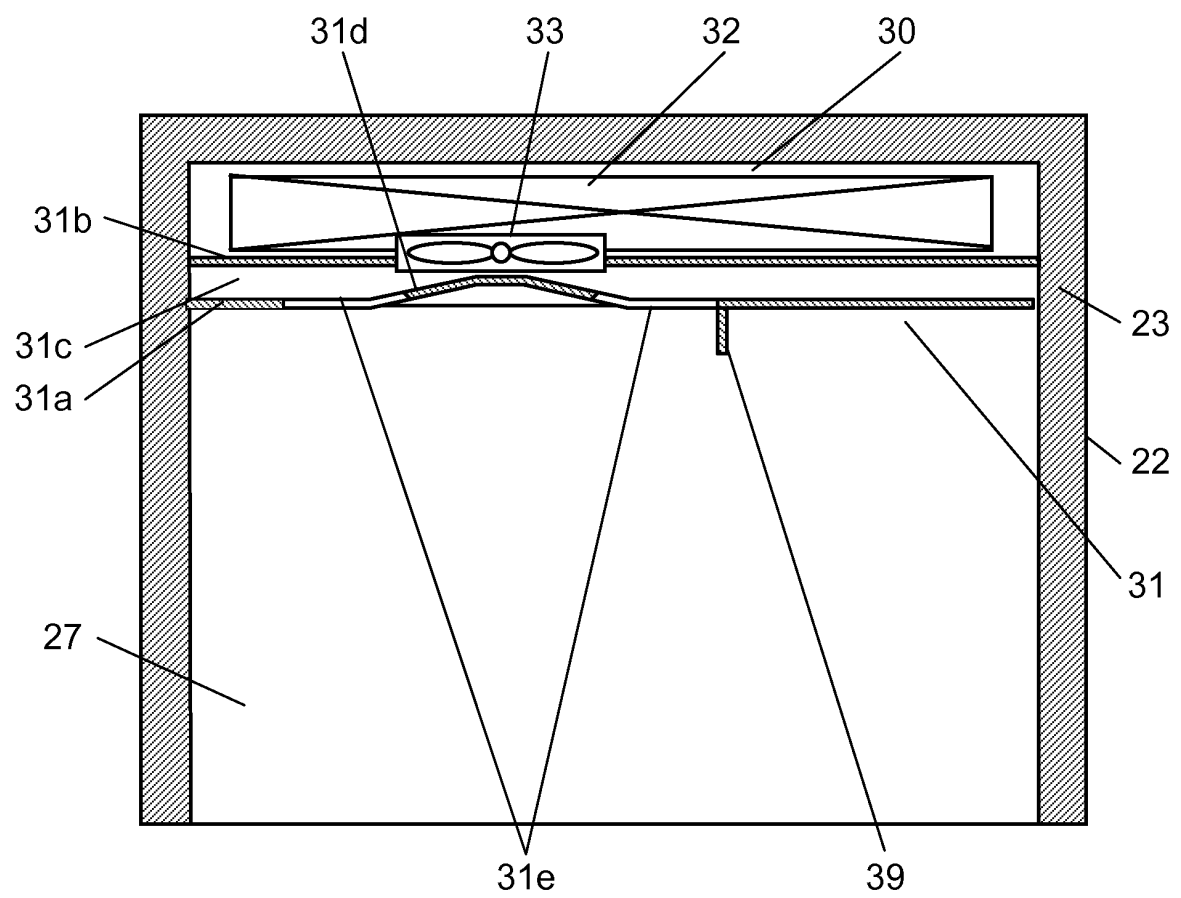


FIG. 11

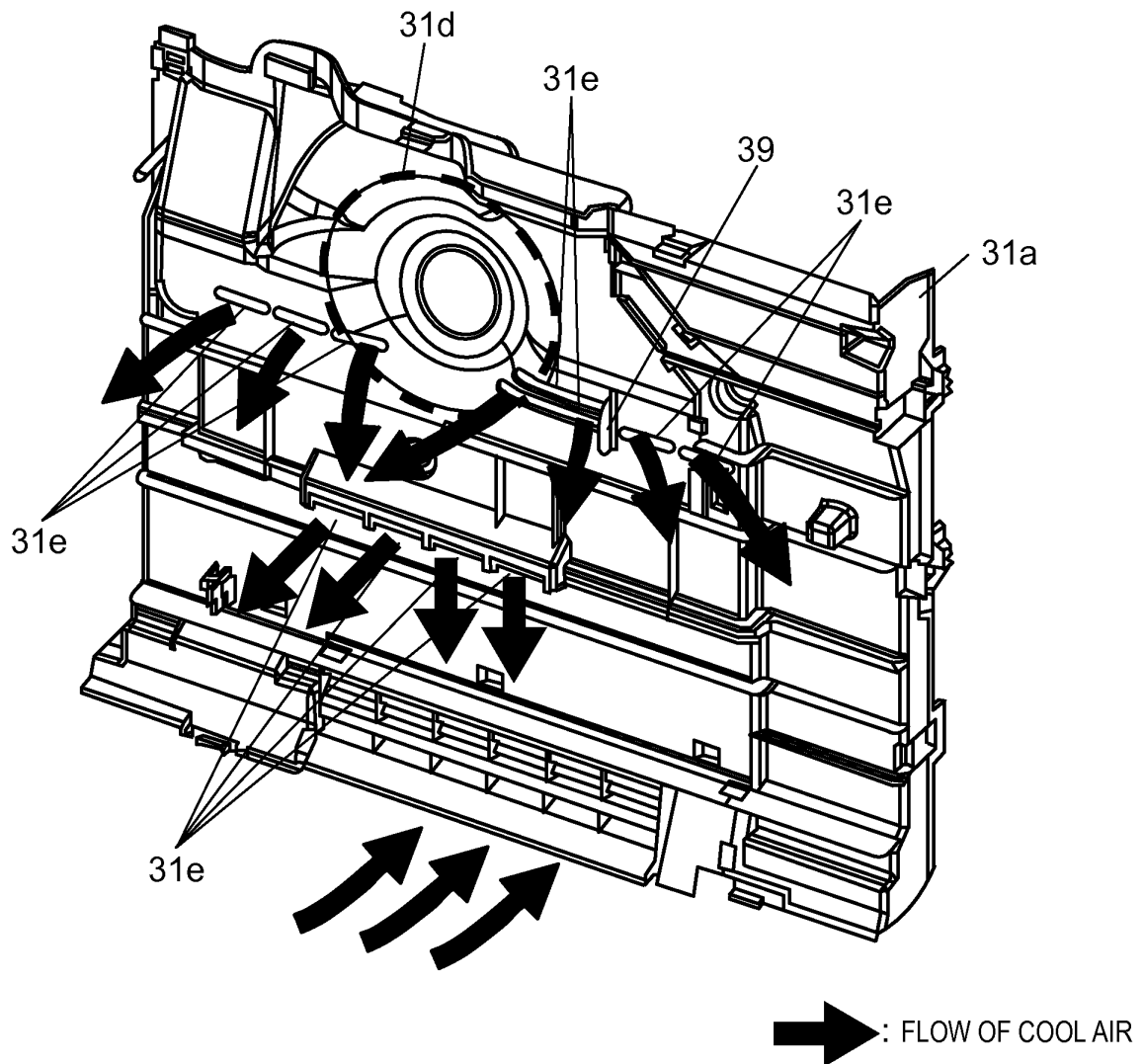


FIG. 12

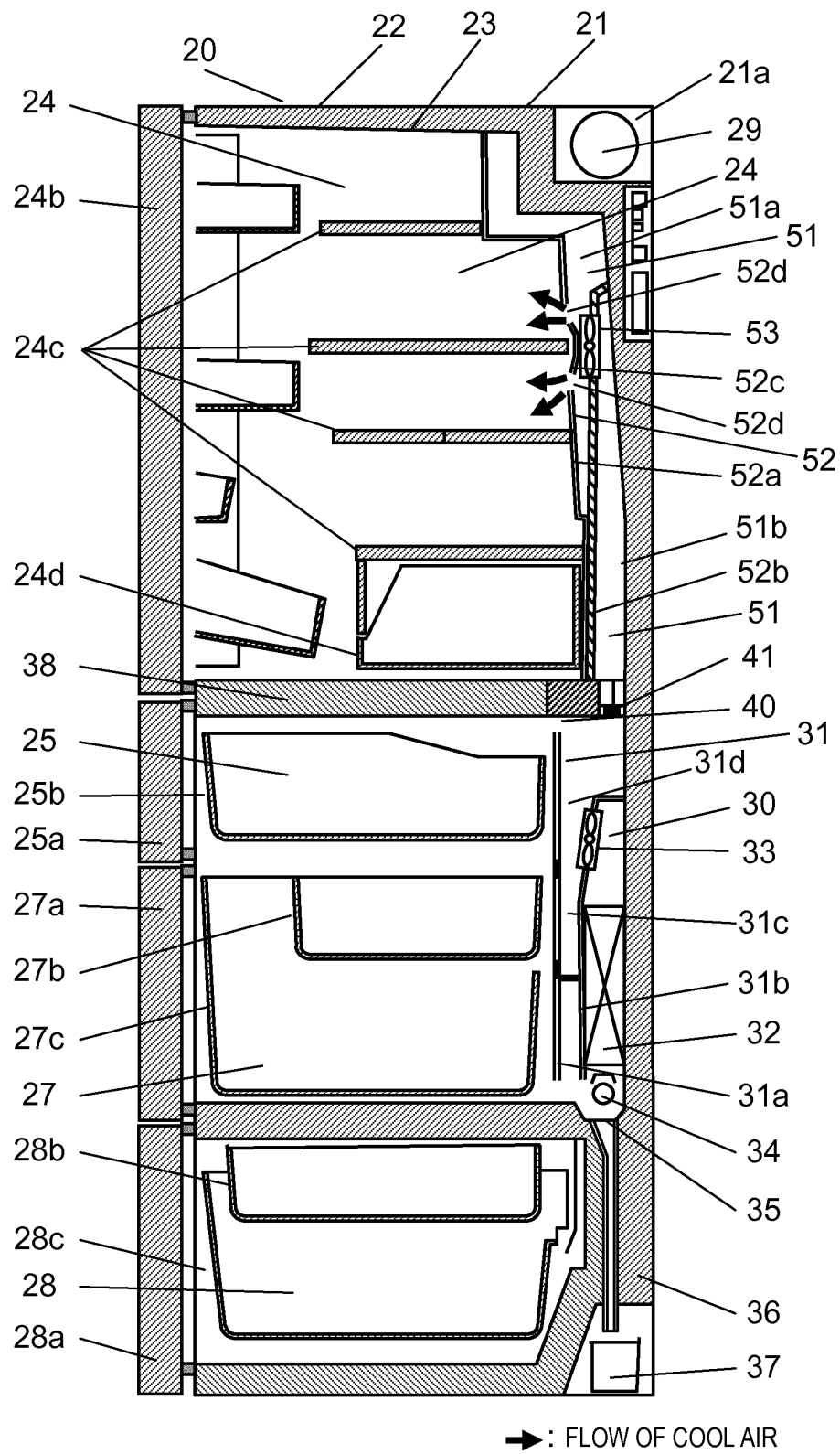


FIG. 13

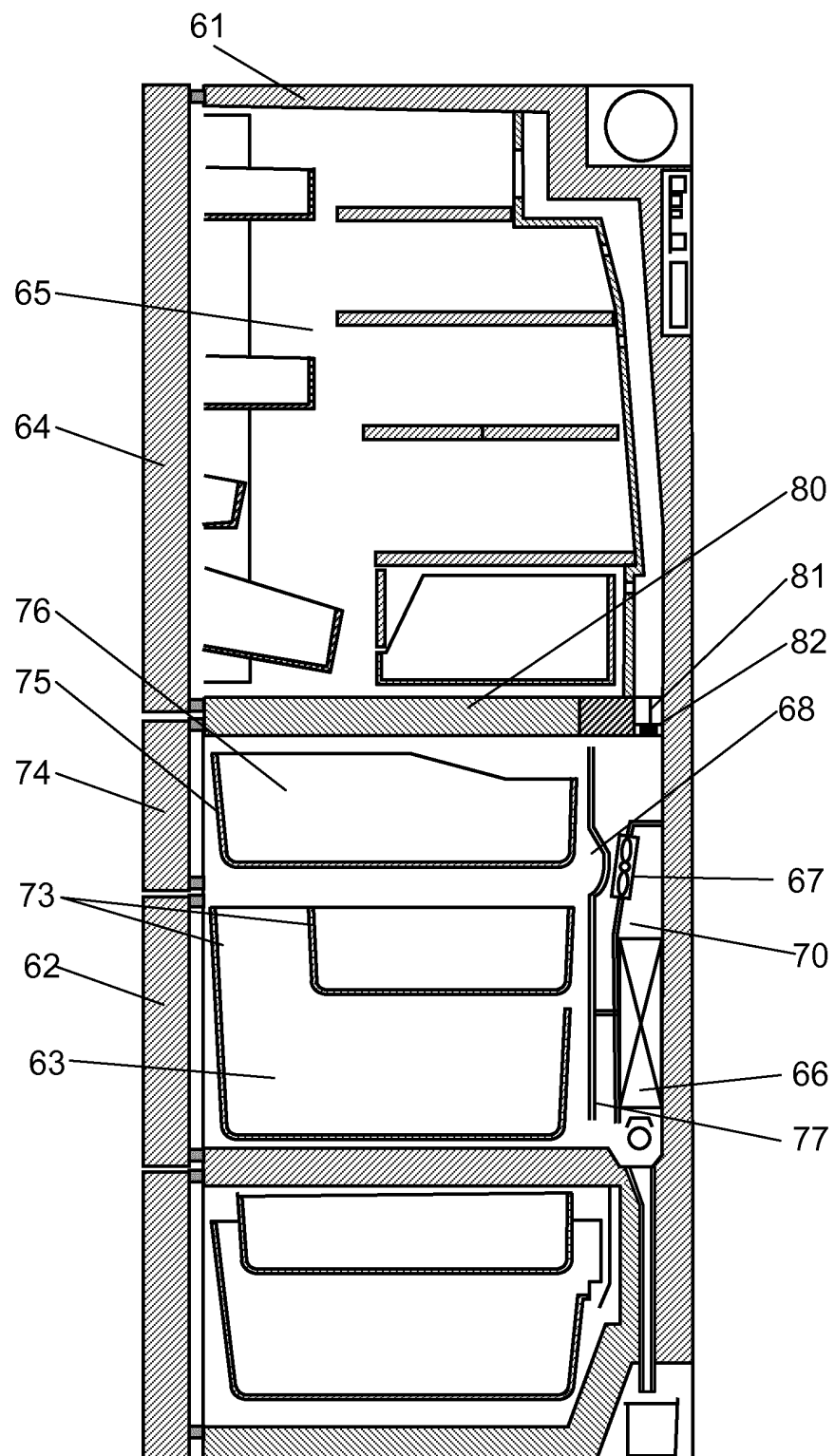


FIG. 14

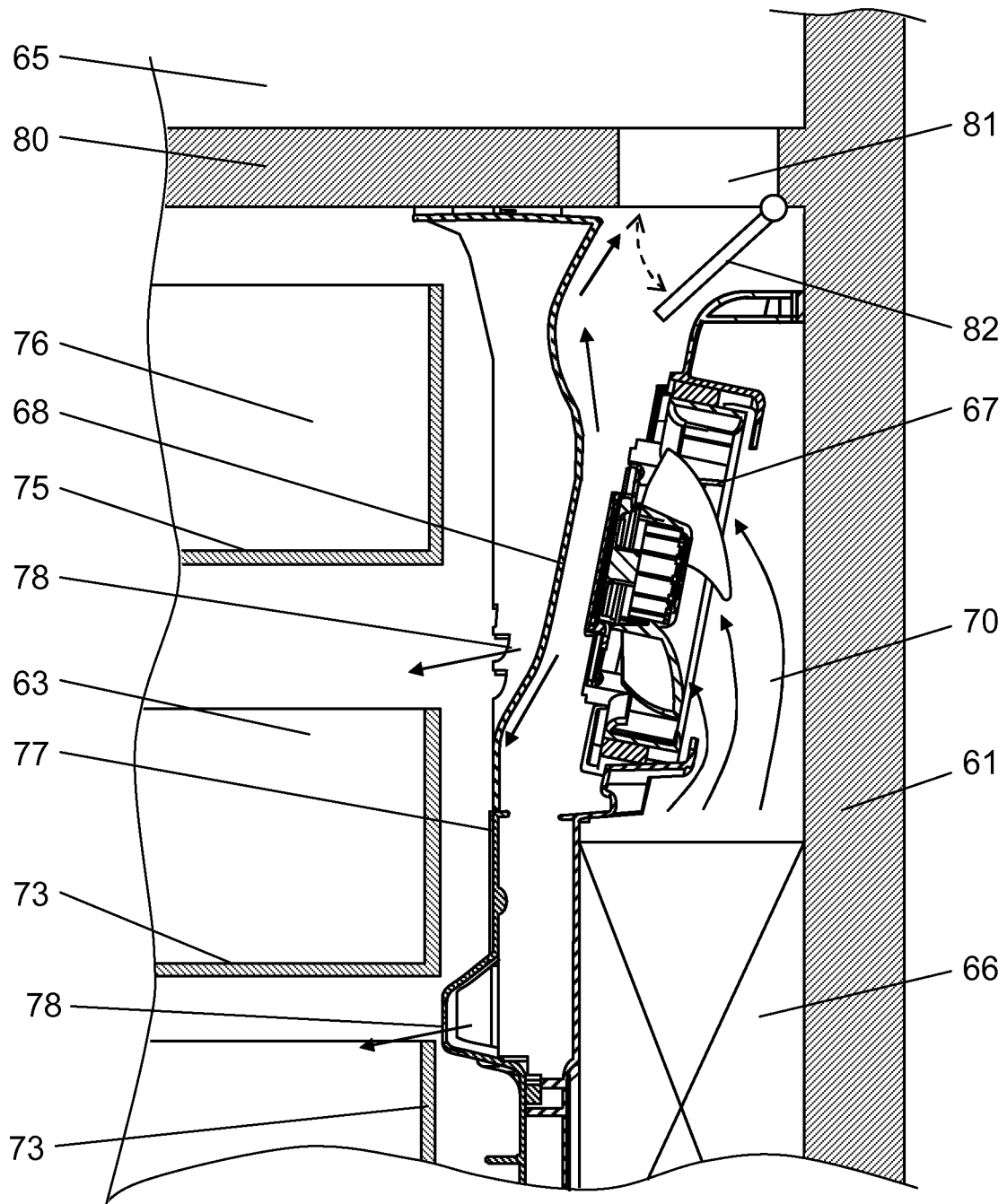


FIG. 15

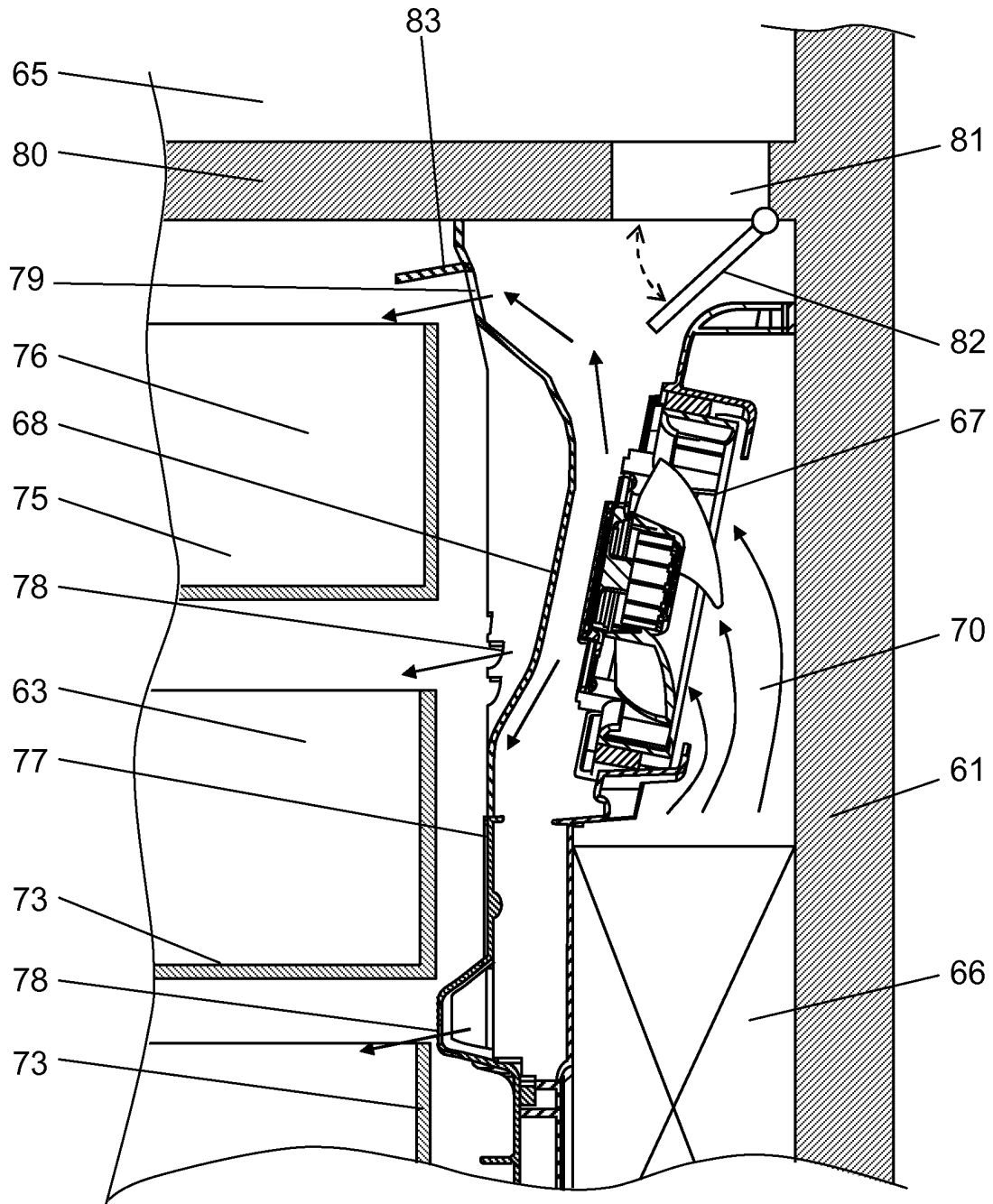


FIG. 16

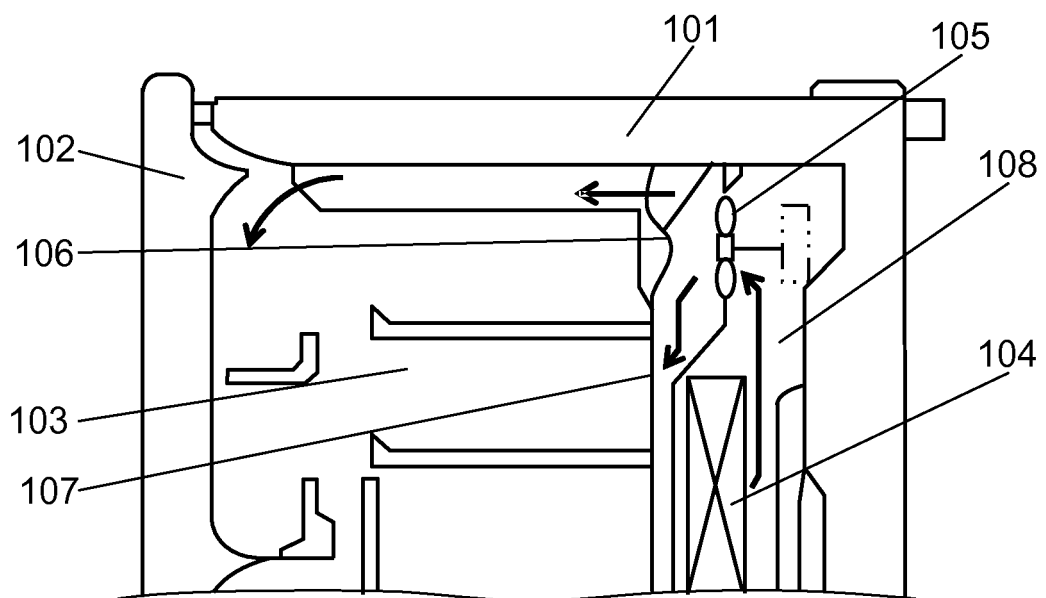


FIG. 17

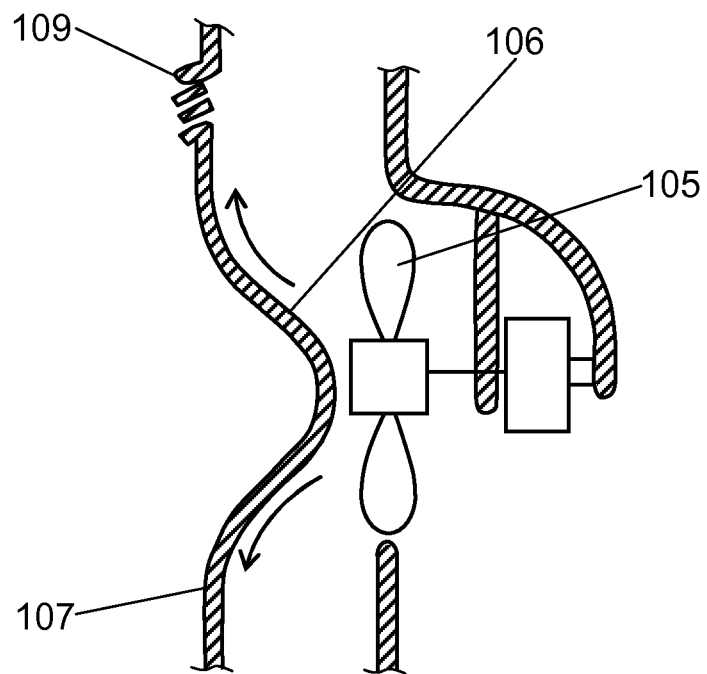


FIG. 18

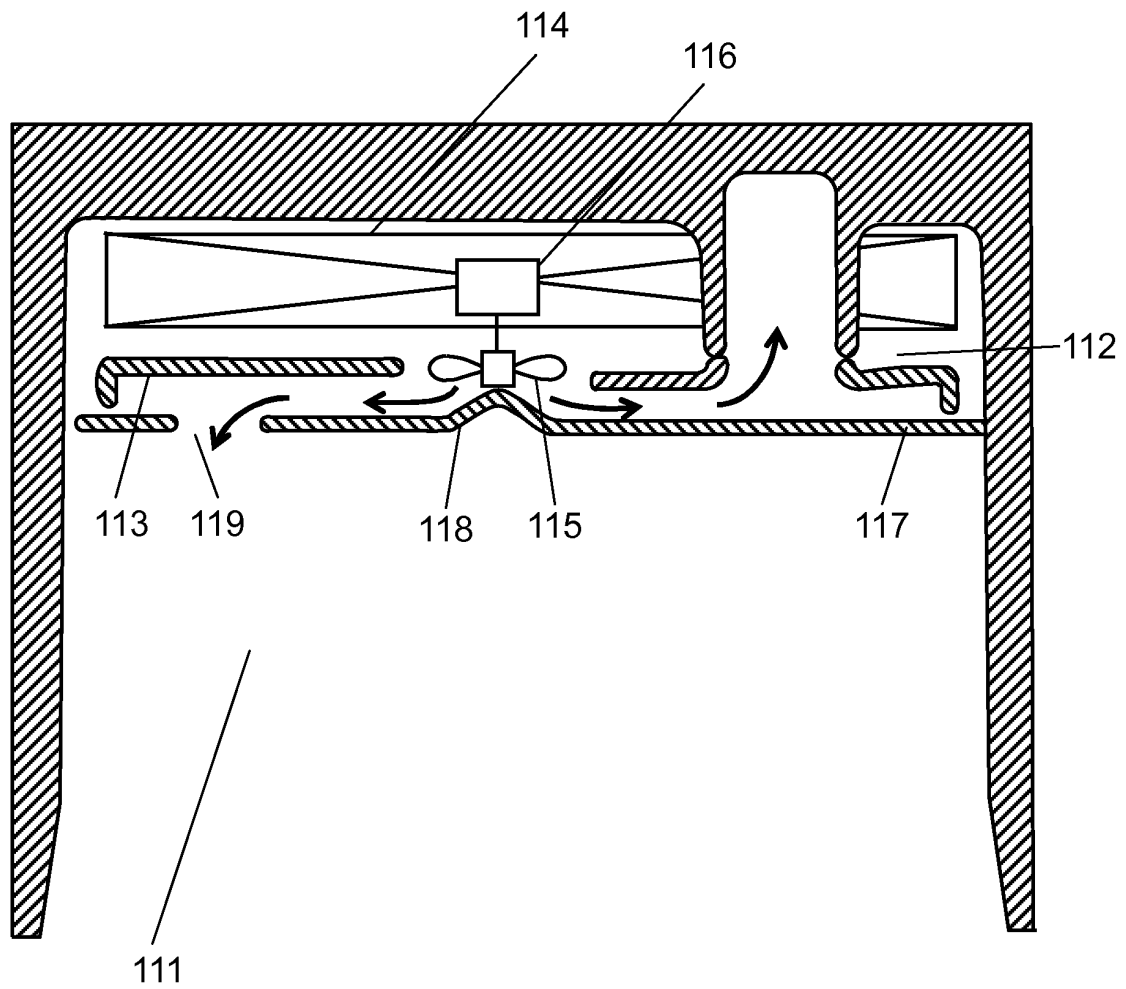


FIG. 19

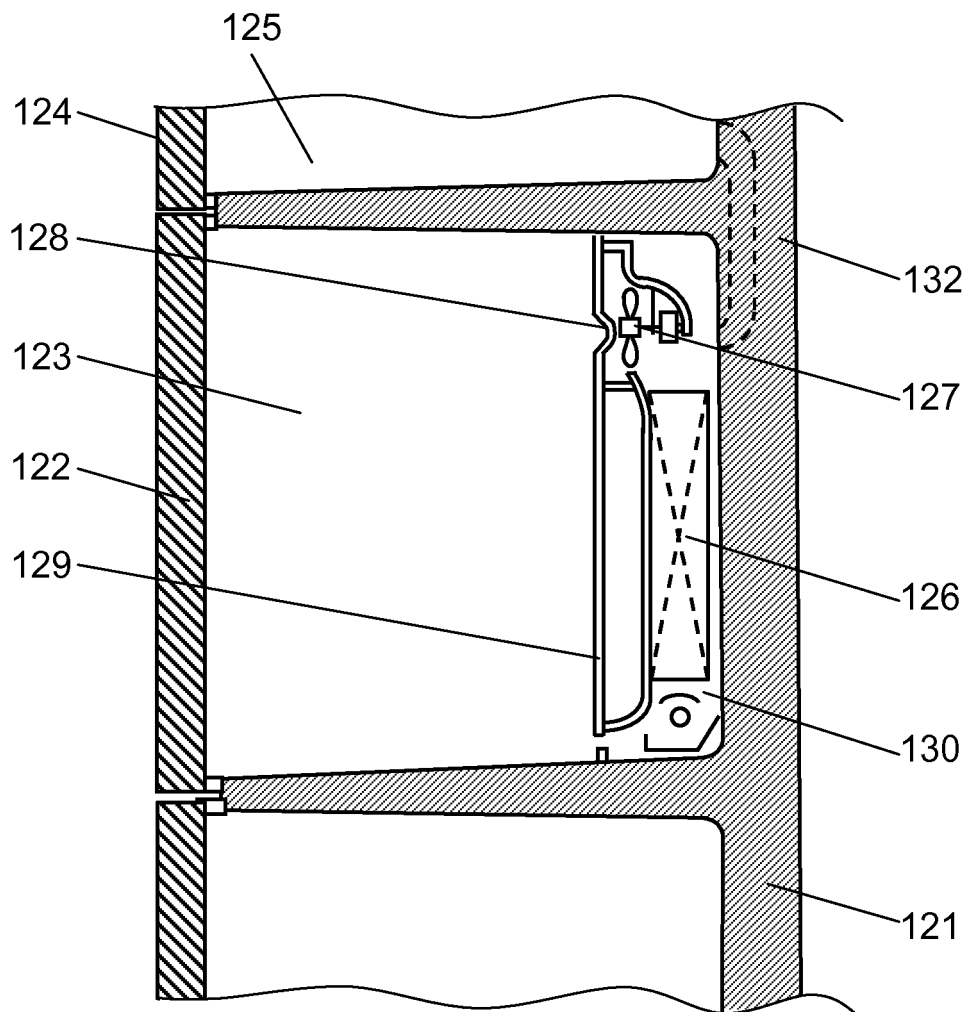
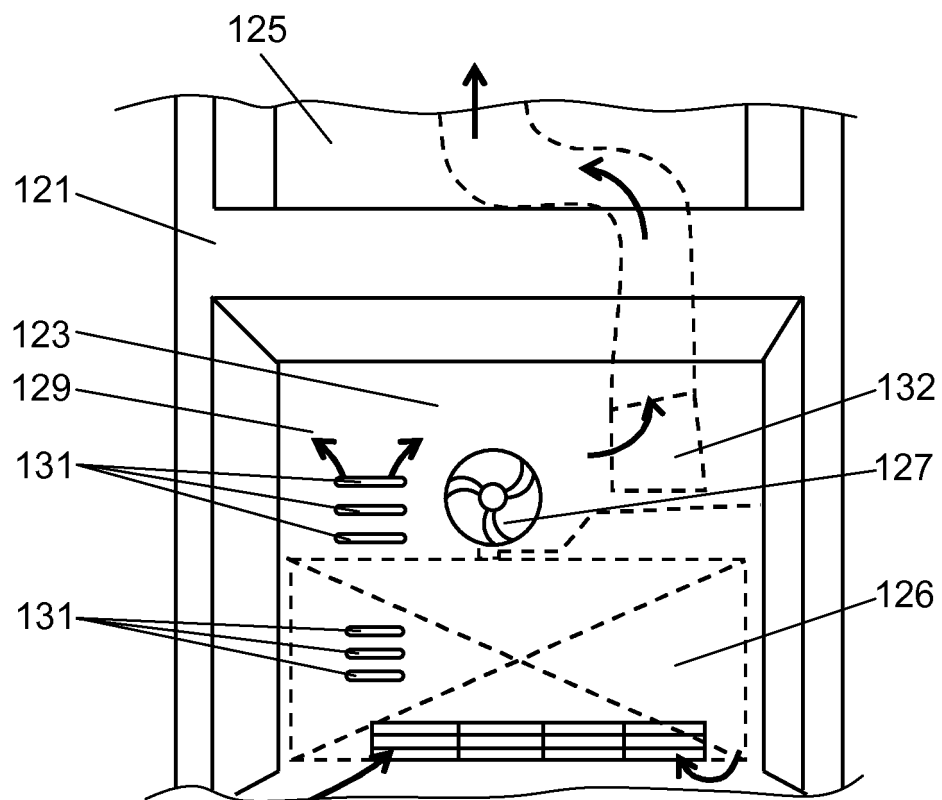


FIG. 20



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2012/007092

A. CLASSIFICATION OF SUBJECT MATTER

F25D17/08(2006.01) i, F25D17/06(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)

F25D17/08, F25D17/06

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

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2012
Kokai Jitsuyo Shinan Koho	1971-2012	Toroku Jitsuyo Shinan Koho	1994-2012

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	JP 2005-291577 A (Mitsubishi Electric Corp.), 20 October 2005 (20.10.2005), fig. 1, 8, 9; paragraphs [0033] to [0034] (Family: none)	1, 4-6 2, 3, 7-11
X Y	JP 2006-183894 A (Hitachi Home & Life Solution, Inc.), 13 July 2006 (13.07.2006), fig. 1 to 3; paragraphs [0020] to [0035] & CN 1796908 A	12-14 2, 3
Y	JP 11-14230 A (Toshiba Corp.), 22 January 1999 (22.01.1999), fig. 1; paragraphs [0013] to [0018] (Family: none)	7-11

☒ 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

"I" 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
10 December, 2012 (10.12.12)Date of mailing of the international search report
25 December, 2012 (25.12.12)Name and mailing address of the ISA/
Japanese Patent Office

Authorized officer

Facsimile No.

Telephone No.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2012/007092

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2003-148853 A (Toshiba Corp.), 21 May 2003 (21.05.2003), claim 5; fig. 2 (Family: none)	11
A	JP 2011-7452 A (Hitachi Appliances, Inc.), 13 January 2011 (13.01.2011), fig. 4 & WO 2011/001479 A1 & KR 10-2012-0023699 A	1-14

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

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2012/007092

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:
See extra sheet.

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☒ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.

Form PCT/ISA/210 (continuation of first sheet (2)) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2012/007092

Continuation of Box No.III of continuation of first sheet(2)

Document 1 (JP 2005-291577 A (Mitsubishi Electric Corp.), 20 October 2005 (20.10.2005)) discloses a refrigerator provided with: a storage room which is surrounded by a heat insulating wall and has an opening in the front surface thereof; a heat insulating door which blocks the opening; a cooler which is housed on the back surface of the storage room; a cooling fan which circulates cool air generated by the cooler into the storage room; and a duct which has a flow adjustment part protruding to the cooling fan side at a position facing the cooling fan, the flow adjustment part having an approximately truncated cone shape provided with a slope section and a flat section (Refer to Fig. 1, 8, 9, paragraphs [0033] to [0034]).

Therefore, the invention of claim 1 cannot be considered to be novel in the light of the invention disclosed in the document 1, and does not have a special technical feature.

Accordingly, three inventions (invention groups) each having a special technical feature indicated below are involved in claims.

Meanwhile, the invention of claim 1 having no special technical feature is classified into invention 1.

(Invention 1) the inventions of claims 1-6

A refrigerator provided with: a storage room which is surrounded by a heat insulating wall and has an opening in the front surface thereof; a heat insulating door which blocks the opening; a cooler which is housed on the back surface of the storage room; a cooling fan which circulates cool air generated by the cooler into the storage room; and a duct which has a flow adjustment part protruding to the cooling fan side at a position facing the cooling fan, the flow adjustment part having an approximately truncated cone shape provided with a slope section and a flat section.

(Invention 2) the inventions of claims 7-11

A refrigerator provided with: a storage room; a cooler which generates cool air for cooling the storage room; a cooling fan which forcibly sends the cool air generated by the cooler to the storage room; and a partition member which is located between the storage room and the cooling fan, the partition member having a discharge port through which the cool air is sent to the storage room, and a cool air flow adjustment part of which a section facing the cooling fan protrudes to the cooling fan side, and at least part of the discharge port being disposed in the cool air flow adjustment part.

(Invention 3) the inventions of claims 12-14

A refrigerator wherein a refrigerating room, a freezing room which is provided below the refrigerating room, a cooler which is provided in the freezing room, a duct which separates the cooler and the freezing room, a cooling fan which circulates cool air from the cooler, a flow adjustment part which is provided at a position facing the cooling fan of the duct, a freezing room-side discharge port which discharges the cool air to the freezing room, and a refrigerating room-side discharge port which guides the cool air to the refrigerating room are provided, the freezing room-side discharge port is provided below the center of the cooling fan, and the refrigerating room-side discharge port is provided above the center of the cooling fan.

REFERENCES CITED IN THE DESCRIPTION

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

Patent documents cited in the description

- JP 3631316 B [0028]