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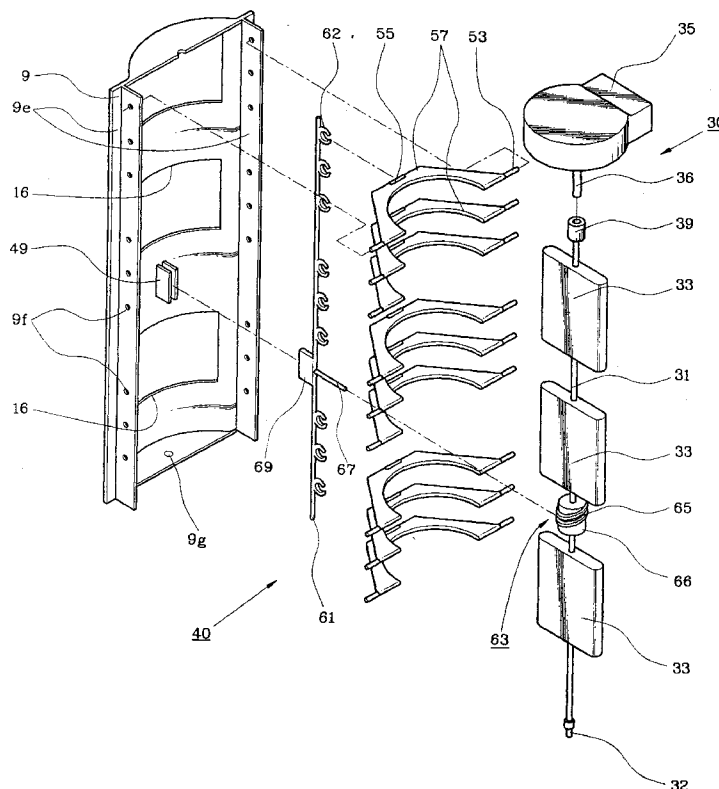
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(54) Refrigerator with cool air directing device

(57) A refrigerator has cool air distributing blades (33, 57). The blades (33, 57) are rotatably disposed near cool air discharge ports (16) opening into a cooling com-

partment (3). The discharge direction of the cool air is determined by angular positions of the blades (33, 57). The blades (33, 57) are positioned in response to the temperature distribution in the compartment (3).

FIG. 6



Description

The present invention relates to a refrigerator comprising a cooling compartment, an aperture opening into the compartment, a heat pump and cool air distributing means for supplying cool air generated by the heat pump to the compartment through the aperture.

Generally, a refrigerator has a cabinet in which there are a freezing compartment and a fresh food compartment. These compartments are separated by a partition wall. Doors are provided at the front of the freezing and cooling compartments. A cooling system supplies the freezing compartment and the fresh food compartment with cool air and comprises a compressor, a condenser and an evaporator. The cool air generated by the evaporator flows along a supply duct formed at the back of each compartment, and is then supplied into each cooling compartment through cool air discharge ports opening thereinto by a fan.

In such a conventional refrigerator, however, cool air tends to be supplied into a particular area of the cooling compartment and other areas tend to be less well served. Consequently, a uniform temperature is not maintained throughout the cooling compartment.

This problem has been addressed by providing cool air discharge ports in the side walls of the cooling compartment as well as in its rear wall. However, there may be still a dead-zone at an edge area which is not supplied with the cool air sufficiently. Furthermore, the ducting required to supply cool air from the sides of the cooling compartment reduces the space available for food and increases the cost of manufacture.

The problem of adequately distributing cool air in a refrigerator is worse for larger refrigerators.

Figures 1 through 3 are a side view, a partial enlarged sectional view, and an exploded perspective view of the main elements of a refrigerator having a device for dispersing cool air as disclosed in WO-A-95/27278.

Referring to Figures 1 to 3, a refrigerator comprises freezing and fresh food compartments 2, 3 in a cabinet 1, which are separated from each other by a partition 5. Respective doors 6, 7 are provided for closing the compartments 2, 3. A cooling system, comprising a compressor 11, a condenser (not shown), a freezing compartment evaporator 12a, and a fresh food compartment evaporator 12b, is installed in the cabinet 1. Cool air generated by the evaporators 12a, 12b is supplied to the corresponding compartments 2, 3 by a freezing compartment fan 13a and a fresh food compartment fan 13b respectively.

A partially cylindrical duct plate 9 is attached to an inner wall plate 23 forming the rear inner wall surface of the fresh food compartment 3. The duct plate 9 has cool air discharge ports 16, opening into the fresh food compartment 3, formed in it. A supply duct 15 and a return duct 17, separated from each other by a seal plate 25, are provided between the duct plate 9 and the rear wall 4 of the cabinet 1. A duct member 21, for guiding down-

wards cool air blown by the fresh food compartment fan 13b, is installed in the supply duct 15. Cool air generated by the fresh food compartment evaporator 12b is blown by the fresh food compartment fan 13b and then supplied to the fresh food compartment 3 via the supply duct 15 and the cool air discharge ports 16.

A cool air dispersing device 130 is installed in the supply duct 15. The cool air dispersing device 130 comprises a rotational shaft 131 having a vertical axis, cool air dispersing blades 132 assembled with the rotational shaft 131 in correspondence with respective cool air discharge ports 16, and a driving motor 135 for rotating the rotational shaft 131. Each of the cool air dispersing blades 132 comprises three discs 136, 137, 138 disposed in parallel with each other along the shaft 131, and first and second blade parts 133, 134 disposed between pairs of the discs 136, 137, 138. Each of the blade parts 133, 134 is curved so that its cross-section is loosely S-shaped. The blade parts 133, 134 are bent in opposite directions to each other.

In a refrigerator having the above-described constitution, when the driving motor 131 rotates the rotational shaft 131 at a low speed, cool air flowing along the supply duct 15 changes its direction along the curved surfaces of the cool air dispersing blades 132, and is directed into the fresh food compartment 3 so as to disperse horizontally. When concentrated cooling in a specific area is needed, the driving motor 135 stops the rotational shaft 131 so that the cool air dispersing blades 132 direct cool air to the specific area. However, since the blade parts 133, 134 of the cool air dispersing device 130 are S-shaped, the left or right sides of the fresh food compartment 3 may not be supplied with the cool air sufficiently and the smooth flow of cool air may be impeded by a vortices in the cool air formed about the cool air discharge ports 16. The present invention has been proposed to overcome the above-described problems in the prior art, and accordingly it is the object of the present invention to provide a refrigerator having a cool air dispersing device capable of preventing vortex of cool air and distributing the cool air effectively.

A refrigerator according to the present invention is characterised by a pivotable blade for directing cool air being supplied to the compartment through the aperture, drive means for pivoting the blade, temperature sensing means for sensing the temperature distribution in the compartment and control means responsive to the output of the temperature sensing means to control the drive means such that the blade moves so as to direct cool air so as to tend to reduce temperature variations across the compartment.

The blade maybe pivotable about a vertical axis or about horizontal axis.

Preferably, one blade is pivotable about a vertical axis and a further blade for directing cool air being supplied to the compartment through the aperture is pivotable about a horizontal axis. The further blade is preferably driven by said drive means.

Preferably, the control means operates to continuously rotate the or each blade when the temperature variation across the compartment meets a predetermined criteria, for example a temperature differential.

An embodiment of the present invention will now be described, by way of example, with reference to Figures 4 to 14 of the accompanying drawings, in which:-

Figure 1 is a side sectional view of a prior art refrigerator having cool air dispersing blades;

Figure 2 is a partial enlarged sectional view of Figure 1;

Figure 3 is an enlarged exploded perspective view of the main elements of Figure 2;

Figure 4 is a front view of a refrigerator according to the present invention;

Figure 5 is a side sectional view of Figure 4;

Figure 6 is an enlarged exploded perspective view of the cool air dispersing device shown in Figure 5;

Figure 7 is a block diagram for the electronics of the cool air dispersing device of Figure 6;

Figures 8 through 10 are enlarged transverse sectional views showing the cool air dispersing process performed by the horizontally-dispersing blades;

Figures 11 through 13 are enlarged side sectional views showing the cool air dispersing process performed by the vertically-dispersing blades;

Figure 14 is a flow chart illustrating the control process of the refrigerator of Figure 4.

Hereinafter, an exemplary embodiment of the present invention will be described in detail with reference to the accompanying drawings. Parts that are the same as or similar to parts shown in Figures 1 through 3 will be identified with the same reference numerals. The description of the parts which are substantially the same as those of the prior art will be omitted.

Referring to Figures 4 and 5, a refrigerator according to the present invention comprises a freezing compartment 2 and a cooling compartment 3 in a cabinet 1. The compartments 2, 3 are separated by a horizontal partition. Doors 6, 7 are provided respectively for the compartments 2, 3. Shelves 8 for supporting food are provided in the fresh food compartment 3 and divide it into three areas one above another. A special fresh chamber 18 for storing food that requires a specific temperature range is formed at the top of the fresh food compartment 3 and a vegetable chamber 19 for storing vegetables is formed at the bottom of the fresh food compartment 3. A heat pump, comprising a compressor 11, a condenser (not shown), a freezing compartment evaporator 12a, and a fresh food compartment evaporator 12b, is installed in the cabinet 1. Cool air generated by the evaporators 12a, 12b is supplied into the corresponding cooling compartments 2, 3 by the freezing compartment fan 13a and the fresh food compartment fan 13b. A supply duct 15 and a return duct 17 are provided at the back of the fresh food compartment 3. The

cool air generated by the fresh food compartment evaporator 12b is driven by the fresh food compartment fan 13b into the fresh food compartment 3 via the supply duct 15 and the cool air discharge ports 16. A device for dispersing the cool air horizontally is installed in the supply duct 15. A pair of temperature sensors 9a, 9b are installed in the fresh food compartment 3. The first temperature sensor 9a is installed in the upper left portion of the fresh food compartment 3 and the second temperature sensor 9b is installed in the lower right portion of the fresh food compartment 3.

The refrigerator has a device 30 for dispersing cool air horizontally and a device 40 for dispersing the cool air vertically. The horizontally-dispersing device 30 has a vertical shaft 31, three horizontally-dispersing blades 33 having the shape of a planar plate, and a driving motor 35 for rotating the rotational shaft 31. Three horizontally-dispersing blades 33 are spaced along the shaft 31 near respective cool air discharge ports 16. A coupling part 39 at the upper end of the rotational shaft 31 is coupled to a drive shaft 36 of the driving motor 35 and a journal part 32 at the bottom of the rotational shaft 31 is rotatably received in a bearing hole 9g at the bottom of the duct plate 9. It is preferable that the driving motor 35 be a stepping motor whose angular stop position can be controlled. Thus, when the driving motor 35 operates, the horizontally-dispersing blades 33 are rotated by the rotational shaft 31, and cool air is discharged through the cool air discharge ports 16 and dispersed horizontally.

The vertically-dispersing device 40 comprises a plurality of vertically-dispersing blades 57 which are disposed near the cool air discharge ports 16 and which are capable of pivoting about respective horizontal axes, a vertically reciprocable link member 61 in the supply duct 15, and a raising and lowering cam 63 for raising and lowering the link member 61. The vertically-dispersing blades 57 are arcuate so as to accommodate the horizontally-dispersing blades 33, and a horizontal stub shaft 53 extend horizontally from the left and right ends thereof. The duct plate 9 has two opposed flange parts 9e which extend backward from its side margins. The flange parts 9e have a plurality of shaft holes 9f for receiving and rotatably supporting the stub shafts 53. The link member 61 is disposed parallel to the rotational shaft 31. The link member 61 is rod-shaped and has a plurality of partially ring-shaped hinge assembly parts 62 which protrude towards respective vertical-dispersing blades 57. Each of the vertically-dispersing blades 57 has a horizontal, cylindrical hinge part 55 at the middle of its front edge. The hinge assembly parts 62 are engaged by the hinge parts 73 so as to be capable of rotating relatively thereto. The raising and lowering cam 63 is installed on the rotational shaft 31.

The raising and lowering cam 63 comprises a cylindrical cam body 66 and a cam groove 65 formed on the outer surface of the cam body 66. The cam groove 65 is a closed loop having a raising and lowering profile.

On the link member 61 is provided an operation part 67 protruding transversely to the longitudinal direction of the link member and the free end of the operation part 67 is received in the cam groove 65. Furthermore, the link member 61 has a guiding piece 69 protruding toward the duct plate 9. The guiding piece 69 is accommodated in the raising and lowering guiding part 49 formed on the inner wall of the duct plate 9. The raising and lowering guiding part 49 accommodates the guiding piece 69 so as to guide it up and down and prevent the link member 61 from rotating.

Referring to Figure 7, the cool air dispersing device is controlled by a microprocessor 70. The microprocessor 70 receives signals from the first and second temperature sensors 9a, 9b and calculates the temperature distribution on the basis of the sensed temperatures. The microprocessor 70 controls the driving motor 35 according to the calculated temperature distribution. Furthermore, although it is not shown in Figure 7, the microprocessor 70 also controls the compressor 11 and the fans 13a, 13b to control the generation and supply of the cool air.

Referring to Figure 8, when the horizontally-dispersing blades 33 are directed to the front, cool air in the supply duct 15 is discharged directly to the front along both sides of the horizontally-dispersing blades 33. When the horizontally-dispersing blades 33 are rotated to the left or the right as shown in Figures 9 and 10, cool air is discharged toward the left or to the right.

While the horizontally-dispersing device 30 is operating, the raising and lowering cam 63 rotates with the rotational shaft 31, and the link member 61 is raised and lowered by the operation part 67 which is engaged with the cam groove 65 of the raising and lowering cam 63. The up and down movement of the link member 61 causes pivoting of the vertically-dispersing blades 57 relatively to the horizontal rotational shaft 53 through the hinge assembly part 62 and the hinge part 55 of the vertically-dispersing blades 57.

The raising and lowering of the link member 61 is guided vertically by the guiding piece 69 and the raising and lowering guiding part 49. Therefore, the link member 61 does not rotate but reciprocates in the vertical direction while the raising and lowering cam 63 rotates.

Referring to Figure 11, while the vertically-dispersing blades 71 are kept horizontal, cool air is discharged horizontally. When the rotational shaft 31 rotates by about 90 degrees, the vertically-dispersing blades 57 are tilted upward as shown in Figure 12, and, in this situation, cool air is discharged upward to the upper area of the fresh food compartment 3. As the rotational shaft 31 further rotates by about 90 degrees from the position shown in Figure 12, the vertically-dispersing blades 57 are returned to the horizontal state as shown in Figure 11, and as it further rotates by about 90 degrees, the vertically-dispersing blades 57 are tilted downward as shown in Figure 13. In this situation, the cool air is discharged downward.

The operation of the above-described refrigerator will now be described with reference to Figure 14.

The microprocessor 70 checks (step S1) whether the fresh food compartment fan 13b is running or not. If the fresh food compartment fan 13b is running, the microprocessor 70 senses the distribution of the temperature in the fresh food compartment 3 in order to perform the concentrative cooling according to the present invention.

The microprocessor 70 senses (step S2) the temperature in the fresh food compartment 3 using the first and second temperature sensors 9a, 9b, and calculates (step S3) the difference between the temperatures at the sensed positions. The microprocessor 70 calculates the degree of the deviation of the temperatures on the basis of whether the temperature difference is over a predetermined value X or not. In such a situation, the predetermined value X is determined in consideration of the kind, size, and cooling capacity of the refrigerator, and is preferably determined to be from 2 to 3 degrees centigrade.

If the temperature difference is below the predetermined value X, the microprocessor 70 rotates (step S4) the rotational shaft 31 continuously in a constant speed. Therefore, the cool air is dispersed uniformly by the rotating horizontally-dispersing blades 33. The vertically-dispersing device 40 operates together while the horizontally-dispersing device 30 is operating, so cool air is dispersed uniformly in horizontal direction as well as vertical direction. Furthermore, since the horizontally-dispersing blades 33 are planar, vortices in the cool air flow are not generated by the horizontally-dispersing blades 33.

If the temperature difference is over the predetermined value X, the microprocessor 70 compares (step S5) the temperature of the first area sensed by the first temperature sensor 9a with the temperature of the second area sensed by the second temperature sensor 9b, and stops the driving motor 35 so that the horizontally-dispersing blades 33 are directed to the area of higher temperature. Thus, the concentrated cooling of a high temperature area is realized.

In other words, if the temperature of the first area is higher than that of the second area, the microprocessor 70 controls (step S6) the driving motor 35 so that the horizontally-dispersing blades 33 are rotated right as shown in Figure 10. In this situation, the vertically-dispersing blades 57 are rotated upward as shown in Figure 13. Then the cool air is discharged to be concentrated on the first area.

According to a similar manner, if the temperature of the second area is higher than that of the first area, the microprocessor 70 controls (step S7) the driving motor 35 so that the horizontally-dispersing blades 33 are rotated left as shown in Figure 9. In this situation, the vertically-dispersing blades 57 are rotated downward as shown in Figure 12. Then cool air is discharged so as to be concentrated on the second area. Since the cool

air is discharged to the high temperature area in a concentrative manner, the temperature in the fresh food compartment 3 is maintained uniform.

In the present embodiment, horizontally-dispersing blades 33 are disposed in correspondence with respective cool air discharge ports 16. However, a single long blade, extending past all of the cool air discharge ports 16, could be used.

Furthermore, in the present embodiment, the vertically-dispersing blades 57 operate together with the horizontally-dispersing blades 33. However, they could be driven independently. That is, if an additional driving motor controlled by the microprocessor 70 is provided, and the link member 61 is operated not by the raising and lowering cam 63 but by the additional driving motor, it is possible to control independently the angular stop positions of the vertically-dispersing blades 57. Then, the concentrative cooling on a specific area or the dispersing of the cool air by continuous reciprocation can be performed in the vertical direction as well. In this case, it is preferable that a plurality of temperature sensors are provided at a plurality of respective positions. Using the plurality of temperature sensors, the highest temperature area can be detected from among a plurality of areas. The vertically-dispersing blades 57 and the horizontally-dispersing blades 33, which are controlled independently of each other, can then direct cool air to the detected high temperature area.

Claims

1. A refrigerator comprising a cooling compartment (3), an aperture (16) opening into the compartment (3), a heat pump (11, 12b) and cool air distributing means (13b, 30) for supplying cool air generated by the heat pump (11, 12b) to the compartment (3) through the aperture (16), **characterised by** a pivotable blade (33, 57) for directing cool air being supplied to the compartment (3) through the aperture (16), drive means (31, 35, 63, 61) for pivoting the blade (33, 57), temperature sensing means (9a, 9b) for sensing the temperature distribution in the compartment (3) and control means (70) responsive to the output of the temperature sensing means (9a, 9b) to control the drive means (31, 35, 63, 61) such that the blade (33, 57) moves so as to direct cool air so as to tend to reduce temperature variations across the compartment (3).
2. A refrigerator according to claim 1, wherein the blade (33) is pivotable about a vertical axis.
3. A refrigerator according to claim 1, wherein the blade (57) is pivotable about a horizontal axis.
4. A refrigerator according to claim 1, wherein said blade (33) is pivotable about a vertical axis and in-

cluding a further blade (57) for directing cool air being supplied to the compartment (3) through the aperture (16) which is pivotable about a horizontal axis.

5. A refrigerator according to claim 4, wherein the further blade (57) is driven by said drive means (31, 35, 63, 61).
6. A refrigerator according to any preceding claim, wherein the control means (70) operates to continuously rotate the or each blade (33, 57) when the temperature variation across the compartment (3) meets a predetermined criteria.
7. A refrigerator having a cooling compartment for storing food, and a duct being provided in a side wall of said cooling compartment, said duct for forming a cool air passage, said duct having at least one cool air discharge port opened into said cooling compartment, said refrigerator comprising:

a horizontal-dispersing blade of planar plate shape being rotatably installed near the cool air discharge port in said duct, said horizontal-dispersing blade for controlling a discharge direction of cool air discharged through the discharge port horizontally according to an angular position thereof;

a rotational shaft being connected with said horizontal-dispersing blade, said rotational shaft being extended along a vertical axis;

a motor for rotating said rotational shaft, said motor being capable of controlling an angular position thereof;

a plurality of temperature sensors being installed in said cooling compartment; and
a control part for controlling stop positions of said driving motor in an angular direction according to temperatures sensed by said temperature sensors, so that the cool air is supplied to an area of high temperature.

8. The refrigerator as claimed in claim 7, wherein said control part controls said driving motor so that said horizontal-dispersing blade is continuously rotated when a deviation of temperatures sensed by said temperature sensors is below a predetermined value.

9. The refrigerator as claimed in claim 7, further comprising:

a plurality of vertical-dispersing blades having a horizontal rotational axis; and
a means for pivoting said vertical-dispersing blades vertically.

10. The refrigerator as claimed in claim 9, wherein said pivoting means comprises:

a link member having a plurality of hinge assembly parts respectively assembled with said vertical-dispersing blades at positions distanced from said horizontal axis, said link member being capable of moving up and down in the vertical direction; and
a means for elevating/de-elevating said link member.

11. The refrigerator as claimed in claim 10, wherein said elevating/de-elevating means comprises:

an elevation/de-elevation cam being installed on said rotational shaft of said horizontal-dispersing blade, said elevation/de-elevation cam rotating together with said rotational shaft; and
an operation part formed in a body with said link member, said operation part interacting with said elevation/de-elevation cam so that a rotational movement of said elevation/de-elevation cam is transmitted to said link member as an elevational/de-elevational movement thereof.

12. The refrigerator as claimed in claim 11, wherein said elevation/de-elevation cam has a cylindrical cam body coaxially installed on said rotational shaft, and a cam groove which is a closed loop having an elevational/de-elevational cam profile at an outer surface of said cam body; and

said operation part protrudes from said link member and is engaged with said cam groove.

13. The refrigerator as claimed in claim 12, further comprising a means for guiding said link member so as to be capable of moving up and down vertically while preventing rotation of said link member.

14. The refrigerator as claimed in claim 13, wherein said guiding means comprises:

a guiding piece protruding along an axis of said link member; and
a guiding part formed at an inner surface of said duct, said guiding part into which said guiding piece is inserted to be capable of moving up and down.

15. The refrigerator as claimed in claim 7, wherein said driving motor is a stepping motor.

FIG. 1
(PRIOR ART)

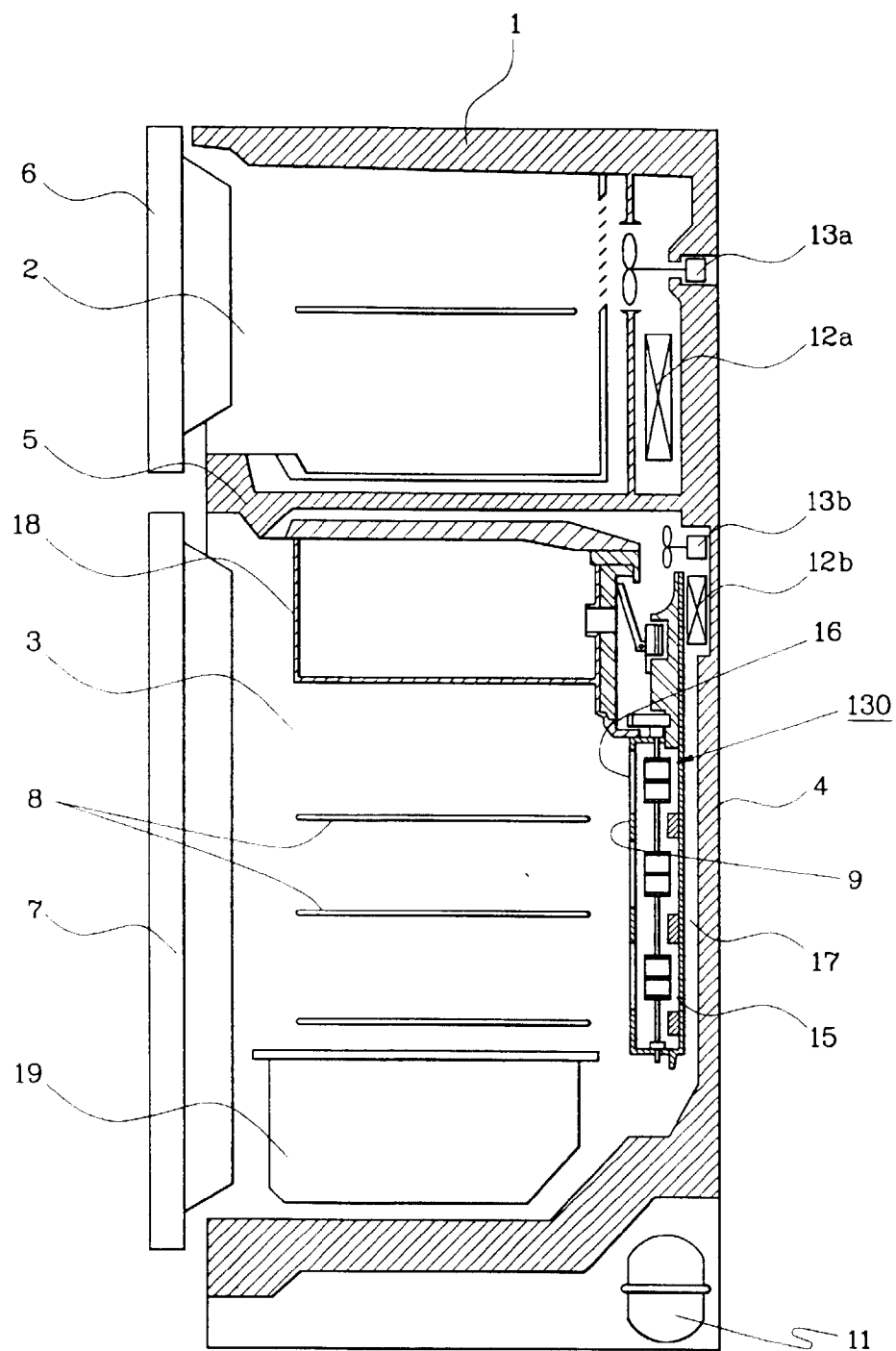


FIG. 2
(PRIOR ART)

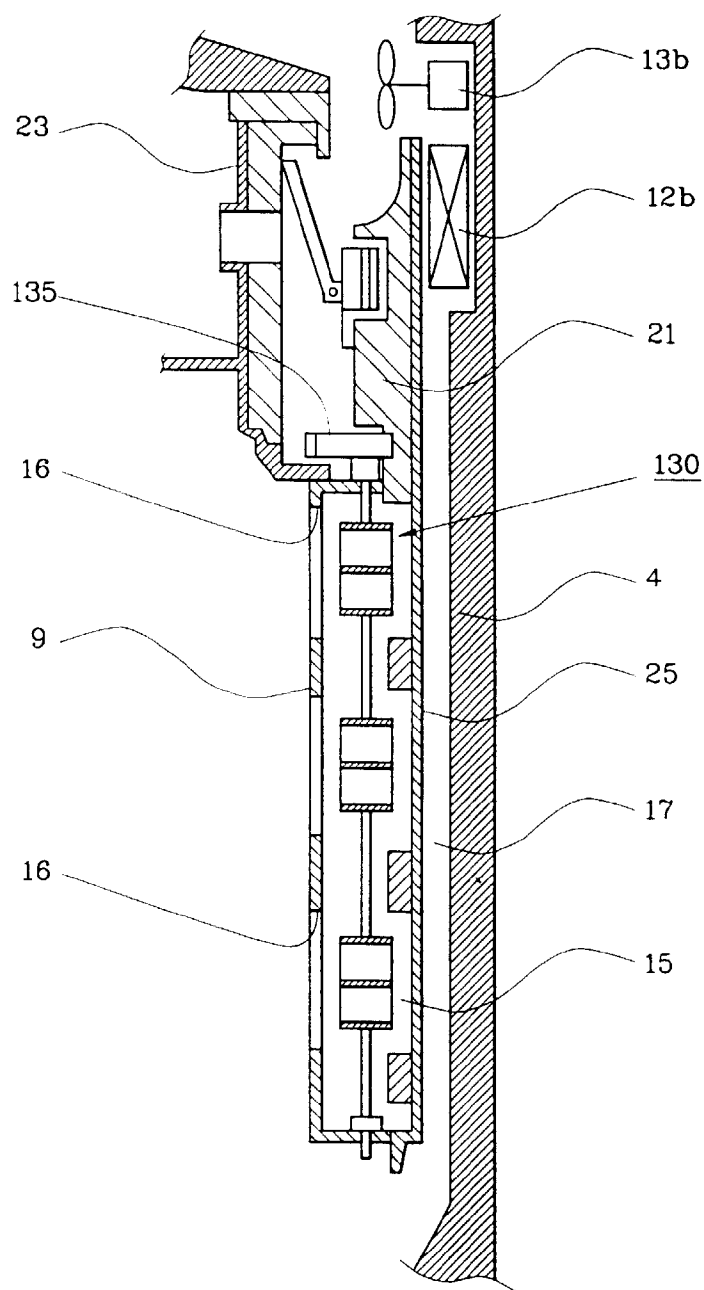


FIG. 3
(PRIOR ART)

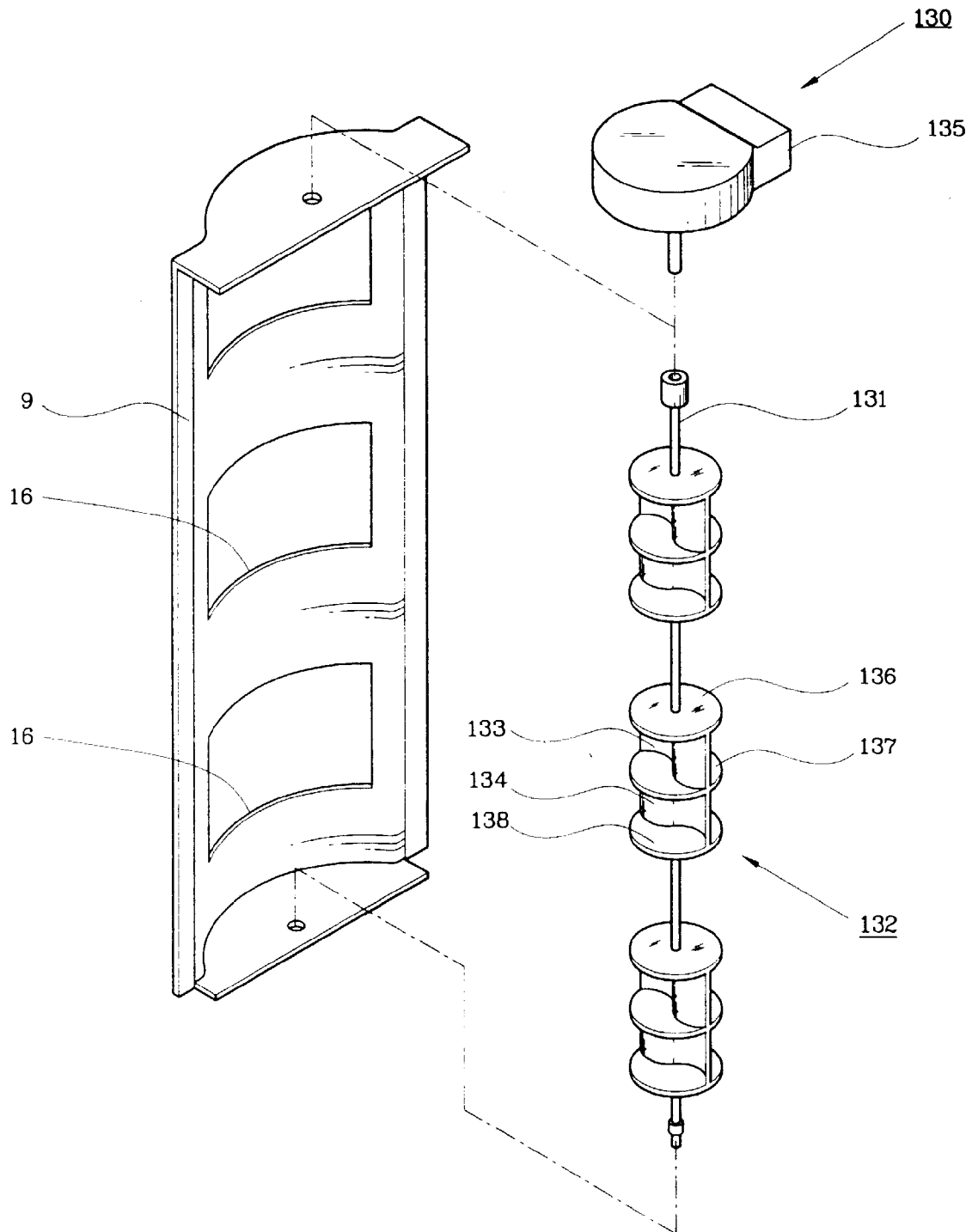


FIG. 4

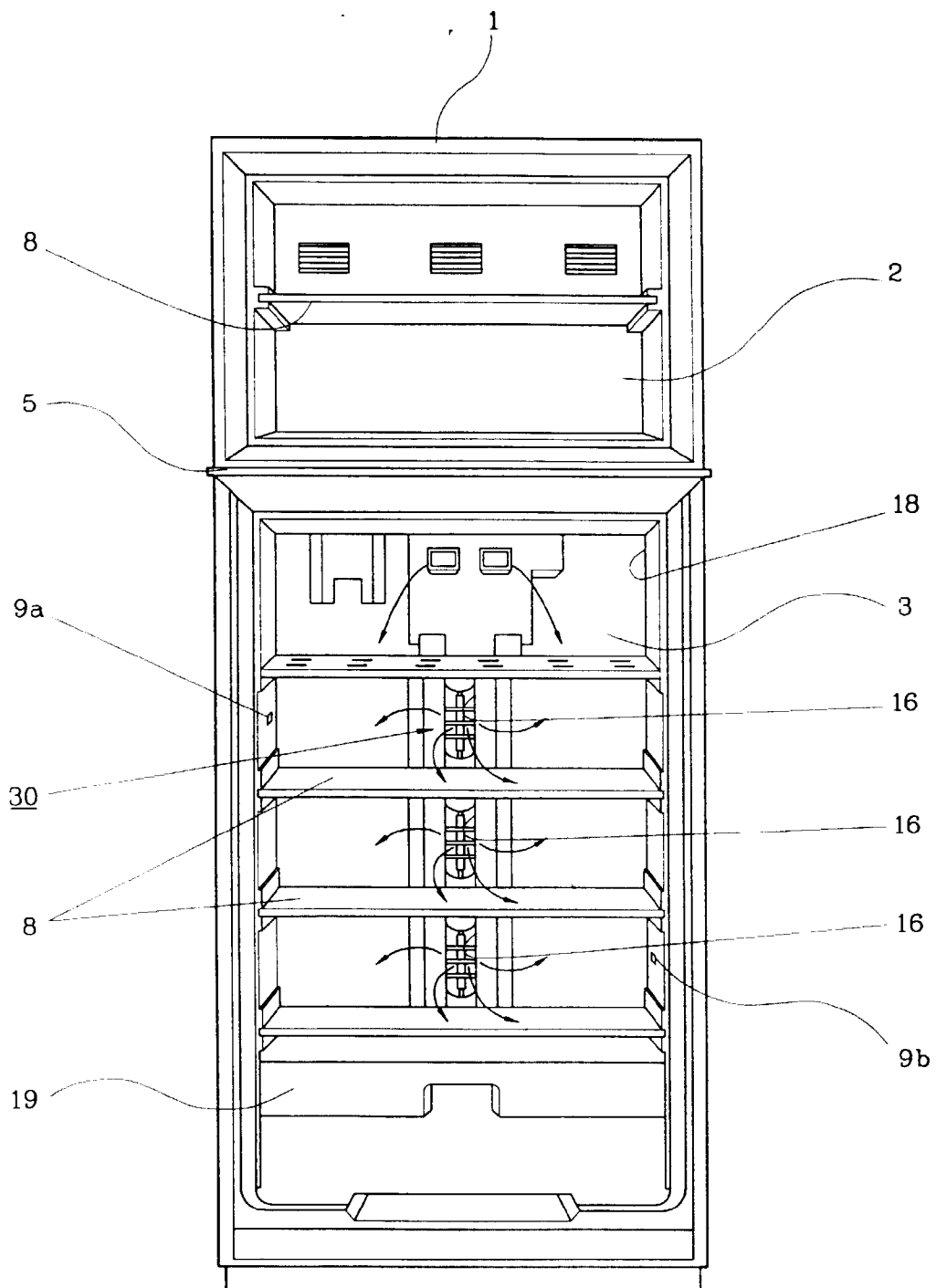


FIG. 5

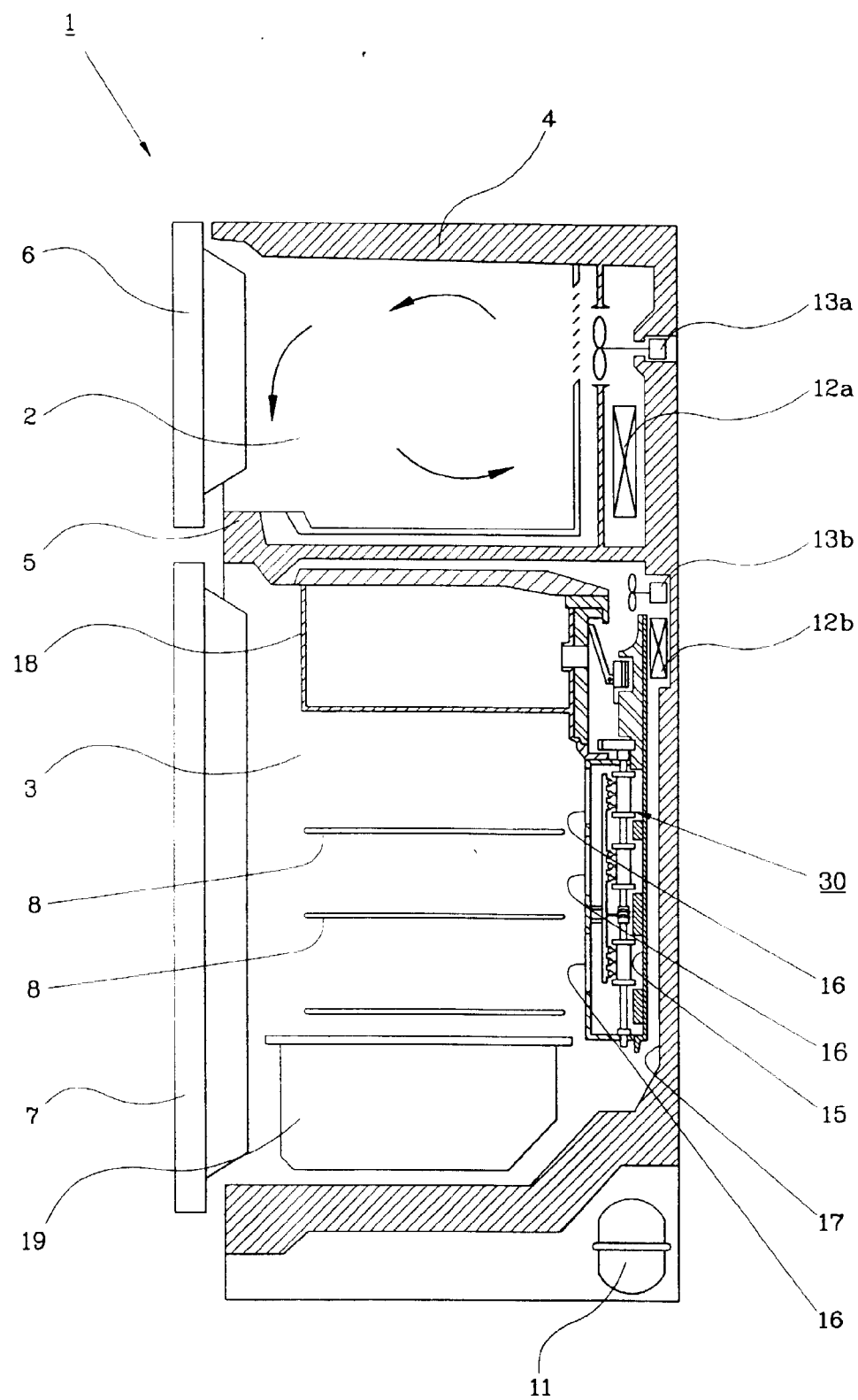


FIG. 6

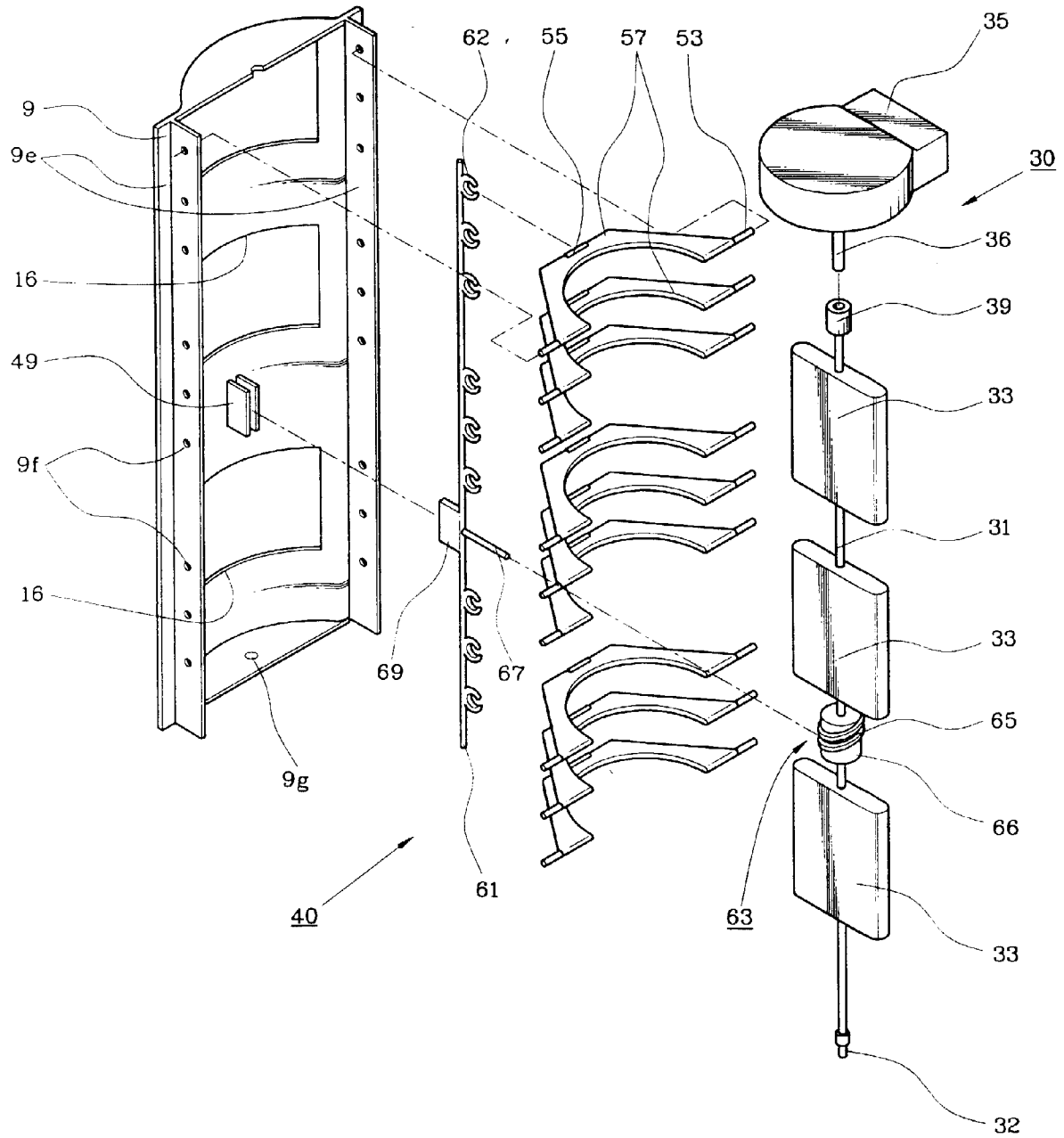


FIG. 7

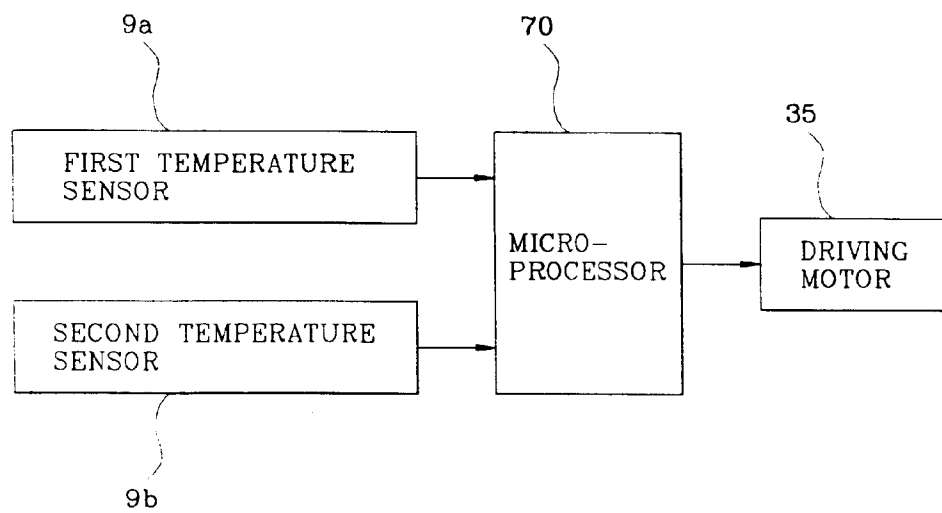


FIG . 8

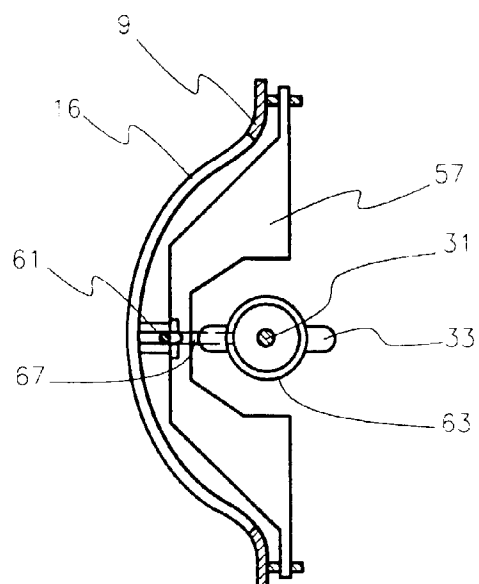


FIG . 9

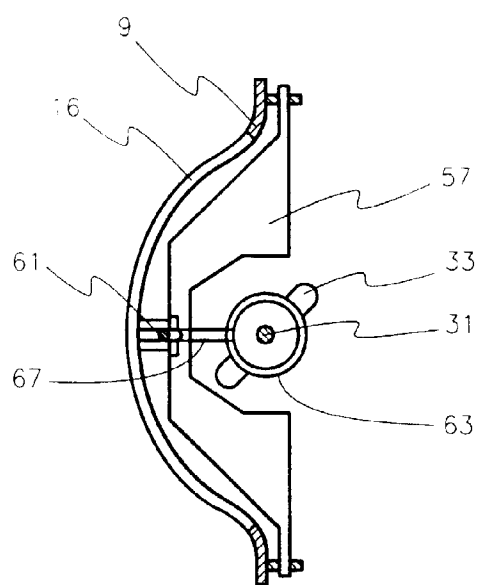


FIG . 10

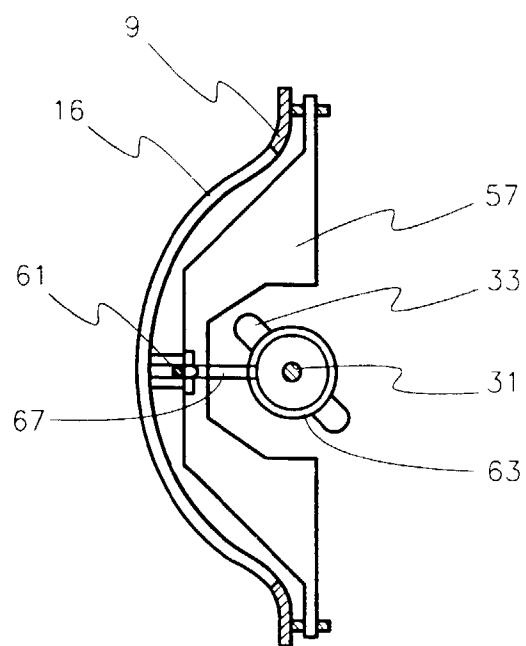


FIG . 11

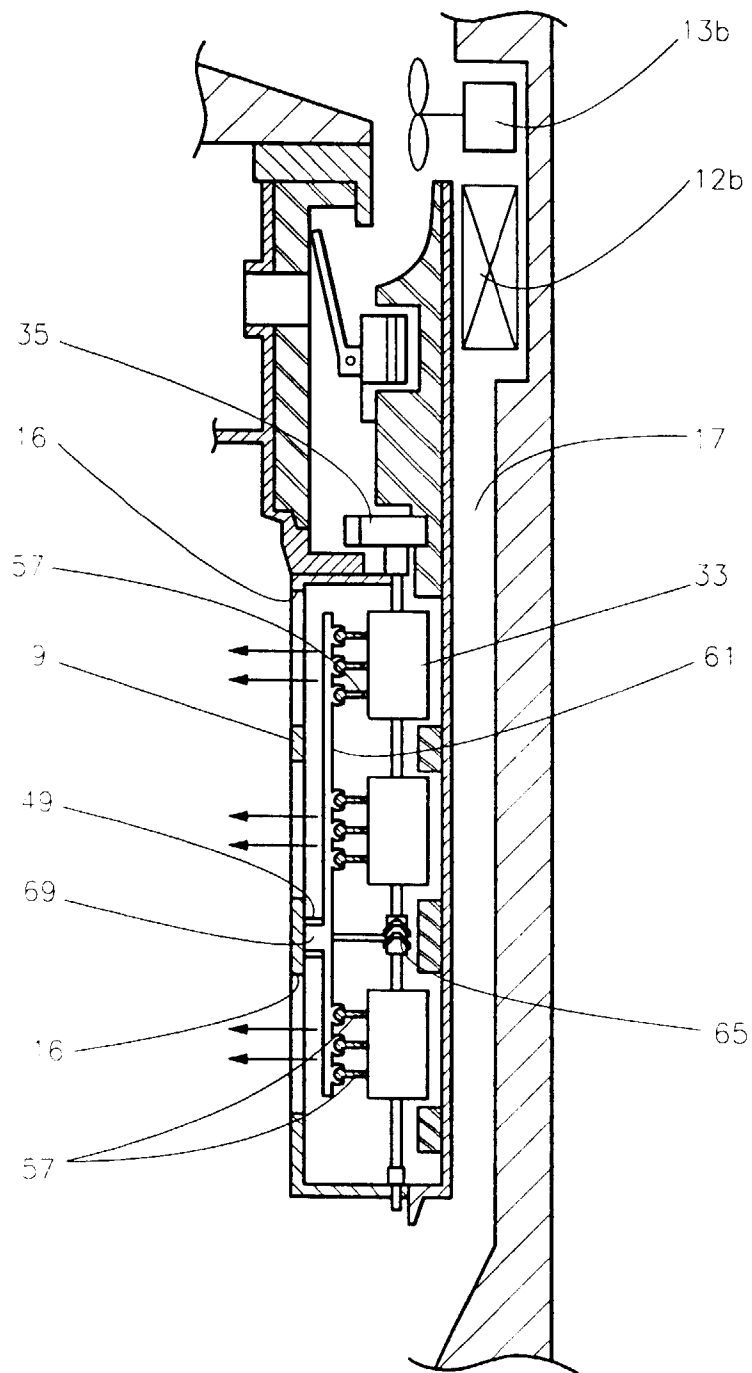


FIG . 12

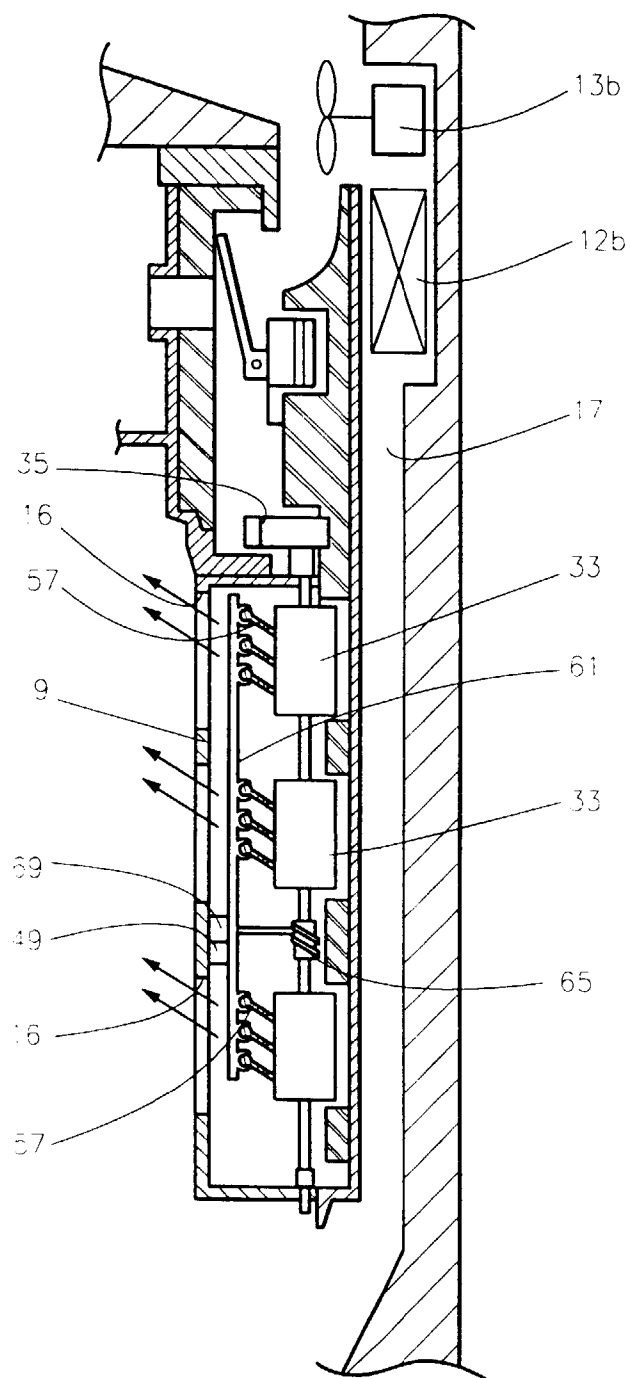


FIG . 13

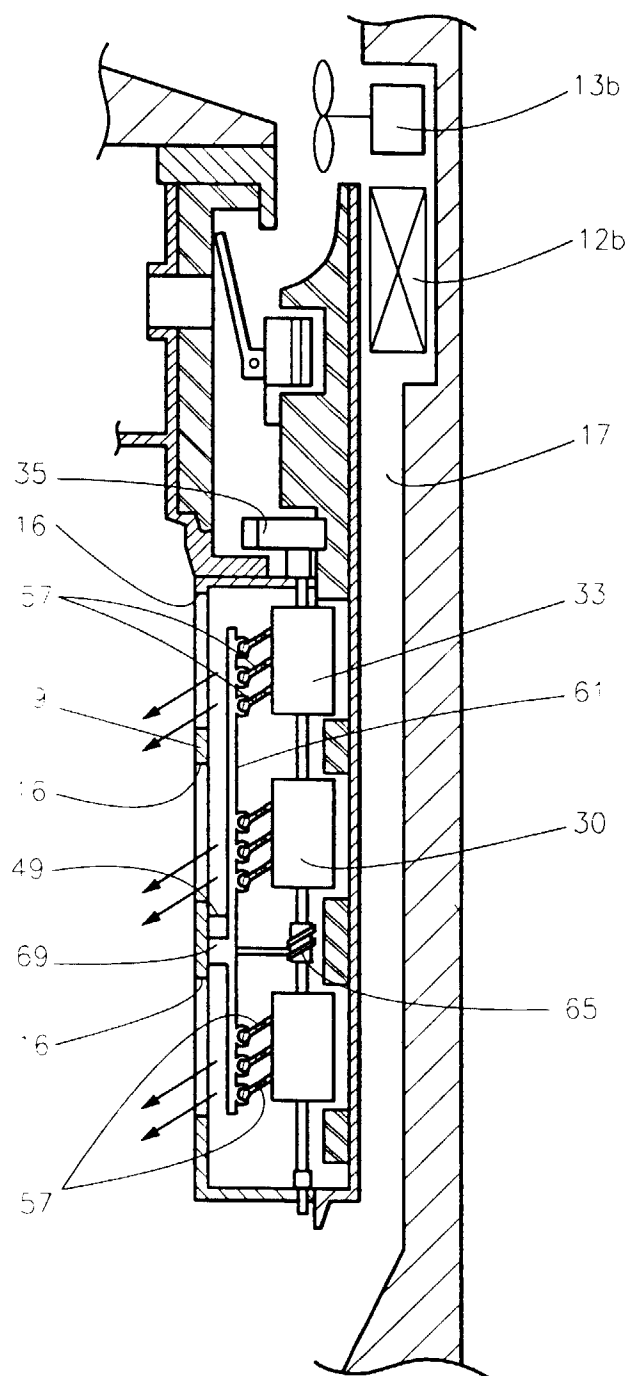


FIG. 14

