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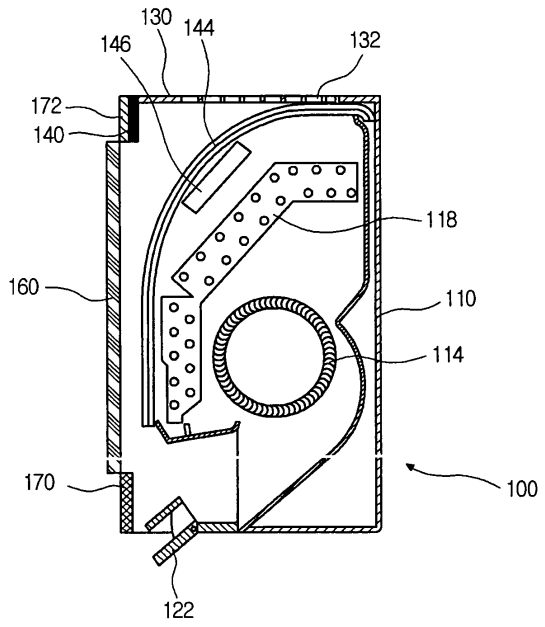
(54) Indoor unit for air conditioner

(57) An indoor unit (100) for an air conditioner includes a casing (102), a front panel (160) installed in front of the casing (102), an air discharge panel (170) installed movably on a side portion of the front panel (160) to selectively open and close an air outlet, and an air discharge vane (122) provided on a side portion of the casing (102) to guide an air exhaust direction.

Fig.5



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Description

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The present invention relates to an air conditioner, and in particular to an indoor unit for an air conditioner.

Description of the Related Art

[0002] Generally, an air conditioner is a system that is used to control the temperature, relative humidity or purity of air, and to circulate cooled air in an enclosed space such as a room. Air conditioners may be classified into a number of types including an integration type where all of components are provided in a single unit, and a separation type having indoor and outdoor units separated from each other.

[0003] Fig. 1 shows a perspective view of an indoor unit of a conventional air conditioner.

[0004] Referring to Fig. 1, an indoor unit of a conventional air conditioner includes a main chassis 1 typically mounted on an inner wall of a room, a front panel 3 installed in front of the main chassis 1, an air intake grill 5a formed on the front panel 3, and an air exhaust grill 7 installed on a lower end of the front panel 3. A display unit 9 for displaying a current operation state and guiding operation by a user is installed between the air intake and exhaust grills 5a and 7.

[0005] Meanwhile, another intake grill 5b may be further provided on a top surface of the main chassis 1.

[0006] The conventional air conditioner has the following problems.

[0007] Since the front panel 3 is rounded and protruded frontward, the internal components may be caused to an external side through the air intake grill 5a formed on the front panel 3. This provides an unfavorable impression to a user. Furthermore, foreign objects and material such as dust may be introduced into the indoor unit.

[0008] In addition, since the air exhaust grill 7 mounted on a lower end of the front panel 3 is oriented downwards, the air cannot be exhausted forwards into the room. Therefore, the effectiveness of the air circulation is reduced.

SUMMARY OF THE INVENTION

[0009] It would be desirable to provide an indoor unit for an air conditioner that addresses one or more problems due to limitations and disadvantages of the related art.

[0010] It would also be desirable to provide an indoor unit for an air conditioner that can improve an outer appearance thereof by preventing internal components from being exposed outside.

[0011] It would also be desirable to provide an indoor unit for an air conditioner that can improve the air circulation by allow cooled air to be exhausted forwards/frontward and/or downward.

[0012] To achieve these objects and other advantages and in accordance with the purpose of the invention, as embodied and broadly described herein, there is provided an indoor unit for an air conditioner, including: a casing; a front panel installed at the front or in front of the casing; an air discharge panel installed movably on a side portion of the front panel to selectively open and close an air outlet; and an air discharge vane provided on a side portion of the casing to guide an air discharge direction.

[0013] In another aspect of the present invention, there is provided an indoor unit for an air conditioner, including: a front frame having an air intake grill; a front panel provided on a front portion of the front frame and defining a front appearance of the indoor unit; a front-upper panel movably provided on an upper portion of the front panel; and an air discharge panel movably provided on a lower portion of the front panel.

[0014] In still another aspect of the present invention, there is provided an indoor unit of an air conditioner, including: a front frame provided with a frontward air outlet, a downward air outlet and a display window; a front-upper panel for selectively screening the display window; an air discharge panel for screening the frontward air outlet; and an air discharge vane for selectively screening the downward air outlet.

[0015] In still yet another aspect of the present invention, there is provided an indoor unit for an air conditioner, including: a casing; a front frame coupled to a front portion of the casing; a front panel pivotally provided on the front portion of the front frame; a front-upper panel provided on an upper portion of the front panel to be capable of pivoting; and an air discharge panel provided on a lower portion of the front panel to be movable upward and downward, wherein the air discharge panel is movable upward and downward by a guide unit without being sided in a direction.

[0016] In still yet another aspect of the present invention, there is provided an indoor unit for an air conditioner, including: a front frame; a front panel pivotally provided on the front portion of the front frame; a decoration link for connecting the front panel to the front frame; a front-upper panel provided on an upper portion of the front panel to be movable upward and downward; and an air discharge panel provided on a lower portion of the front panel to be movable upward and downward, wherein the decoration link has a first end detachably coupled to the front frame.

[0017] According to the present invention, since the indoor unit has the air discharge panel and the air vane, the air exhaust direction can be easily controlled.

[0018] That is, since the air discharge panel and the air discharge vane are designed to be operated independently, the air can be exhausted frontward and/or downward according to the manipulation of the user.

[0019] Describing in more detail, the front-upper panel and the air discharge panel formed on upper and lower portions of the front panel and the air discharge vane provided on a lower end of the front frame are driven by different driving units so that they can be operated independently. Therefore, the air can be exhausted in a desired direction, thereby improving the convenience in use.

[0020] In addition, since the front panel is installed on a front portion of the front frame to be capable of pivoting frontward, the replacement of the air filter and/or the maintenance of the internal components can be easily done by simply opening or removing the front portion or the front panel.

[0021] Furthermore, since the front panel is formed in a smooth plate shape, the outer appearance of the indoor unit is improved and the introduction of foreign objects into the indoor unit can be prevented.

[0022] In addition, since the air inlet/outlet and/or the display unit is formed on the front-upper end of the main chassis, a variety of functions can be realized.

[0023] For example, when the display unit is formed on the front-upper end of the main chassis, the user can identify a variety of information in front of the indoor unit.

[0024] In addition, when the air inlet/outlet is formed on the front-upper end of the main chassis, they can be simultaneously operated with an air inlet and air outlet formed on the upper and lower ends of the indoor unit, the air circulation can be more effectively realized, thereby improving the air conditioning efficiency.

[0025] Meanwhile, when the front upper panel and the air discharge panel are closed, the front panel is disposed on an identical plane with a front surface of the indoor unit and thus the outer appearance of the indoor unit can be improved.

[0026] Furthermore, since the air discharge panel is driven by a plurality of links, the manufacturing costs and load of the products can be further reduced as compared with a conventional art where a rack and pinion are used to drive the front panel.

[0027] In addition, since the panel projections and frame projections are formed on the front and rear surfaces of the air discharge panel, the contact area between the air discharge panel, the front panel and the front frame. That is, when the air discharge panel is driven, the panel projections and the frame projections contact respectively the front panel and the front frame and thus the contact area between the air discharge panel and the front panel or between the air discharge panel and the front frame can be reduced, thereby effectively driving the air discharge panel without any frictional resistance.

BRIEF DESCRIPTION OF THE DRAWINGS

[0028] The accompanying drawings, which are included to provide a further understanding of the invention and are incorporated in and constitute a part of this application, illustrate embodiment(s) of the invention and together with the description serve to explain the principle of the invention. In the drawings:

Fig. 1 is a perspective view of an indoor unit of a conventional separation type air conditioner;

Figs. 2 and 3 are perspective views of an indoor unit for an air condition according to an embodiment of the present invention;

Fig. 4 is an exploded perspective view of the indoor unit of Figs. 2 and 3;

Fig. 5 is a sectional view taken along line I-I' of Fig. 2;

Figs. 6 and 7 are perspective views of a front frame of Figs. 2 and 3, when an air discharge panel is coupled to a front upper panel;

Fig. 8 is a rear perspective view of the front frame of Figs. 6 and 7;

Fig. 9 is a sectional view taken along line II-II' of Fig. 7;

Fig. 10 is a sectional view taken along line III-III' of Fig. 7;

Fig. 11 is a rear perspective view of a front panel according to an embodiment of the present invention;

Fig. 12 is a partly broken, perspective view of a front portion of an air discharge panel according to an embodiment of the present invention;

Fig. 13 is a partly broken, perspective view of a rear portion of an air discharge panel according to an embodiment of the present invention;

Fig. 14 is a perspective view of an indoor unit exhausting air frontward according to an embodiment of the present invention;

Fig. 15 is a sectional view of airflow in the indoor unit of Fig. 14;

Fig. 16 is a perspective view of an indoor unit exhausting air downward according to an embodiment of the present invention;

Fig. 17 is a sectional view of airflow in the indoor unit of Fig. 16;

Fig. 18 is a perspective view of an indoor unit exhausting air downward and frontward according to an embodiment to of the present invention;

Fig. 19 is a sectional view of airflow in the indoor unit of Fig. 18;

Fig. 20 is a perspective view of an indoor unit whose display window is exposed by a front upper panel descended according to an embodiment of the present invention;

Fig. 21 is a perspective view of an indoor unit whose front portion is partly according to an embodiment of the present invention;

Fig. 22 is a perspective view of an indoor unit whose front portion is fully opened according to an embodiment of the present invention;

Fig. 23 is a side sectional view of an indoor unit to which indoor air is introduced through a front portion according to an embodiment of the present invention;

Fig. 24 is a side sectional view of an indoor unit to which indoor air is introduced through a front portion according to another embodiment of the present invention;

Fig. 25 is an indoor unit where an front upper panel and an air discharge panel are disposed on a same plane as that of a front panel according to an embodiment of the present invention;

Fig. 26 is a side sectional view illustrating operations of the front-upper panel and air discharge panel of Fig. 25; and

Fig. 27 is a side sectional view illustrating operations of the front-upper panel and air discharge panel according to another embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0029] While the present invention has been particularly shown and described with reference to exemplary embodiments thereof, it will be understood by those of ordinary skill in the art that various changes in form and details may be made therein without departing from the scope of the present invention as defined by the following claims.

[0030] Figs. 2 and 3 show an indoor unit for an air conditioner according to an embodiment of the present invention.

[0031] Referring to Figs. 2 and 3, an indoor unit 100 includes a casing 102, a front panel 160 coupled to a front portion of the casing 102, an air discharge panel 170 slidably coupled to a lower end of the front panel 160, a front-upper panel 172 slidably coupled to an upper end of the front panel 160, and an air discharge vane 122 slidably coupled to a lower end of the casing 102.

[0032] The casing 102 includes a main chassis 110 and a front frame 130 coupled to a front portion of the main chassis 110 and a front frame 130 coupled to a front portion of the main chassis 110. An air intake grill 132 is formed on a top surface of the front frame 130 and a remote control signal receiving portion 150 is formed on a lower portion of the casing 102.

[0033] The air introduced through the air intake grill 132 passes through a heat exchanger installed in the indoor unit and is then exhausted to the room through the air discharge vane 122. By the vertical movement of the air discharge panel 170, the air is exhausted frontward from the indoor unit 100. This will be described later.

[0034] Fig. 4 is an exploded perspective view of the indoor unit and Fig. 5 is a side sectional view of the indoor, which is taken along line I-I' of Fig. 2.

[0035] Referring to Figs. 4 and 5, the indoor unit 100 of the air conditioner is formed in a hexahedron shape and the casing defines a contour of the indoor unit 100.

[0036] That is, the indoor unit 100 includes a heat exchanger 118 coupled to a front portion of the main chassis 110 to allow the air introduced to heat-exchange with a refrigerant, a blower fan 114 installed in rear of the heat exchanger 118 to intake and exhaust the indoor air, a motor assembly 116 installed on a side portion of the main chassis 110 to drive the blower fan 114, and an air filter 144 and electric dust collector 146 detachably mounted on the front portion of the front frame 130.

[0037] The main chassis 110 includes a rear chassis unit 110' defining a rear contour of the main chassis 110 and a front chassis unit 110' positioned in front of the rear chassis 110'. The main chassis 110 is provided at the top with an air inlet 112 through which the indoor air is introduced. The air intake grill is positioned on the air inlet 112.

[0038] The blower fan 114 may be a cross flow fan arranged horizontally. The air introduced through the air inlet 112 is exhausted through the air discharge vane 122 by the blower fan 114.

[0039] The motor assembly 116 is installed at right side of the flower fan 114 to generate rotational force using electric power applied from an external side. The rotational force generated by the motor assembly 116 is transmitted to the flower fan 114.

[0040] In addition, the heater exchanger 118 is installed in front of the front chassis 110'' to heat-exchange the air introduced through the air inlet 112 with the air. That is, like the blower fan 114, the heat exchanger 118 is disposed to extend horizontally such that it can enclose the front and upper portions of the blower fan 114. The main display unit 120 is formed on the front-upper end of the front chassis 10''. The main display unit 120 displays a variety of information and is selectively screened by the front-upper panel 172.

[0041] The air discharge vane 122 installed on the lower end of the front chassis unit 110'' over the lower end of the front frame 130.

[0042] The air discharge vane 122 is driven by a driving unit (not shown) and simultaneously or independently opened and closed together with or from the air discharge panel 170 and the front-upper panel 172.

[0043] A mode display unit 124 is further provided on the front-right-lower end of the front chassis unit 110" . The mode display unit 124 displays a current operation mode or a current setting state of the air conditioner.

[0044] The front frame is installed in front of the main-chassis. That is, the front frame 130 defines a front contour of the indoor unit 100. The front frame 130 is coupled to enclose the front chassis unit 110" of the main chassis 110. The air intake grill 132 is formed on a top of the front frame 130. That is, the air intake grill 132 is positioned above the air inlet 112 of the main chassis 110 when the front frame 130 is coupled to the main chassis 110. The air intake grill 132 is provided with a plurality of slits through which the air passes.

[0045] The front frame 130 is provided with a filter supporting portion 134 and dust collector supporting portion 136 for respectively supporting the air filter 144 and dust collector 146. A checking hole 138 is formed near a front-right end of the front frame 130. A checking plate 138' is selectively mounted in the checking hole 138. Therefore,

the checking plate 138' selectively opens and closes the checking hole 138.

[0046] A display window 140 is formed on a front-upper end of the front frame 130. The display window 140 is sized to correspond to the main display unit 120 of the main chassis 110 and formed in a transparent material. Therefore, the information displayed on the main display unit 120 can be identified in front of the front frame 130.

[0047] Meanwhile, a mode display window 142 is formed on a front-lower right side of the front frame 130. The mode display window 142 is also formed of a transparent material and sized to correspond to the mode display unit 124 of the main chassis 110. Therefore, the information displayed on the mode display unit 124 can be identified in front of the front frame.

[0048] As described above, the air filter 144 and the electric dust collector 146 are mounted on the front frame 130. Here, the air filter 144 functions to filter off foreign objects contained in the air introduced through the air inlet 112. The air filter 130 is installed on the front and upper portions of the front frame 130. The air filter 144 is formed of a flexible material so that it can be curved at a predetermined curvature when viewed from a side.

[0049] In addition, the electric dust collector 146 functions to collect foreign objects such as dusts contained in the air through an ionizing process using electric power applied from the external side. The electric dust collector 146 is installed in rear of the air filter 144 and supported by the dust collector supporting portion 136.

[0050] In addition, the remote control signal receiving unit 150 has a circular button structure for receiving a signal transmitted from a remote controller, thereby controlling the operation of the air conditioner. As described above, the remote control signal receiving unit 150 is provided on the bottom of the front frame 130 considering that the indoor unit 100 is generally mounted at a predetermined height of the inner wall of the room.

[0051] In addition, the front panel 160 installed in front of the front frame 130 is formed in a rectangular flat plate to define a front contour of the indoor unit 100. That is, the front panel 160 includes a decoration glass 162 that is transparent while, if required, having a predetermined color, and a decoration frame 164 on which the decoration glass 162 is mounted.

[0052] Furthermore, the decoration frame 164 is sized and shaped to correspond to the decoration glass 162. The decoration glass 162 may be attached to the decoration frame 164 using an adhesive of coupled to the decoration frame 164 using a coupling unit such as a hook or a screw.

[0053] The air discharge panel 170 coupled to a lower portion of the front panel 160 has a length corresponding to a left-and-right length of the front panel 160. The air discharge panel 170 can move upward or downward by a lower panel driving unit 190' (see FIG. 8) that will be described later.

[0054] In the indoor unit 100, when the blower fan 114 is driven, the indoor air is introduced into the indoor unit 100 through the air intake grill 132 and air inlet. Then, the air passes through the air filter 144 and electric dust collector 146, in the course of which the foreign objects contained in the air is filtered off. Then, the air is heat-exchanged with the refrigerant while passing through the heat exchanger. In the heating mode, the room temperature increases. In the cooling mode, the room temperature decreases. The air heat-exchanged with the refrigerant is exhausted to the room through the air outlet opened by the air discharge vane 122 and air discharge panel 170.

[0055] Figs. 6 and 7 are perspective views of the front frame of Figs. 2 and 3, when an air discharge panel is coupled to the front upper panel.

[0056] Referring to Figs. 6 and 7, a frontward air outlet 174 is formed on a lower -center portion of the front frame 130. That is, the frontward air outlet 174 is formed to extend from the mode display window 142 to a left end. The air introduced by the blower fan 114 is exhausted frontward of the indoor unit 100. Then, the frontward air outlet 174 is selectively screened by the air discharge panel 170. When the air discharge panel 170 moves upward, the frontward air outlet 174 is opened. When the air discharge panel 170 moves downward, the frontward air outlet 174 is screened.

[0057] In addition, the front frame 130 is provided at a bottom with a receiving hole 152 in which the remote control signal receiving unit 150. A cover 154 is further installed at a lower portion of the remote control signal unit 150 to enclose the remote control signal receiving unit 150. The cover 154 of the remote control signal receiving unit 150 may be formed of a transparent material.

[0058] In addition, the front frame 130 is provided at a front portion with a plurality of coupling and supporting grooves 180 and 182. That is, the coupling and supporting grooves 180 and 192 are portions in which coupling and supporting projections 220 and 222 (see Fig. 11) are inserted. Here, the number and forming positions of the coupling and supporting grooves 180 and 182 are not limited to this embodiment.

[0059] Meanwhile, link seating portions 210 are formed on respective front-left and front-right side ends of the front frame 130. Decoration links 230 (see Fig. 11) seat on the link seating portions 210. The link seating portions 210 are concaved to depths corresponding to the decoration lines 230. That is, in a state where the front panel 160 is closed, the decoration links 230 are inserted into the line seating portion 210 and thus no gap is formed between the front panel 160 and the front frame 130.

[0060] In addition, a link shaft cover 212 is formed on a lower end of the link seating portions 210. The link shaft cover 212 is a portion in which the link projection 232 formed on an end of the decoration link 230 is inserted. An upper portion of the link shaft cover 212 is partly opened. That is, the link shaft cover is formed in a hook-shape when viewed from a side. The line projection 232 is inserted and hooked on the link shaft cover 212.

[0061] In addition, a switch groove 214 is formed on a right side of the front frame 130. An operation switch (not shown) is installed in the switch groove 214. The operation switch is provided to forcedly operate or stop the air conditioner by the user.

[0062] Meanwhile, the operation switch is separately provided on the side surface of the front frame 130 or integrally provided with the remote control signal receiving unit 150. That is, the on/off operation switch is inserted in the receiving hole 152 formed on the bottom of the front frame and a remote control signal receiving unit 150 may be installed in the operation switch. At this point, the cover of the operation switch may be formed of a transparent material.

[0063] A plurality of guide units 200 and 200' are formed on a front-lower portion of the front frame 130 to guide the vertical movement of the air discharge panel 170 without shaking or moving in a side direction. The guide units 200 and 200' will be described in more detail with reference to the accompanying drawings later.

[0064] Fig. 8 is a rear perspective view of the front frame.

[0065] Referring to Fig. 8, panel driving units 190 and 190' are respectively installed on a rear surface of the front frame to control the vertical movement of the air discharge panel 170 and the front-upper panel 172. That is, the upper panel driving unit 190 is provided near the rear-upper end of the front frame 130 and the lower panel driving unit 190' is provided on the rear-lower end of the front frame to control the vertical movement of the air discharge panel 170.

[0066] The upper and lower panel driving units 190 and 190' are identical in the structure to each other. The upper and lower panel driving units 190 and 190' are symmetrically installed in the vertical direction. In the following description, only the lower panel driving unit 190' will be described.

[0067] The panel driving unit 190' includes a driving motor 192 installed on a rear left end or a rear right end of the front frame 130 to generate rotational force, a driving shaft installed on the rear surface of the front frame 130 horizontally transmit the rotational force generated by the driving motor 192, a shaft supporting unit 195 for supporting the driving shaft 194, and a link 196 for connecting the driving shaft 194 to the front-upper panel 172 or the air discharge panel 170.

[0068] The driving motor 192 may be a step motor installed on the rear surface of the front frame 130. The driving shaft 194 extends from a central axis of the driving motor 192 to transmit the rotational force generated from the driving motor 192 to the link 196. The driving shaft 194 extends from a left end to a right end of the front frame 130. The link 196 is pivotally installed on the both ends of the driving shaft 194.

[0069] The link 196 is provided by a plurality to convert the rotation motion of the driving shaft 194 into a vertical motion and transmit the vertical motion to the air discharge panel 170 or the front-upper panel 172.

[0070] That is, the link 196 includes a shaft link 196' fixedly coupled to the driving shaft 194 and a panel link 196'' hingedly coupled to the air discharge panel 170 or front-upper panel 172. The shaft link 196' is pivotally coupled to the panel line 196''. Therefore, the shaft link 196' and the panel link 196'' may be linearly arranged or arranged with a between angle. Therefore, the air discharge panel 170 or front-upper panel 172 can move upward or downward.

[0071] Connecting slits 198 are formed on left and right side ends of the front frame 130 and the panel link 196" is connected to the air discharge panel 170 or front-upper panel 172 through the connecting slits 198. Therefore, by the rotational force of the driving motor 192, the air discharge panel 170 and the front-upper panel 172 move upward or downward as the between angle θ is reduced and increased. That is, as the between angle is reduced, the air discharge panel 170 moves upward to open the frontward air outlet 174. The front-upper panel 172 moves downward to expose the display window to the external side.

[0072] On the contrary, when the angle between the shaft link 196' and the panel link 196'' increases or becomes 180°, the air discharge panel 170 moves downward and the front-upper panel 172 moves upward. Therefore, the frontward air outlet 174 is screened by the air discharge panel 170 and the display window is 140 closed by the front-upper panel 172 so that the information display on the main display unit 120 cannot be identified from the external side.

[0073] In addition, a link guide 199 is further formed on a rear portion of the connecting slit 198. The link guide 199 receives a panel supporting unit 240 (see Fig. 12). That is, the link guide 199 guides the vertical movement of the panel supporting unit 240 to which an end of the panel link 196'' is coupled.

[0074] Meanwhile, the front frame 130 is further provided with guide units 200 and 200' for guiding the vertical movement of the air discharge panel 170.

[0075] That is, the guide unit 200 is provided on a left side of the front frame 130 when viewed from a front side and the guide unit 200' is provided on a right side of the front frame 130. The guide units 200 and 200' are symmetrically disposed. The coupling structure of the guide units 200 and 200' will now be described in detail with reference to the accompanying drawings.

[0076] Fig. 9 is a sectional view taken along line II-II' of Fig. 7 and Fig. 10 is a sectional view taken along line III-III' of Fig.7.

[0077] Referring to Figs. 9 and 10, the guide unit 200, 200' includes a frame guide 202, 202' and a panel guide 204, 204'.

[0078] That is, the left guide unit 200 includes the left frame guide 202 and the left panel guide 204. The right guide unit 200' includes the right frame guide 202' and the right panel guide 204'.

[0079] That is, the left and right guide units 200 and 200' are symmetrical with reference to the vertical line.

That is, the left and right frame guides 202 and 202' are symmetrical with each other and the left and right panel guides 204 and 204' are also symmetrical with each other.

[0080] For example, the left panel guide 204 extends downward from the bottom of the air discharge panel 170 and perpendicularly bent rightward to have a $L_{L\text{-shape}}$. The right panel guide 204' extends downward from the bottom of the air discharge panel 170 and bent leftward to have a ⌟-shape.

[0081] In addition, the left frame guide 202 extends vertically upward from the top of the front frame 130 and bent leftward to have ¬-shape and the right frame guide 202' extends upward from the top of the front frame 130 and bent right ward to have a Γ-shape.

[0082] Accordingly, the left panel guide 204 and the left frame guide 202 slide in a state where they are combined and the right panel guide 204' and the right frame guide 202' slide in a state where they are combined.

[0083] The reason for symmetrically forming the left and right guide units 200 and 200' is to prevent the air discharge panel 170 and the front frame 130 from being sided during the sliding motion thereof and thus prevent them from being separated from the front frame 130.

[0084] FIG. 11 is a rear perspective view of the front panel according to an embodiment of the present invention.

[0085] Referring to FIG. 11, a plurality of coupling and supporting projections 220 and 222 are formed on the rear surface of the front panel 160.

[0086] That is, three coupling projections 220 are formed to extend rearward at a central-left and central-right ends near the rear-upper end of the front panel 160. The coupling projections 220 are inserted into coupling grooves 180 of the front frame 130. Once the coupling projections 220 are inserted into the coupling grooves 180, they are not removed from the coupling grooves 180 unless the external force is applied thereto.

[0087] Meanwhile, the supporting projections 222 are provided on the rear-lower portion of the front panel 160. The supporting projections 222 extend rearward from the rear surface of the front panel 160 and are inserted into the supporting grooves 182 of the front frame 130.

[0088] The supporting projection 222 is formed in a hook-shape and a hook member may be provided in the supporting groove 182 so that the supporting projection 222 is pivotally hooked thereon. Therefore, the front panel 160 can pivot within a predetermined angle range in a state where the supporting projections 222 are inserted into the supporting grooves 182. That is, the front panel 160 is designed to be opened by pivoting frontward of the front frame 130. When the front panel 160 pivots around the supporting projections 222.

[0089] Meanwhile, the decoration links 230 are installed on the opposite ends of the front panel 160 to control the frontward pivot motion of the front panel 160.

[0090] First ends of the decoration links 230 are pivotally inserted in the left and right side ends of the rear-upper end of the front panel 160. The second ends of the decoration links 230 are pivotally inserted to the front frame 130. The decoration links 230 are formed of one, two or three links. The first ends of the decoration links 230 are hingedly coupled to the rear surface of the front panel 160. The second ends of the decoration links 230 are pivotally inserted in the link shaft cover 212 of the front frame 130. The link projection 232 protrudes sideward at an end of the decoration link 230. The link projection 232 is inserted and hooked in and on the link shaft cover 212 of the front frame 130. That is, the link projection 232 is inserted or removed through an upper opening of the link shaft cover 212.

[0091] Fig. 12 is a partial perspective view of the front portion of the air discharge panel according to an embodiment of the present invention.

[0092] Referring to Fig. 12, the panel supporting units 240 are respectively formed on opposite ends of the air discharge panel 170. That is, the panel supporting units 240 are provided to support the air discharge panel 170 mounted on the front frame 130. Ends of the panel supporting units 240 are inserted in the link guides 199 to be guided upward and downward.

[0093] A link coupling hook 242 is formed on the end of the panel supporting unit 240. The link coupling hook 242 has a circular groove to which one end of the link 196 is connected.

[0094] In addition, a fixing groove 244 is further formed on the lower end of the panel supporting unit 240. The fixing groove 244 is concaved upward from the bottom of the panel supporting unit 240 to receive the lower end of the connecting slit 198. That is, when the air discharge panel 170 moves downward and the lower end of the connecting slit 198 is inserted into the fixing groove 244, the air discharge panel 170 cannot move downward any more.

[0095] In addition, a plurality of panel projections 250 are further formed on the front portion of the air discharge panel 170. That is, the panel projections 250 functions to space the front panel 160 away from the air discharge panel 170 when the air discharge panel 170 moves upward and downward. That is, during the vertical motion of the air discharge panel 170, an extreme end of the panel projection 250 slides along the rear surface of the front panel 160.

[0096] Fig. 13 is a partial perspective view of the rear portion of the air discharge panel according to an embodiment of the present invention.

[0097] Referring to Fig. 13, the frame projection 252 is formed on the rear surface of the air discharge panel 170. That is, the frame projection 252 allows the front frame 130 to be spaced away from the air discharge panel 170 when the air discharge panel 170 moves upward and downward. That is, when the air discharge panel 170 moves in the vertical direction, the rear end of the frame projection 252 contacts the front frame 130.

[0098] By forming the panel projection 250 and the frame projection 252 on the front and rear portions of the

air discharge panel 170, respectively, the contact area of the front panel 160 with the front frame 130 is minimized during the movement of the air discharge panel 170. Therefore, the frictional force between the front panel 160 and the front frame 130 is minimized during the movement of the air discharge panel 170.

[0099] Meanwhile, an end of the panel link 196" is pivotally coupled to the link coupling hook 242 of the panel supporting unit 240.

[0100] That is, from a state shown in Fig. 13, a first link shaft 196''a that is pivotally inserted in the link coupling hook 242 protrudes from the left side of the panel link 196''. A second link shaft 196''b that is coupled to the shaft link 196' protrudes from the upper-right side of the panel link 196''.

[0101] In addition, a first fixing hook 196'a having a shape identical to that of the link coupling hook 242 is formed on the lower end of the shaft link 196'. A second fixing hook 196'b is formed on an upper end of the shaft link 196'. That is, a second link shaft 196'' b of the panel link 196'' is inserted in the first fixing hook 196'' a. Then, the driving shaft 194 is fixedly inserted in the second fixing hook 196'b. Therefore, the shaft link 196' integrally rotates together with the driving shaft 194.

[0102] Fig. 14 is a perspective view of the indoor unit exhausting air frontward according to an embodiment of the present invention and Fig. 15 is a sectional view of airflow in the indoor unit of Fig. 14.

[0103] Referring to Figs. 14 and 15, the indoor unit 100 of the present invention can be configured to exhaust the air only frontward.

[0104] That is, in order to exhaust the air only frontward of the indoor unit 100, the air discharge panel 170 is designed to move upward by the lower panel driving unit 190' in a state where the air discharge vane 122 is closed. That is, the angle between the shaft link 196' and the panel link 196'' is reduced by the driving motor 192. Then, the air discharge panel 170 is guided by the guide units 200 and 200' to move upward of the front frame 130. As a result, the frontward air outlet 174 is opened to allow cooled or heated air to be exhaust to the room through the frontward air outlet 174.

[0105] In addition, as the air discharge panel 170 moves upward, the mode display window 142 is exposed frontward and thus the user can identify the current operation mode of the air conditioner through the mode display window 142.

[0106] Fig. 16 is a perspective view of the indoor unit exhausting air downward according to an embodiment of the present invention and Fig. 17 is a sectional view of airflow in the indoor unit of Fig. 16.

[0107] Referring to Figs. 16 and 17, the indoor unit 100 of the present invention can operate to exhaust the air only downward.

[0108] That is, in order to exhaust the air only downward of the indoor unit 100, the air discharge panel 170 is designed to maintain its downward state to screen the frontward air outlet 174. Then, the air discharge vane 122 pivots by a predetermined angle to open the downward air outlet. Then, the air is guided by the air discharge vane 122 and exhausted downward from the indoor unit 100.

[0109] Fig. 18 is a perspective view of the indoor unit exhausting air downward and frontward according to an embodiment to of the present invention and Fig. 19 is a sectional view of airflow in the indoor unit of Fig. 18.

[0110] Referring to Figs. 18 and 19, the indoor unit 100 of the present invention can operate to exhaust the air frontward and downward.

[0111] That is, in order to exhaust the air downward and frontward of the indoor unit 100, the air discharge panel 170 is designed to move upward to open the frontward air outlet 174 and the air discharge vane 122 pivots by a predetermined angle to open the downward air outlet. Then, the air is exhausted frontward of the indoor unit 100 through the frontward air outlet as well as downward through the air discharge vane 122.

[0112] Fig. 20 is a perspective view of the indoor unit whose display window is exposed by a front upper panel moved downward according to an embodiment of the present invention.

[0113] Referring to Fig. 20, when the front-upper panel 172 moves downward, the display window 140 is exposed at the front-upper portion of the indoor unit 100.

[0114] In order to move the front-upper panel 172 downward, the driving motor 192 is driven to reduce the angle between the shaft link 196' and the panel link 196''. As a result, the front-upper panel 172 slides rearward of the front panel 160. In addition, the display window 140 positioned in rear of the front-upper panel 172 is exposed to the external side so that the user can identify the information displayed on the main display unit 120.

[0115] Fig. 21 is a perspective view of the indoor unit whose front portion is partly according to an embodiment of the present invention.

[0116] Referring to Fig. 21, in order to check or maintain the indoor unit 100 or to replace or clean the components such as the air filter 144, the front panel 160 must pivot frontward.

[0117] Therefore, when the user pulls the upper end of the front panel 160, the coupling projection 220 of the front panel 160 is removed from the coupling groove 180 of the front frame 130. Then, the front panel 160 pivots frontward in a state where the supporting projection 222 formed on the rear-lower portion of the front panel 160 is inserted in the supporting groove 182 of the front frame 130. By this operation, the front panel 160 pivots frontward about the shaft of the supporting projection 222.

[0118] Here, the decoration link 230 has opposite ends that are respectively connected to the front panel 160 and the front frame 130 and thus the opening range of the front panel 160 is limited by the decoration link 230.

[0119] As described above, when the front panel 160 is opened frontward by a predetermined angle, the user can remove or check the internal components such as the air filter 144 from the indoor unit.

[0120] Fig. 22 is a perspective view of the indoor unit whose front portion is fully opened according to an embodiment of the present invention.

[0121] Referring to Fig. 22, when it is difficult to remove or check the internal components such as the air filter in the state of Fig. 21, there is a need to fully remove the front panel 160 from the front frame 130.

[0122] In order to fully remove the front panel 160 from the front frame 130, as shown in Fig. 21, the front panel 160 is lifted in a state where the front panel 160 pivots frontward by a predetermined angle. Then, the supporting projection 222 formed in a hook shape is separated from the supporting groove 182 and thus the front panel 160 is fully removed from the front frame 130.

[0123] In addition, when releasing the front panel 160, as shown in Fig. 22, the front panel 160 hangs on the front frame 130. That is, since the front panel 160 and the front frame 130 are connected to each other by the decoration links 230, the front panel 160 does not fall down. In this state, the user can remove the air filter 144 frontward or check other internal components.

[0124] In addition, since the upper portion of the link shaft cover 212 is opened, the front frame 130 can be fully removed by lifting the front panel 160.

[0125] That is, in a state where the front panel 160 hands on the front frame 130, the front panel 160 is lifted. Then, the link projection 232 of the decoration line 230, which is inserted in the link shaft cover 212 of the front frame 130, is separated through the upper opening of the link shaft cover 212. Then, the front panel 160 is fully removed from the front frame 130.

[0126] Next, when the replacement of the air filter 144 or the checking of the internal components is finished, the front panel 160 is mounted on the front frame 130. This is processed in a reverse order to the above-described separation order.

[0127] Describing in more detail, the link projection 232 of the decoration link 230 is inserted into the link shaft cover 121 as shown in Fig. 22. Then, the supporting projection 222 formed on the rear portion of the front panel 160 is inserted in the supporting groove 182 of the front frame 130 as shown in Fig. 21. Then, the front upper portion of the front panel 16 is pushed rearward so that the coupling projection 220 of the front panel 160 is inserted in the coupling groove 180 of the front frame 130. At this point, since the coupling projection 220 is provided at the end with a projection structure (not shown), the front panel 160 is not opened unless outer force is applied to the front panel 160.

[0128] It will be apparent to those skilled in the art that various modifications and variations can be made in the present invention. Thus, it is intended that the present invention covers the modifications and variations of this invention provided they come within the scope of the above-described technologies and their equivalents.

[0129] For example, in the foregoing embodiment, the link 196 is used as the panel driving units 190 and 190' for driving the front-upper panel 172 and the air discharge panel 170. However, instead of the link 196, a variety of other mechanisms can be used. For example, a rack and pinion can be used as the panel driving units 190 and 190'. That is, the pinion is fixed on the rotational shaft of the driving motor 192 and the rack is formed on surfaces of the air discharge panel 170 and front-upper panel 172. According to the rotation direction of the pinion, the air discharge panel 170 and front-upper panel 72 can move upward and downward.

[0130] In addition, although the front panel 160, front-upper panel 172 and air discharge panel 170 are stepped in the foregoing embodiment, they can be formed on a same plane.

[0131] That is, when the front-upper panel 172 and air discharge panel 170 are closed, the front-upper panel 172 and air discharge panel 170 are positioned rearward by a thickness of the front panel 160. However, by varying the rear surface structure of the front panel 160, the front-upper panel 172 and the air discharge panel 170 may be formed on the same plane when the front-upper panel 172 and the air discharge panel 170 are closed.

[0132] In addition, although the air inlet is formed on only the top of the indoor unit 100 in the foregoing embodiment, the air inlet may be further formed on the front portion of the indoor unit 100 by varying the front structure of the indoor unit 100. Other possible embodiments will now be described in more detail with reference to the accompanying drawings.

[0133] Fig. 23 is a side sectional view of an indoor unit to which indoor air is introduced through a front portion according to an embodiment of the present invention.

[0134] Referring to Fig. 23, a frontward air inlet 260 is formed between an upper end of the front panel 160 and a lower end of the display window 140.

[0135] The front-upper panel 172 is positioned in front of the display window 140 and moves downward through the frontward air inlet 260 to selectively open and close the frontward air inlet 260. As shown in Fig. 23, when the front-upper panel 172 moves downward, the display window 140 and frontward air inlet 260 are simultaneously opened.

[0136] Therefore, the air is introduced into the indoor unit 100 through the air inlet 132 as well as the frontward air inlet 260.

[0137] Fig. 24 is a side sectional view of an indoor unit to which indoor air is introduced through a front portion according to another embodiment of the present invention.

[0138] Referring to Fig. 24, a frontward air inlet 240 is formed on a portion where the main display unit 120 is formed.

[0139] That is, instead of the main display unit 120, the frontward air inlet 260 is formed on the front-upper end of the main chassis 110. In addition, instead of the display window 140, a front air intake grill 262 having a plurality of slits is formed on the front upper end of the front frame 130.

[0140] Therefore, the frontward air inlet 260 and the

front air intake grill 262 are selectively opened and closed by the front-upper panel 172.

[0141] That is, when the front-upper panel 172 moves downward, foreign objects cannot be introduced into the indoor unit 100 by the front air intake grill 262.

[0142] Instead of the frontward air inlet, an upper air outlet may be formed on the portion where the main display unit 120 is formed in the foregoing embodiment. Therefore, the air being exhausted is guided by the upper air outlet. That is, a portion of the air forcedly directed from the blower fan 114 is exhausted frontward through the upper air outlet formed on the front-upper end of the main chassis 110. Then, the air can be exhausted through the front-lower end as well as the front-upper end of the indoor unit 100.

[0143] Meanwhile, in the foregoing embodiment, although the front panel 160, front-upper panel 172 and air discharge panel 170 are stepped in the foregoing embodiment, they can be formed on a same plane. This will now be described with reference to the accompanying drawings.

[0144] Fig. 25 is an indoor unit where an front upper panel and an air discharge panel are disposed on a same plane as that of a front panel according to an embodiment of the present invention and Fig. 26 is a side sectional view illustrating operations of the front-upper panel and air discharge panel panel of Fig. 25.

[0145] Referring to Fig. 25, the indoor unit 100 of the air conditioner has a front portion having a smooth single plane to improve the outer appearance of the indoor unit.

[0146] That is, when the front-upper panel 172 and the air discharge panel 170 are closed, they are arranged in series with the front panel 160. At this point, the front surface of the front panel 160 and the front surfaces of the front-upper panel 172 and air discharge panel 170 are positioned on the same plane.

[0147] More in detail, guide surfaces 160' are formed on rear-upper and rear-lower ends of the front panel 160 to guide the movement of the front-upper panel 172 and air discharge panel 170. In addition, the guide surfaces 160' are inclined at a predetermined angle. Therefore, the front-upper panel 172 and air discharge panel 170 smoothly slide in a state where they contact the rear surface of the front panel 160.

[0148] Referring to Fig. 26, there is shown a state where the front-upper panel 172 and air discharge panel 170 are opened and the front panel 160 is disposed rearward.

[0149] That is, in a state where the front-upper panel 172 and air discharge panel 170 are closed as shown in Fig. 25, the front-upper panel 172 and air discharge panel 170 moves rearward of the front panel 160 along the guide surfaces 160' by the operation of the upper and lower panel driving units 190 and 190' as shown in Fig. 26. As a result, the display window 140 provided on the front-upper end of the front frame 130 is exposed frontward and the frontward air outlet 174 is opened.

[0150] In addition, panel receiving grooves for the respective front-upper panel 172 and air discharge panel 170 are formed on the front portion of the front frame 130 or the rear portion of the front panel 160.

[0151] Meanwhile, the structure for disposing the front panel 160, front-upper panel 172 and air discharge panel 170 on the same plane can be realized by a variety of other structures in addition to the structure shown in Figs. 25 and 26.

[0152] In the embodiment of Figs. 25 and 26, the front-upper panel 172 and air discharge panel 170 are simultaneously moved by the upper and lower panel driving units 190 and 190'. However, the front-upper panel 172 and air discharge panel 170 can be sequentially moved by two driving unit. This and another possible embodiment will now be described.

[0153] Fig. 27 is a side sectional view illustrating operations of the front-upper panel and air discharge panel according to another embodiment of the present invention.

[0154] Referring to Fig. 27, in addition to the upper and lower panel driving units 190 and 190' for moving upward and downward the front-upper panel 172 and air discharge panel 170, a front-rear driving unit (not shown) may be further provided to move frontward and rearward the front-upper panel 72 and air discharge panel 170.

[0155] That is, when the air discharge panel 170 is opened, the air discharge panel 170 moves rearward (in a direction ①) by the front-rear driving unit and then moves upward (in a direction ②) by the lower panel driving unit 190'. Then, the frontward air outlet 174 is opened.

[0156] Next, in order to close the air discharge panel 170, the air discharge panel 170 moves downward (in a direction ①') by the lower panel driving unit 190' and then moves frontward (in a direction ②'). Then, the air discharge panel 170 is fully closed and, at this point, the front surfaces of the air discharge panel 170 and front panel 160 are positioned at the same plane.

[0157] Furthermore, the opening and closing of the front-upper panel 172 can be realized in the same process. Then, the front-rear driving unit may have a structure identical to those of the panel driving units 190 and 190'.

[0158] According to the described embodiments, since the air discharge panel and air discharge vane are provided, the air exhaust direction can be easily can be easily controlled. Furthermore, since the air discharge panel and air discharge vane are independently operated, the air exhaust direction can be easily controlled by the user.

Claims

1. An indoor unit for an air conditioner, comprising a blower fan for introducing and discharging indoor air and a heat exchanger for heat-exchanging with the air introduced by the blower fan, **characterized in that** the indoor unit further comprises:

   a casing having a chassis for receiving the blow-

er fan and the heat exchanger and a front frame coupled to the chassis and having an air intake grill;
an air discharge panel movably installed on a side of the front frame to selectively discharge the air frontward; and
an air discharge vane provided on a side of the front frame to guide the air discharged downward.

2. The indoor unit according to claim 1, **characterized in that** the indoor unit further comprises a front-upper panel installed on the front frame to be movable in a vertical direction and selectively opening a display window coupled to the front frame.

3. The indoor unit according to claim 1, **characterized in that** the indoor unit further comprises a front-upper panel installed on the front frame to be movable in a vertical direction and selectively guiding the air introduced frontward or discharged upward.

4. The indoor unit according to claim 1, **characterized in that** the indoor unit further comprises a front panel pivotally provided in front of the front frame.

5. The indoor unit according to claim 1, **characterized in that** the indoor unit further comprises a front panel detachably coupled to the front frame.

6. The indoor unit according to any one of claims 4 and 5, **characterized in that** the indoor unit further comprises a link member for connecting the front panel to the front frame.

7. The indoor unit according to claim 6, wherein the front frame includes a link seating portion in which the link member is received; and
a link shaft cover in which one end of the link member is removably fitted.

8. The indoor unit according to any one of claims 4 and 5, **characterized in that** the indoor unit further comprises a coupling projection extending from a rear surface of the front panel; and
a coupling groove formed on the front frame to receive the coupling projection.

9. The indoor unit according to any one of claims 4 and 5, **characterized in that** the indoor unit further comprises a supporting projection extending from a rear surface of the front panel and functioning as a pivot axis of the front panel; and
a supporting groove formed on the front frame to receive the supporting projection.

10. The indoor unit according to claim 1, **characterized in that** the indoor unit further comprises a guide unit allowing for the upward and downward movement of the air discharge panel without being sided in a direction.

11. The indoor unit according to claim 10, **characterized in that** the guide unit is provided by a plurality of guides that are symmetrically disposed.

12. The indoor unit according to claim 10, **characterized in that** the guide unit comprises:

a panel guide formed on a rear surface of the air discharge panel; and
a frame guide formed on a front surface of the front frame,
wherein the air discharge panel slides on the front frame by the combination of the panel guide and the frame guide.

13. The indoor unit according to claim 12, **characterized in that** the panel guide and the frame guide are symmetrically bent and slidably coupled to each other.

14. The indoor unit according to claim 1, **characterized in that** the indoor unit further comprises a remote control signal receiving unit coupled to a bottom of the front frame; and
a cover for covering the remote control signal receiving unit.

15. The indoor unit according to claim 1, **characterized in that** the indoor unit further comprises an operation switch provided on a side of the casing.

16. An indoor unit for an air conditioner, comprising a casing having a front frame provided with an air intake grill, a blower fan installed in the case to forcedly introduce and discharge indoor air, and a heat exchanger for heat-exchanging with the air introduced by the blower fan, **characterized in that** the indoor unit further comprises:

a front panel installed in front of the casing;
an air discharge panel installed movably on a lower portion of the front panel to control the air discharged frontward; and
a front-upper panel movably installed on an upper portion of the front panel.

17. The indoor unit according to claim 16, **characterized in that** the air discharge panel and the front-upper panel slide rearward of the front panel.

18. The indoor unit according to claim 16, **characterized in that** the front-upper panel and the air discharge panel are positioned on the same plane as the front panel in a state where the front-upper panel and air discharge panel are closed.

19. The indoor unit according to claim 16, **characterized in that** rear-upper and rear-lower ends of the front panel are inclined at a predetermined angle.

20. The indoor unit according to claim 16, **characterized in that** the display unit mounted on the casing is selectively screened by the vertical motion of the front-upper panel.

21. The indoor unit according to claim 16, **characterized in that** the front frame is provided at a lower end with an air outlet that is selectively closed by the air discharge panel.

22. The indoor unit according to claim 16, **characterized in that** the indoor unit further comprises an air discharge vane provided on a lower end of the casing to guide the heat-exchanged air discharged downward.

23. The indoor unit according to claim 22, **characterized in that** the heat-exchanged air is discharged forward and/or downward by the operation of the air discharge panel and air discharge vane.

24. The indoor unit according to claim 16, **characterized in that** the front-upper panel and air discharge panel move frontward/rearward and upward/downward sequentially so that the front-upper panel and the air discharge panel can be positioned on the same plane as the front panel.

25. The indoor unit according to claim 16, **characterized in that** the front frame is provided at a front portion with an air inlet that is selectively closed by the front-upper panel.

26. The indoor unit according to claim 25, **characterized in that** an air intake grill is formed in the air inlet.

27. The indoor unit according to claim 16, **characterized in that** the front frame is provided at a front portion with an air outlet that is selectively closed by the front-upper panel.

28. The indoor unit according to claim 16, **characterized in that** the indoor unit further comprises a mode display unit provided on a lower portion of the front frame, wherein the mode display unit is selectively screened by the air discharge panel.

29. The indoor unit according to claim 16, **characterized in that** the indoor unit further comprises a remote control signal receiving unit and power switch provided on a side of the casing, wherein the remote control signal receiving unit is integrally formed with or independently formed from the power switch.

30. The indoor unit according to claim 16, **characterized in that** the indoor unit further comprises a vertical driving unit for vertically moving the front-upper panel and the air discharge panel.

31. The indoor unit according to claim 30, **characterized in that** the panel driving unit comprises:

a driving motor for generating rotational force for moving the front-upper panel and air discharge panel upward and downward;
a driving shaft for transmitting the rotational force; and
a link member for converting a rotational force into a reciprocal motion by connecting the driving shaft to the front-upper panel or air discharge panel.

32. The indoor unit according to claim 28, **characterized in that** the link member comprises:

a shaft link connected to the driving shaft; and
a panel link connecting the shaft link to the front-upper panel or air discharge panel.

33. The indoor unit according to claim 31, **characterized in that** the link member is a single-link or a multi-link.

34. The indoor unit according to claim 25, **characterized in that** the front-upper panel or a front or rear surface of the air discharge panel is provided with a plurality of projections.

Fig.1

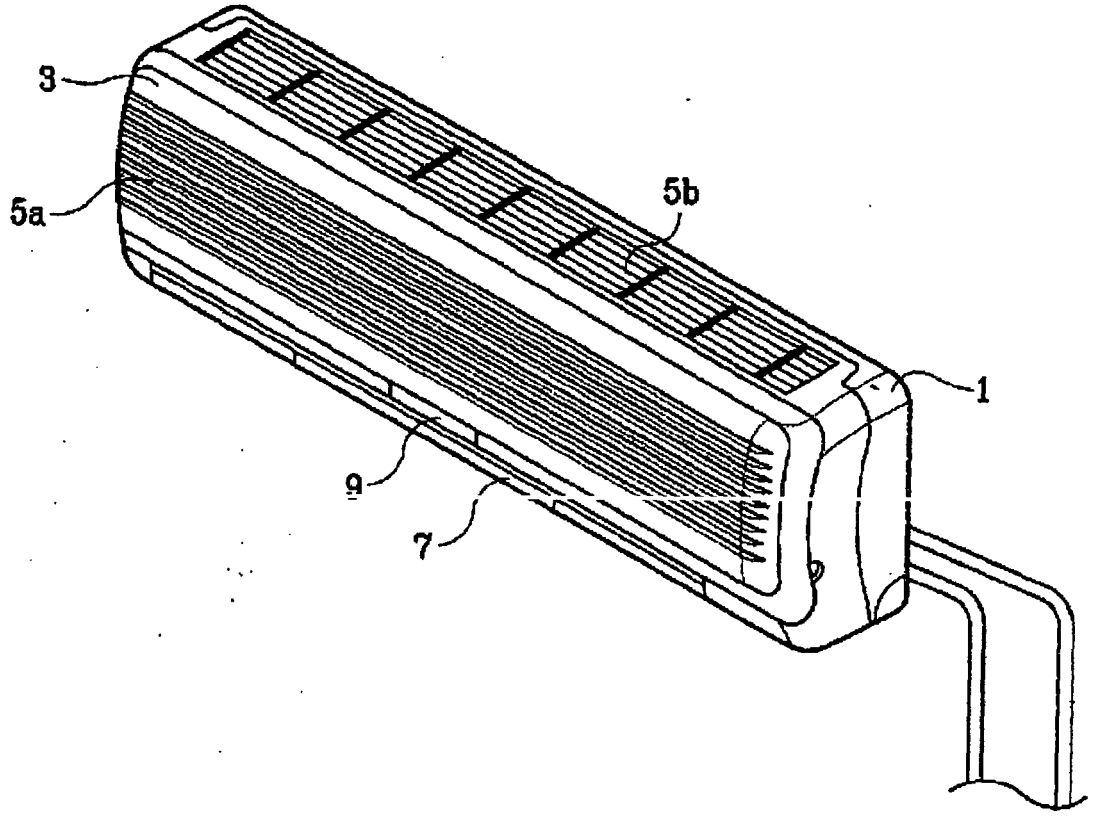
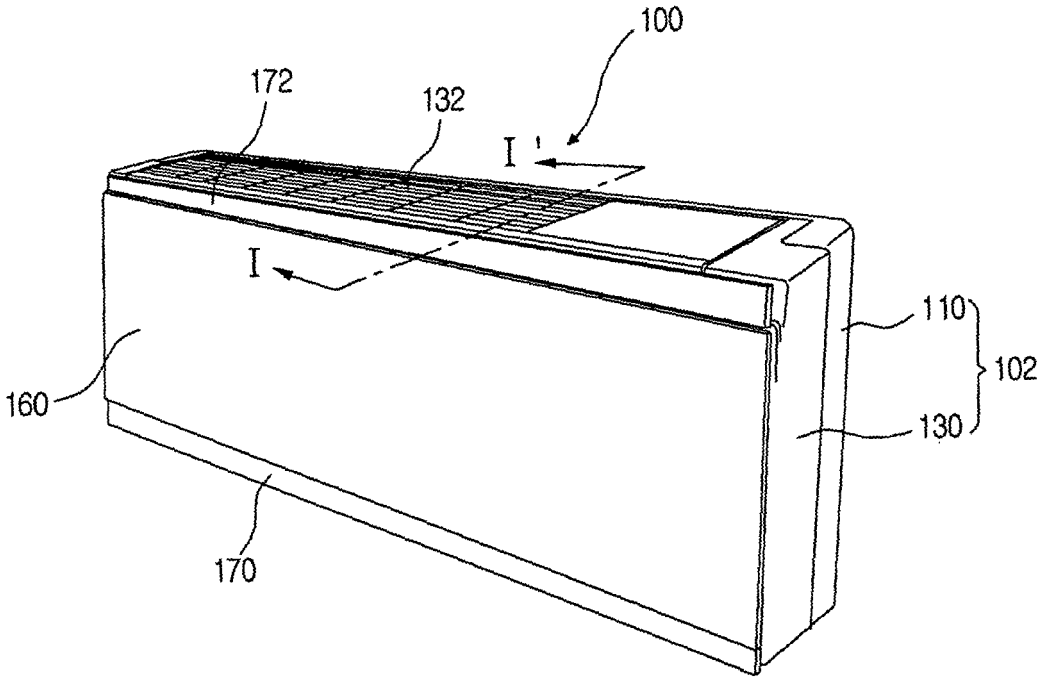


Fig.2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170

Fig.3

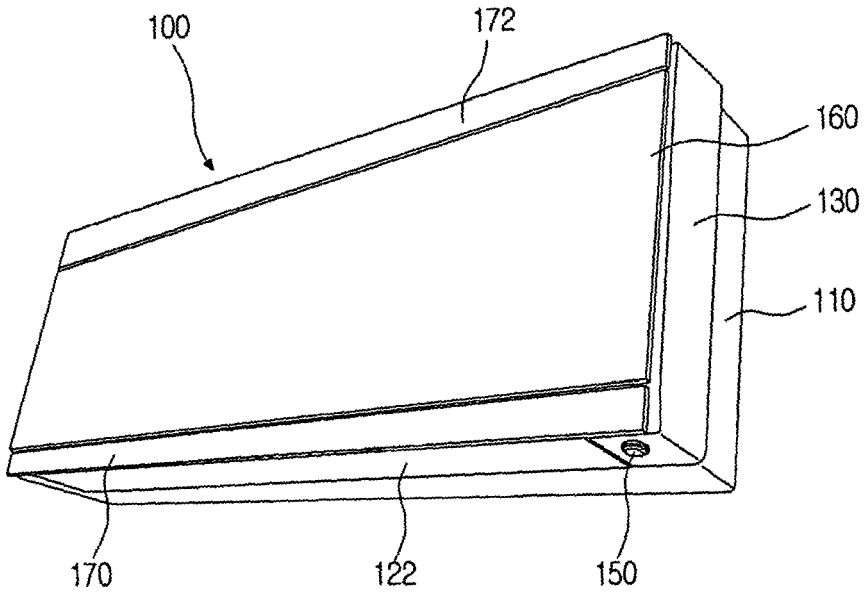
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Fig.4

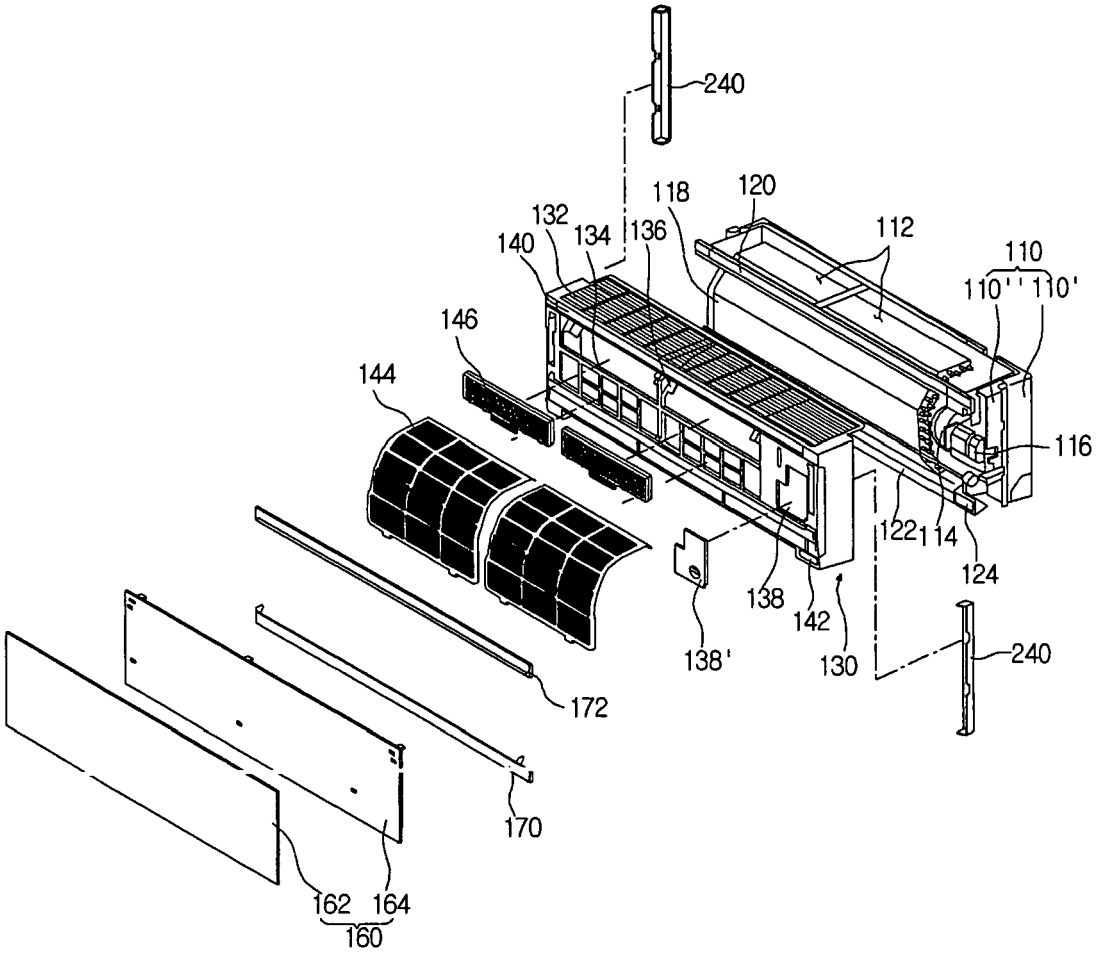
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Fig.5

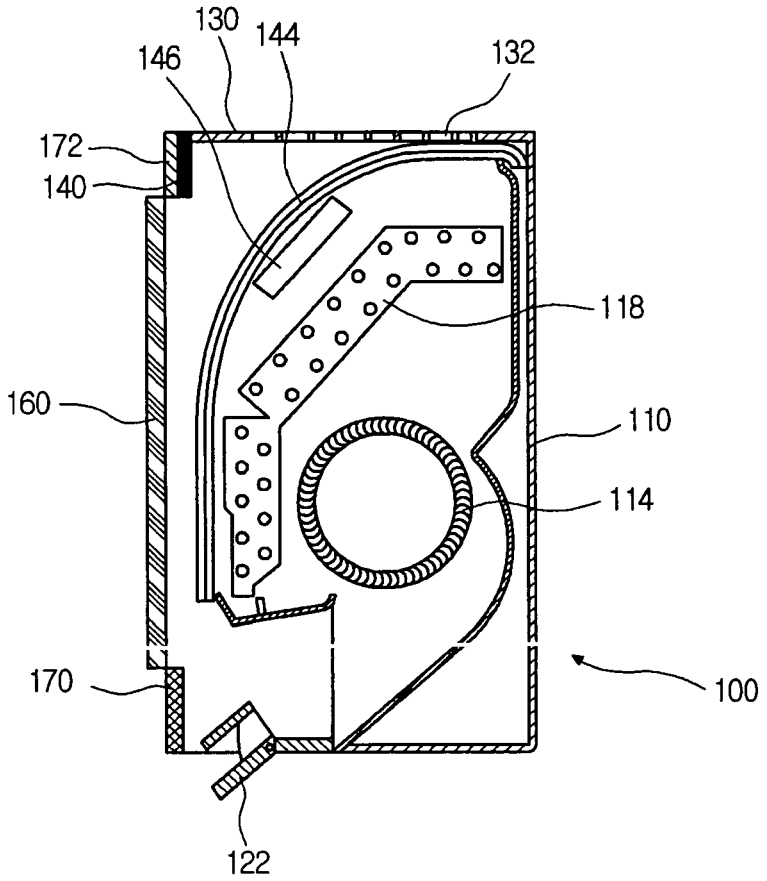


Fig.6

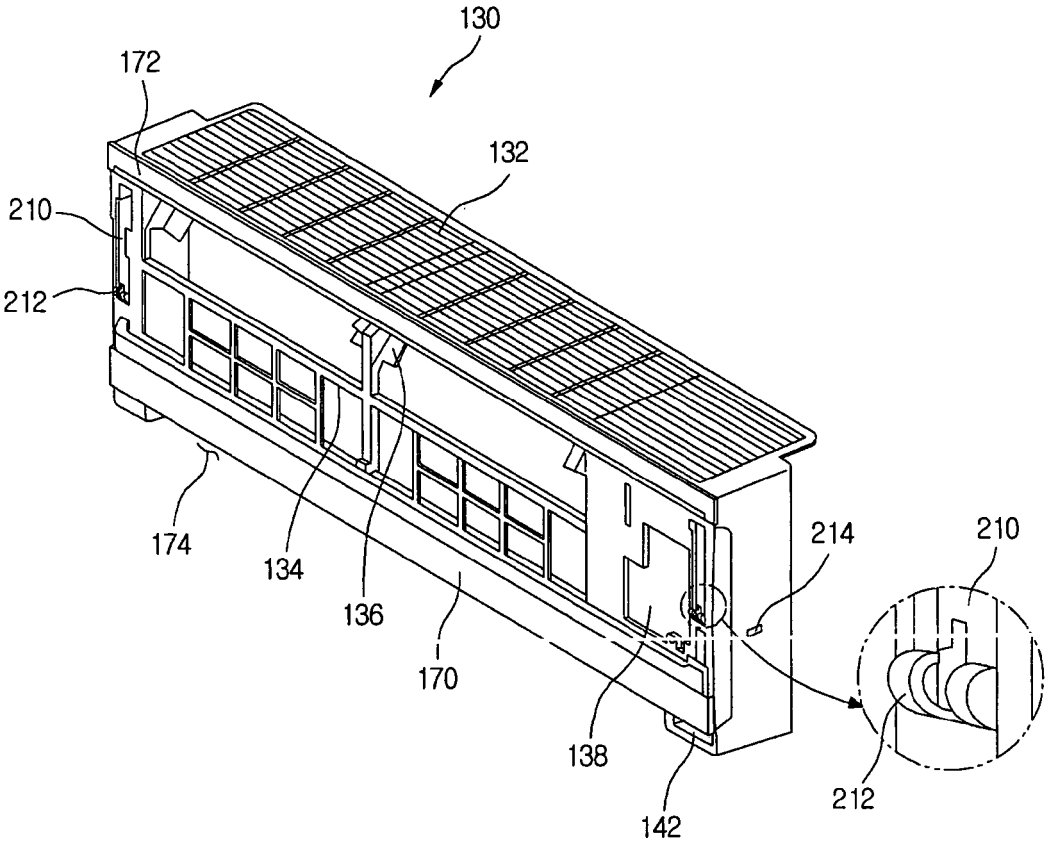
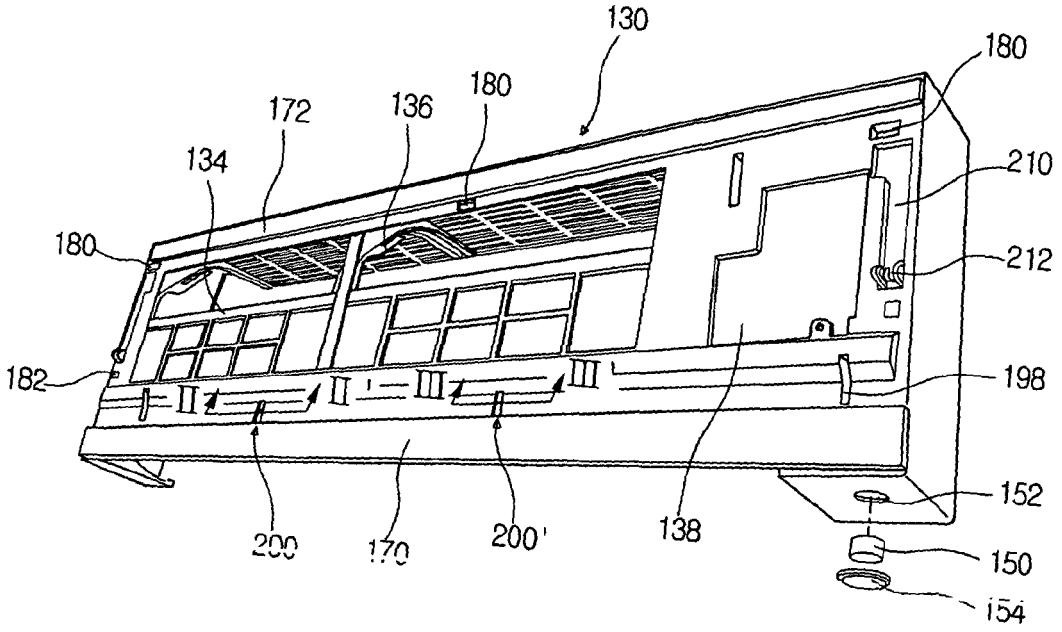


Fig.7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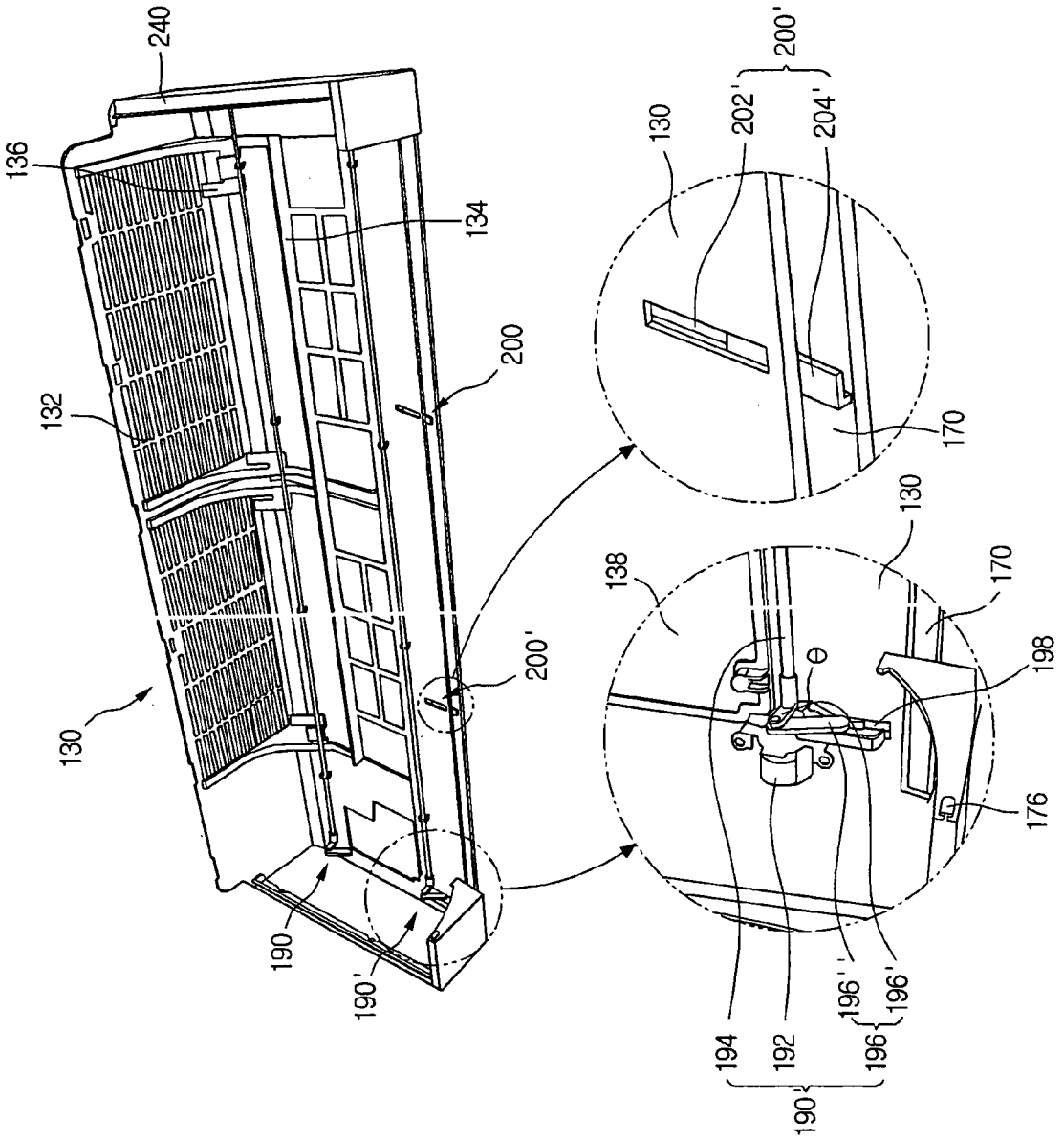
200'
138
150
154

Fig.8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190'
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202'
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192
196
196''
196'
190'

Fig.9

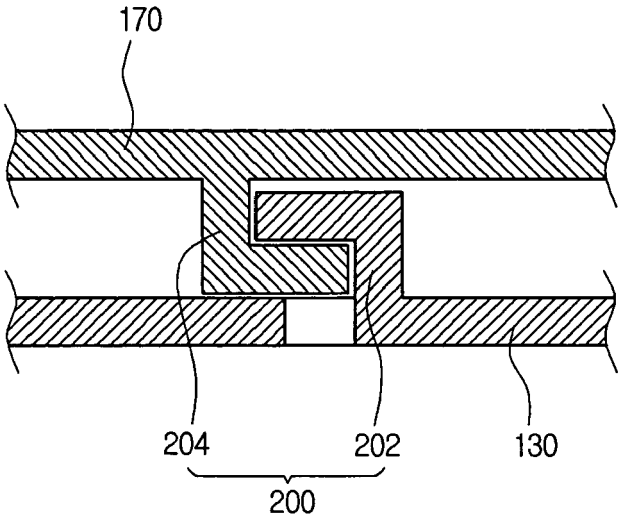


Fig.10

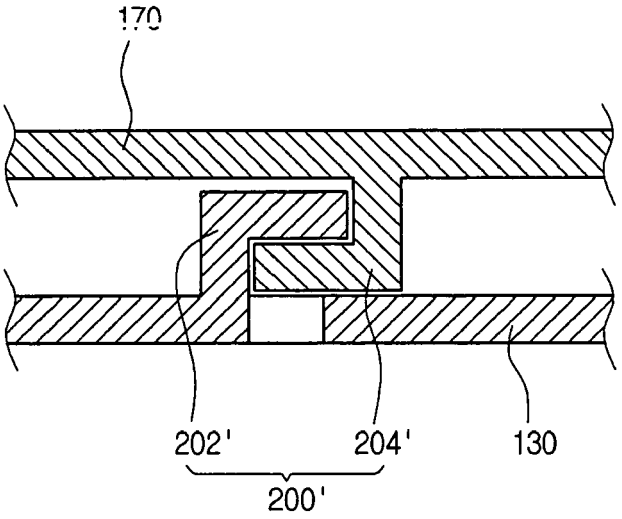


Fig.11

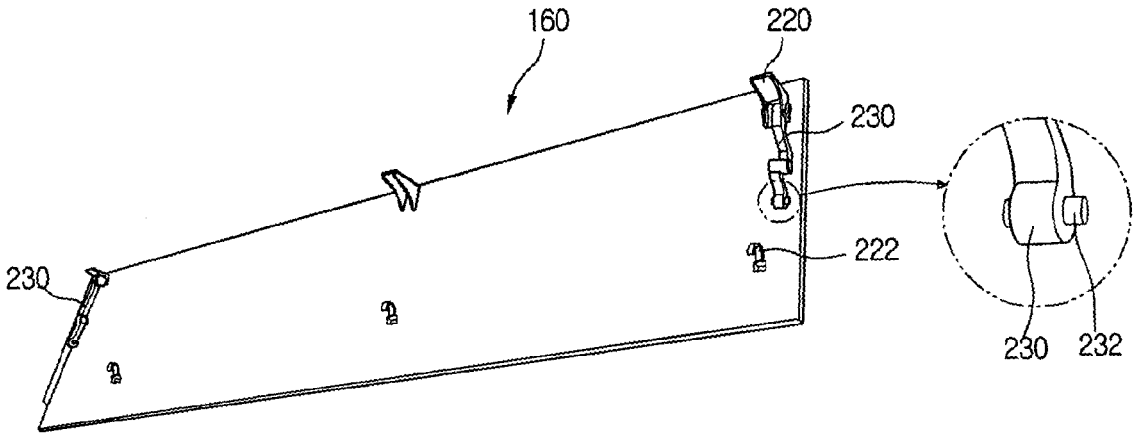


Fig.12

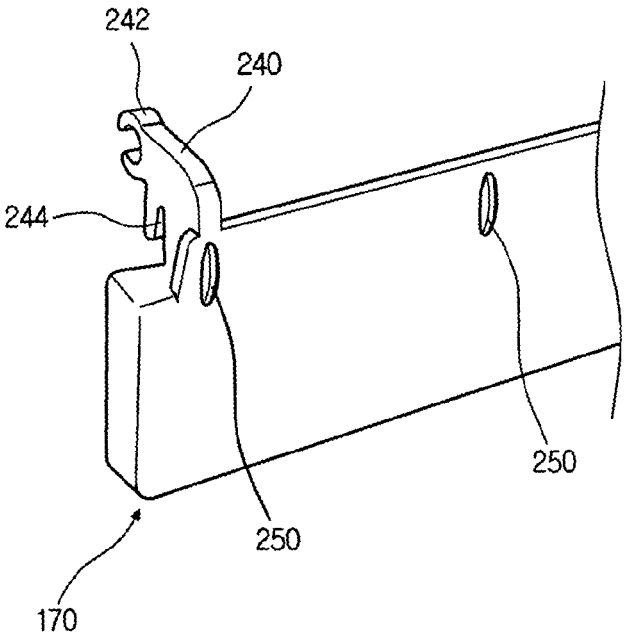


Fig.13

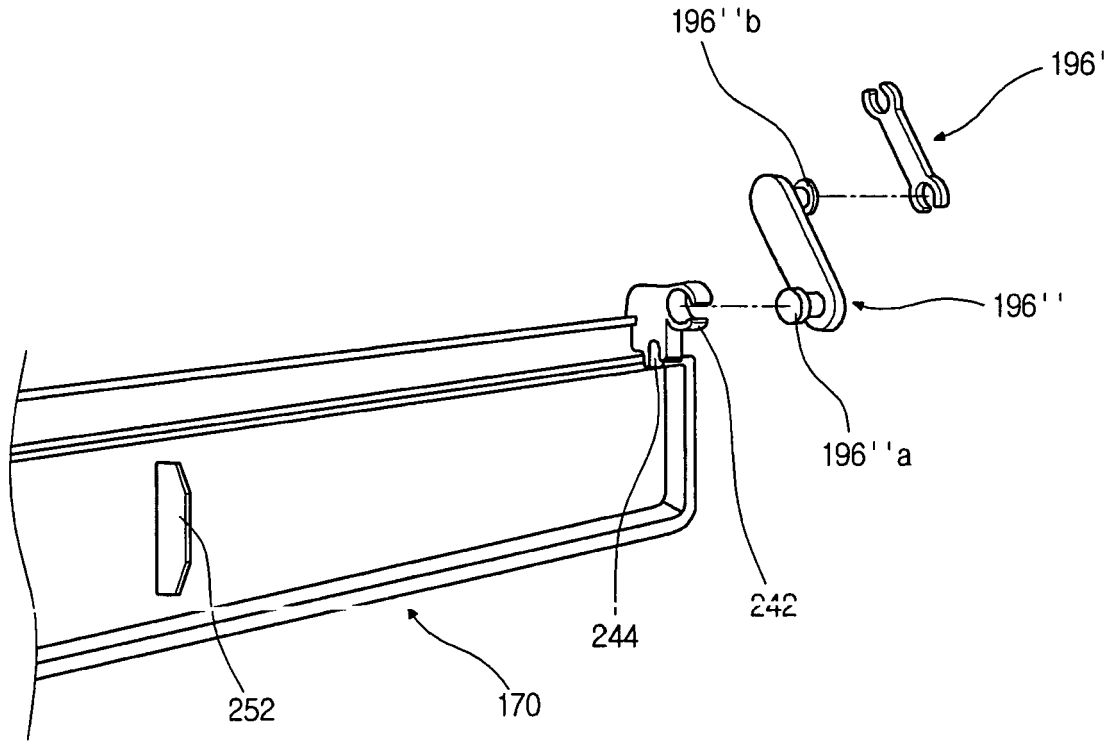


Fig.14

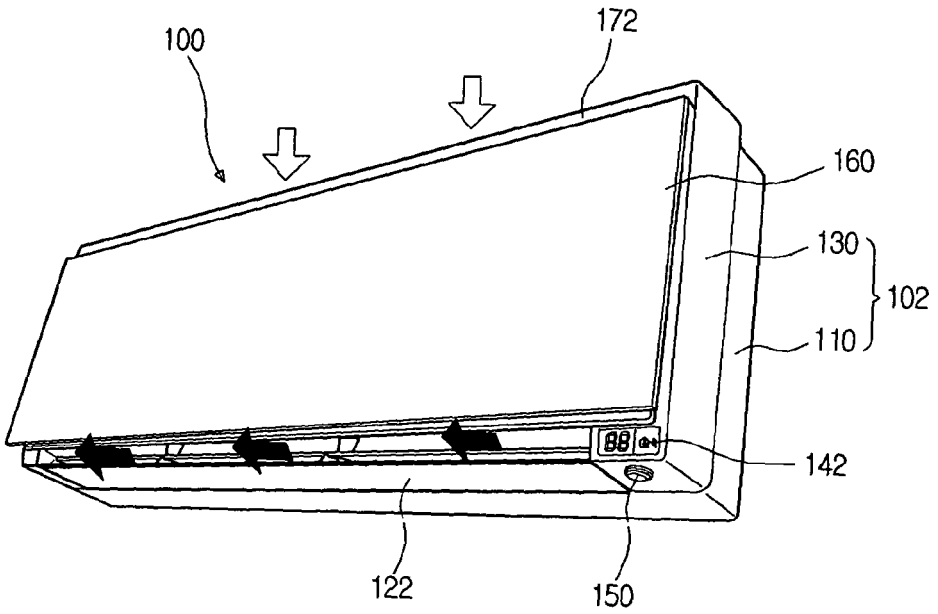


Fig.15

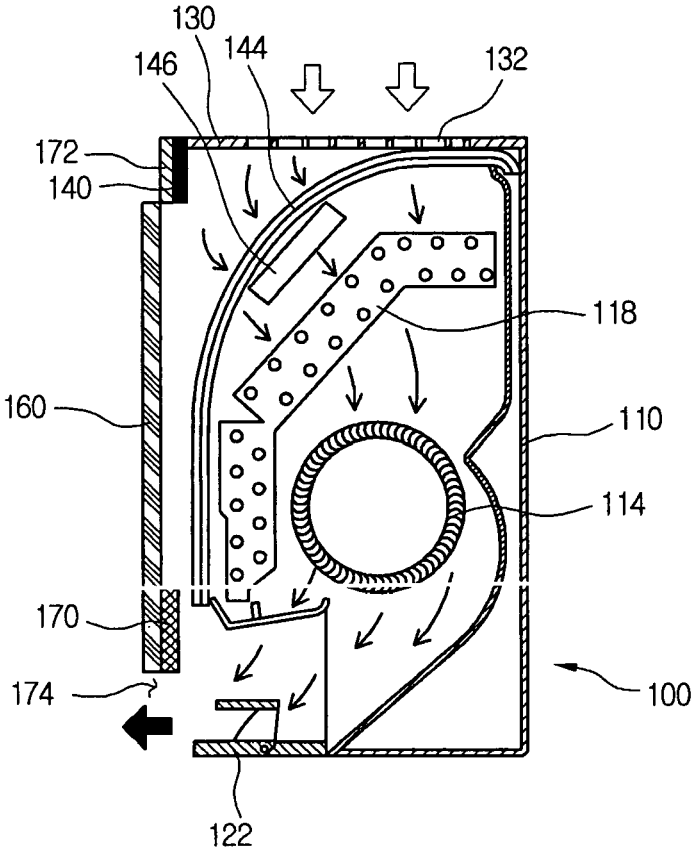


Fig.16

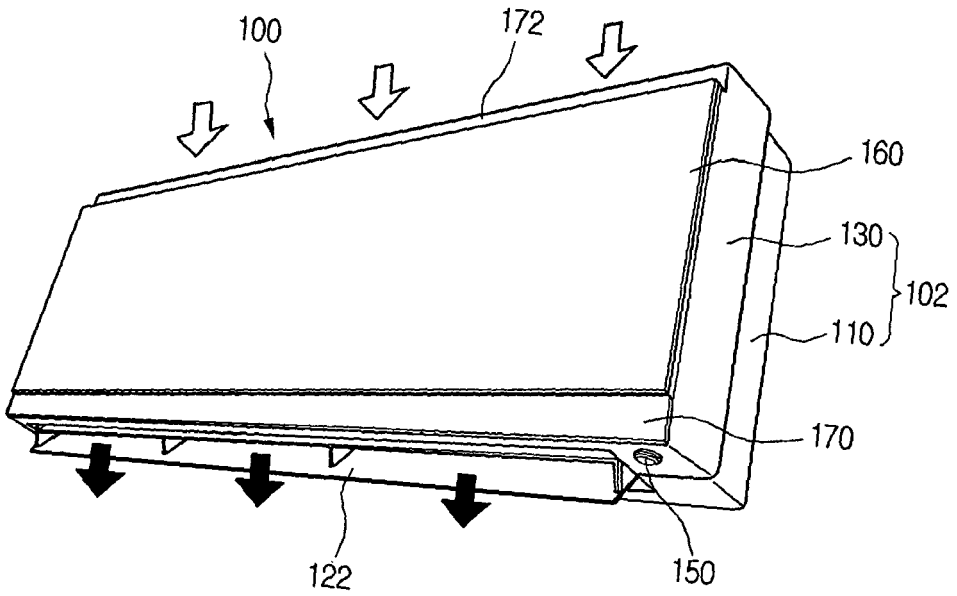


Fig.17

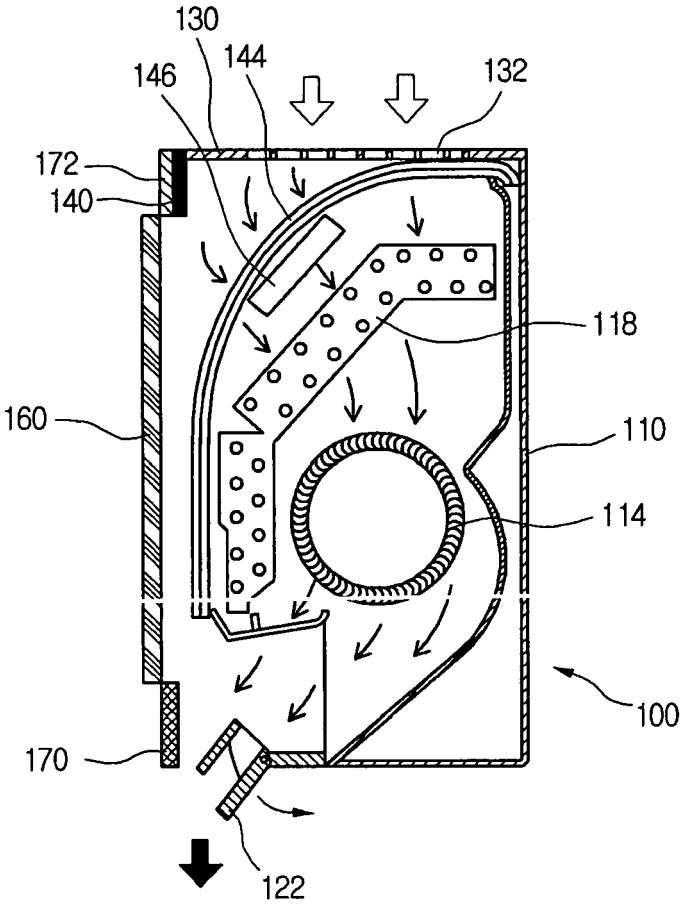


Fig.18

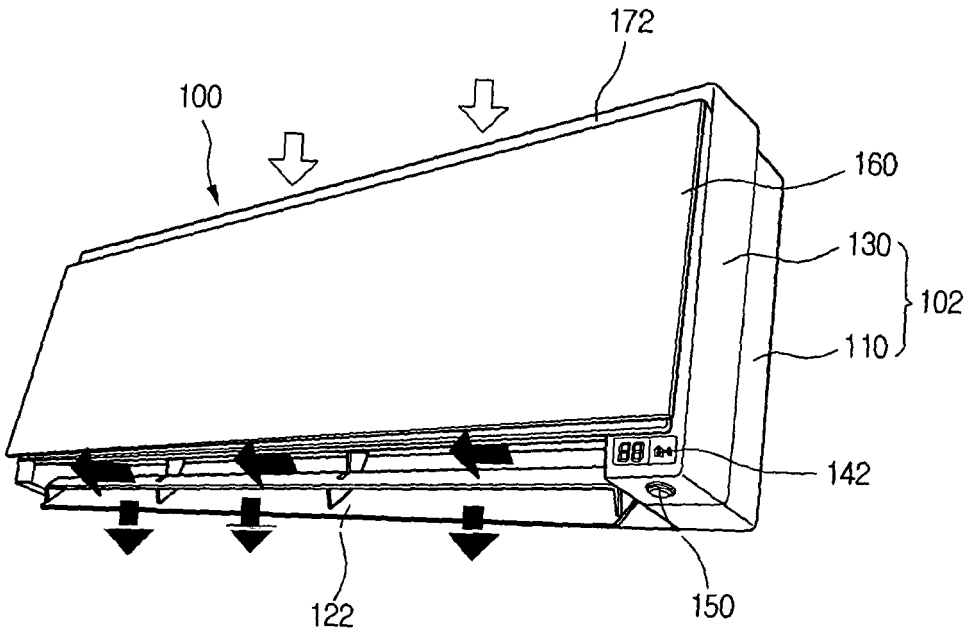


Fig.19

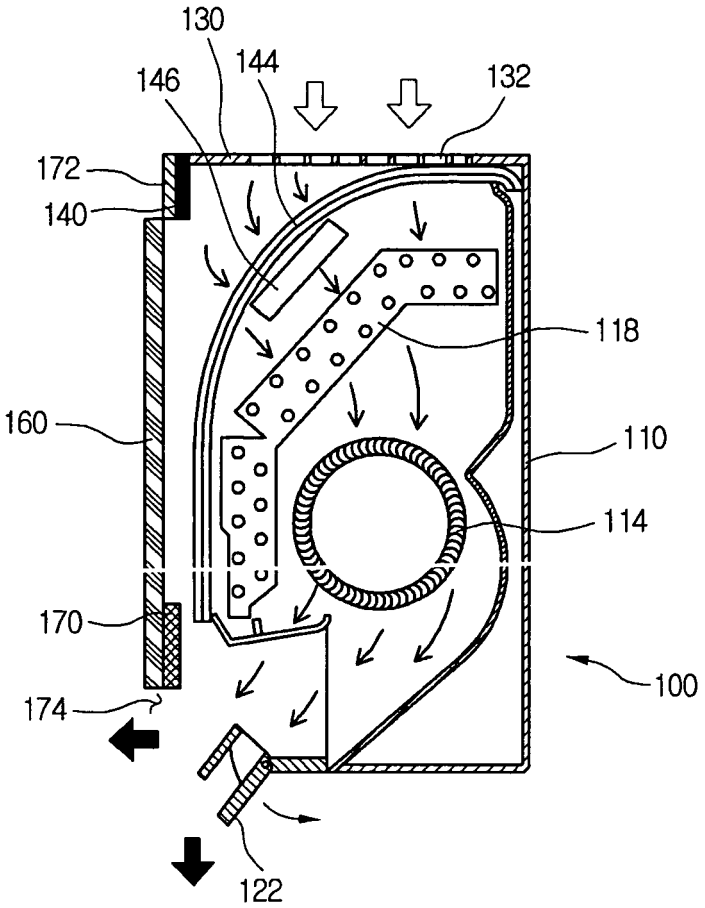


Fig.20

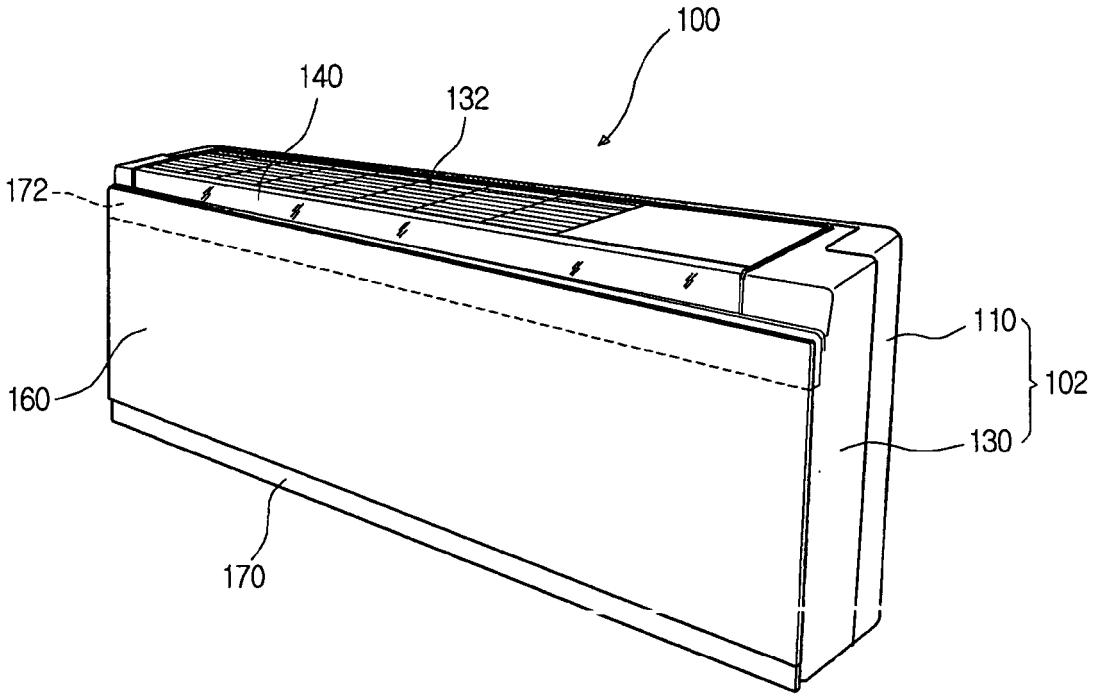


Fig.21

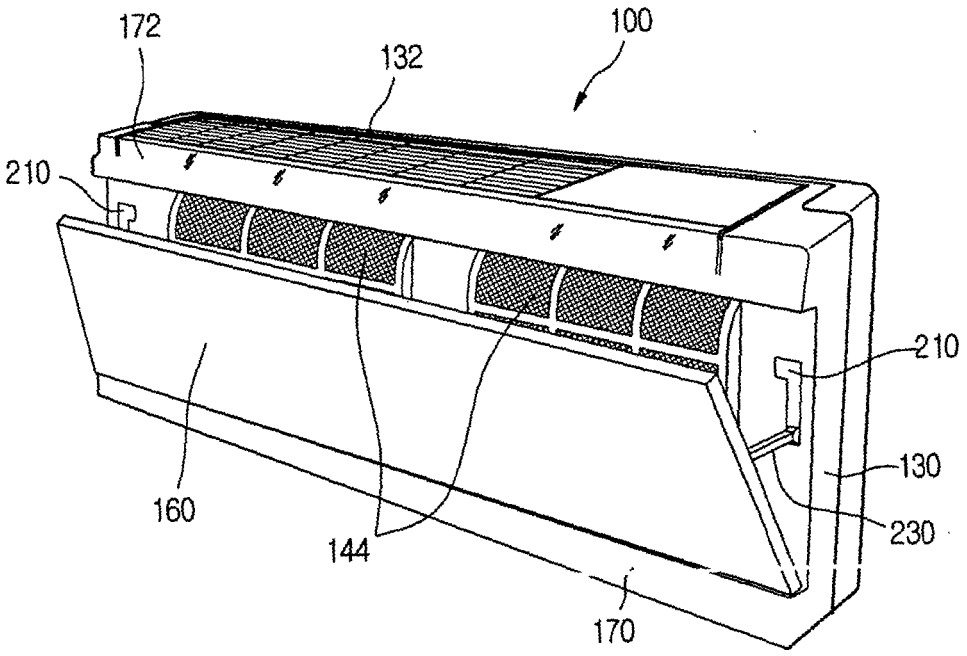


Fig.22

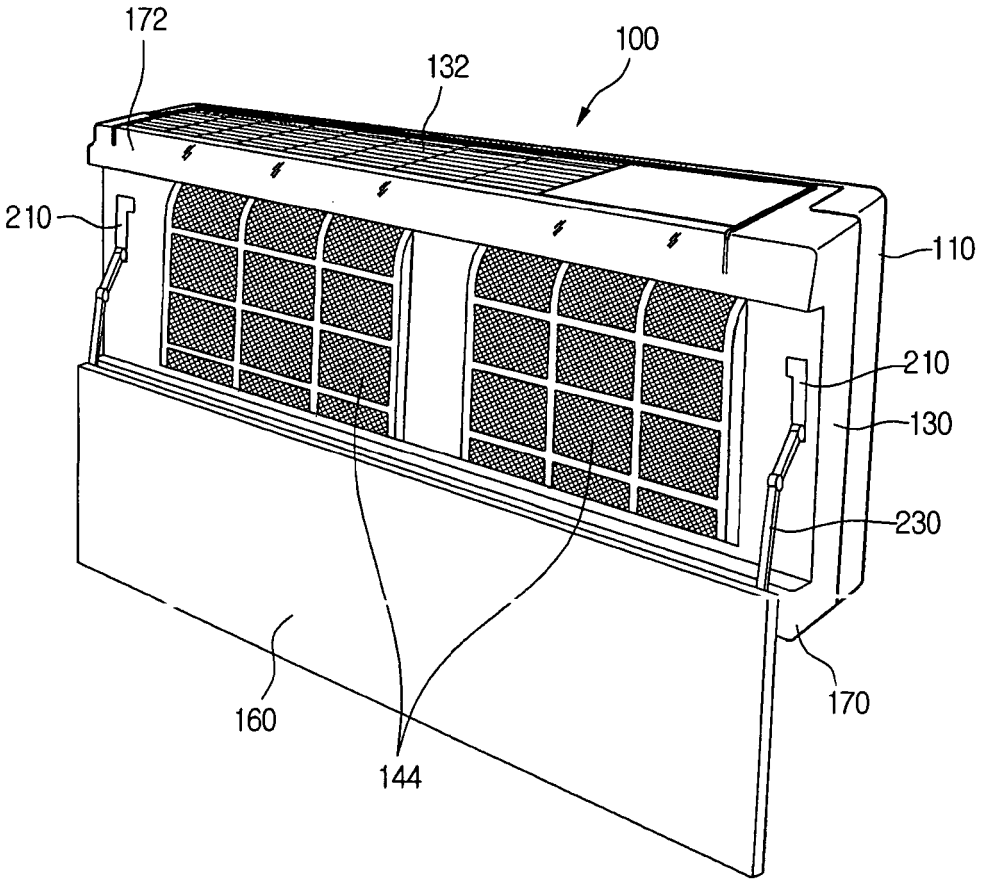


Fig.23

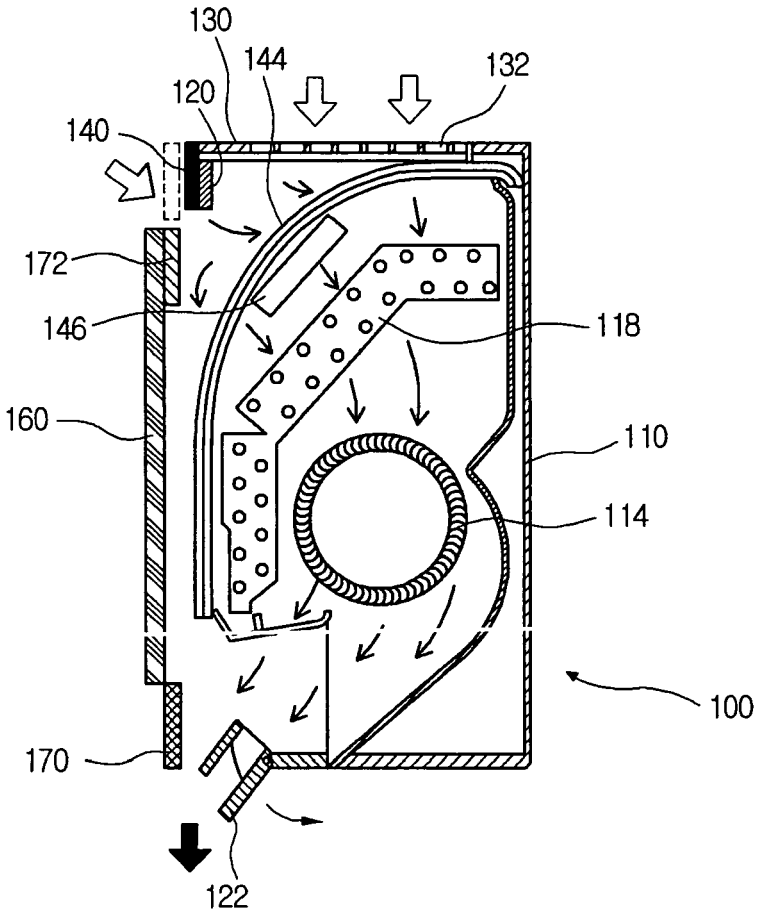


Fig.24

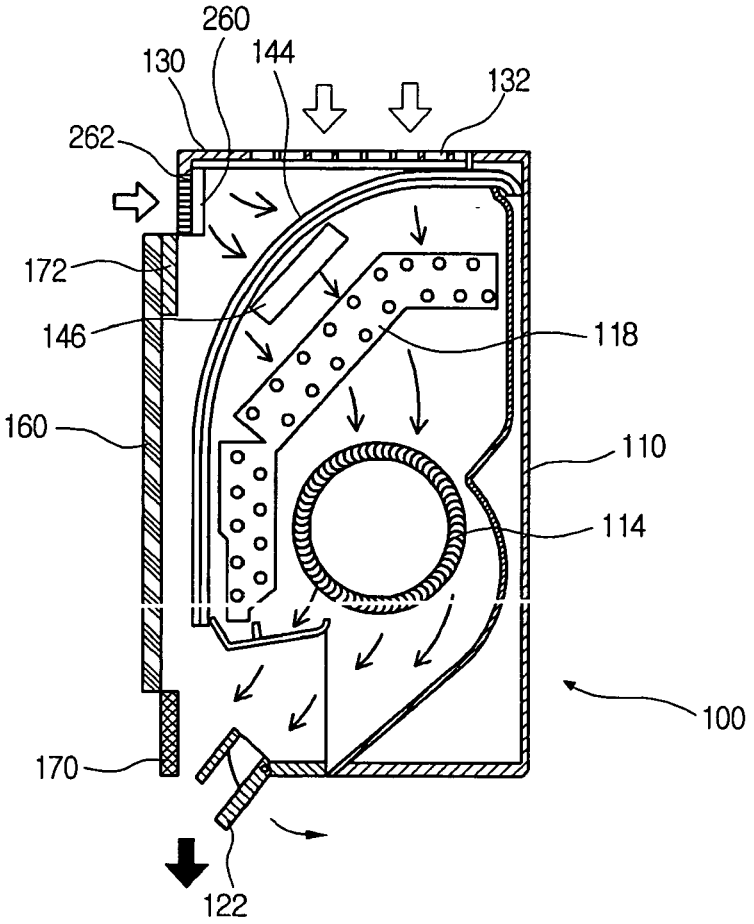


Fig.25

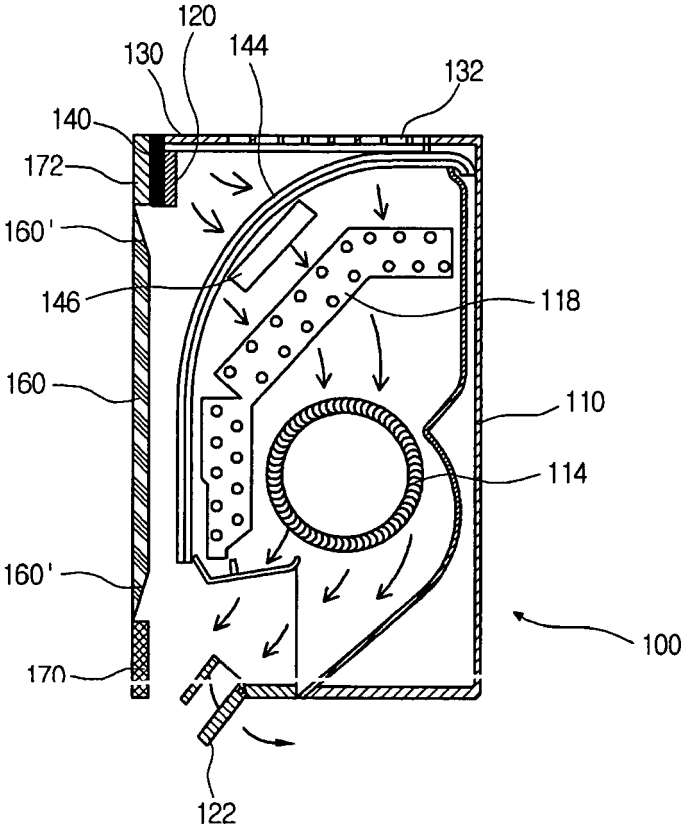
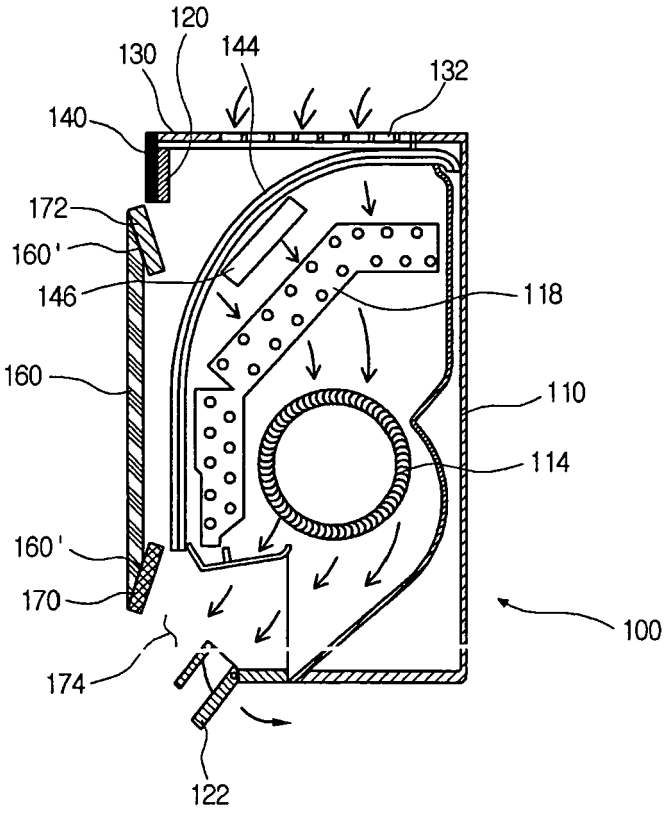


Fig.26


120
130
144
132
140
172
160'
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160
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160'
170
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174
122

Fig.27