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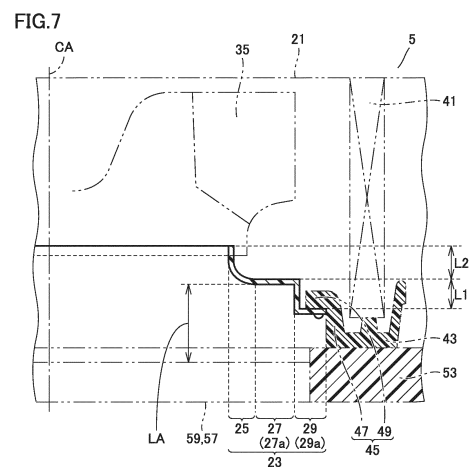
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(54) **INDOOR UNIT AND AIR CONDITIONING DEVICE PROVIDED WITH SAME**

(57) In an indoor unit (5), a bell mouth (23) includes a first section (25), a second section (27) having a flat portion (27a), and a third section (29) having a flat portion (29a). $L1 < L2$ is satisfied, where $L1$ is a distance in an axial direction of a rotational shaft (CA) between the flat portion (27a) and the flat portion (29a), and $L2$ is a distance in the axial direction between the flat portion (27a) and an open end of the first section (25). The flat portion (27a) of the second section (27) is located between a second extension (49) of a drain pan (43) and a fan (35) in the axial direction.



EP 4 060 246 A1

Description

TECHNICAL FIELD

[0001] The present invention relates to an indoor unit and an air conditioning apparatus including the same.

BACKGROUND ART

[0002] Some air conditioning apparatuses include, as an indoor unit placed in a room, a ceiling-embedded type indoor unit which is embedded in the ceiling. PTL 1 is a patent literature example disclosing an air conditioning apparatus including this type of indoor unit.

[0003] In an indoor unit, a casing contains a bell mouth, a fan, a fan motor, a heat exchanger, a drain pan and the like. A panel is disposed to cover the bell mouth, the fan and the like contained in the casing. The panel includes an intake grill to take in indoor air, and an outlet to feed air into a room. A filter is attached to the intake grill. The filter is disposed to face the bell mouth.

[0004] The air taken in through the intake grill is directed to the fan by the bell mouth having an opening. The air directed to the fan is fed toward the surroundings of the fan and flows through the heat exchanger. As the air flows through the heat exchanger, heat exchange takes place between refrigerant and the air flowing through the heat exchanger. The heat exchanged air is fed into the room through the outlet of the panel. The interior of the room is cooled or heated in this manner.

CITATION LIST

PATENT LITERATURE

[0005] PTL 1: Japanese Patent Laying-Open No. 2013-108684

SUMMARY OF INVENTION

TECHNICAL PROBLEM

[0006] In an air conditioning apparatus, if a bell mouth and a filter are relatively close to each other, a flow of air passing through the filter will be concentrated near the center of the bell mouth, resulting in increase in airflow resistance. The increase in airflow resistance causes increase in noise. It also causes increase in power consumption of a fan motor. There is thus a need for further reduction in airflow resistance in an indoor unit.

[0007] The present invention was made as part of such development. One object of the present invention is to provide an indoor unit in which airflow resistance is further reduced, and another object of the present invention is to provide an air conditioning apparatus including such an indoor unit.

MEANS FOR SOLVING THE PROBLEM

[0008] An indoor unit according to the present invention includes a fan, a bell mouth, a drain pan, a heat exchanger, a panel, and a filter. The fan has a rotational shaft, and is configured to suck air and feed the sucked air toward surroundings. The bell mouth has an opening that opens toward the fan, and is configured to direct air to the fan. The drain pan is disposed to surround the bell mouth. The heat exchanger is placed on the drain pan to surround the fan. The panel is disposed opposite to the fan with respect to the bell mouth and the drain pan, and has an air intake grill. The filter is mounted on the intake grill at a distance from the bell mouth. The bell mouth includes a first section, a second section and a third section. The first section is formed such that the opening narrows toward the fan. The second section is disposed around the first section and connected to the first section. The third section is disposed around the second section and connected to the second section and to the drain pan. The second section includes a first flat portion. The third section includes a second flat portion. $L1 < L2$ is satisfied, where $L1$ is a distance in an axial direction of the rotational shaft between the first flat portion and the second flat portion, and $L2$ is a distance in the axial direction between the first flat portion and an open end of the first section. The first flat portion of the second section is located between the drain pan and the fan in the axial direction.

[0009] An air conditioning apparatus according to the present invention is an air conditioning apparatus including the indoor unit described above.

ADVANTAGEOUS EFFECTS OF INVENTION

[0010] According to an indoor unit of the present invention, a bell mouth includes a first section, a second section having a first flat portion, and a third section having a second flat portion. $L1 < L2$ is satisfied, where $L1$ is a distance in an axial direction of a rotational shaft between the first flat portion and the second flat portion, and $L2$ is a distance in the axial direction between the first flat portion and an open end of the first section on a fan side. The first flat portion of the second section is located between a drain pan and a fan in the axial direction. Accordingly, a distance between the bell mouth and a filter is secured, which enables airflow resistance to be further reduced.

[0011] According to an air conditioning apparatus of the present invention, airflow resistance can be reduced by inclusion of the indoor unit described above.

BRIEF DESCRIPTION OF DRAWINGS

[0012]

Fig. 1 shows a refrigerant circuit example of an air conditioning apparatus including an indoor unit ac-

cording to each embodiment of the present invention.

Fig. 2 is a cross-sectional view showing an indoor unit according to a first embodiment of the present invention.

Fig. 3 is a perspective view showing a bell mouth in the first embodiment.

Fig. 4 is a perspective view showing a panel and a drain pan in the first embodiment.

Fig. 5 is a first perspective view showing a state where the bell mouth is attached to the drain pan in the first embodiment.

Fig. 6 is a second perspective view showing the state where the bell mouth is attached to the drain pan in the first embodiment.

Fig. 7 is a partial enlarged cross-sectional view for illustrating the structures of the bell mouth and the drain pan in the first embodiment.

Fig. 8 is a cross-sectional view showing an indoor unit according to a comparative example.

Fig. 9 is a cross-sectional view for illustrating advantageous effects of the indoor unit in the first embodiment.

Fig. 10 is a cross-sectional view showing an indoor unit according to a modification in the first embodiment.

Fig. 11 is a cross-sectional view showing an indoor unit according to a second embodiment of the present invention.

Fig. 12 is a perspective view showing a panel and a drain pan in the second embodiment.

Fig. 13 is a cross-sectional view showing an indoor unit according to a third embodiment of the present invention.

Fig. 14 is a perspective view for illustrating advantageous effects of the indoor unit in the third embodiment.

Fig. 15 is a perspective view showing a panel and a drain pan in an indoor unit according to a fourth embodiment of the present invention.

Fig. 16 is a perspective view for illustrating advantageous effects of the indoor unit in the fourth embodiment.

Fig. 17 is a cross-sectional view showing an indoor unit according to a fifth embodiment of the present invention.

Fig. 18 is a perspective view showing a panel and a drain pan in the indoor unit in the fifth embodiment.

Fig. 19 is a perspective view for illustrating advantageous effects of the indoor unit in the fifth embodiment.

DESCRIPTION OF EMBODIMENTS

[0013] First, a refrigerant circuit example of an air conditioning apparatus including an indoor unit according to each embodiment is described. As shown in Fig. 1, an air conditioning apparatus 1 includes a compressor 3, an

indoor unit 5, an expansion valve 7, an outdoor heat exchanger 9, an outdoor fan 13, and a four-way valve 15. Compressor 3, indoor unit 5, expansion valve 7, outdoor heat exchanger 9, and four-way valve 15 are connected to one another through a refrigerant pipe 17. A heat exchanger 41, a fan 35 and the like are disposed in indoor unit 5. The structure of indoor unit 5 will be described later in detail.

[0014] Next, a heating operation is described first as an operation of air conditioning apparatus 1 described above. By driving compressor 3, high-temperature and high-pressure gas refrigerant is discharged from compressor 3. The discharged high-temperature and high-pressure gas refrigerant (single phase) flows into heat exchanger 41 of outdoor unit 5 through four-way valve 15. In heat exchanger 41, heat exchange takes place between the gas refrigerant that has flowed therein and air fed therein by fan 35. The high-temperature and high-pressure gas refrigerant condenses into high-pressure liquid refrigerant (single phase). The heat exchanged air is fed into a room from indoor unit 5, to heat the interior of the room. The high-pressure liquid refrigerant fed from heat exchanger 41 is turned into two-phase refrigerant including low-pressure gas refrigerant and liquid refrigerant by expansion valve 7.

[0015] The two-phase refrigerant flows into outdoor heat exchanger 9. Outdoor heat exchanger 9 functions as an evaporator. In outdoor heat exchanger 9, heat exchange takes place between the two-phase refrigerant that has flowed therein and air supplied by outdoor fan 13. In the two-phase refrigerant, the liquid refrigerant evaporates into low-pressure gas refrigerant (single phase). The low-pressure gas refrigerant fed from outdoor heat exchanger 9 flows into compressor 3 through four-way valve 15. The low-pressure gas refrigerant that has flowed into compressor 3 is compressed into high-temperature and high-pressure gas refrigerant, and discharged from compressor 3 again. This cycle is subsequently repeated.

[0016] A cooling operation is described next. By driving compressor 3, high-temperature and high-pressure gas refrigerant is discharged from compressor 3. The discharged high-temperature and high-pressure gas refrigerant (single phase) flows into outdoor heat exchanger 9 through four-way valve 15. Outdoor heat exchanger 9 functions as a condenser. In outdoor heat exchanger 9, heat exchange takes place between the refrigerant that has flowed therein and air supplied by outdoor fan 13. The high-temperature and high-pressure gas refrigerant condenses into high-pressure liquid refrigerant (single phase).

[0017] The high-pressure liquid refrigerant fed from outdoor heat exchanger 9 is turned into two-phase refrigerant including low-pressure gas refrigerant and liquid refrigerant by expansion valve 7. The two-phase refrigerant flows into heat exchanger 41 of indoor unit 5. In heat exchanger 41, heat exchange takes place between the two-phase refrigerant that has flowed therein and air

fed into indoor unit 5 by fan 35. In the two-phase refrigerant, the liquid refrigerant evaporates into low-pressure gas refrigerant (single phase). The heat exchanged air is fed into the room from indoor unit 5, to cool the interior of the room. The low-pressure gas refrigerant fed from heat exchanger 41 flows into compressor 3 through four-way valve 15. The low-pressure gas refrigerant that has flowed into compressor 3 is compressed into high-temperature and high-pressure gas refrigerant, and discharged from compressor 3 again. This cycle is subsequently repeated. Next, indoor unit 5 according to each embodiment is specifically described.

First Embodiment

[0018] An indoor unit according to a first embodiment is described. As shown in Fig. 2, in indoor unit 5, a casing 21 contains fan 35, a fan motor 39, a bell mouth 23, a drain pan 43, and heat exchanger 41. Casing 21 has a panel 53 including an air intake grill 55 and an air outlet 59.

[0019] Fan 35 has a rotational shaft CA, which is connected to fan motor 39. Fan 35 sucks indoor air into casing 21 through intake grill 55, and feeds the sucked air into a room through outlet 59 via heat exchanger 41. Bell mouth 23 directs air to fan 35. Bell mouth 23 has an opening 24 that opens toward fan 35. As shown in Fig. 3, opening 24 has a circular shape, for example.

[0020] As shown in Figs. 4 and 5, drain pan 43 is disposed to surround bell mouth 23. Fig. 5 shows a state as seen from inside the casing. Drain pan 43 is fixed to casing 21. As shown in Fig. 6, panel 53 includes intake grill 55 and outlet 59. Intake grill 55 has a rectangular shape, for example. Panel 53 is removably attached to casing 21.

[0021] Panel 53 is disposed opposite to fan 35 with respect to bell mouth 23. A filter 57 is mounted on intake grill 55 at a distance from bell mouth 23.

[0022] An electrical component box 51 is disposed between panel 53 and bell mouth 23. Electrical component box 51 is located in a region surrounded by drain pan 43. Electrical component box 51 contains a control board and the like (not shown) for controlling the operation of indoor unit 5. Fig. 6 shows a state as seen from outside the casing (inside the room).

[0023] Next, the structures of bell mouth 23 and the like are described in more detail. As shown in Fig. 7, bell mouth 23 includes a first section 25, a second section 27 and a third section 29. First section 25 is formed such that opening 24 narrows toward fan 35. Opening 24 is formed to have an opening diameter that decreases toward fan 35.

[0024] Second section 27 is disposed around first section 25 and connected to first section 25. Second section 27 includes a flat portion 27a as a first flat portion. Flat portion 27a is located in a direction crossing rotational shaft CA.

[0025] Third section 29 is disposed around second

section 27 and connected to second section 27 and to drain pan 43. Third section 29 includes a flat portion 29a as a second flat portion. Flat portion 29a is located in the direction crossing rotational shaft CA.

[0026] Here, a distance in an axial direction of rotational shaft CA between flat portion 27a of second section 27 and flat portion 29a of third section 29 is represented by L1. A distance in the axial direction of rotational shaft CA between flat portion 27a of second section 27 and an open end of first section 25 is represented by L2. Distance L2 is set to be longer than distance L1 ($L1 < L2$).

[0027] An inner circumferential portion 45 of drain pan 43 located on an inner circumferential side has a first extension 47 extending in the axial direction of rotational shaft CA, and a second extension 49 extending in the direction crossing the axial direction of rotational shaft CA. Third section 29 of bell mouth 23 is connected to second extension 49. Flat portion 27a of second section 27 of bell mouth 23 is located between second extension 49 of drain pan 43 and fan 35 in the axial direction of rotational shaft CA. Flat portion 27a is located above second extension 49. Accordingly, a distance LA in the axial direction of rotational shaft CA between flat portion 27a of second section 27 of bell mouth 23 and filter 57 is secured. Indoor unit 5 according to the first embodiment is configured as described above.

[0028] In indoor unit 5 described above, bell mouth 23 including first section 25, second section 27 and third section 29 having a desired length relationship is disposed, which enables airflow resistance and the like to be suppressed. This is described in comparison with an indoor unit according to a comparative example.

[0029] For the indoor unit according to the comparative example, the same members as those of indoor unit 5 according to the first embodiment are denoted by the same reference characters and description thereof will not be repeated unless necessary. As shown in Fig. 8, in indoor unit 5 according to the comparative example, a bell mouth 123 is disposed for directing air sucked through intake grill 55 to fan 35.

[0030] Bell mouth 123 includes a portion 123b extending from a lower end portion of second extension 49 at inner circumferential portion 45 of drain pan 43 toward rotational shaft CA, and a portion 123a extending from that portion 123b toward fan 35 in a curved manner.

[0031] In indoor unit 5 according to the comparative example, portion 123b connecting portion 123a of bell mouth 123 to drain pan 43 extends from the lower end portion of second extension 49 of drain pan 43 toward rotational shaft CA.

[0032] Thus, portion 123b of bell mouth 123 is close to filter 57. A distance LB in the axial direction of rotational shaft CA between portion 123b and filter 57 is shorter than distance LA (see Fig. 7) in indoor unit 5 according to the first embodiment.

[0033] Air that has passed through filter 57 flows into opening 24 in the bell mouth. At this time, airflow resistance increases if bell mouth 123 (portion 123b) is close

to filter 57. The increase in airflow resistance causes increase in noise. It also causes increase in power consumption of fan motor 39 that drives fan 35.

[0034] Furthermore, some of the air fed from fan 35 may flow from heat exchanger 41 toward bell mouth 123 (portion 123b) without passing through heat exchanger 41. The air that has flowed toward bell mouth 123 flows through a gap between bell mouth 123 and fan 35, and is fed into fan 35 along with air flowing through opening 24 in bell mouth 123.

[0035] This flow of air that is fed into fan 35 again without passing through heat exchanger 41 in the air that was fed from fan 35 is called a circulating flow. The circulating flow will cause reduced efficiency of fan 35.

[0036] In contrast to indoor unit 5 according to the comparative example, in indoor unit 5 according to the first embodiment, bell mouth 23 includes first section 25, second section 27 having flat portion 27a, and third section 29 having flat portion 29a. Flat portion 27a of second section 27 is located above second extension 49 of drain pan 43.

[0037] Accordingly, distance LA in the axial direction of rotational shaft CA between flat portion 27a of second section 27 of bell mouth 23 and filter 57 is secured. By securing distance LA, velocity distribution of air flowing into opening 24 in bell mouth 23 is made more uniform than that in indoor unit 5 according to the comparative example, which enables the airflow resistance to be reduced.

[0038] In addition, as shown in Figs. 7 and 9, a portion of bell mouth 23 located between second section 27 and third section 29 in the axial direction of rotational shaft CA serves as a resistance, to facilitate the flow of air passing through heat exchanger 41. Accordingly, the circulating flow of air fed into fan 35 again through a gap between bell mouth 23 and fan 35 can be reduced.

[0039] As a result of these features, noise of indoor unit 5 can be suppressed, and power consumption of fan motor 39 can be suppressed.

[0040] In addition, distance L2 in the axial direction of rotational shaft CA between second section 27 (flat portion 27a) and the end portion of first section 25 on the fan 35 side is set to be longer than distance L1 in the axial direction of rotational shaft CA between second section 27 (flat portion 27a) and third section 29 (flat portion 29a) ($L1 < L2$).

[0041] Accordingly, separation of air in first section 25 of bell mouth 23 is suppressed, which enables disturbance in the flow of air fed to fan 35 to be suppressed, and velocity distribution of air flowing into opening 24 in bell mouth 23 is made uniform, which enables airflow resistance to be reduced. As a result, reduction in noise and reduction in power consumption of fan motor 39 can be attained.

[0042] In indoor unit 5 described above, second section 27 and the third section of bell mouth 23 may be smoothly connected in a curved manner.

(Modification)

[0043] As shown in Fig. 10, a first inclined portion 27b inclined relative to rotational shaft CA may be provided at a portion of second section 27 which is located at a circumferential position as a first circumferential position corresponding to a corner of intake grill 55 in a circumferential direction of bell mouth 23. By providing first inclined portion 27b, air can flow smoothly through bell mouth 23, which enables a loss associated with the generation of vortices to be reduced. A first inclination angle $\theta 1$ of first inclined portion 27b is desirably from 45° to 90° , for example. If first inclination angle $\theta 1$ is smaller than 45° , the effect of suppressing the circulating flow of air is reduced. First inclination angle $\theta 1$ is an angle formed with the direction crossing the axial direction of rotational shaft CA.

[0044] In addition, a second inclined portion 27c may be provided at a portion of second section 27 which is located at a circumferential position as a second circumferential position other than the circumferential position at bell mouth 23 corresponding to the corner of intake grill 55. Here, a second inclination angle $\theta 2$ of second inclined portion 27c is desirably set such that first inclination angle $\theta 1$ is smaller than second inclination angle $\theta 2$.

[0045] The velocity of air flowing from the corner of intake grill 55 toward opening 24 in bell mouth 23 is higher than the velocity of air flowing from portions other than the corner toward opening 24 in bell mouth 23. Thus, the setting of first inclination angle $\theta 1$ to be smaller than second inclination angle $\theta 2$ can suppress the separation of air.

35 Second Embodiment

[0046] An indoor unit according to a second embodiment is described. The indoor unit according to the second embodiment is different in that the second extension at the inner circumferential portion of the drain pan has a thickness that varies between its portion where the electrical component box is disposed and its portion where the electrical component box is not disposed.

[0047] As shown in Fig. 11, in indoor unit 5, electrical component box 51 is disposed between panel 53 and bell mouth 23. As shown in Fig. 12, electrical component box 51 is disposed along one side of rectangular intake grill 55. In second extension 49 at inner circumferential portion 45 of drain pan 43, a thickness T1 of a second extension second section 49b where electrical component box 51 is disposed is smaller than a thickness T2 of a second extension second section 49a where electrical component box 51 is not disposed.

[0048] A height position (position in the axial direction of rotational shaft CA) of the upper end of inner circumferential portion 45 of drain pan 43 is set to a constant height position throughout the entire circumference of drain pan 43. As the configuration is otherwise the same

as that of indoor unit 5 shown in Fig. 2, the same members are denoted by the same reference characters and description thereof will not be repeated unless necessary.

[0049] In indoor unit 5 described above, by making thickness T1 of second extension second section 49b smaller than thickness T2 of second extension second section 49a, electrical component box 51 can be brought closer to fan 35, and a gap between electrical component box 51 and filter 57 can be correspondingly secured.

[0050] Accordingly, the indoor unit described above produces the following advantageous effects in addition to the advantageous effects described above. When indoor air flows from intake grill 55 to opening 24 in bell mouth 23, the passing of air through filter 57 is facilitated and airflow resistance of filter 57 is reduced. With the reduced airflow resistance, circumferential air velocity distribution in filter 57 becomes uniform in the circumferential direction.

[0051] In addition, by setting the height position of the upper end of inner circumferential portion 45 of drain pan 43 to a constant height position throughout the entire circumference of drain pan 43, the occurrence of disturbance in the flow of air fed from fan 35 toward heat exchanger 41 and circulating in the circumferential direction can be suppressed.

Third Embodiment

[0052] An indoor unit according to a third embodiment is described. As shown in Fig. 13, in indoor unit 5, electrical component box 51 is disposed between panel 53 and bell mouth 23. Electrical component box 51 is disposed at a distance L3 from flat portion 27a of second section 27 of bell mouth 23.

[0053] Electrical component box 51 is in contact with flat portion 29a of third section 29 of bell mouth 23. Electrical component box 51 is fixed such that flat portion 29a is sandwiched between electrical component box 51 and second extension 49 of drain pan 43. As the configuration is otherwise the same as that of indoor unit 5 shown in Fig. 2, the same members are denoted by the same reference characters and description thereof will not be repeated unless necessary.

[0054] When electrical component box 51 is disposed with respect to opening 24 in bell mouth 23 so as to cover part of opening 24 in a plan view, in indoor unit 5 according to the comparative example shown in Fig. 8, for example, a region of stagnant air flow (dead water region) may be generated in a region of electrical component box 51 on the bell mouth 23 side (downstream of the flow).

[0055] In contrast, indoor unit 5 described above produces the following advantageous effects in addition to the advantageous effects described in the first embodiment. Electrical component box 51 is disposed at distance L3 from flat portion 27a of second section 27 of bell mouth 23, and a gap is secured between electrical component box 51 and flat portion 27a of second section 27.

[0056] Accordingly, as shown in Figs. 13 and 14, when indoor air flows from intake grill 55 into opening 24 in bell mouth 23, the air can be passed through the space between electrical component box 51 and flat portion 27a of second section 27, which enables the stagnant air flow to be suppressed (see dotted arrows). With the reduced dead water region, distribution of air flowing into fan 35 can be made uniform.

Fourth Embodiment

[0057] An indoor unit according to a fourth embodiment is described. As shown in Fig. 15, in indoor unit 5, ribs 31 are disposed on a surface of bell mouth 23 on the intake grill 55 side. Ribs 31 are formed radially toward rotational shaft CA at a portion of a circumferential position as a third circumferential position corresponding to a corner (see a dotted frame DC) of rectangular intake grill 55 in the circumferential direction of bell mouth 23. As the configuration is otherwise the same as that of indoor unit 5 shown in Fig. 2, the same members are denoted by the same reference characters and description thereof will not be repeated unless necessary.

[0058] In indoor unit 5, the quantity of air flowing from the corner of intake grill 55 toward opening 24 in bell mouth 23 is higher than the quantity of air flowing from portions other than the corner toward opening 24 in bell mouth 23. Thus, the velocity of air flowing from the corner of intake grill 55 toward opening 24 in bell mouth 23 tends to be higher than the velocity of air flowing from portions other than the corner toward opening 24 in bell mouth 23. It is thus assumed that the circumferential velocity distribution of air flowing from intake grill 55 toward opening 24 in bell mouth 23 will be uneven.

[0059] Indoor unit 5 described above produces the following advantageous effects in addition to the advantageous effects described in the first embodiment. In indoor unit 5, ribs 31 are formed at the portion of the circumferential position corresponding to the corner (see dotted frame DC) of rectangular intake grill 55 in the circumferential direction of bell mouth 23. Ribs 31 are formed radially toward rotational shaft CA.

[0060] Thus, as shown in Fig. 16, ribs 31 act as airflow resistance, to reduce the velocity of air flowing from the corner of intake grill 55 toward opening 24 in bell mouth 23. Accordingly, the circumferential velocity distribution of air flowing from intake grill 55 toward opening 24 in bell mouth 23 can be made uniform.

Fifth Embodiment

[0061] An indoor unit according to a fifth embodiment is described. As shown in Fig. 17, in indoor unit 5, bell mouth 23 includes a first curvature portion 33a having a smaller curvature and a second curvature portion 33b having a larger curvature.

[0062] As shown in Fig. 18, first curvature portion 33a is disposed at a portion of a circumferential position as

a fourth circumferential position corresponding to a corner of rectangular intake grill 55 in the circumferential direction of bell mouth 23. Second curvature portion 33b is disposed at a portion of a circumferential position as a fifth circumferential position corresponding to a portion other than the corner of rectangular intake grill 55 in the circumferential direction of bell mouth 23. In addition, a distance LC between the portion of bell mouth 23 where first curvature portion 33a is disposed and filter 57 is shorter than a distance LD between the portion of bell mouth 23 where second curvature portion 33b is disposed and filter 57.

[0063] Fig. 17 shows cross sections of both first curvature portion 33a and second curvature portion 33b in order to simplify the drawing and to facilitate understanding of the difference in curvature between first curvature portion 33a and second curvature portion 33b. As the configuration is otherwise the same as that of indoor unit 5 shown in Fig. 2, the same members are denoted by the same reference characters and description thereof will not be repeated unless necessary.

[0064] As described above, in indoor unit 5, the velocity of air flowing from the corner of intake grill 55 toward opening 24 in bell mouth 23 tends to be higher than the velocity of air flowing from portions other than the corner toward opening 24 in bell mouth 23. It is thus assumed that the circumferential velocity distribution of air flowing from intake grill 55 toward opening 24 in bell mouth 23 will be uneven.

[0065] Indoor unit 5 described above produces the following advantageous effects in addition to the advantageous effects described in the first embodiment. In indoor unit 5, first curvature portion 33a having a small curvature is disposed at the portion of the circumferential position at bell mouth 23 corresponding to the corner of rectangular intake grill 55. Second curvature portion 33b having a large curvature is disposed at the portion of the circumferential position at bell mouth 23 corresponding to a portion other than the corner of intake grill 55.

[0066] Accordingly, as shown in Fig. 19, when air flows from intake grill 55 toward opening 24 in bell mouth 23, separation of the air flowing from the corner of intake grill 55 toward opening 24 in bell mouth 23 is particularly suppressed, which enables disturbance in the air flow to be suppressed.

[0067] In addition, distance LC in the axial direction of rotational shaft CA between the portion of bell mouth 23 where first curvature portion 33a is disposed and filter 57 is shorter than distance LD in the axial direction of rotational shaft CA between the portion of bell mouth 23 where second curvature portion 33b is disposed and filter 57. Accordingly, as shown in Fig. 19, when air flows from intake grill 55 toward opening 24 in bell mouth 23, the velocity of air flowing from the corner of intake grill 55 toward opening 24 in bell mouth 23 is reduced, which enables the circumferential velocity distribution of air flowing toward opening 24 in bell mouth 23 to be made uniform.

[0068] The indoor units described in the embodiments can be combined as appropriate in various ways.

[0069] The embodiments disclosed herein are illustrative and non-restrictive. The present invention is defined by the terms of the claims, rather than the scope described above, and is intended to include any modifications within the meaning and scope equivalent to the terms of the claims.

10 INDUSTRIAL APPLICABILITY

[0070] The present invention is effectively utilized for an air conditioning apparatus including an indoor unit.

15 REFERENCE SIGNS LIST

[0071] 1 air conditioning apparatus; 3 compressor; 5 indoor unit; 7 expansion valve; 9 outdoor heat exchanger; 13 outdoor fan; 15 four-way valve; 17 refrigerant pipe; 21 casing; 23 bell mouth; 24 opening; 25 first section; 27 second section; 27a flat portion; 27b first inclined portion; 27c second inclined portion; 29 third section; 29a flat portion; 31 rib; 33a first curvature portion; 33b second curvature portion; 35 fan; 37 rotational shaft; 39 fan motor; 41 heat exchanger; 43 drain pan; 45 inner circumferential portion; 47 first extension; 49 second extension; 49a second extension first section; 49b second extension second section; 51 electrical component box; 53 panel; 55 intake grill; 57 filter; 59 outlet; CA central axis; L1, L2, L3, LA, LB, LC, LD distance; T1, T2 thickness; DC dotted frame.

Claims

35 1. An indoor unit comprising:

a fan having a rotational shaft and configured to suck air and feed the sucked air toward surroundings;
a bell mouth having an opening that opens toward the fan and configured to direct air to the fan;
a drain pan disposed to surround the bell mouth;
a heat exchanger placed on the drain pan to surround the fan;
a panel disposed opposite to the fan with respect to the bell mouth and the drain pan, the panel having an air intake grill; and
a filter mounted on the intake grill at a distance from the bell mouth, wherein
the bell mouth includes

a first section formed such that the opening narrows toward the fan,
a second section disposed around the first section and connected to the first section, and
a third section disposed around the second

section and connected to the second section and to the drain pan,

the second section includes a first flat portion, the third section includes a second flat portion, $L1 < L2$ is satisfied, where $L1$ is a distance in an axial direction of the rotational shaft between the first flat portion and the second flat portion, and $L2$ is a distance in the axial direction between the first flat portion and an open end of the first section, and the first flat portion of the second section is located between the drain pan and the fan in the axial direction.

2. The indoor unit according to claim 1, wherein

the drain pan has an annular shape, an inner circumferential portion of the annular drain pan located on an inner circumferential side includes a first extension extending in the axial direction, and a second extension extending from the first extension toward the rotational shaft, an electrical component box is disposed in a region surrounded by the drain pan between the panel and the bell mouth, the second extension includes

a second extension first section located such that the electrical component box is sandwiched between the second extension and the panel, and a second extension second section without the electrical component box located between the second extension and the panel, and

the second extension first section has a thickness greater than a thickness of the second extension second section.

3. The indoor unit according to claim 2, wherein the electrical component box is disposed at a distance in the axial direction from the second section of the bell mouth.

4. The indoor unit according to claim 2 or 3, wherein the inner circumferential portion of the drain pan has a constant height in a circumferential direction.

5. The indoor unit according to any one of claims 1 to 4, wherein the second section has an inclined portion inclined toward the rotational shaft from its portion connected to the third section toward the first flat portion of the second section.

6. The indoor unit according to claim 5, wherein

the intake grill has a rectangular shape, the opening in the bell mouth has a circular shape, the inclined portion includes

a first inclined portion located at a first circumferential position corresponding to a corner of the rectangular intake grill in a circumferential direction of the opening in the bell mouth, and a second inclined portion located at a second circumferential position other than the first circumferential position, and

a first inclination angle of the first inclined portion is smaller than a second inclination angle of the second inclined portion.

7. The indoor unit according to claim 6, wherein the first inclination angle is from 45° to 90° .

8. The indoor unit according to any one of claims 1 to 4, wherein

the intake grill has a rectangular shape, the opening in the bell mouth has a circular shape, and a rib is formed at a portion of the bell mouth facing the intake grill, the portion located at a third circumferential position corresponding to a corner of the rectangular intake grill in a circumferential direction of the opening in the bell mouth, the rib extending toward the opening.

9. The indoor unit according to any one of claims 1 to 4, wherein

the intake grill has a rectangular shape, the opening in the bell mouth has a circular shape, portions of the first section and the second section of the bell mouth located at a fourth circumferential position corresponding to at least one of a plurality of corners of the rectangular intake grill in a circumferential direction of the opening in the bell mouth have a first curvature, portions of the first section and the second section of the bell mouth located at a fifth circumferential position other than the fourth circumferential position have a second curvature, and the first curvature is smaller than the second curvature.

10. The indoor unit according to claim 9, wherein a distance between the portions of the first section and the second section of the bell mouth located at

the fourth circumferential position and the filter is shorter than a distance between the portions of the first section and the second section of the bell mouth located at the fifth circumferential position and the filter.

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11. An air conditioning apparatus comprising the indoor unit according to any one of claims 1 to 10.

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FIG.1

—→ REFRIGERANT FLOW DURING HEATING OPERATION
---→ REFRIGERANT FLOW DURING COOLING OPERATION

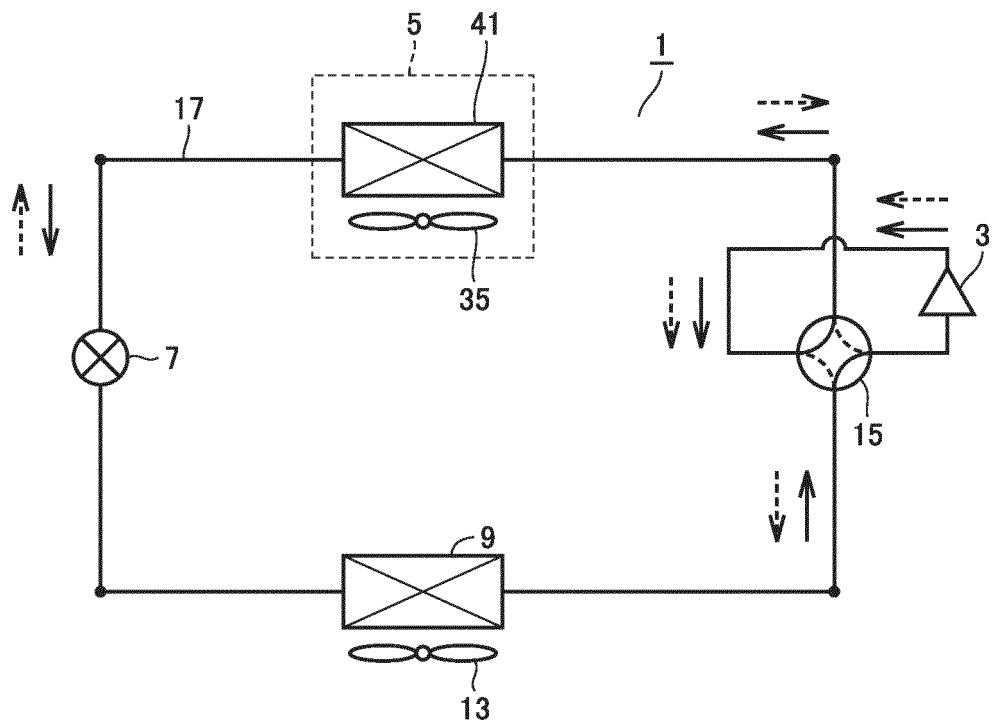


FIG.2

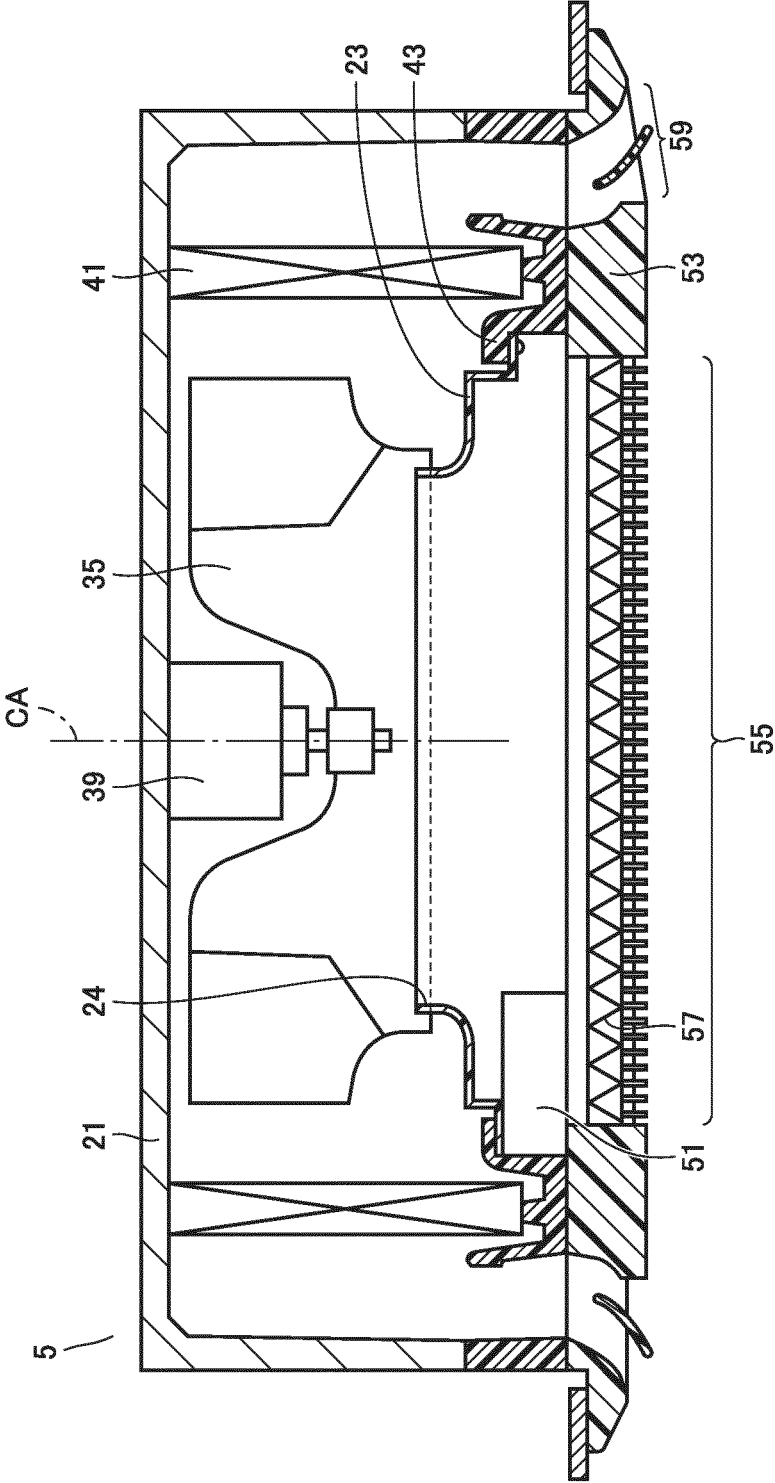


FIG.3

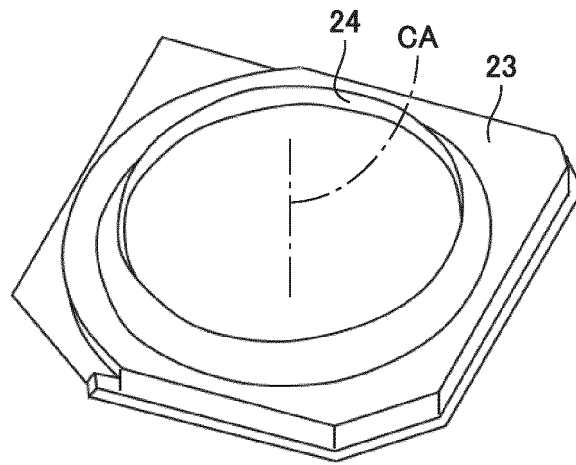


FIG.4

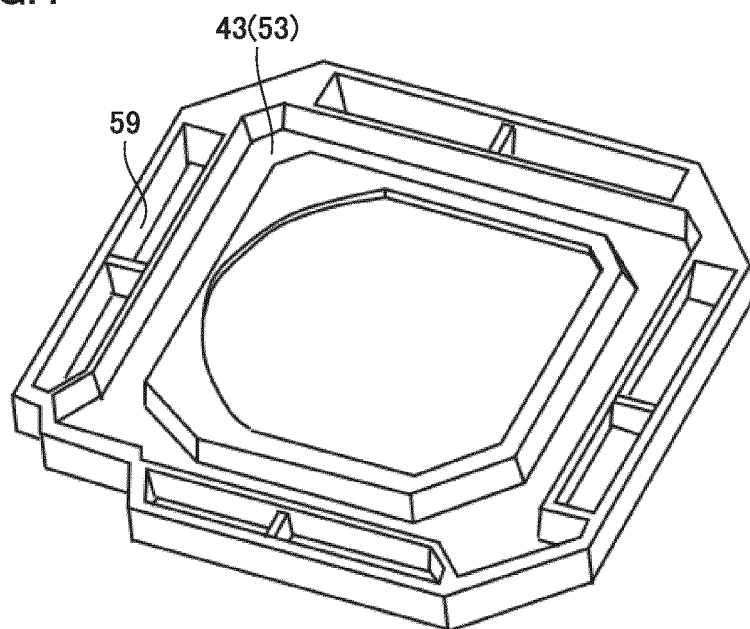


FIG.5

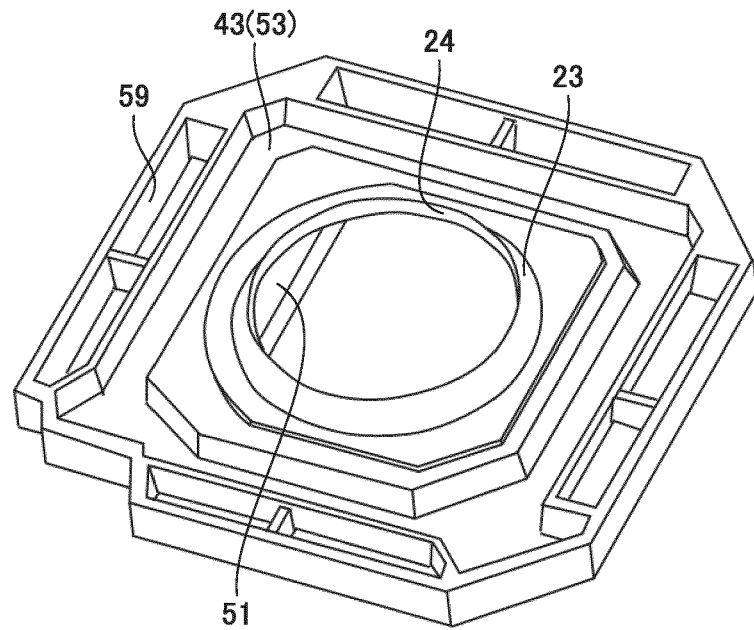


FIG.6

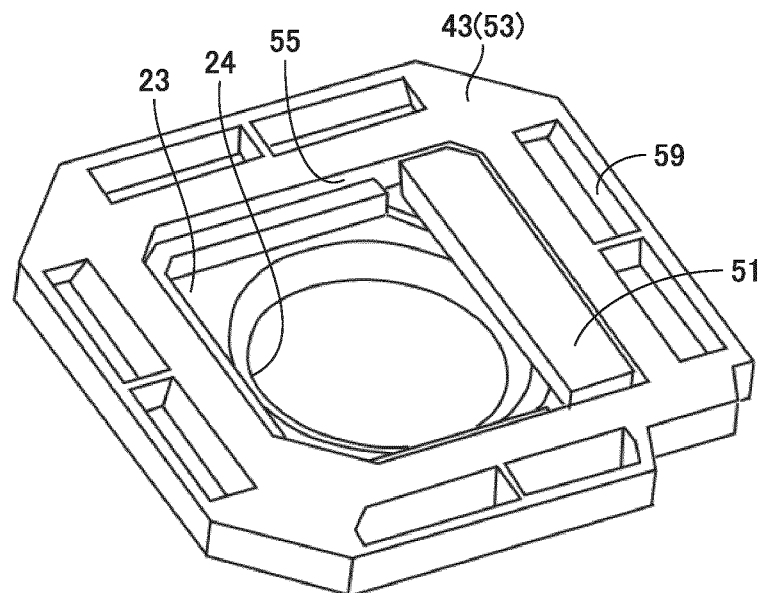


FIG.7

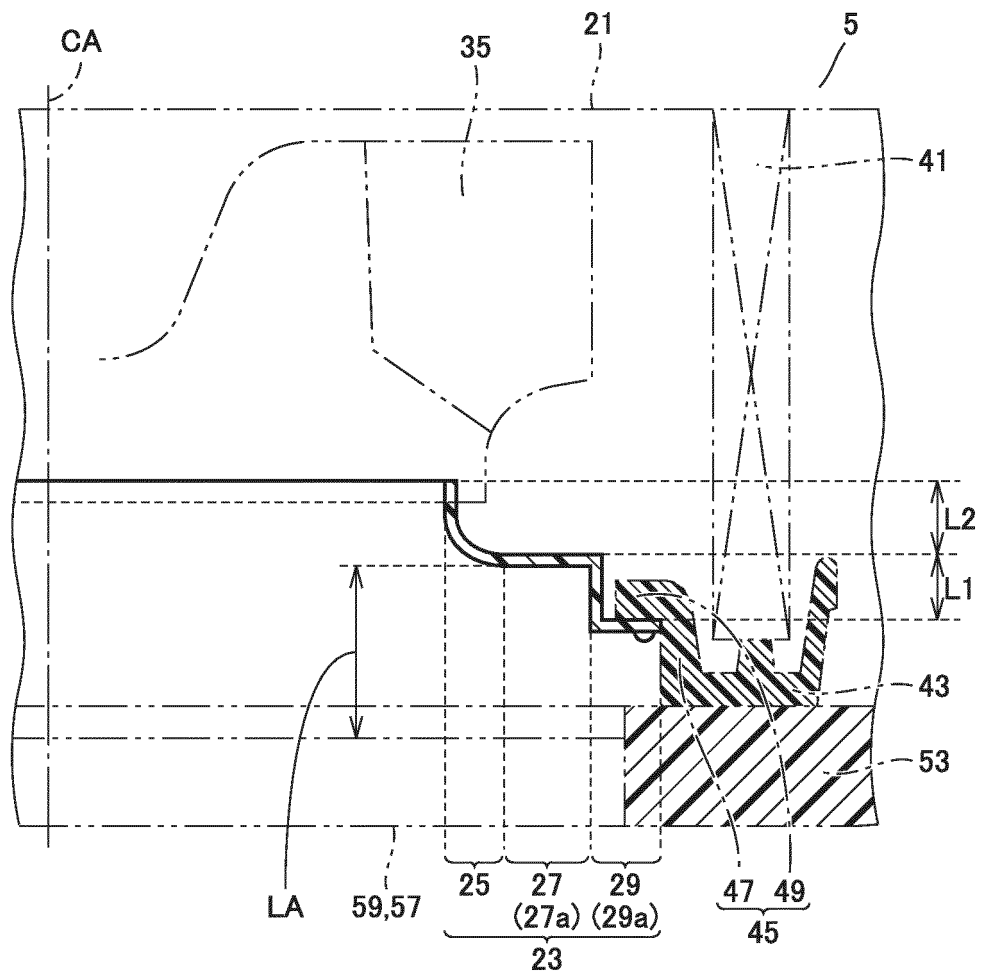


FIG.8

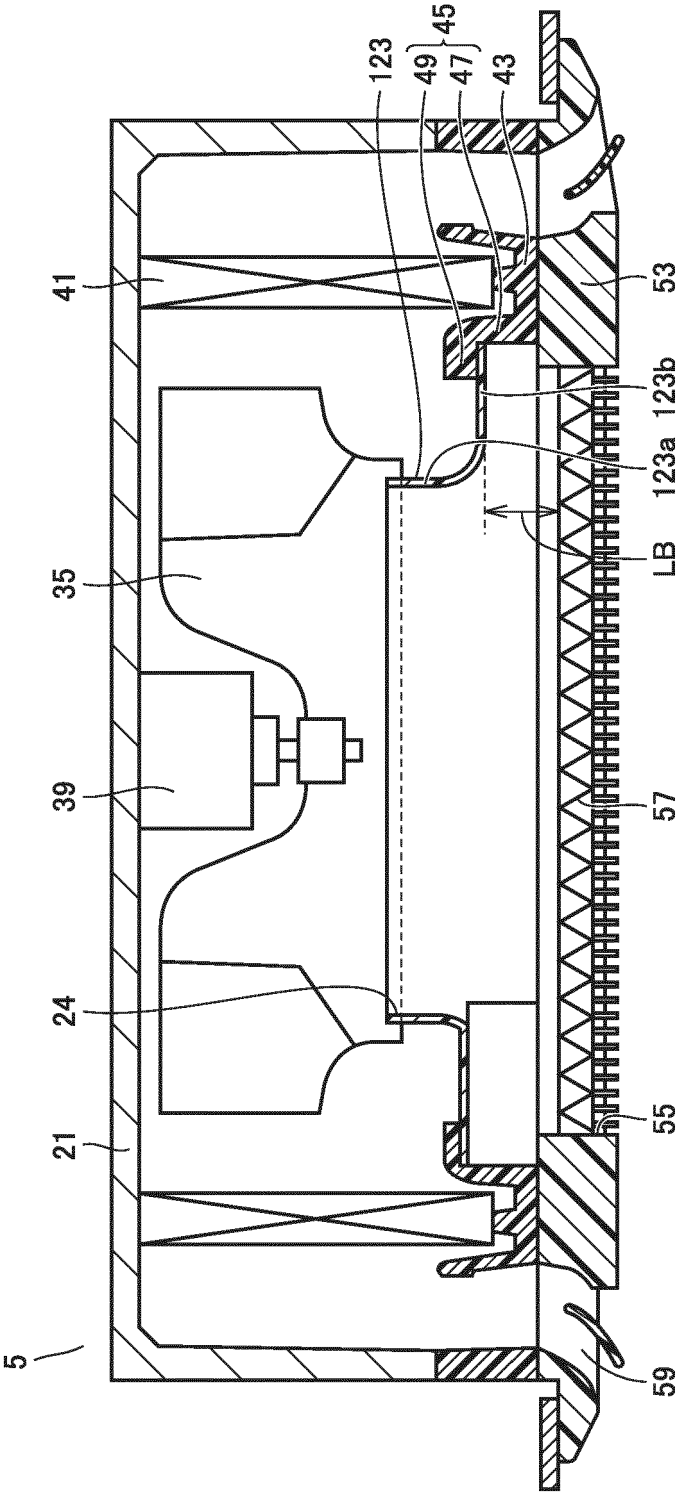
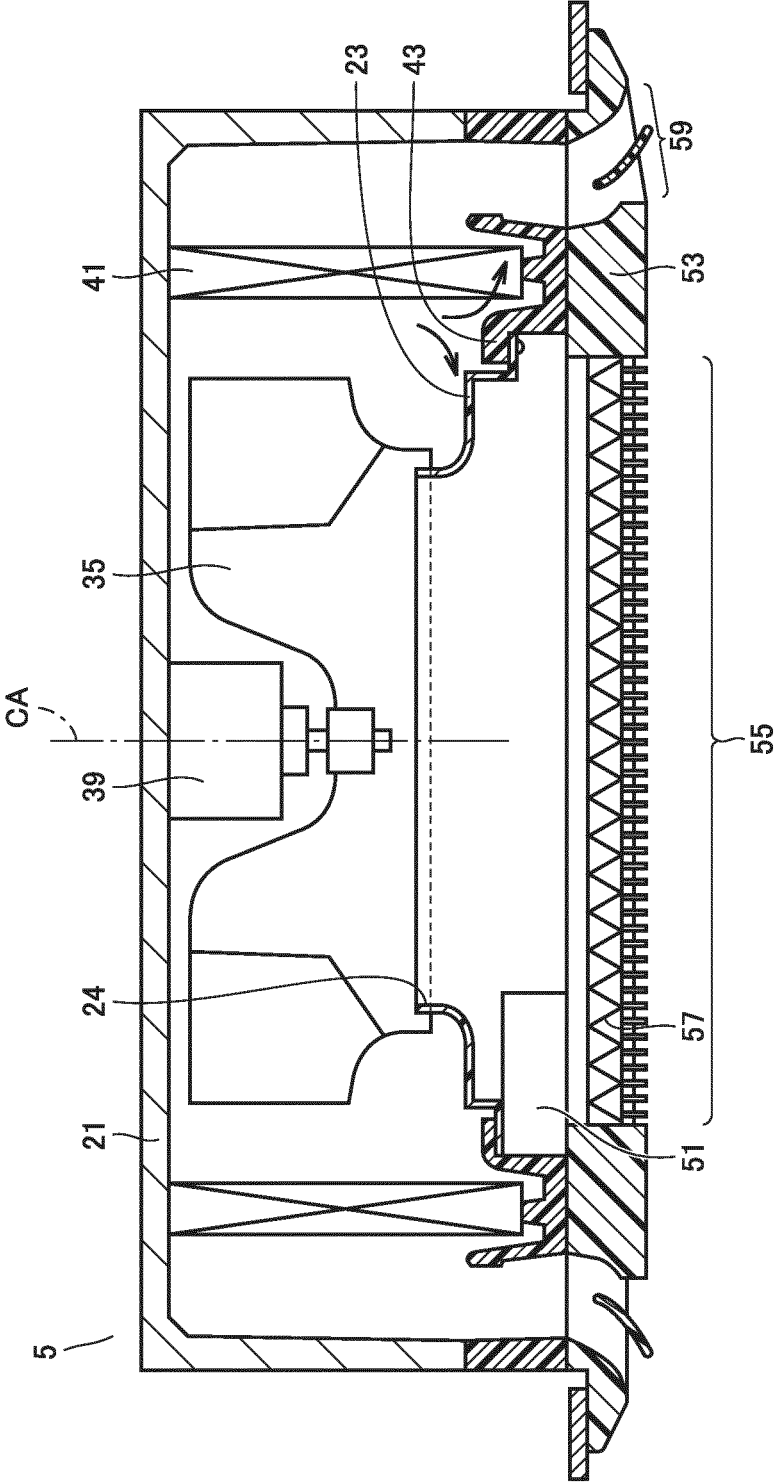


FIG.9



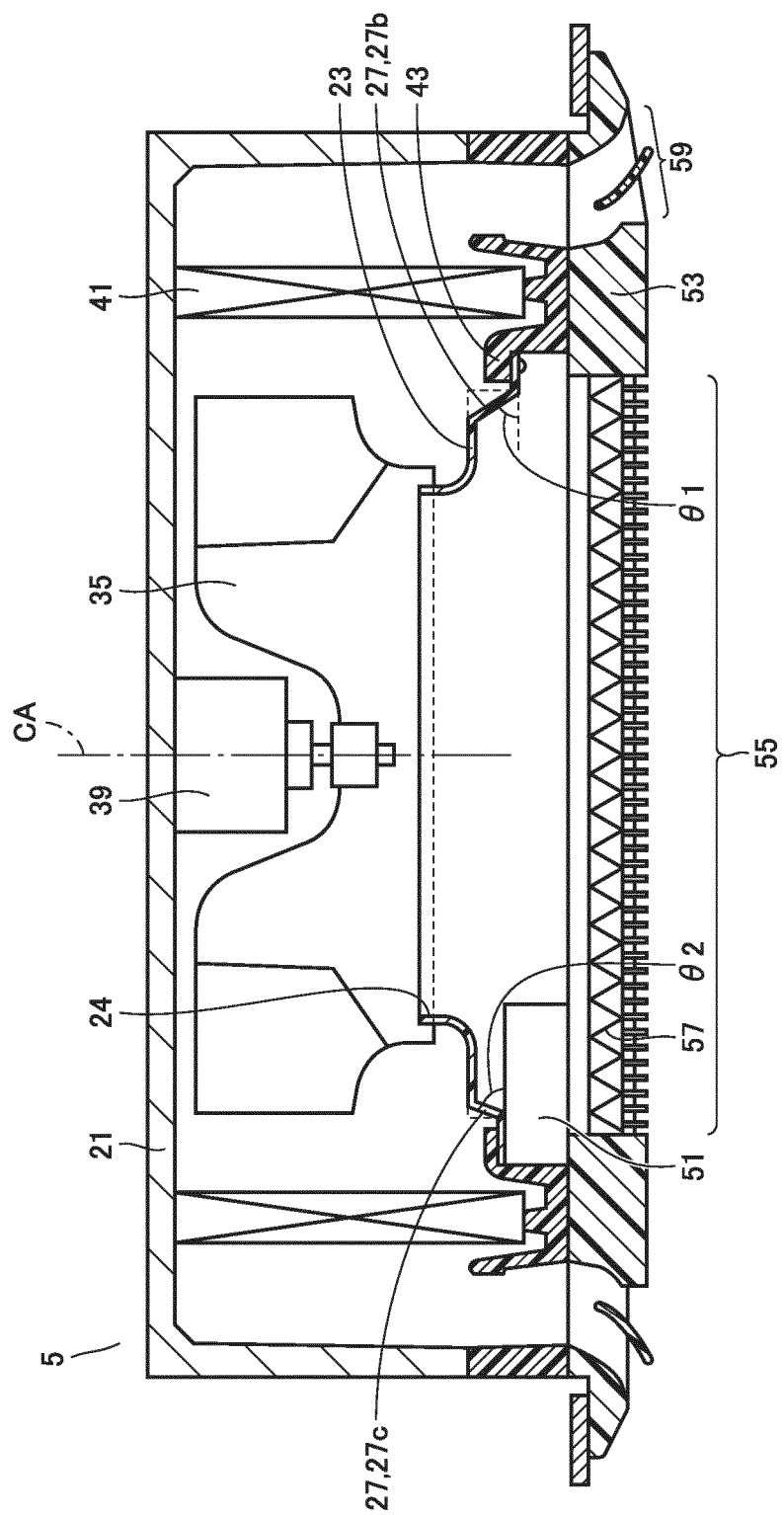


FIG. 10

FIG.11

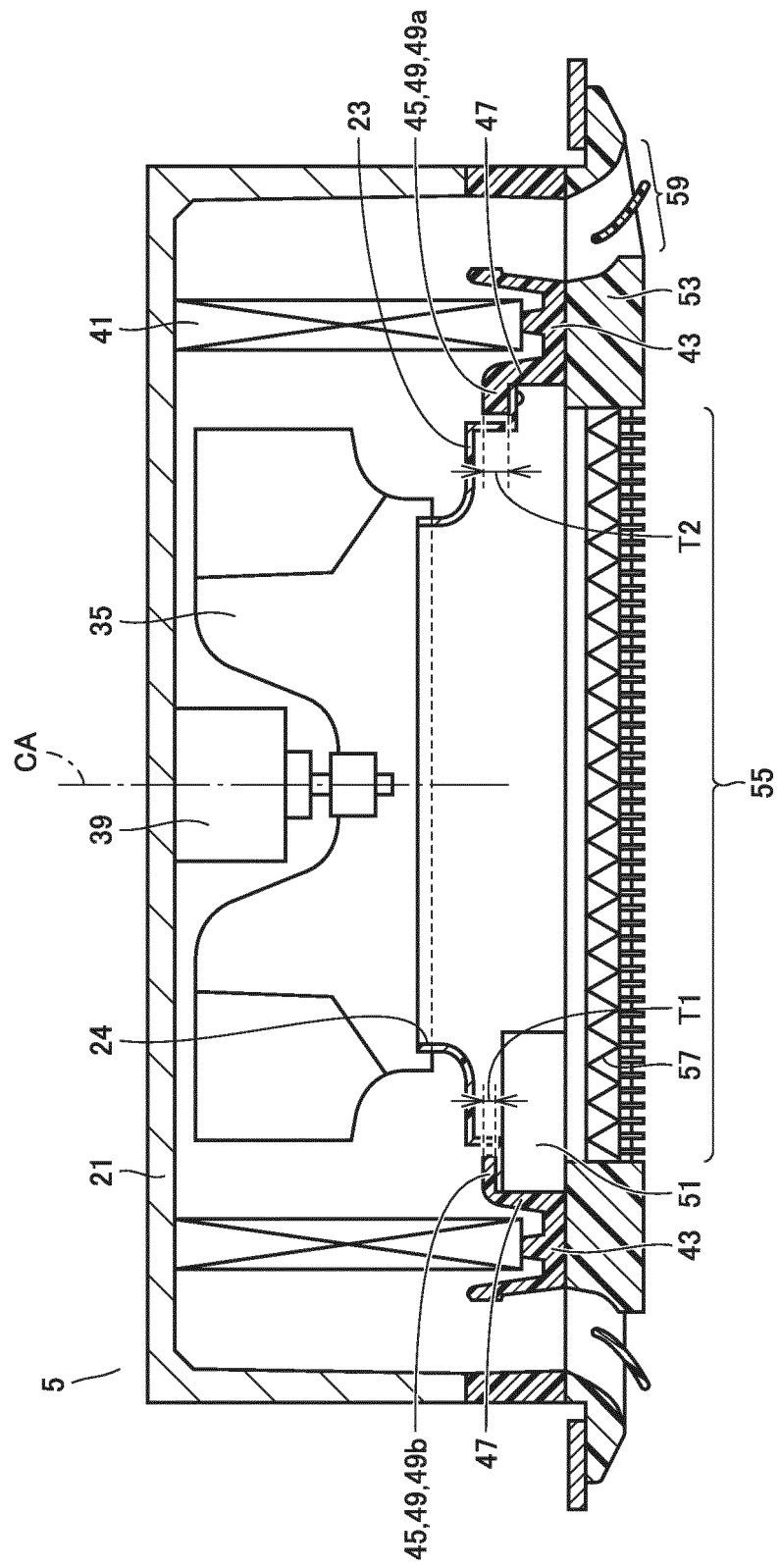


FIG.12

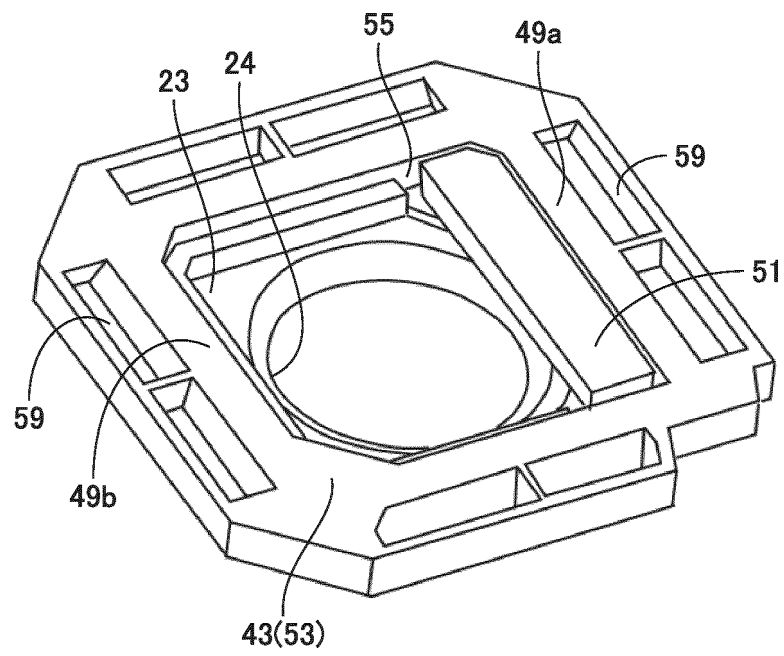


FIG.13

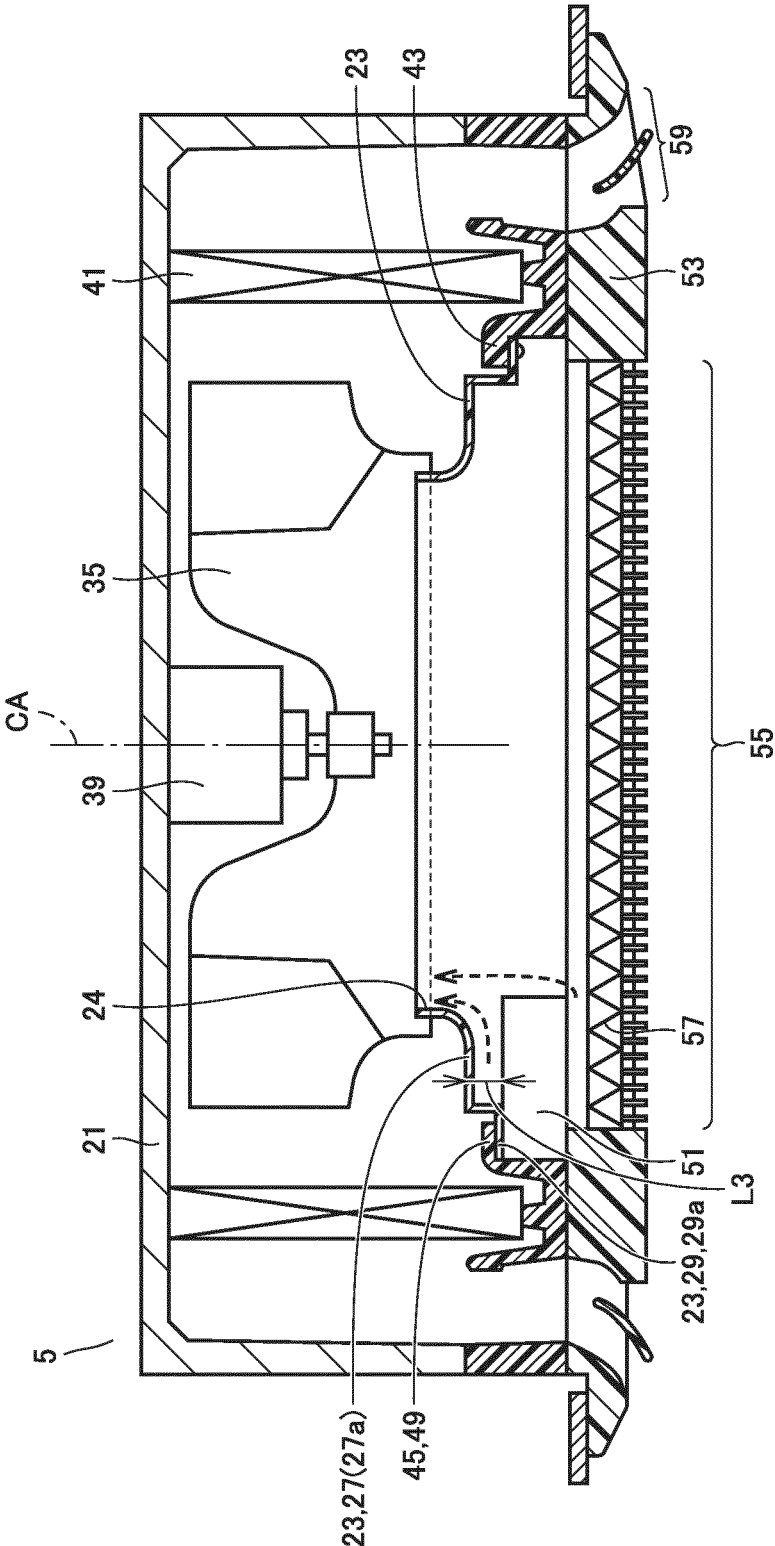


FIG.14

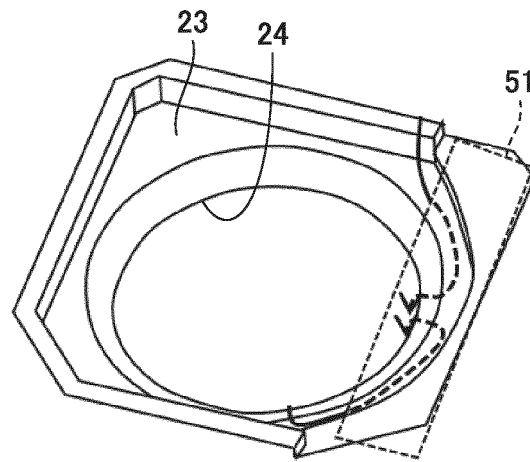


FIG.15

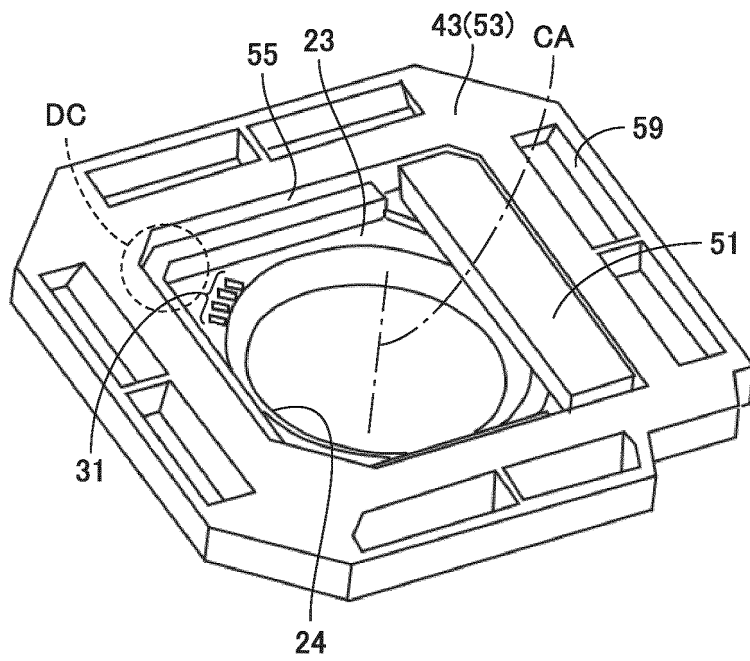


FIG.16

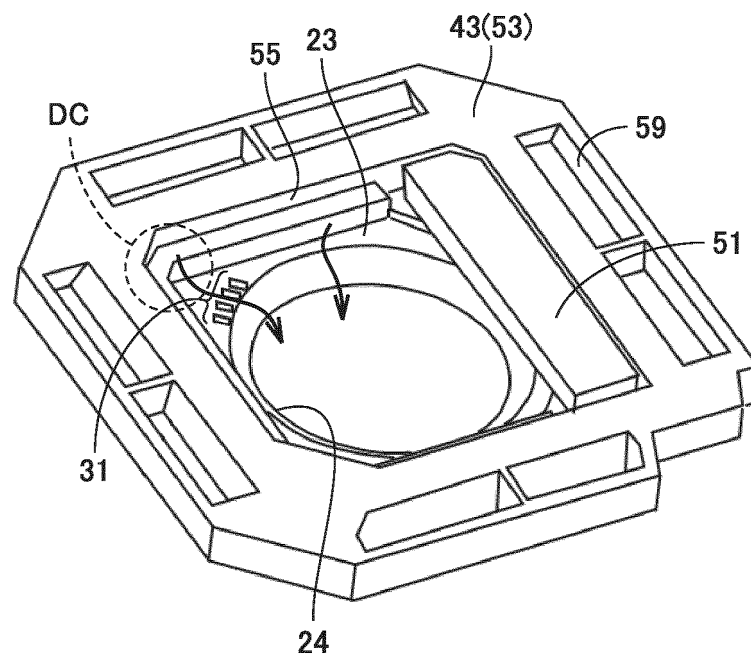


FIG.17

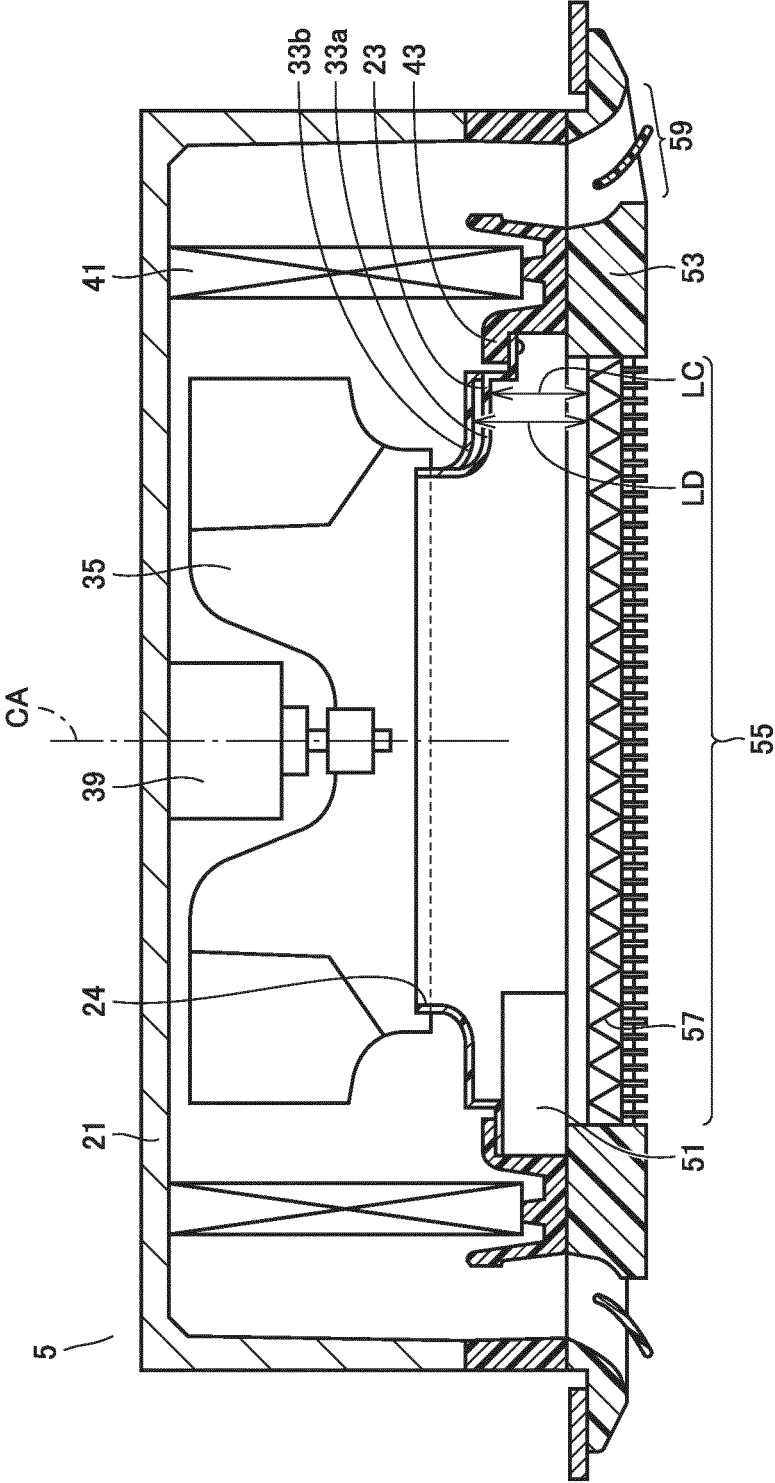


FIG.18

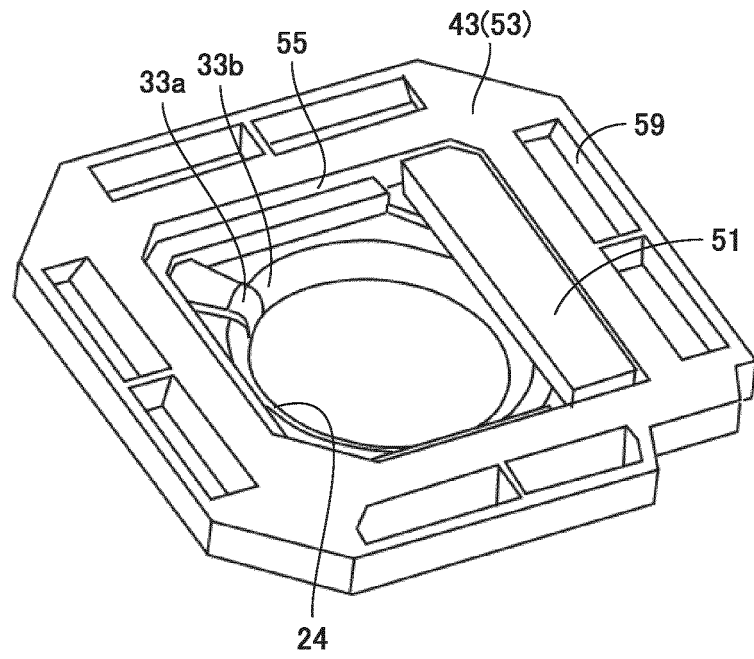
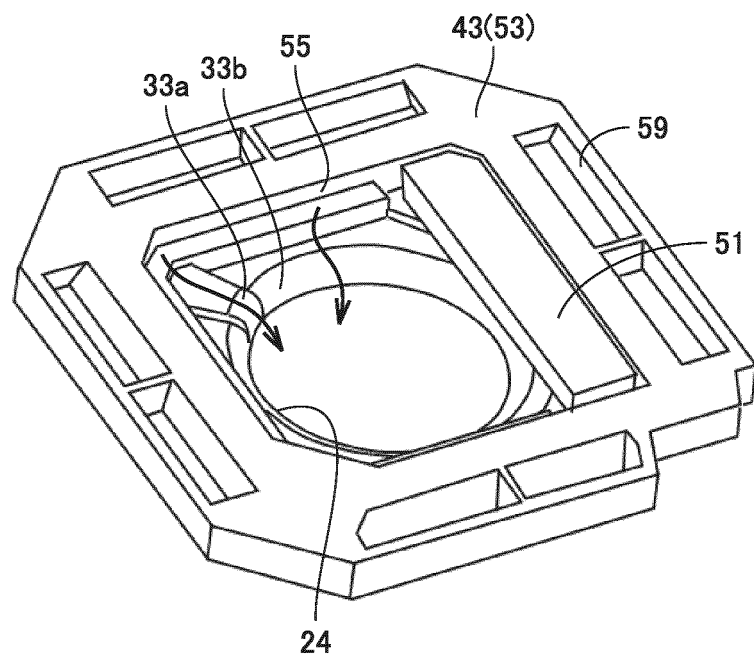


FIG.19



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INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2019/044400

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A. CLASSIFICATION OF SUBJECT MATTER

Int.Cl. F24F13/20 (2006.01) i, F24F13/22 (2006.01) i

According to International Patent Classification (IPC) or to both national classification and IPC

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B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Int.Cl. F24F13/20, F24F13/22

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

Published examined utility model applications of Japan	1922-1996
Published unexamined utility model applications of Japan	1971-2019
Registered utility model specifications of Japan	1996-2019
Published registered utility model applications of Japan	1994-2019

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

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

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Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	JP 2013-108684 A (HITACHI APPLIANCES INC.) 06 June 2013, paragraphs [0022]-[0033], fig. 1-4 (Family: none)	1-5, 8, 11 6-7, 9-10
Y	JP 11-281085 A (FUJITSU GENERAL LIMITED) 15 October 1999, paragraph [0022], fig. 1, 6 (Family: none)	1-5, 8, 11
Y	JP 2017-48979 A (FUJITSU GENERAL LIMITED) 09 March 2017, paragraphs [0018]-[0033], fig. 1-5 (Family: none)	2-5, 8, 11

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Further documents are listed in the continuation of Box C.



See patent family annex.

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Date of the actual completion of the international search
28.11.2019Date of mailing of the international search report
10.12.2019

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Japan Patent Office
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Tokyo 100-8915, Japan

Authorized officer

Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2019/044400

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2014-190656 A (PANASONIC CORPORATION) 06 October 2014, paragraph [0020], fig. 2 (Family: none)	4-5, 8, 11
Y	JP 2014-126245 A (MITSUBISHI HEAVY IND LTD.) 07 July 2014, paragraphs [0014]-[0030], fig. 1-4 (Family: none)	8, 11
A	JP 2011-252672 A (MITSUBISHI ELECTRIC CORPORATION) 15 December 2011, entire text, all drawings (Family: none)	1-11
A	JP 2004-156885 A (MITSUBISHI HEAVY INDUSTRIES, LTD.) 03 June 2004, entire text, all drawings (Family: none)	1-11

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Patent documents cited in the description

- JP 2013108684 A [0005]