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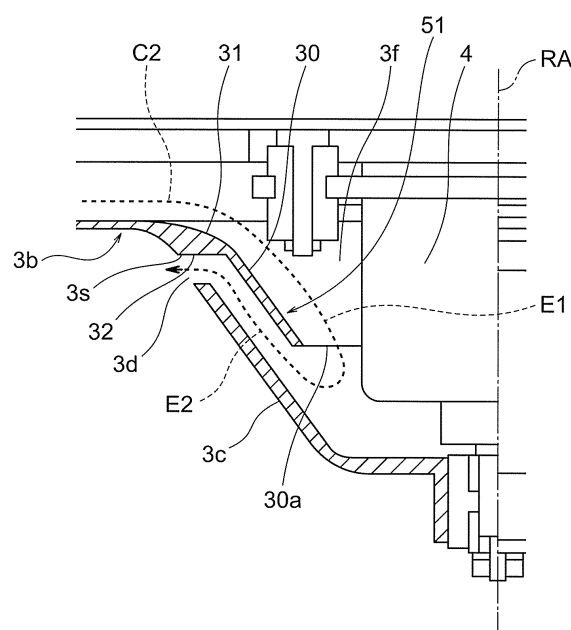
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(54) **CENTRIFUGAL FAN, AIR-CONDITIONING DEVICE, AND AIR-CLEANING DEVICE**

(57) Provided is a centrifugal fan (3), including: a main plate (3b) ; a shroud (3g) ; and a plurality of blades (3a). The main plate (3b) includes a base (3cd), a hub (3c), and a guide portion (51). The hub (3c) projects toward the shroud (3g) in a central portion of the main plate (3cd). The base (3cd) is positioned on a periphery of the hub (3c). The guide portion (51) is positioned outside the hub (3c). The guide portion (51) includes a rotating wall (30) and an induction portion (31). The rotating wall (30) extends to be inclined with respect to a direction in which the base (3cd) extends when viewed in vertical section. The induction portion (31) is formed on an outer surface of the guide portion (51) on an upstream side of the rotating wall (30).

FIG. 5



Description

Technical Field

[0001] The present invention relates to a centrifugal fan, an air-conditioning apparatus, and an air-cleaning apparatus.

Background Art

[0002] A ceiling-concealed air-conditioning apparatus has an air inlet and air outlets formed at a lower surface of the apparatus facing a room to be air-conditioned. Then, air sucked into a case through the air inlet is adjusted in temperature by a heat exchanger mounted in a ceiling in the case, and is then fed into the room through the air outlets.

[0003] The above-mentioned airflow in the air-conditioning apparatus is generated by a centrifugal fan configured to suck the air upward from below and blow out the sucked air in a flow direction changed to a radially outward direction. The centrifugal fan includes a shroud, a main plate, and a plurality of blades arranged between the shroud and the main plate.

[0004] There is also given an air-conditioning apparatus configured to generate, when the airflow changed from an upward direction to the radially outward direction using the above-mentioned centrifugal fan (airflow flowing between the main plate and the shroud of the centrifugal fan) is defined as a main flow, a subflow in which air travels from outside (upper side) of the main plate to inside of the main plate.

[0005] For example, in Patent Literature 1, a guide is formed at a center of a main plate on its upper side to cause such an airflow as to move along inside and outside the guide, thus generating a subflow. Further, a drive motor of a centrifugal fan is arranged at the center of the main plate on its upper side, and it is expected to obtain a drive motor cooling effect through the subflow.

Citation List

Patent Literature

[0006] [PTL 1] JP 4684085 B2

Summary of Invention

Technical Problem

[0007] In this regard, the subflow tends to have a narrow path as compared to the main flow, and hence there is a risk in that flow turbulence is liable to occur correspondingly.

[0008] The present invention has been made in view of the above, and an object of the present invention is to provide a centrifugal fan capable of obtaining a subflow that is less liable to cause turbulence.

Solution to Problem

[0009] In order to achieve the above-mentioned object, according to one embodiment of the present invention, there is provided a centrifugal fan, including: a main plate; a shroud; and a plurality of blades, in which the main plate includes a base, a hub, and a guide portion, in which the hub projects toward the shroud in a central portion of the main plate, in which the base is positioned on a periphery of the hub, in which the guide portion is positioned outside the hub, in which the guide portion includes a rotating wall and an induction portion, in which the rotating wall extends to be inclined with respect to a direction in which the base extends when viewed in vertical section, and in which the induction portion is formed on an outer surface of the guide portion on an upstream side of the rotating wall.

[0010] The induction portion may be a round portion. Alternatively, the induction portion may be a recessed portion that opens toward outside the guide portion.

[0011] The guide portion and the base may be formed by integral molding. In this case, a flat surface may be formed between a defining portion of a subflow outlet formed in the main plate and an inner surface of the rotating wall.

[0012] The guide portion may be welded to at least the base or the hub. In this case, an inner surface of the rotating wall may include a guide surface configured to guide a subflow to a subflow outlet formed in the main plate. Further, the guide surface may be flush with a defining portion of the subflow outlet formed in the main plate. In addition, the guide portion may be welded to an outer surface of the hub. Further, the guide portion may include a flange portion extending along the base, the flange portion may be held in surface contact with the base, and the guide portion may be welded to the base at the flange portion.

[0013] In order to achieve the object, according to one embodiment of the present invention, there is provided an air-conditioning apparatus, including: a case; a heat exchanger mounted in a ceiling in the case; and the above-mentioned centrifugal fan of the present invention, the centrifugal fan being mounted in the ceiling in the case.

[0014] In order to achieve the object, according to one embodiment of the present invention, there is provided an air-cleaning apparatus, including: a case; a filter mounted in a ceiling in the case; and the above-mentioned centrifugal fan of the present invention, the centrifugal fan being mounted in the ceiling in the case.

Advantageous Effects of Invention

[0015] According to the present invention, the subflow that is less liable to cause turbulence can be obtained in the centrifugal fan.

Brief Description of Drawings

[0016]

FIG. 1 is a view for illustrating a mounted state of an air-conditioning apparatus according to a first embodiment of the present invention.

FIG. 2 is a side view for illustrating the internal structure of the air-conditioning apparatus according to the first embodiment.

FIG. 3 is a plan view for illustrating the internal structure of the air-conditioning apparatus according to the first embodiment.

FIG. 4 is a view for illustrating a centrifugal fan and its peripheral portion according to the first embodiment in the same manner as FIG. 2.

FIG. 5 is an enlarged view for illustrating a guide portion and its peripheral portion according to the first embodiment.

FIG. 6 is a view for illustrating a second embodiment of the present invention in the same manner as FIG. 4.

FIG. 7 is a view for illustrating the second embodiment in the same manner as FIG. 5.

FIG. 8 is a perspective view for illustrating a guide portion according to the second embodiment.

FIG. 9 is a view for illustrating a third embodiment of the present invention in the same manner as FIG. 6.

FIG. 10 is a view for illustrating the third embodiment in the same manner as FIG. 7.

FIG. 11 is a view for illustrating the third embodiment in the same manner as FIG. 8.

FIG. 12 is a view for illustrating a fourth embodiment of the present invention in the same manner as FIG. 6.

FIG. 13 is a view for illustrating the fourth embodiment in the same manner as FIG. 8.

FIG. 14 is a view for illustrating a combined form of a configuration of the first embodiment with a configuration of the fourth embodiment in the same manner as FIG. 6.

FIG. 15 is a view for illustrating a combined form of the configuration of the first embodiment with configurations of the third and fourth embodiments in the same manner as FIG. 6.

Description of Embodiments

[0017] Now, embodiments of the present invention are described with reference to the accompanying drawings. In the drawings, the same reference symbols represent the same or corresponding parts.

First Embodiment

[0018] FIG. 1 is a view for illustrating a mounted state of an air-conditioning apparatus according to a first embodiment of the present invention. FIG. 2 is a side view

for illustrating the internal structure of the air-conditioning apparatus according to the first embodiment. FIG. 3 is a plan view for illustrating the internal structure of the air-conditioning apparatus according to the first embodiment. FIG. 4 is a view for illustrating a centrifugal fan and its peripheral portion according to the first embodiment in the same manner as FIG. 2. FIG. 5 is an enlarged view for illustrating a guide portion and its peripheral portion according to the first embodiment (enlarged view of a portion V in FIG. 4).

[0019] An air-conditioning apparatus 100 is an indoor unit of a so-called package air conditioner, and a most part of the air-conditioning apparatus 100 is concealed in a ceiling of a room 15 being a space to be air-conditioned. A state in which a lower portion of a case 1 of the air-conditioning apparatus 100 is viewed up from inside the room is illustrated in FIG. 1.

[0020] The air-conditioning apparatus 100 includes the case 1 concealed in a ceiling 15a of the space to be air-conditioned (room 15). As an example, the case 1 is formed into an approximately rectangular parallelepiped shape. The case 1 has an upper surface 1a, a side surface 1b, and a decorative panel 2 being a lower surface. The upper surface 1a and the side surface 1b are each formed of a sheet metal member. Further, a heat insulator 1c is arranged inside each of the upper surface 1a and the side surface 1b, and an air path wall surface is formed by the upper surface 1a and the side surface 1b formed as described above.

[0021] As illustrated in FIG. 3, the side surface 1b includes four main surfaces 21 oriented along two orthogonal axes, and further includes corner portions 22 between corresponding two main surfaces 21. The side surface 1b is formed into a tubular shape extending in a vertical direction. An upper portion of the side surface 1b is closed by the upper surface 1a, and the decorative panel 2 is mounted in a ceiling at a lower portion of the side surface 1b. The case 1 is formed into an approximately box shape by the upper surface 1a, the side surface 1b, and the decorative panel 2.

[0022] At least one air inlet 2a and at least one air outlet 2b are formed at a lower portion of the case 1, namely, the decorative panel 2 according to the first embodiment. As an example, the air-conditioning apparatus 100 according to the first embodiment has one air inlet 2a and four air outlets 2b as described later.

[0023] A centrifugal fan (turbofan) 3 serving as an air blowing unit, a fan motor 4, a bellmouth 5, and a heat exchanger 6 are accommodated in the case 1. The centrifugal fan 3 generates a stream of air that is sucked into the case 1 through the air inlet 2a and blown out into the target space through the air outlets 2b. The heat exchanger 6 is arranged in such an air flow path and is configured to adjust air temperature.

[0024] The air inlet 2a is formed at a central portion of the decorative panel 2 over a wide region in the decorative panel 2. Further, the air inlet 2a according to the first embodiment is formed as a grille-type air inlet, but the

present invention is not limited thereto. A filter 14 configured to remove dust from air having passed through the air inlet 2a is arranged on an upstream side of the air inlet 2a (on an inner side of the case 1).

[0025] As an example, according to the first embodiment, the decorative panel 2 and the air inlet 2a each have a rectangular perimeter in plan view.

[0026] The plurality of air outlets 2b are formed in a region between the perimeter of the decorative panel 2 and the perimeter of the air inlet 2a. According to the first embodiment, the four air outlets 2b are formed correspondingly to the four-side perimeters of the decorative panel 2 and the air inlet 2a, and the respective air outlets 2b are formed so as to extend along corresponding sides of the decorative panel 2 and the air inlet 2a except for the corner portions to be described later. Further, the four air outlets 2b are positioned so as to surround the air inlet 2a. Each of the air outlets 2b includes an airflow direction flap 2c configured to adjust a direction of air to be blown out.

[0027] The fan motor 4 is arranged in a central portion inside the case 1. The fan motor 4 is supported on a lower surface of the upper surface 1a of the case 1 (internal space side of the case). The centrifugal fan 3 is mounted to a rotary shaft of the fan motor 4, which extends downward. Further, the bellmouth 5 forming a suction air path directed from the air inlet 2a toward the centrifugal fan 3 is arranged between the centrifugal fan 3 and the air inlet 2a. The centrifugal fan 3 is configured to suck air into the case 1 through the air inlet 2a and blow out the air through the air outlets 2b into the room (room inside) 15 being a target space.

[0028] The heat exchanger 6 being an example of a pressure loss unit is arranged radially outside the centrifugal fan 3. In other words, the heat exchanger 6 is arranged in the air flow path formed by the centrifugal fan 3 inside the case and is configured to exchange heat between the air and refrigerant.

[0029] The heat exchanger 6 includes a plurality of fins arranged at predetermined intervals and a heat transfer tube penetrating the fins. The heat transfer tube is connected to a publicly-known outdoor unit (not shown) by a connection pipe. With this, cooled refrigerant or heated refrigerant is supplied to the heat exchanger 6.

[0030] Further, two ends 6a of the heat exchanger 6 are connected to each other by a heat exchanger connecting plate 7. A space is formed outside the heat exchanger connecting plate 7 between the heat exchanger connecting plate 7 and a side surface heat insulator 1d. A top and a bottom of the space are closed by the upper surface 1a and a drain pan 12, respectively, to form a piping accommodation space 10. A header 8 and a distributor 9, which are connected to a heat transfer tube 6b extending from one end 6a among the two ends 6a, are arranged inside the piping accommodation space 10.

[0031] The drain pan 12, which is configured to temporarily store condensed water, is arranged below the heat exchanger 6. Further, an electrical component box

13 configured to accommodate an electronic circuit board is arranged on a back side of the drain pan 12. Configurations and modes of the centrifugal fan 3, the bellmouth 5, and the heat exchanger 6 are not particularly limited, but publicly-known types are used in the first embodiment.

[0032] In such a configuration, rotation of the centrifugal fan 3 in a direction of the arrow A causes air in the room 15 to be sucked into the air inlet 2a of the decorative panel 2, as indicated by the arrow B. Then, the air from which dust is removed in the filter 14 is guided by the bellmouth 5 and sucked into the centrifugal fan 3. Further, in the centrifugal fan 3, the air sucked upward from below is blown out through a fan air outlet 3i in a horizontal direction and in a radially outward direction, as indicated by the arrow C1. The thus blown out air is subjected to heat exchange and humidity adjustment when passing through the heat exchanger 6 being the pressure loss unit, and is thereafter blown out into the room 15 through the respective air outlets 2b while the flow direction is changed to a downward direction. Further, the air blowing out into the room 15 is controlled in airflow direction by the airflow direction flap 2c.

[0033] Now, a description is made of an airflow inside the case 1 of the air-conditioning apparatus 100. A main flow and a subflow are generated inside the case 1. The main flow is a flow indicated by the arrows B and C1 as described above. In other words, the main flow is an airflow that flows out of the bellmouth 5, flows into the centrifugal fan 3, flows through a space between a main plate 3b and a shroud 3g of the centrifugal fan 3, which are described later, and flows out of the fan air outlet 3i. The subflow is a flow indicated by the arrows C2, E1, and E2. In other words, the subflow is an airflow that passes from a space radially outside the fan air outlet 3i to flow through an upper side of the centrifugal fan 3 (between the centrifugal fan 3 and the upper surface 1a) and flows into the centrifugal fan 3 from a central portion in a vicinity of a rotation axis to join the main flow, and the detail of the subflow is described later.

[0034] Next, the centrifugal fan 3 is described in detail. The centrifugal fan 3 includes a plurality of blades 3a, the main plate 3b, and the shroud 3g.

[0035] The shroud 3g is an annular member in plan view, which forms a suction/guide flow path to the blades 3a. The shroud 3g is arranged so as to be opposed to the main plate 3b in a direction of a rotation axis RA of the centrifugal fan 3 and to be away from the main plate 3b in the direction of the rotation axis RA of the centrifugal fan 3. The main plate 3b is arranged on the upper surface 1a side of the case 1, and the shroud 3g is arranged on the bellmouth 5 side.

[0036] The plurality of blades 3a are welded between the shroud 3g and the main plate 3b. In other words, one end of each blade 3a is welded to the main plate 3b, and the other end of each blade 3a is welded to the shroud 3g.

[0037] The main plate 3b includes a base 3cd, a hub 3c, and a guide portion 51. At least the guide portion 51

and the base 3cd are formed by integral molding. As an example, according to the first embodiment, the base 3cd, the hub 3c, and the guide portion 51 are formed by integral molding.

[0038] The hub 3c projects toward the shroud 3g in a central portion of the main plate 3b (rotation axis RA of the centrifugal fan 3 and its vicinity). The hub 3c has a diameter reduced as approaching the rotation axis RA side, and has a portion approaching the shroud 3g as approaching the rotation axis RA side. The above-mentioned fan motor 4 is arranged inside a fan central portion outside air path 3f located outside (on an upper side of) the hub 3c.

[0039] "Outside" and "inside" in each portion concerning the centrifugal fan 3 are now defined as follows. First, as for "inside" in that portion, a space side formed between the main plate and the shroud in that member is defined as inside. As for "outside" in that portion, an opposite side to the space formed between the main plate and the shroud in that member is defined as outside. Therefore, description is made based on the definitions of the "outside" and "inside" as follows. An outer surface of a rotating wall 30 to be described later is an upper surface of the rotating wall 30, an inner surface of the rotating wall 30 is a lower surface (surface on the hub 3c side, surface on the shroud 3g side) of the rotating wall 30, and an outer surface of the hub 3c is an upper surface (surface on the rotating wall 30 side) of the hub 3c and is an inner surface (surface on the shroud 3g side) of the hub 3c.

[0040] A boss 3h configured to fix the rotary shaft 4a of the fan motor 4 is integrally molded at a projected end 3cb of the hub 3c.

[0041] The base 3cd is a portion located on a periphery of the hub 3c. The base 3cd is an annular portion having a circular perimeter in plan view. Further, as an example, the base 3cd is an approximately flat, plate-like portion and extends along one plane.

[0042] The guide portion 51 is positioned outside the hub 3c. The guide portion 51 includes the rotating wall 30 and an induction portion 31. The rotating wall 30 extends to be inclined with respect to a direction in which the base 3cd extends when viewed in vertical section (viewed in FIG. 4 and FIG. 5). The rotating wall 30 extends away from the hub 3c and forms a part of the subflow path with the hub 3c.

[0043] Further, the rotating wall 30 is configured to guide the subflow, which has flowed outside the rotating wall 30 as indicated by the reference symbol E1, so as to flow in a flow path between the inside of the rotating wall 30 and the outside of the hub 3c as indicated by the reference symbol E2, and further to guide the subflow to subflow outlets 3d formed in the main plate 3b.

[0044] The induction portion 31 is formed on an outer surface of the guide portion 51 on an upstream side of the rotating wall 30 (upstream side of the subflow). The induction portion 31 is a round portion smoothly connecting an outer surface of the base 3cd with the outer surface

of the rotating wall 30, and is a surface curved so as to expand toward outside the guide portion 51. The induction portion 31 is configured to suppress separation of the subflow, which flows from outside the base 3cd to outside the rotating wall 30.

[0045] At least one subflow outlet 3d (a plurality of subflow outlets in the first embodiment) being a through-hole connecting the outside of the main plate 3b (fan central portion outside air path 3f) with the inside of the main plate 3b (fan inside air path 3e) is formed in the main plate 3b. More specifically, in a direction in which the rotation axis RA extends, the subflow outlet 3d is arranged on a side closer to the base 3cd than a distal end opening portion 30a being a distal end of the rotating wall 30 on the shroud 3g side. Specifically, the distal end opening portion 30a is formed in the hub 3c.

[0046] A flat surface 32 is formed between a defining portion 3s of the subflow outlet 3d formed in the main plate 3b and the inner surface of the rotating wall 30. The flat surface 32 is a guide surface configured to guide the subflow to the subflow outlet 3d formed in the main plate 3b.

[0047] On the basis of such a configuration, as the subflow, a part of air having flowed out of the fan air outlet 3i flows radially inward (flows toward the rotation axis RA) through a gap between the outer surface of the base 3cd and the heat insulator 1c on the upper surface 1a side as indicated by the reference symbol C2, flows through the induction portion 31 from the outer surface of the base 3cd along the outer surface of the rotating wall 30 as indicated by the reference symbol E1, further flows radially outward through a gap between the inner surface of the rotating wall 30 and the outer surface of the hub 3c as indicated by the reference symbol E2, and flows out of the subflow outlet 3d into the space between the main plate 3b and the shroud 3g (fan inside air path 3e) to join the main flow.

[0048] The thus constructed centrifugal fan and air-conditioning apparatus according to the first embodiment can achieve the following advantages. First, along with flow of the main flow, the subflow flowing along the fan central portion outside air path is obtained, and hence the fan motor can be cooled through flow of the subflow as described above around the fan motor. Further, the induction portion formed of a curved surface is formed upstream of the rotating wall, and hence when the subflow flows through the fan central portion outside air path, the effect that the airflow is not liable to be separated but flows along the outer surface of the rotating wall is obtained, thereby being capable of obtaining the subflow that is less liable to cause turbulence. In particular, if the subflow does not flow along the outer surface of the rotating wall when flowing in the fan central portion outside air path, noise due to turbulence is increased or motor cooling performance is decreased due to reduction of an effective passage area. However, according to the first embodiment, the subflow that is less liable to cause turbulence can be obtained. Thus, increase in noise can be

prevented, and reliability in motor drive can be improved owing to a sufficient motor cooling effect.

[0049] Further, the flat surface being the guide surface to the subflow outlet is formed, and hence the first embodiment is also advantageous in that, when the subflow flows between the outer surface of the hub and the inner surface of the rotating wall, the subflow can flow smoothly without stagnating due to collision of the subflow having flowed extremely far over the subflow outlet with its subsequent subflow or disturbance caused by its subsequent subflow.

[0050] The airflow after cooling the motor, which is discharged from the subflow outlet to the fan inside air path, is discharged to a region near a corner portion where a hub extension direction intersects with a base extension direction, and hence turbulence at a time when the subflow joins the main flow can be suppressed, thus also leading to noise reduction.

[0051] Further, according to the first embodiment, the guide portion and the base are formed by integral molding, and hence a continuous surface having extremely few irregularities can be obtained in a region from the outer surface of the base through the induction portion to the outer surface of the rotating wall. Also with this, turbulence of the subflow can be reduced.

[0052] Further, the guide surface and the defining portion of the subflow outlet are flush with each other. In other words, the guide surface is continuous with the defining portion of the subflow outlet, and the defining portion of the subflow outlet is an exit portion of a surface forming the guide surface. Therefore, losses in subflow due to the irregularities can be suppressed, and turbulence of the subflow can be reduced by providing the air outlet portion having extremely few irregularities.

Second Embodiment

[0053] Next, a second embodiment of the present invention is described with reference to FIG. 6 to FIG. 8. FIG. 6 and FIG. 7 are views for illustrating the second embodiment in the same manner as FIG. 4 and FIG. 5, respectively. FIG. 8 is a perspective view for illustrating a guide portion according to the second embodiment. The second embodiment is the same as the above-mentioned first embodiment except for parts to be described below.

[0054] A main plate 203b includes the base 3cd, the hub 3c, and a guide portion 251. The guide portion 251 is positioned outside the hub 3c, and includes the rotating wall 30, the induction portion 31, and a flange portion 233. The flange portion 233 extends radially outward along the base 3cd.

[0055] The guide portion 251 is a member separate from the base 3cd and the hub 3c, and is welded to at least the base 3cd or the hub 3c. According to the second embodiment, the flange portion 233 of the guide portion 251 is held in surface contact with the base 3cd, and the guide portion 251 is welded to the outer surface of the

base 3cd at an inner surface of the flange portion 233.

[0056] The inner surface of the rotating wall 30 includes a guide surface 232 configured to guide the subflow to the subflow outlet 3d formed in the main plate 3b. The guide surface 232 is formed so as to be flush with the defining portion 3s of the subflow outlet 3d formed in the main plate 3b.

[0057] Also in the second embodiment constructed as described above, as in the first embodiment, the subflow that is less liable to cause turbulence can be obtained. Thus, increase in noise can be prevented, and reliability in motor drive can be improved owing to a sufficient motor cooling effect.

[0058] Further, the guide surface to the subflow outlet is formed, and hence, as in the first embodiment, there is obtained an advantage in that, when the subflow flows between the outer surface of the hub and the inner surface of the rotating wall, the subflow can flow smoothly without stagnating due to collision of the subflow having flowed extremely far over the subflow outlet with its subsequent subflow or disturbance caused by its subsequent subflow.

[0059] Further, as in the first embodiment, the airflow after cooling the motor, which is discharged from the subflow outlet to the fan inside air path, is discharged to the region near the corner portion where the hub extension direction intersects with the base extension direction, and hence turbulence at a time when the subflow joins the main flow can be suppressed, thus also leading to noise reduction.

[0060] Further, the guide portion is the member separate from the base and the hub, and hence even when the motor is changed in size, replacement of the guide portion is only necessary. Thus, there is no need to newly manufacture the entire centrifugal fan so that an embodiment having versatility can be provided. In addition, it is not necessary to manufacture a large die again, and hence resource saving and cost reduction can be achieved.

[0061] Further, the guide portion is welded to the base of the main plate at the flange portion. Thus, a large area can be secured for welding between the guide portion and the base, and the adhesion between the guide portion and the base can be improved to enhance the connection strength. Further, the guide portion is held in contact with the outer surface of the base at the inner surface of the flange portion, and hence the guide portion can be reliably prevented from dropping down.

Third Embodiment

[0062] Next, a third embodiment of the present invention is described with reference to FIG. 9 to FIG. 11. FIG. 9 to FIG. 11 are views for illustrating the third embodiment in the same manner as FIG. 6 to FIG. 8, respectively. The third embodiment is the same as the corresponding configuration of the above-mentioned first or second embodiment except for parts to be described below.

[0063] A main plate 303b includes the base 3cd, the hub 3c, and a guide portion 351. The guide portion 351 includes the rotating wall 30, an induction portion 331, and the flange portion 233. The induction portion 331 is a recessed portion that opens toward outside the guide portion 351.

[0064] The guide portion 351 is a member separate from the base 3cd and the hub 3c, and is welded to at least the base 3cd or the hub 3c. According to the third embodiment, the guide portion 351 is welded to the outer surface of the base 3cd at the inner surface of the flange portion 233.

[0065] The inner surface of the rotating wall 30 includes the guide surface 232 configured to guide the subflow to the subflow outlet 3d formed in the main plate 3b. The guide surface 232 is formed so as to be flush with the defining portion 3s of the subflow outlet 3d formed in the main plate 3b.

[0066] In the third embodiment constructed as described above, the induction portion formed of the recessed portion is formed upstream of the rotating wall, and hence when the subflow flows into the fan central portion outside air path, the sub flow is attracted toward the outer surface of the guide portion by a negative pressure caused by the recessed portion, and the effect that the airflow is not liable to be separated but flows along the outer surface of the rotating wall is thus obtained, thereby being capable of obtaining the subflow that is less liable to cause turbulence. Therefore, as in the first embodiment, the subflow that is less liable to cause turbulence can be obtained. Thus, increase in noise can be prevented, and reliability in motor drive can be improved owing to a sufficient motor cooling effect.

[0067] Further, the guide surface to the subflow outlet is formed, and hence, as in the first embodiment, there is obtained an advantage in that, when the subflow flows between the outer surface of the hub and the inner surface of the rotating wall, the subflow can flow smoothly without stagnating due to collision of the subflow having flowed extremely far over the subflow outlet with its subsequent subflow or disturbance caused by its subsequent subflow.

[0068] Further, as in the first embodiment, the airflow after cooling the motor, which is discharged from the subflow outlet to the fan inside air path, is discharged to the region near the corner portion where the hub extension direction intersects with the base extension direction, and hence turbulence at a time when the subflow joins the main flow can be suppressed, thus also leading to noise reduction.

[0069] Further, the guide portion is the member separate from the base and the hub, and hence even when the motor is changed in size, replacement of the guide portion is only necessary. Thus, there is no need to newly manufacture the entire centrifugal fan so that an embodiment having versatility can be provided. In addition, it is not necessary to manufacture a large die again, and hence resource saving and cost reduction can be

achieved.

[0070] Further, the guide portion is welded to the base of the main plate at the flange portion. Thus, a large area can be secured for welding between the guide portion and the base, and the adhesion between the guide portion and the base can be improved to enhance the connection strength. Further, the guide portion is held in contact with the outer surface of the base at the inner surface of the flange portion, and hence the guide portion can be reliably prevented from dropping down.

Fourth Embodiment

[0071] Next, a fourth embodiment of the present invention is described with reference to FIG. 12 and FIG. 13. FIG. 12 and FIG. 13 are views for illustrating the fourth embodiment in the same manner as FIG. 6 and FIG. 8, respectively. The fourth embodiment is the same as the corresponding configurations of the above-mentioned first to third embodiments except for parts to be described below.

[0072] A main plate 403b includes the base 3cd, the hub 3c, and a guide portion 451. The guide portion 451 includes the rotating wall 30 and the induction portion 331. The induction portion 331 is a recessed portion that opens toward outside the guide portion 451.

[0073] The guide portion 451 is a member separate from the base 3cd and the hub 3c, and is welded to at least the base 3cd or the hub 3c. According to the fourth embodiment, the guide portion 451 is welded to the outer surface of the hub 3c at an inner surface of the guide portion 451, which is positioned on an opposite side to the induction portion 331. Further, an upper end of the guide portion 451, which is an end on an opposite side to the distal end opening portion 30a (lower end after assembly), is flush with the outer surface of the base 3cd of the main plate 403b.

[0074] The inner surface of the rotating wall 30 includes the guide surface 232 configured to guide the subflow to the subflow outlet 3d formed in the main plate 3b. The guide surface 232 is formed so as to be flush with the defining portion 3s of the subflow outlet 3d formed in the main plate 3b.

[0075] In the fourth embodiment constructed as described above, the induction portion formed of the recessed portion is formed upstream of the rotating wall, and hence when the subflow flows into the fan central portion outside air path, the sub flow is attracted toward the outer surface of the guide portion by a negative pressure caused by the recessed portion, and the effect that the airflow is not liable to be separated but flows along the outer surface of the rotating wall is thus obtained, thereby being capable of obtaining the subflow that is less liable to cause turbulence. Therefore, as in the first embodiment, the subflow that is less liable to cause turbulence can be obtained. Thus, increase in noise can be prevented, and reliability in motor drive can be improved owing to a sufficient motor cooling effect.

[0076] Further, the guide surface to the subflow outlet is formed, and hence, as in the first embodiment, there is obtained an advantage in that, when the subflow flows between the outer surface of the hub and the inner surface of the rotating wall, the subflow can flow smoothly without stagnating due to collision of the subflow having flowed extremely far over the subflow outlet with its subsequent subflow or disturbance caused by its subsequent subflow.

[0077] Further, as in the first embodiment, the airflow after cooling the motor, which is discharged from the subflow outlet to the fan inside air path, is discharged to the region near the corner portion where the hub extension direction intersects with the base extension direction, and hence turbulence at a time when the subflow joins the main flow can be suppressed, thus also leading to noise reduction.

[0078] Further, the guide portion is the member separate from the base and the hub, and hence even when the motor is changed in size, replacement of the guide portion is only necessary. Thus, there is no need to newly manufacture the entire centrifugal fan so that an embodiment having versatility can be provided. In addition, it is not necessary to manufacture a large die again, and hence resource saving and cost reduction can be achieved.

[0079] Further, the upper end of the guide portion is flush with the outer surface of the base of the main plate, and hence turbulence due to the irregularities can be prevented from occurring immediately behind the induction portion in the subflow, which flows on the outer surface of the base of the main plate.

[0080] Although the details of the present invention are specifically described above with reference to the preferred embodiments, it is apparent that persons skilled in the art may adopt various modifications based on the basic technical concepts and teachings of the present invention.

[0081] The present invention is not limited to the above-mentioned respective embodiments but may also be carried out by combining characteristic configurations of the above-mentioned respective embodiments. For example, as illustrated in FIG. 14, the centrifugal fan may have an embodiment in which the configuration of the first embodiment, including the induction portion 31 being the round portion, is combined with the configuration as in the fourth embodiment, in which the base 3cd and the hub 3c are the members separate from a guide portion 551, and the guide portion 551 is welded to the outer surface of the hub 3c at the inner surface of the guide portion 551, which is positioned on an opposite side to the induction portion 31.

[0082] Alternatively, as another example, as illustrated in FIG. 15, the centrifugal fan may have an embodiment in which the configuration as in the first embodiment, in which the base 3cd and the hub 3c are molded integrally with a guide portion 651 to form a main plate 603b, is combined with the configuration of the third or fourth em-

bodiment, including the induction portion 331 being the recessed portion.

[0083] Further, in the above-mentioned embodiments, the subflow is described as the flow serving as a cooling flow for the motor positioned in the fan central portion outside air path. However, the present invention is not limited thereto. Some devices having a centrifugal fan may adopt a layout in which a fan motor is not arranged in the fan central portion outside air path. However, also in this case, in a centrifugal fan in which the flow direction is changed, the outside of the fan central portion forms a dead region. Therefore, the present invention may also be carried out as structure capable of reducing an influence of turbulence caused by the presence of the dead region through obtainment of the subflow in the layout in which a fan motor is not arranged in the fan central portion outside air path.

[0084] Further, the heat exchanger illustrated in the above-mentioned embodiments is merely an example of the pressure loss unit arranged in the air flow path formed by the centrifugal fan in the air-conditioning apparatus. Therefore, for example, an air-cleaning filter may be given as a pressure loss unit arranged in an air flow path formed by a centrifugal fan in an air-cleaning apparatus. In other words, the present invention may also be carried out as the air-cleaning apparatus.

Reference Signs List

[0085] 3 centrifugal fan, 3a blade, 3b, 203b, 303b, 403b, 603b main plate, 3c hub, 3cd base, 3d subflow outlet, 3e fan inside air path, 3f fan central portion outside air path, 3g shroud, 30 rotating wall, 30a distal end opening portion, 31, 331 induction portion, 32 flat surface, 51, 251, 351, 451, 551, 651 guide portion, 100 air-conditioning apparatus, 232 guide surface, 233 flange portion

Claims

1. A centrifugal fan, comprising:

a main plate;
a shroud; and
a plurality of blades,
wherein the main plate comprises a base, a hub, and a guide portion,
wherein the hub projects toward the shroud in a central portion of the main plate,
wherein the base is positioned on a periphery of the hub,
wherein the guide portion is positioned outside the hub,
wherein the guide portion comprises a rotating wall and an induction portion,
wherein the rotating wall extends to be inclined with respect to a direction in which the base extends when viewed in vertical section, and

wherein the induction portion is formed on an outer surface of the guide portion on an up-stream side of the rotating wall.

the centrifugal fan of any one of claims 1 to 10, the centrifugal fan being mounted in the ceiling in the case.

2. A centrifugal fan according to claim 1, wherein the induction portion comprises a round portion. 5
3. A centrifugal fan according to claim 1, wherein the induction portion comprises a recessed portion that opens toward outside the guide portion. 10
4. A centrifugal fan according to any one of claims 1 to 3, wherein the guide portion and the base are formed by integral molding. 15
5. A centrifugal fan according to claim 4, wherein a flat surface is formed between a defining portion of a subflow outlet formed in the main plate and an inner surface of the rotating wall. 20
6. A centrifugal fan according to any one of claims 1 to 3, wherein the guide portion is welded to at least the base or the hub. 25
7. A centrifugal fan according to claim 6, wherein an inner surface of the rotating wall comprises a guide surface configured to guide a subflow to a subflow outlet formed in the main plate. 30
8. A centrifugal fan according to claim 7, wherein the guide surface is flush with a defining portion of the subflow outlet formed in the main plate. 35
9. A centrifugal fan according to any one of claims 6 to 8, wherein the guide portion is welded to an outer surface of the hub. 40
10. A centrifugal fan according to any one of claims 6 to 8, wherein the guide portion comprises a flange portion extending along the base, wherein the flange portion is held in surface contact with the base, and wherein the guide portion is welded to the base at the flange portion. 45
11. An air-conditioning apparatus, comprising:
 - a case;
 - a heat exchanger mounted in a ceiling in the case; and 50
 - the centrifugal fan of any one of claims 1 to 10, the centrifugal fan being mounted in the ceiling in the case.
12. An air-cleaning apparatus, comprising: 55
 - a case;
 - a filter mounted in a ceiling in the case; and

FIG. 1

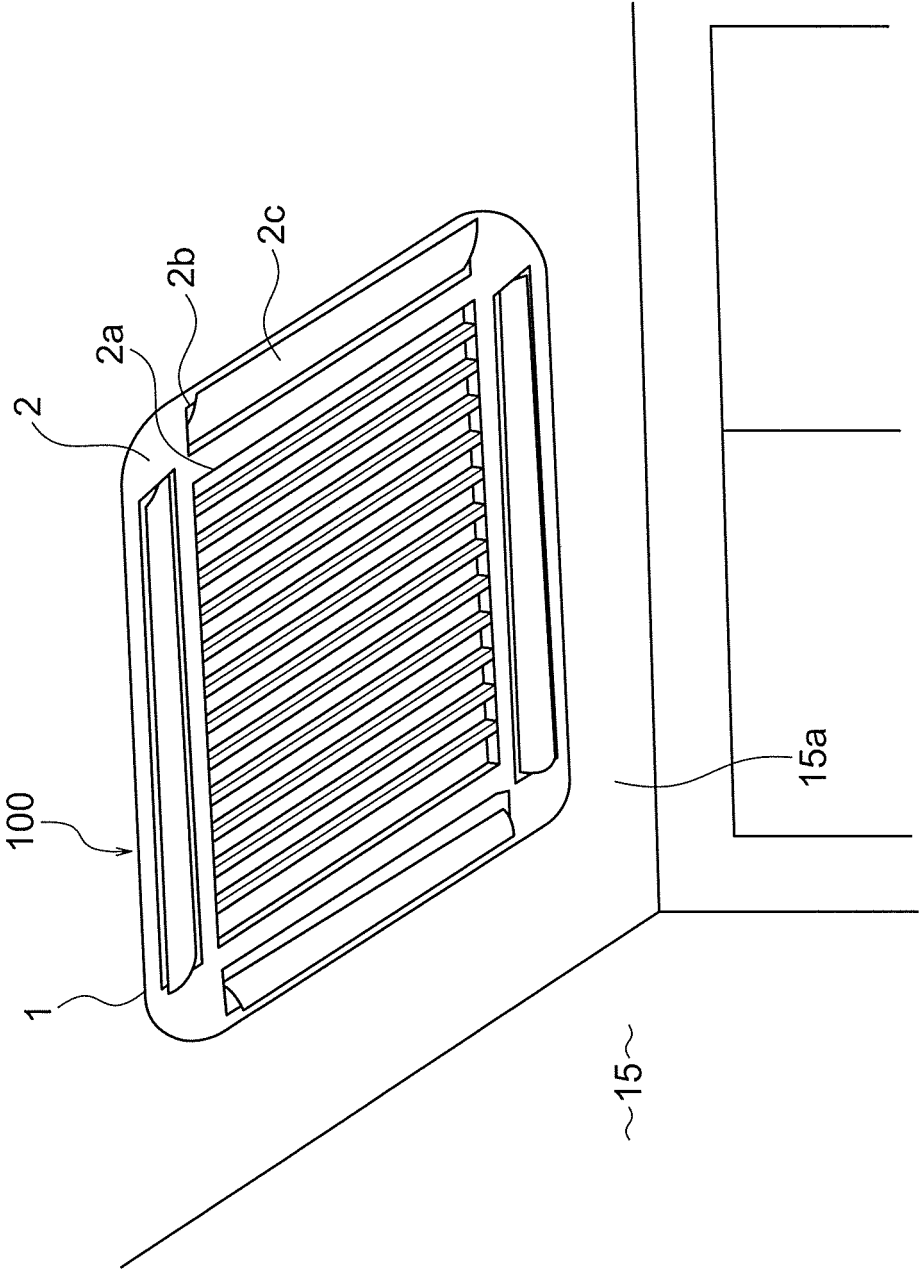


FIG. 2

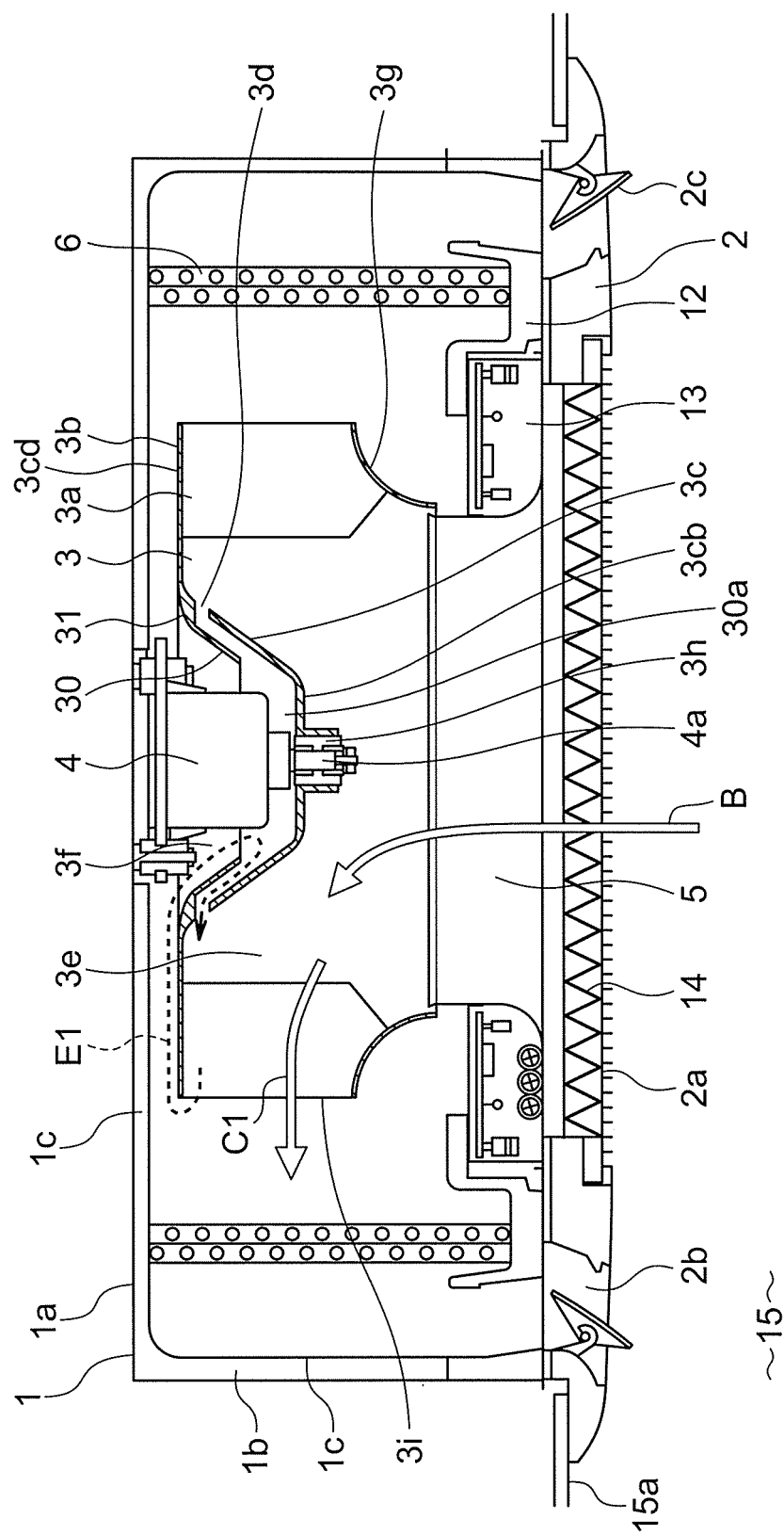


FIG. 3

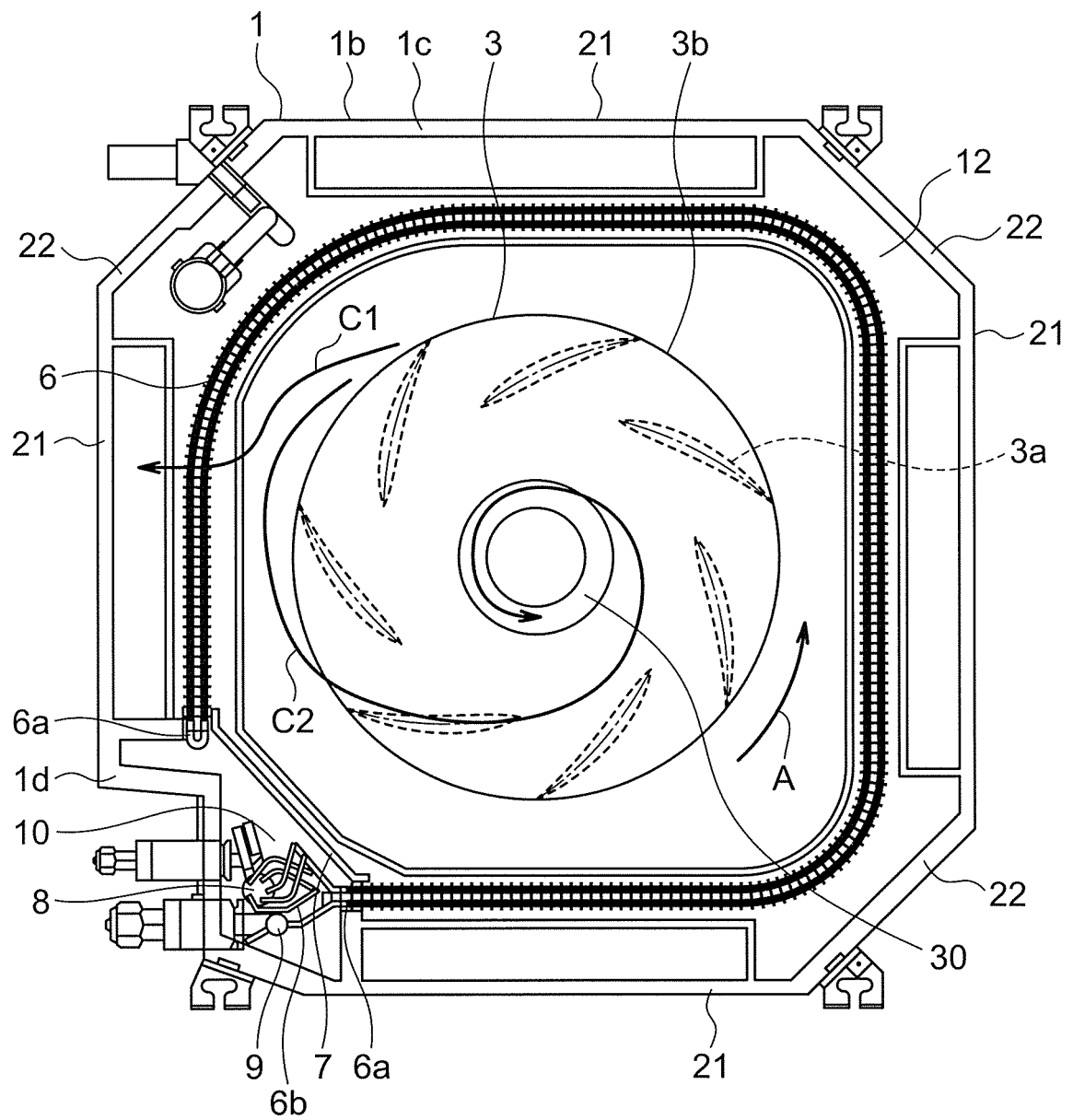


FIG. 4

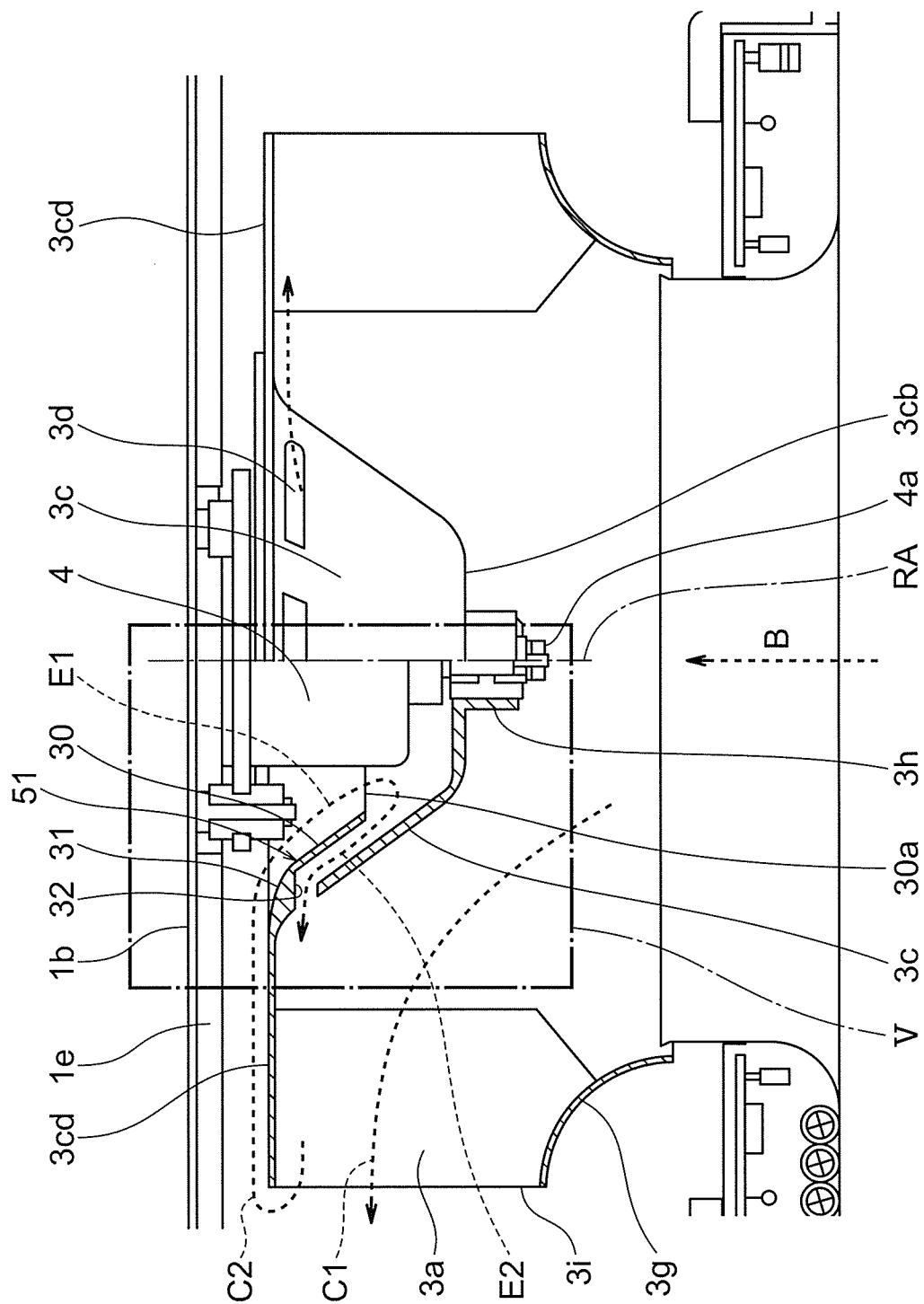


FIG. 5

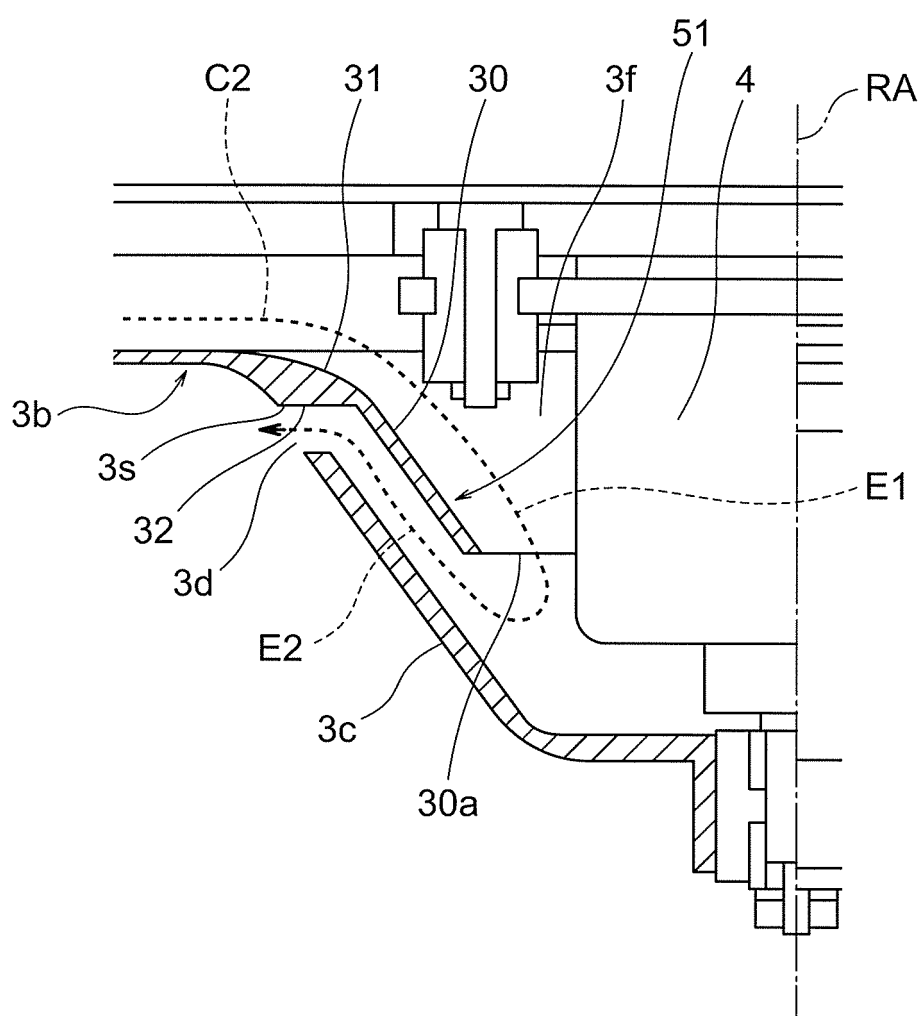


FIG. 6

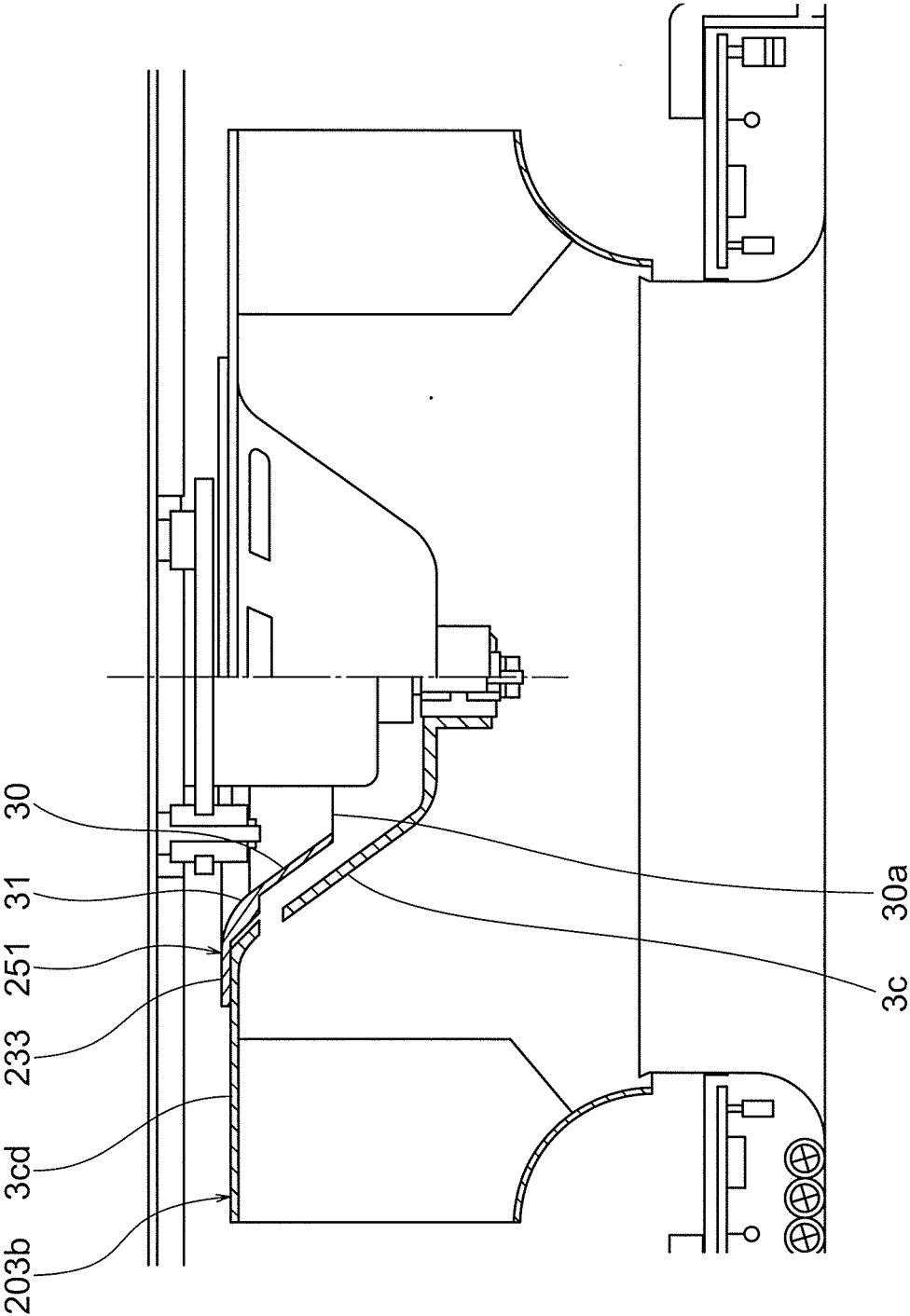


FIG. 7

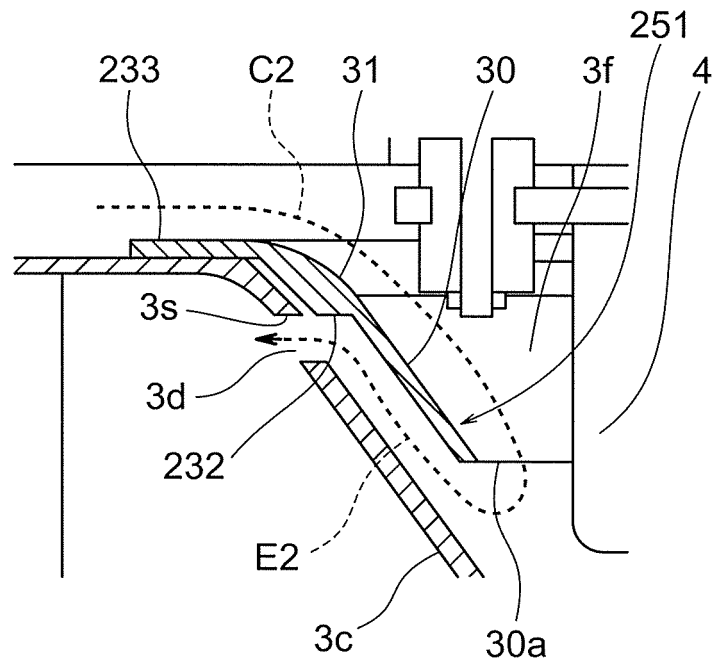


FIG. 8

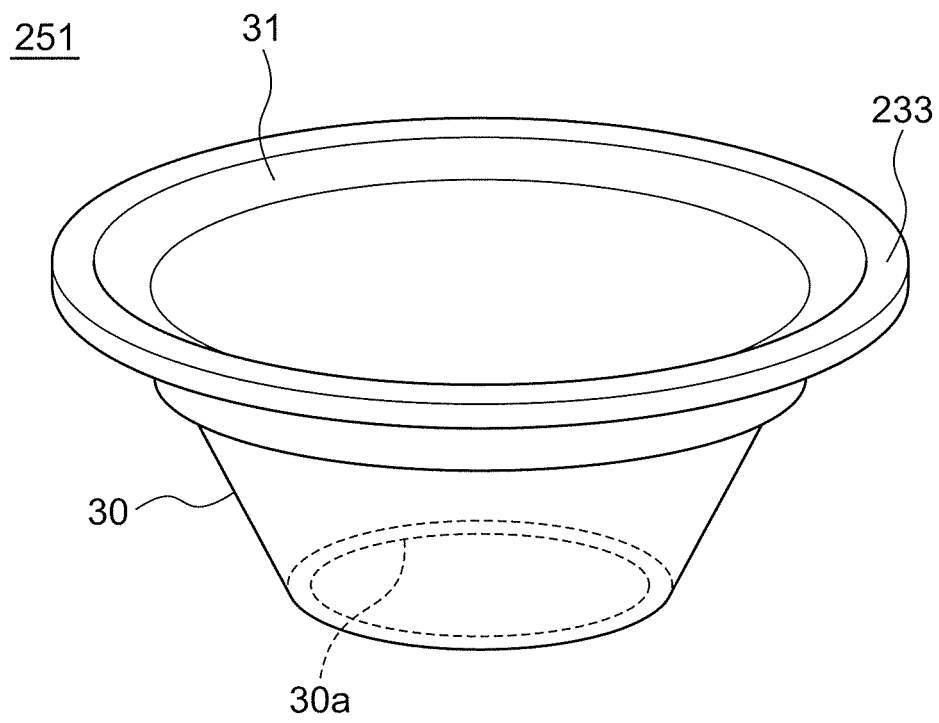


FIG. 9

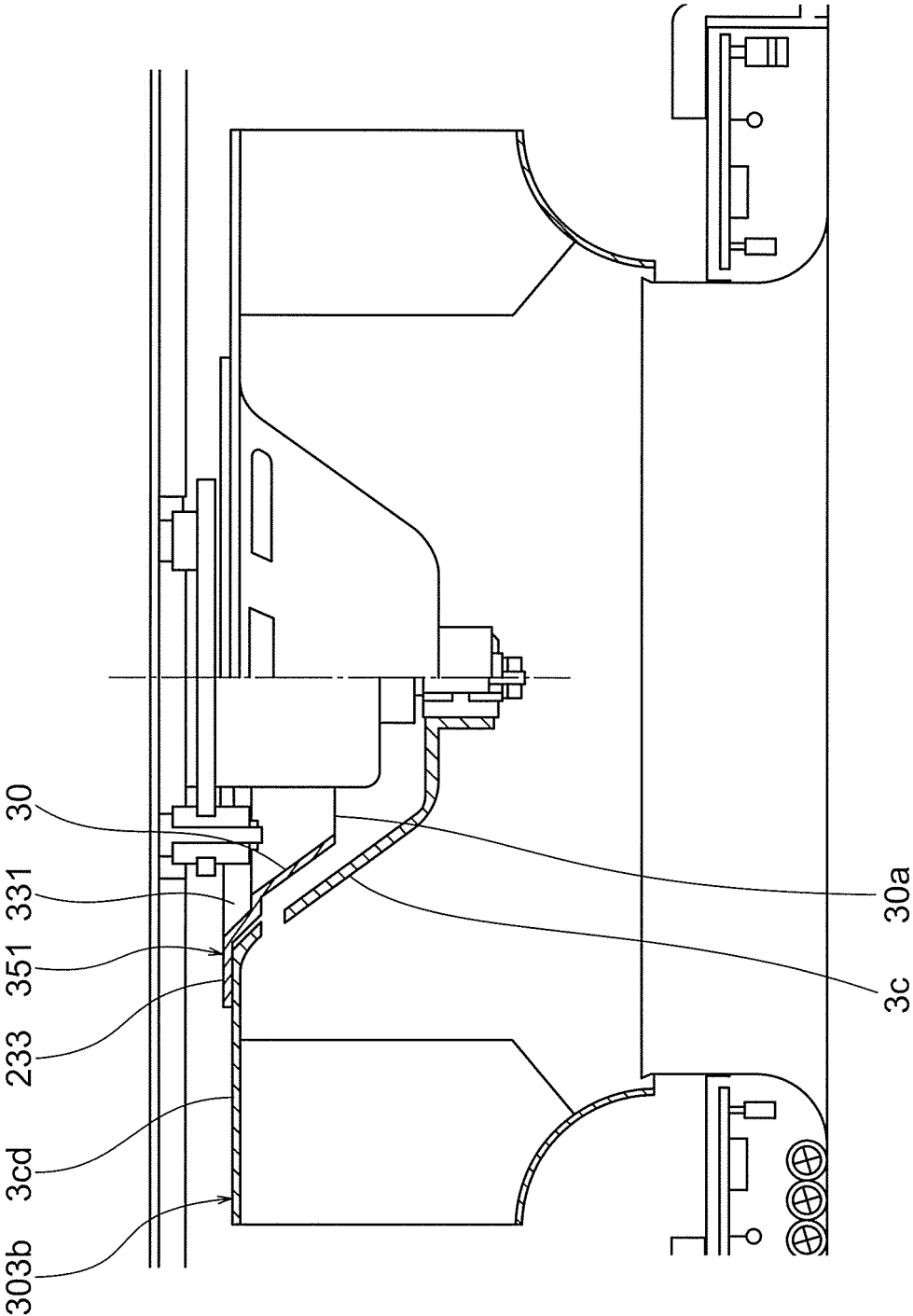


FIG. 10

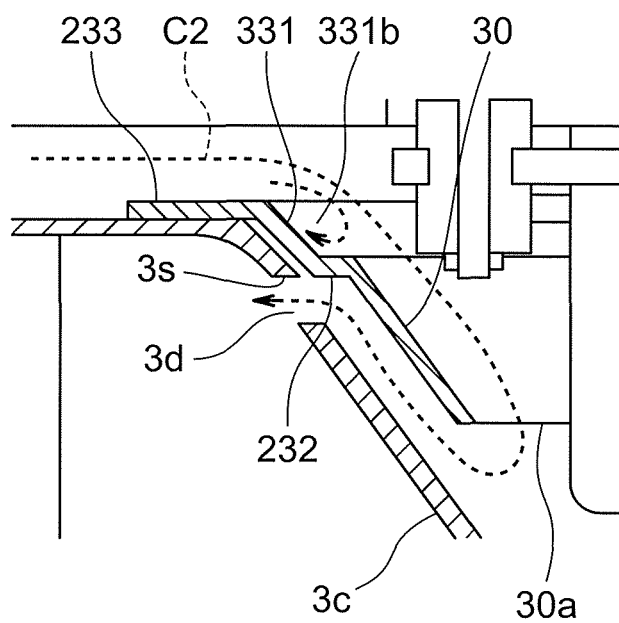


FIG. 11

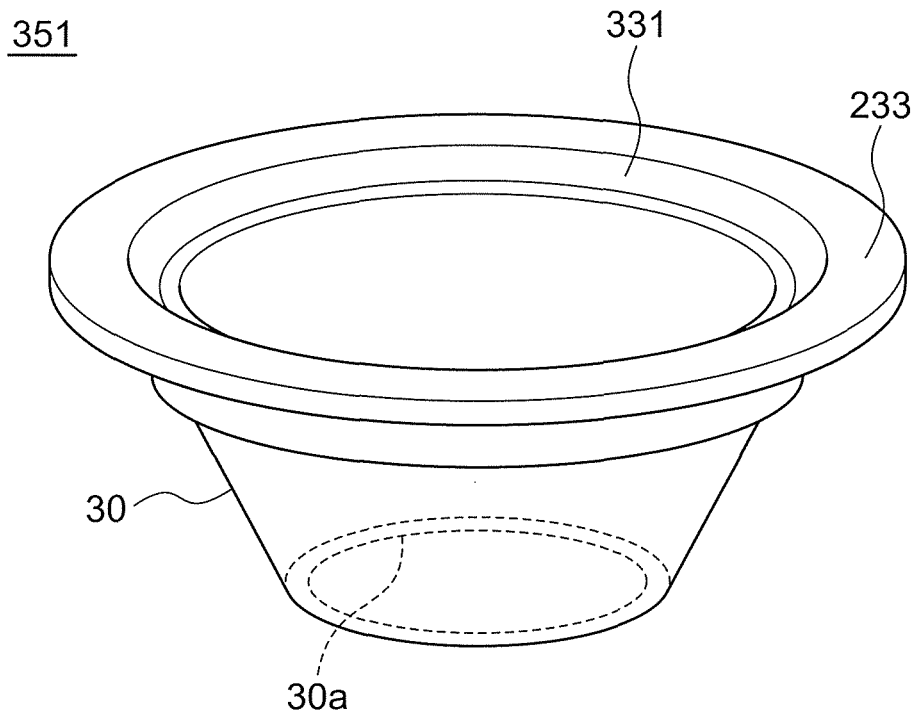


FIG. 12

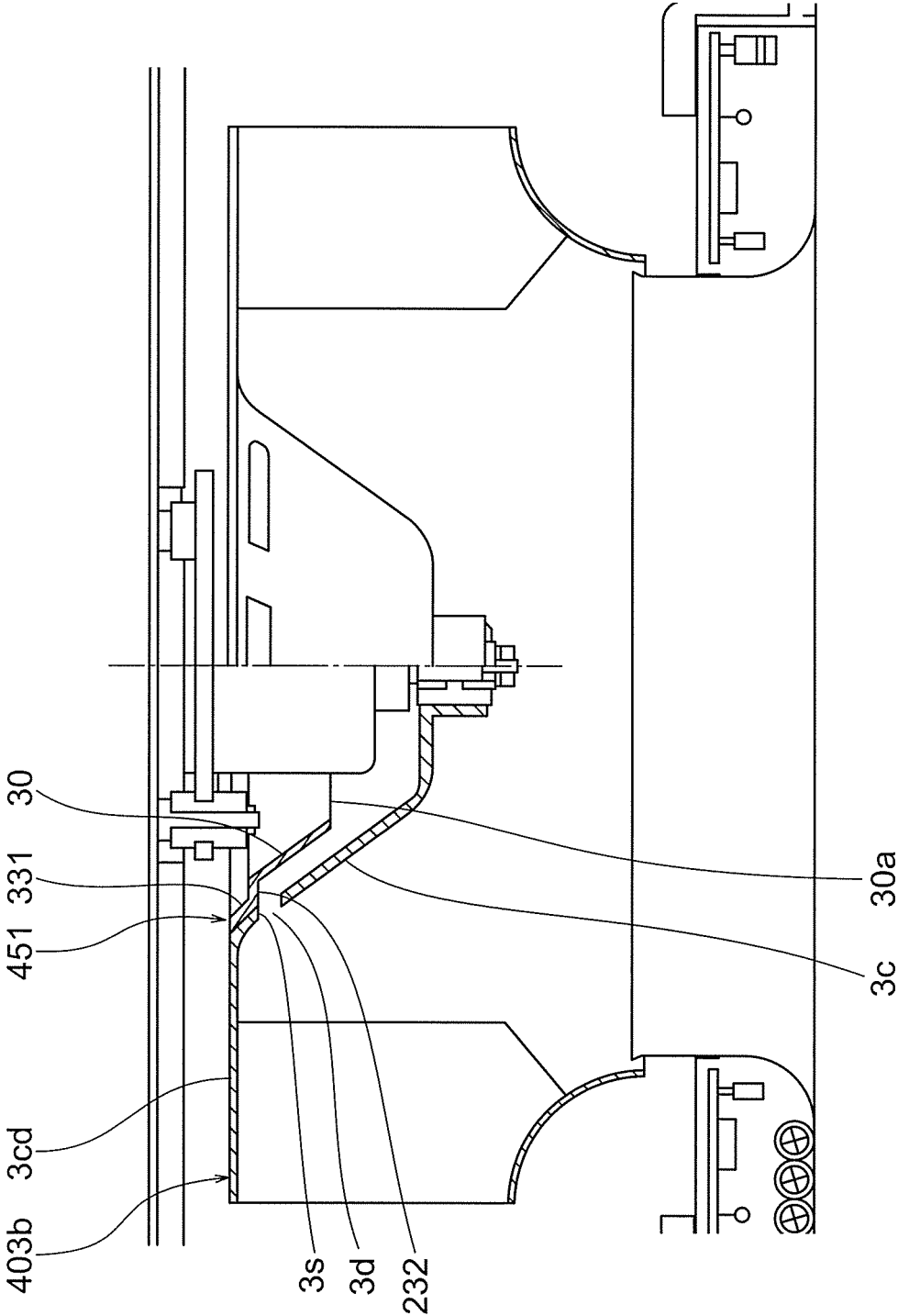


FIG. 13

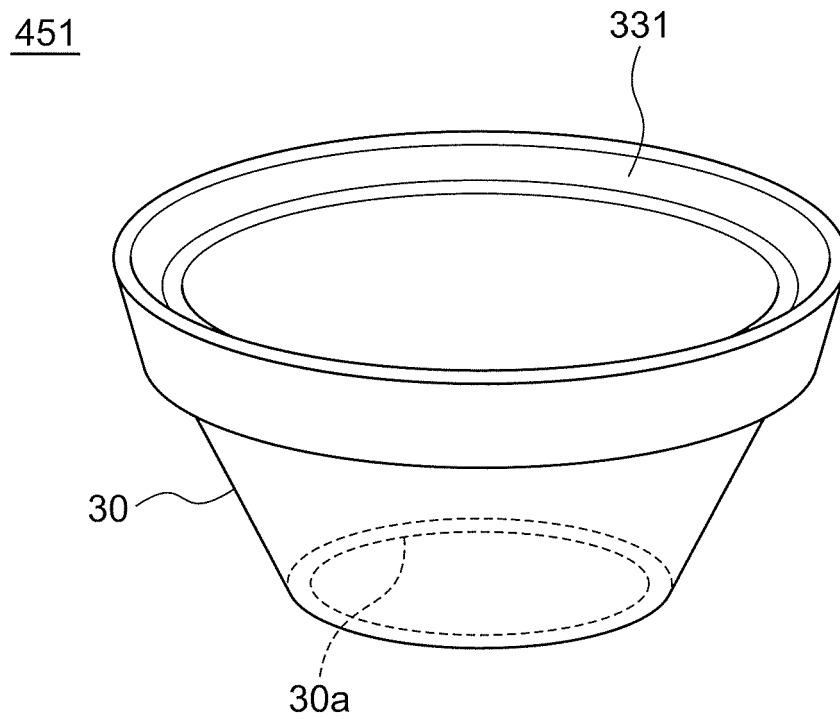


FIG. 14

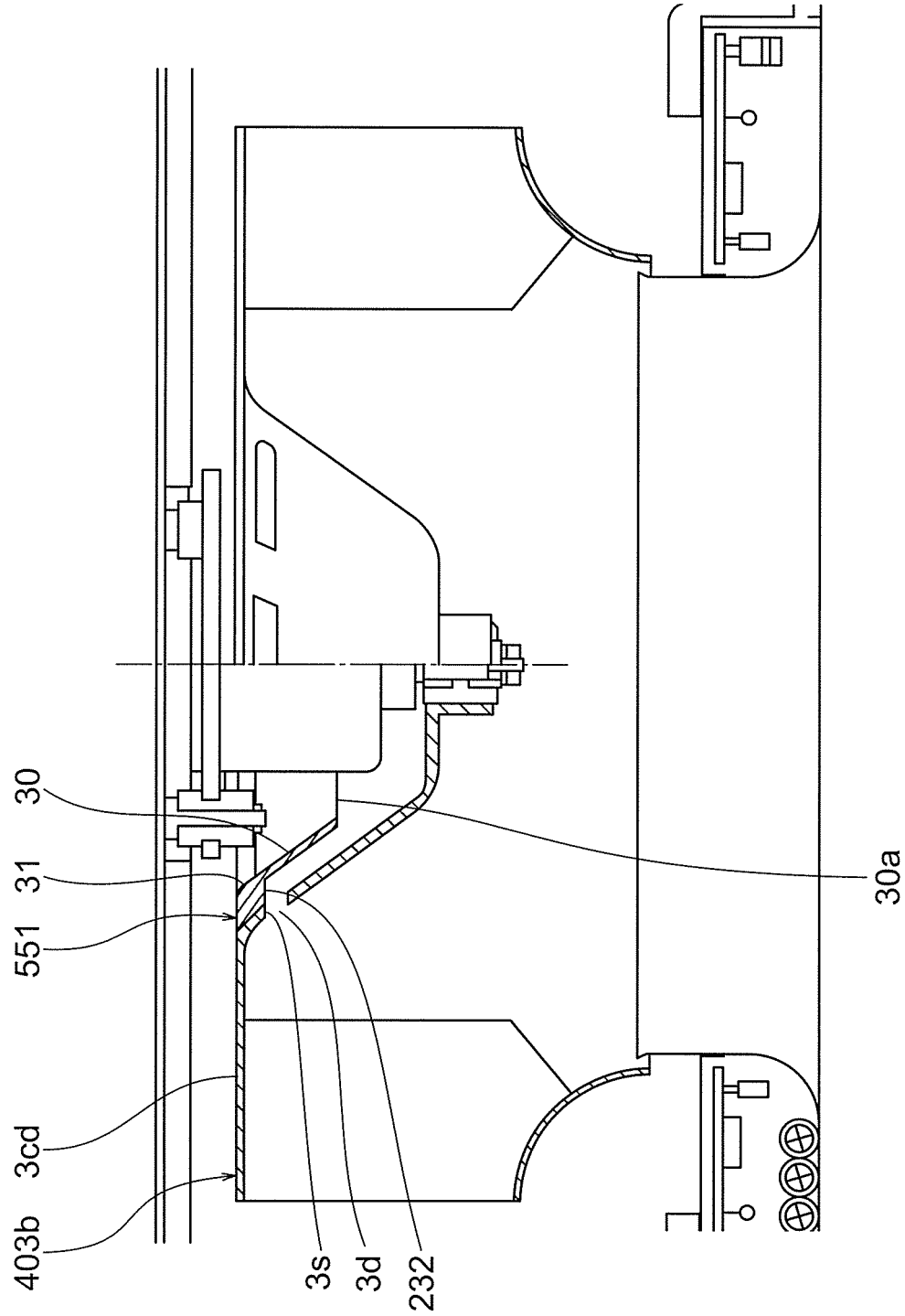
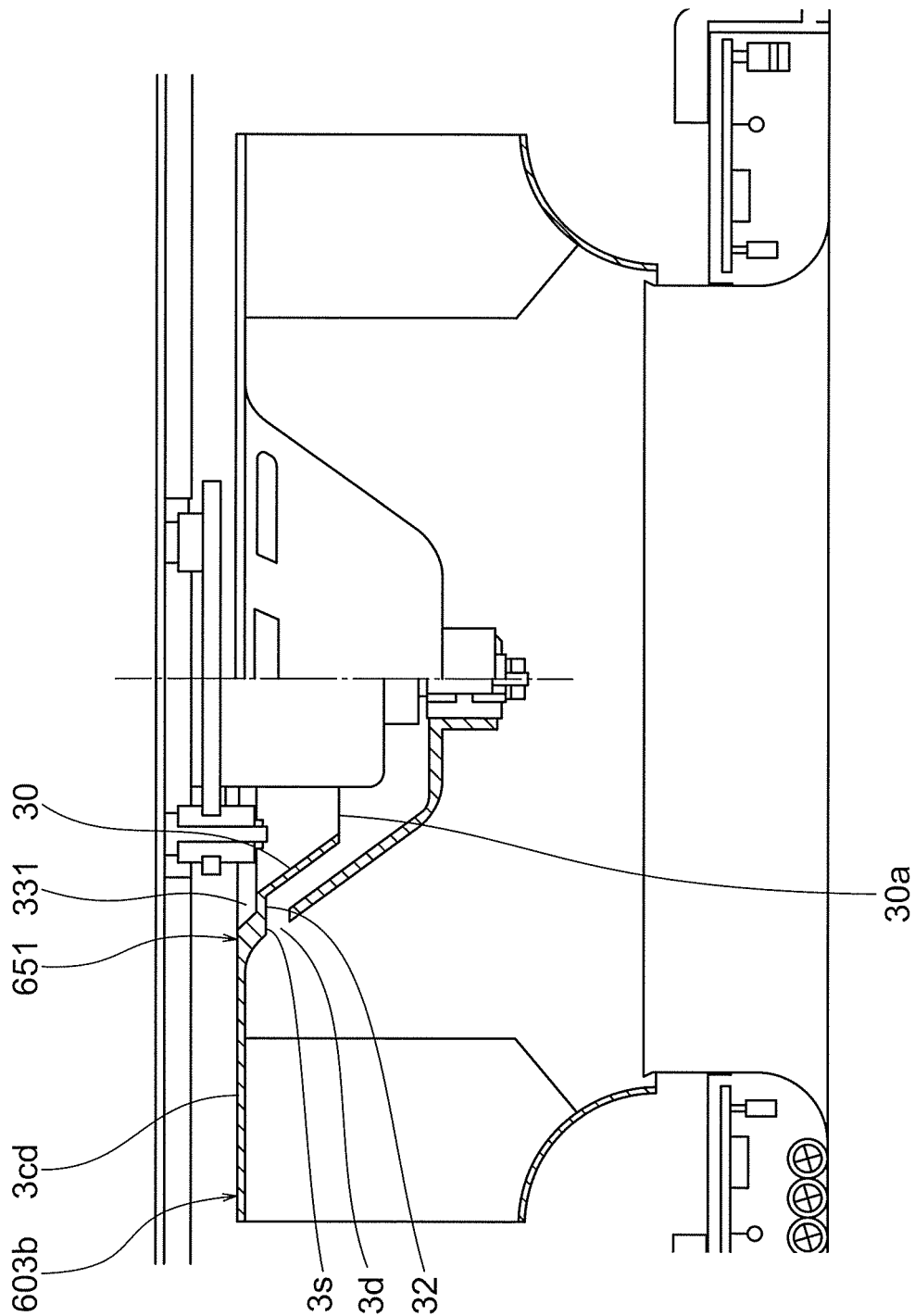


FIG. 15



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2014/050337

A. CLASSIFICATION OF SUBJECT MATTER

F04D29/58 (2006.01) i, F04D29/28 (2006.01) i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

F04D29/58, F04D29/28

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

Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2014

Kokai Jitsuyo Shinan Koho 1971-2014 Toroku Jitsuyo Shinan Koho 1994-2014

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 4684085 B2 (Mitsubishi Electric Corp.), 18 May 2011 (18.05.2011), paragraphs [0023] to [0024], [0037], [0043] to [0045]; fig. 13 & EP 1873461 A1 & EP 2273207 A2 & EP 2390590 A2 & WO 2006/090564 A1 & CN 1942716 A & CN 101907325 A & ES 2370410 T	1, 3-12
X	WO 2004/055380 A1 (Daikin Industries, Ltd.), 01 July 2004 (01.07.2004), fig. 6 & US 2005/0103042 A1 & EP 1574718 A1 & AU 2003284610 A & CN 1508440 A & CN 2762000 Y	1-2, 4-12

☒ 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
24 March, 2014 (24.03.14)Date of mailing of the international search report
08 April, 2014 (08.04.14)Name and mailing address of the ISA/
Japanese Patent Office

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Facsimile No.

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

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2014/050337

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 2000-205195 A (Mitsubishi Electric Corp.), 25 July 2000 (25.07.2000), fig. 10 (Family: none)	1-2, 4-12
X	JP 2000-227231 A (Fujitsu General Ltd.), 15 August 2000 (15.08.2000), fig. 2, 5 (Family: none)	1-2, 4-10
A	JP 2010-255451 A (Panasonic Corp.), 11 November 2010 (11.11.2010), paragraphs [0030], [0035], [0045]; fig. 7 (Family: none)	1-12

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Patent documents cited in the description

- JP 4684085 B [0006]