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(2013.01); **F04D 29/4226** (2013.01)(72) Inventors: **Fumiya ISHII**, Kariya-city (JP); **Shuzo**
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YASUDA, Nishio-city (JP)(57) **ABSTRACT**

The inside of a blower casing of a centrifugal blower includes a discharge airflow path, which extends outward in a radial direction of a rotating shaft, on an airflow downstream side from a trailing edge of each of blades of a centrifugal fan. The discharge airflow path includes an adjacent airflow path adjacent to the trailing edge of each blade. When the length in the axial direction of the blade at the trailing edge is assumed to be blade height, and when the length in the axial direction at the trailing edge of the centrifugal fan is assumed to be fan height, the length in the axial direction of the adjacent airflow path is equal to or larger than the blade height and equal to or smaller than the fan height.

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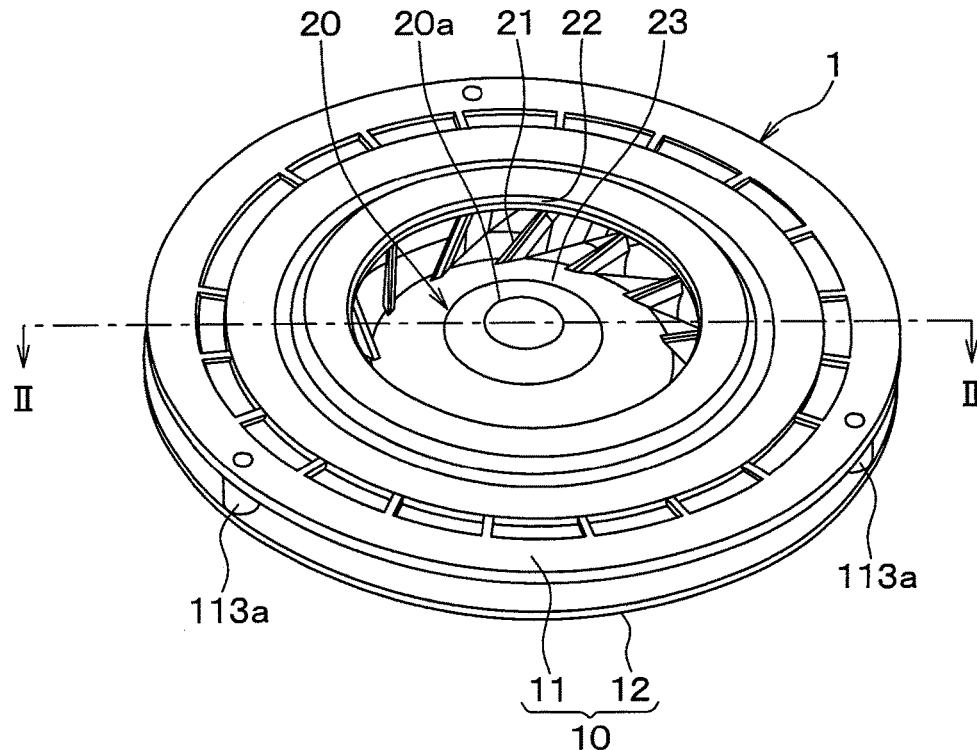


FIG. 1

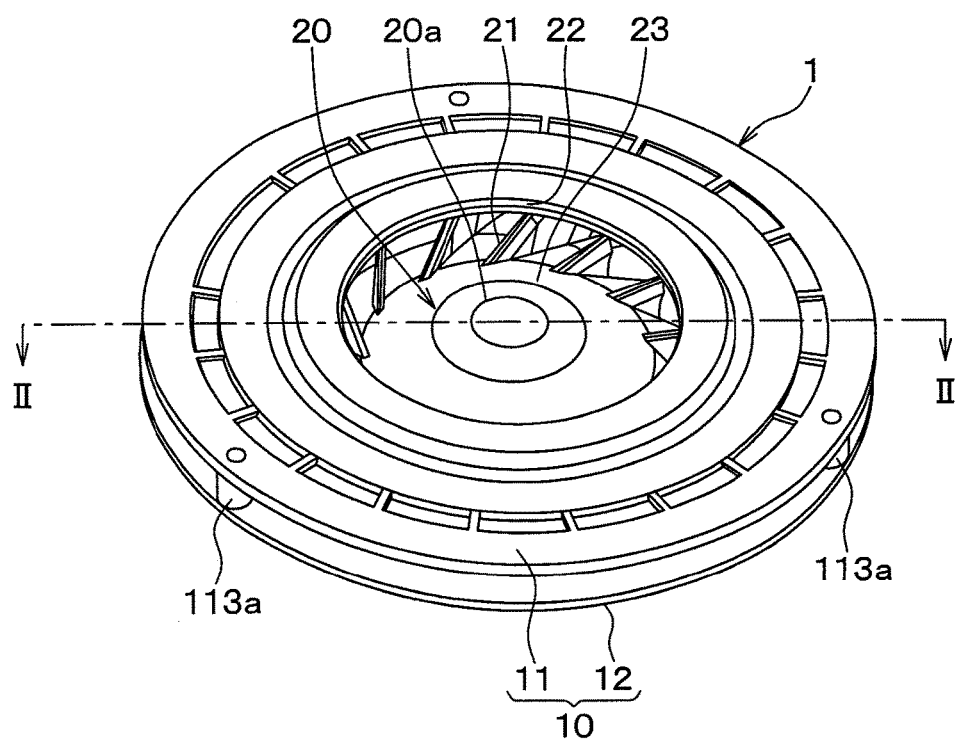


FIG. 3

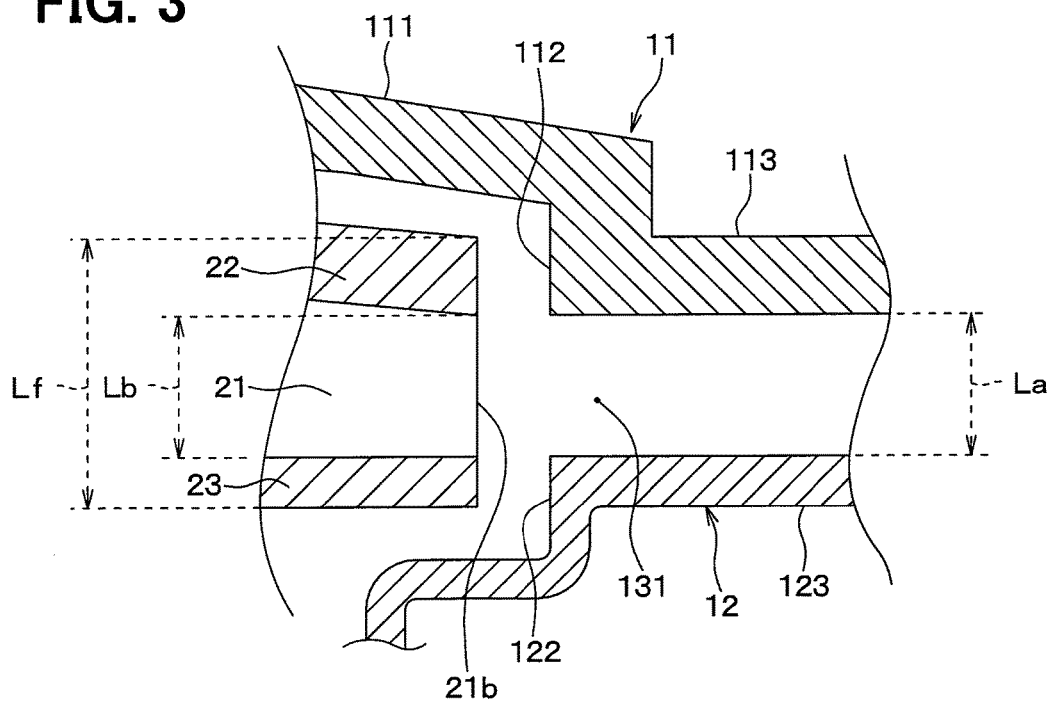


FIG. 4

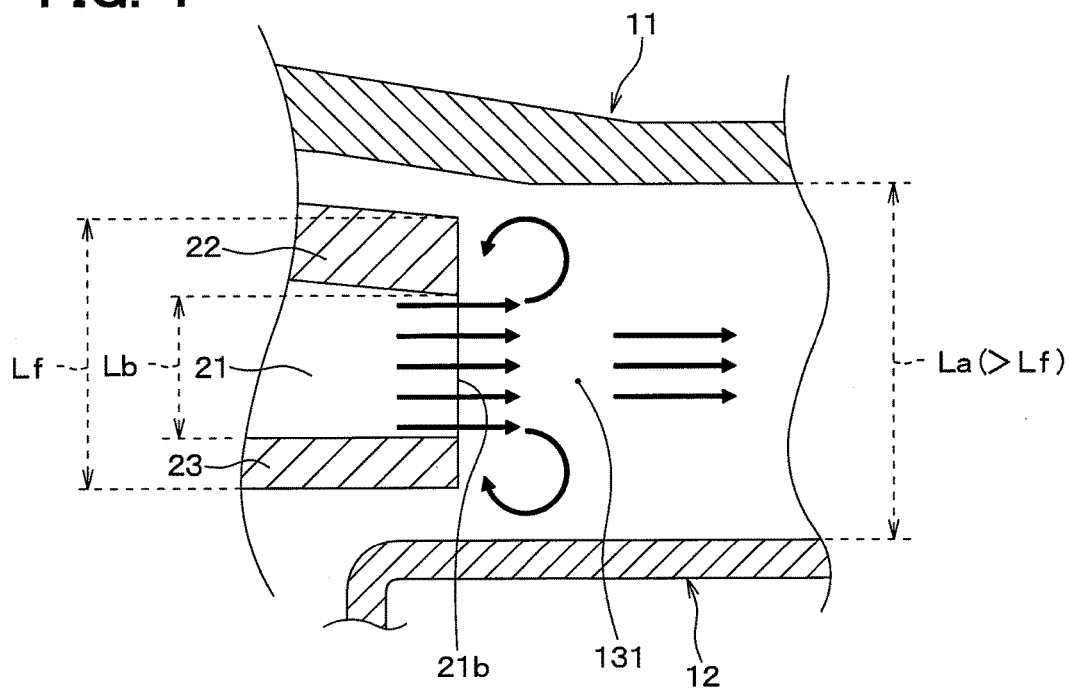


FIG. 5

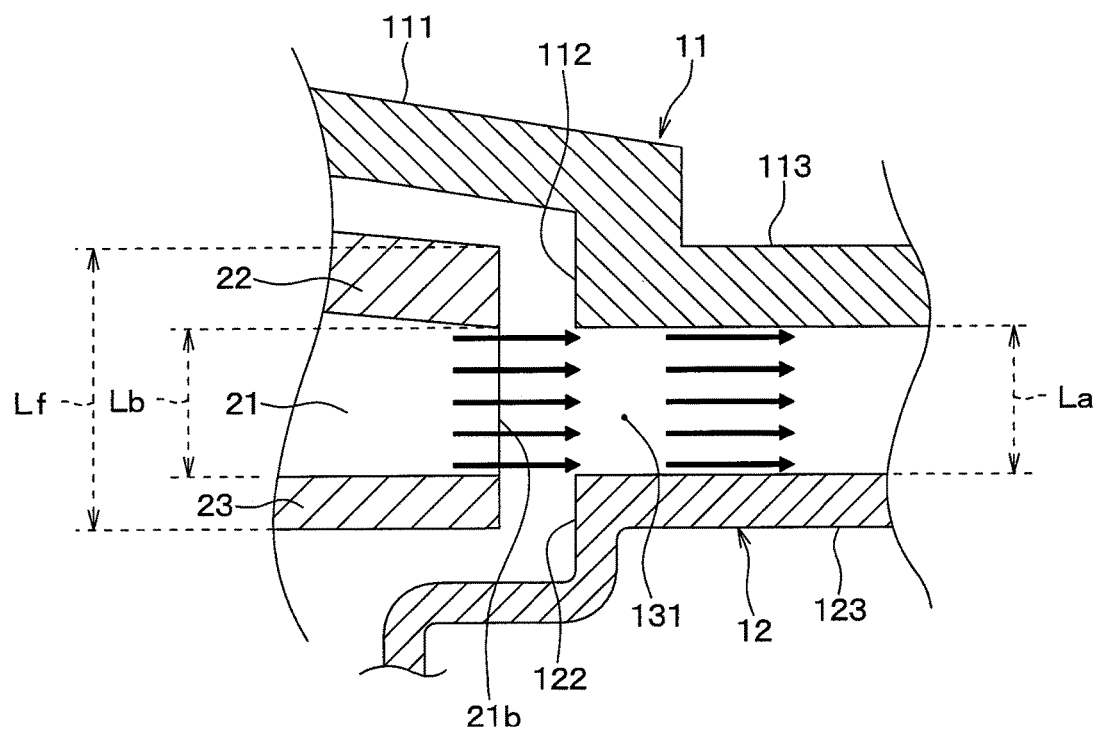
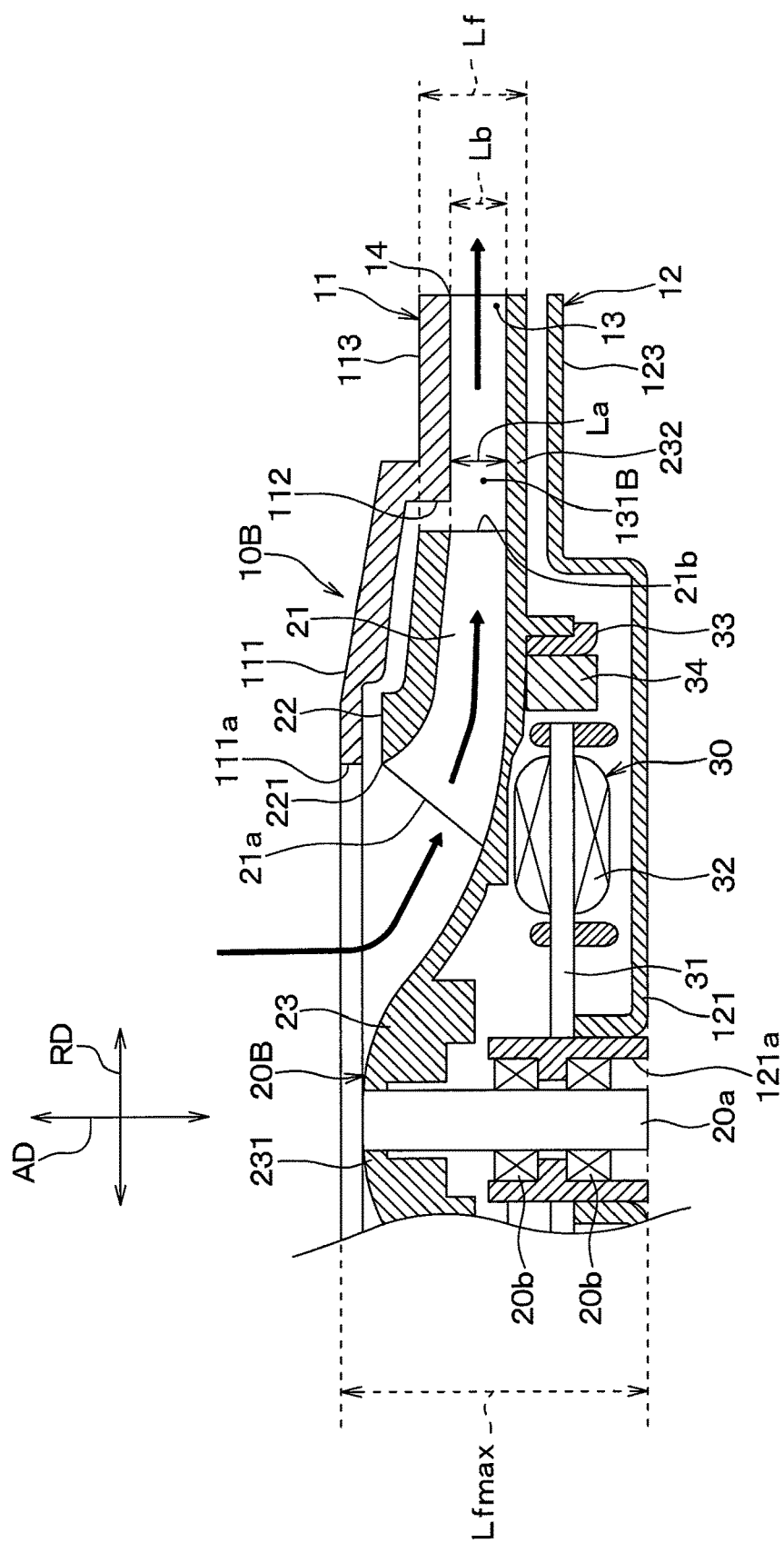


FIG. 7



CENTRIFUGAL BLOWER

CROSS REFERENCE TO RELATED APPLICATION

[0001] This application is based on Japanese Patent Application No. 2015-99311 filed on May 14, 2015, the disclosure of which is incorporated herein by reference.

TECHNICAL FIELD

[0002] The present disclosure relates to a centrifugal blower that blows air.

BACKGROUND ART

[0003] A previously known centrifugal blower is designed such that a centrifugal fan is accommodated in the inside of a scroll casing having a spiral ventilation flue (for example, see Patent Document 1). The Patent Document 1 discloses that a height of a wall surface opposed to a centrifugal fan in the scroll casing is varied in the circumferential direction starting from a nose portion, which is closest to the fan, of the scroll casing.

PRIOR ART DOCUMENT

Patent Document

[0004] Patent Document 1: JP2014-132164A

SUMMARY OF INVENTION

[0005] The inventors have made investigations on use of a type of a blower casing (full blowoff type casing), which is opened over its entire circumference and blows air from the entire circumference, instead of the scroll casing for a centrifugal blower.

[0006] The inventors have found that when a centrifugal blower includes the full blowoff type casing and when a height of a wall surface opposed to a centrifugal fan is intentionally varied in the circumferential direction to reduce noise as in Patent Document 1, the noise is rather increased.

[0007] The inventors have made earnest investigations on the cause of such an increase in noise. As a result, it is found that when the height of the wall surface opposed to the centrifugal fan is varied in the circumferential direction, sudden expansion or sudden contraction occurs in a shape of an airflow path defined by the casing and the centrifugal fan. An unstable vortex occurs due to the sudden expansion or the sudden contraction in the airflow path defined by the casing and the centrifugal fan, leading to an increase in noise.

[0008] It is an objective of the present disclosure to provide a centrifugal blower capable of suppressing noise generated due to a shape of an airflow path defined by a blower casing opened over its entire circumference and a centrifugal fan.

[0009] The disclosure aims at a centrifugal blower that includes a centrifugal fan that sucks air from one side in an axial direction of a rotating shaft and discharges the air outward in a radial direction of the rotating shaft, and a blower casing that accommodates the centrifugal fan and is opened over its entire circumference around the rotating shaft.

[0010] In an aspect of the present disclosure, a centrifugal fan of a centrifugal blower includes a plurality of blades arranged side by side in a circumferential direction of a rotating shaft, a shroud that connects between first sides (one sides) in an axial direction of the blades, and a main plate that connects between second sides (the other sides) in the axial direction of the blades and is connected to the rotating shaft.

[0011] The inside of the blower casing includes a discharge airflow path, which extends outward in a radial direction of the rotating shaft, on an airflow downstream side from a trailing edge of each of the blades. Furthermore, the discharge airflow path includes an adjacent airflow path adjacent to the trailing edge of each of the blades.

[0012] When the length in the axial direction of each of the blades at the trailing edge is assumed to be blade height and when the length in the axial direction of the centrifugal fan at the trailing edge is assumed to be fan height, the length in the axial direction of the adjacent airflow path is equal to or larger than the blade height and equal to or smaller than the fan height.

[0013] In this way, the length in the axial direction of the airflow path adjacent to the centrifugal fan in the blower casing is set between the blade height at the trailing edge of the blade and the fan height, thereby the shape of the airflow path defined by the centrifugal fan and the blower casing has substantially no sudden expansion and no sudden contraction.

[0014] Hence, the centrifugal blower including the blower casing opened over its entire circumference and the centrifugal fan makes it possible to suppress noise generated due to the shape of the airflow path defined by the blower casing and the centrifugal fan.

[0015] The term “adjacent airflow path adjacent to the trailing edge of each of the plurality of blades” includes not only the airflow path in direct contact with the trailing edge of the blade but also an airflow path that is not in contact with the trailing edge of the blade while having an adjacent relationship with the trailing edge of the blade with a predetermined distance.

[0016] In another aspect of the present disclosure, a centrifugal fan of a centrifugal blower includes a plurality of blades arranged side by side in a circumferential direction of a rotating shaft, a shroud that connects between first sides in an axial direction of the blades, and a main plate that connects between second sides in the axial direction of the blades and is connected to the rotating shaft. The inside of the blower casing includes a discharge airflow path, which extends outward in a radial direction of the rotating shaft, on an airflow downstream side from a trailing edge of each of the blades. Furthermore, the discharge airflow path includes an adjacent airflow path adjacent to the trailing edge of each of the blades. It is assumed that a length in the axial direction of the discharge airflow path at a position closest to the trailing edge of each of the blades is an airflow path height, a length in the axial direction of each of the blades at the trailing edge is blade height, and the length in the axial direction of the centrifugal fan at the trailing edge is fan height. At this time, the airflow path height of the adjacent airflow path is equal to or larger than the blade height and equal to or smaller than the fan height.

[0017] This also allows the shape of the airflow path defined by the centrifugal fan and the blower casing to have substantially no sudden expansion and no sudden contrac-

tion. Hence, the centrifugal blower including the blower casing opened over its entire circumference and the centrifugal fan makes it possible to suppress noise generated due to the shape of the airflow path defined by the blower casing and the centrifugal fan.

BRIEF DESCRIPTION OF DRAWINGS

[0018] The above and other objects, features and advantages of the present disclosure will become more apparent from the following detailed description made with reference to the accompanying drawings. In the drawings:

[0019] FIG. 1 is a perspective view illustrating an appearance of a centrifugal blower of a first embodiment;

[0020] FIG. 2 is a sectional view in an axial direction of the centrifugal blower of the first embodiment;

[0021] FIG. 3 is an enlarged view of a portion III of FIG. 2;

[0022] FIG. 4 is an enlarged view illustrating an airflow in a main part of a centrifugal blower of a comparative example;

[0023] FIG. 5 is an enlarged view illustrating an airflow in a main part of the centrifugal blower of the first embodiment;

[0024] FIG. 6 is a sectional view in an axial direction of a centrifugal blower of a second embodiment;

[0025] FIG. 7 is a sectional view in an axial direction of a centrifugal blower of a third embodiment;

[0026] FIG. 8 is a sectional view in an axial direction of a centrifugal blower of a fourth embodiment;

[0027] FIG. 9 is a sectional view in an axial direction of a centrifugal blower of a fifth embodiment; and

[0028] FIG. 10 is a sectional view in an axial direction of a centrifugal blower of a sixth embodiment.

EMBODIMENTS FOR CARRYING OUT INVENTION

[0029] Hereinafter, embodiments of the disclosure are described with reference to drawings. In each of the following embodiments, portions that are the same as or equivalent to those described in the preceding embodiment are designated with the same reference numerals, and the description thereof may be omitted. In each of the embodiments, when only a part of a component is described, other parts of the component are assumed to be similar to those of a corresponding component described in the preceding embodiment.

First Embodiment

[0030] A centrifugal blower 1 of a first embodiment is described with reference to FIGS. 1 to 5. An arrow AD in FIG. 2 indicates an axial direction of a rotating shaft 20a of a centrifugal fan 20 to be described later. An arrow RD in FIG. 2 indicates a radial direction of the rotating shaft 20a of the centrifugal fan 20 to be described later. The same holds true for drawings other than FIG. 2. FIG. 2 shows a part of a sectional shape of the centrifugal blower 1 cut along a line II-II shown in FIG. 1.

[0031] The centrifugal blower 1 of the first embodiment shown in FIGS. 1 and 2 serves as air blowing means applied to a vehicle as a moving body. The centrifugal blower 1 of the first embodiment is used as, for example, air blowing means of an indoor air conditioner for air-conditioning of a

passenger compartment or air blowing means of a seat air conditioner provided in a seat.

[0032] As shown in FIG. 2, the centrifugal blower 1 of the first embodiment is designed as a flat-type blower, in which the dimension in the radial direction RD of the rotating shaft 20a is larger than the dimension in the axial direction AD of the rotating shaft 20a in order to improve mountability in a vehicle.

[0033] The centrifugal blower 1 of the first embodiment includes main components including a blower casing 10 configuring an outer shell, a centrifugal fan 20 accommodated in the blower casing 10, and an electric motor 30.

[0034] The blower casing 10 is a container casing that accommodates the centrifugal fan 20 and the electric motor 30. The blower casing 10 of the first embodiment has a fan cover 11 and a motor cover 12. The fan cover 11 and the motor cover 12 are opposed to each other with a space in the axial direction AD of the rotating shaft 20a. In the first embodiment, the fan cover 11 and the motor cover 12 configure a pair of wall portions opposed to each other in the axial direction AD of the rotating shaft 20a.

[0035] The fan cover 11 is disposed on a first side (one side) in the axial direction AD of the rotating shaft 20a. The fan cover 11 is a cover that covers a part of the centrifugal fan 20 from the first side in the axial direction AD. The fan cover 11 is made of an annular member having an opening in its middle. The fan cover 11 is roughly divided into a fan-side inner circumferential portion 111, a fan-side step portion 112, and a fan-side outer circumferential portion 113.

[0036] The fan-side inner circumferential portion 111 is an inner portion of the fan cover 11 that overlaps with blades 21 of the centrifugal fan 20 in the axial direction

[0037] AD. The fan-side inner circumferential portion 111 has a shape that extends along the radial direction RD so as to cover the blades 21 of the centrifugal fan 20. The fan-side inner circumferential portion 111 has a circular air suction port 111a penetrating in the axial direction AD in its middle.

[0038] The fan-side outer circumferential portion 113 is a portion of the fan cover 11 on a side outer than the fan-side inner circumferential portion 111 in the radial direction RD. The fan-side outer circumferential portion 113 has a shape extending along the radial direction RD. The fan-side outer circumferential portion 113 has a plurality of protrusions 113a on an outer side in the radial direction RD.

[0039] As shown in FIG. 1, the fan-side outer circumferential portion 113 of the first embodiment has three protrusions 113a with a predetermined interval in its circumferential direction.

[0040] The protrusions 113a protrude to a motor cover 12 side in the axial direction AD. Each of the protrusions 113a has a screw hole, through which an undepicted screw is inserted so as to connect the fan cover 11 to the motor cover 12, at its end portion on the motor cover 12 side.

[0041] Returning to FIG. 2, the fan-side step portion 112 connects the fan-side inner circumferential portion 111 to the fan-side outer circumferential portion 113. The fan-side step portion 112 has a shape extending along the axial direction AD such that a step is formed between the fan-side inner circumferential portion 111 and the fan-side outer circumferential portion 113.

[0042] The motor cover 12 is disposed on a second side (the other side) in the axial direction AD of the rotating shaft 20a. The motor cover 12 covers the electric motor 30 from

the second side in the axial direction AD. The motor cover 12 is made of a disk-like member. The motor cover 12 is roughly divided into a motor-side inner circumferential portion 121, a motor-side step portion 122, and a motor-side outer circumferential portion 123.

[0043] The motor-side inner circumferential portion 121 is an inner portion of the motor cover 12 that overlaps with the electric motor 30 in the axial direction AD.

[0044] The motor-side inner circumferential portion 121 has a through hole 121a penetrating therethrough in the axial direction AD in its middle.

[0045] The motor-side outer circumferential portion 123 is a portion of the motor cover 12 on a side outer than the motor-side inner circumferential portion 121 in the radial direction RD. The motor-side outer circumferential portion 123 has screw holes, through which undepicted screws are inserted, in regions corresponding to the protrusions 113a formed on the fan-side outer circumferential portion 113.

[0046] The motor-side step portion 122 connects the motor-side inner circumferential portion 121 to the motor-side outer circumferential portion 123. The motor-side step portion 122 has a shape extending along the axial direction AD such that a step is formed between the motor-side inner circumferential portion 121 and the motor-side outer circumferential portion 123.

[0047] In the blower casing 10 of the first embodiment, the fan cover 11 and the motor cover 12 are fastened together with undepicted screws in a state where the projections 113a of the fan cover 11 are butted against the motor cover 12.

[0048] The fan cover 11 and the motor cover 12 may be fastened together by a member other than the screw. In addition, the fan cover 11 and the motor cover 12 may not be designed to be connected to each other, but may be connected to, for example, a stay used to attach the centrifugal blower 1 to equipment.

[0049] The blower casing 10 has a discharge airflow path 13, through which the air discharged from the centrifugal fan 20 flows, between the fan-side outer circumferential portion 113 and the motor-side outer circumferential portion 123. The discharge airflow path 13 is an airflow path in the inside of the blower casing 10, which extends outward in the radial direction RD, on an airflow downstream side from a trailing edge 21b of each blade 21 of the centrifugal fan 20. The discharge airflow path 13 is described in detail later.

[0050] An air blowoff portion 14 to blow air to the outside is provided between the outer ends of the fan-side outer circumferential portion 113 and the motor-side outer circumferential portion 123. The air blowoff portion 14 is opened over the entire circumference of the blower casing 10 around the rotating shaft 20a along the side surface of the centrifugal blower 1. In the region having the protrusion 113a, air-blowoff from the blower casing 10 is obstructed by the protrusion 113a. Hence, the state where the air blowoff portion 14 is opened over the entire circumference of the blower casing 10 includes a state where the air outlet 14 is opened over substantially the entire circumference of the blower casing 10.

[0051] The centrifugal fan 20 sucks air from the first side in the axial direction AD of the rotating shaft 20a and discharges the air outward in the radial direction RD of the rotating shaft 20a. In the first embodiment, a backward fan (turbo fan), in which the outlet side of the fan faces backward with respect to the rotation direction of the fan, is used as the centrifugal fan 20.

[0052] The centrifugal fan 20 includes a plurality of blades 21 arranged side by side in the circumferential direction of the rotating shaft 20a, a shroud 22 that connects between first sides in the axial direction AD of the blades 21, and a main plate 23 that connects between second sides in the axial direction AD of the blades 21.

[0053] An airflow path through which air flows is provided between the blades 21 adjacent to each other. Each blade 21 has a leading edge 21a configuring an air inflow portion and a trailing edge 21b configuring an air outflow portion.

[0054] The shroud 22 is made of an annular member having an opening in its middle. The shroud 22 has an air suction port 221 for guiding the air sucked from the air suction port 111a into the centrifugal fan 20. The shroud 22 is separated from the fan-side inner circumferential portion 111, and the inner surface side of the shroud 22 opposed to the main plate 23 is connected to the first side in the axial direction AD of each blade 21.

[0055] The main plate 23 is made of a conical member recessed to an air suction port 111a side in the axial direction AD. The main plate 23 has a boss portion 231 for connection of the rotating shaft 20a in its middle. The main plate 23 is separated from the motor-side inner circumferential portion 121, and the surface side thereof opposed to the shroud 22 is connected to the second side in the axial direction AD of the blade 21.

[0056] The rotating shaft 20a is made of a cylindrical rod-like member. The rotating shaft 20a is rotatably supported with respect to the motor cover 12 via a bearing 20b disposed in the through hole 121a of the motor cover 12. The rotating shaft 20a protrudes from the through hole 121a to a main plate 23 side. A portion of the rotating shaft 20a protruding to the main plate 23 side is connected to the main plate 23 so that the main plate 23 rotates integrally with the rotating shaft 20a.

[0057] The electric motor 30 rotationally drives the centrifugal fan 20. The electric motor 30 of the first embodiment is disposed on the back side of the surface of the main plate 23 opposed to the blades 21 and the shroud 22. Specifically, the electric motor 30 of the first embodiment is disposed in a space formed between the main plate 23 and the motor-side inner circumferential portion 121 of the motor cover 12.

[0058] In the first embodiment, an outer-rotor-type brushless DC motor is used as the electric motor 30. The electric motor 30 includes a stator 31 connected to the motor cover 12, a coil 32 wound around the stator 31, a rotor 33 connected to the back surface of the main plate 23, and a permanent magnet 34 disposed on the inner circumferential side of the rotor 33 opposed to the coil 32.

[0059] In the electric motor 30 of the first embodiment, the stator 31, the coil 32, the rotor 33, and the permanent magnet 34 are arranged side by side in the radial direction RD so as to overlap with the bearing 20b in the radial direction RD. This results in a small body size of the electric motor 30 in the axial direction AD.

[0060] The discharge airflow path 13 of the first embodiment is now described. The discharge airflow path 13 of the first embodiment extends along the radial direction RD such that the length in the axial direction AD is substantially uniform over the entire region in the radial direction RD.

[0061] The discharge airflow path 13 of the first embodiment has an adjacent airflow path 131 adjacent to the trailing edge 21b of each blade 21. Specifically, the adjacent airflow

path **131** is closer to the fan-side step portion **112** and the motor-side step portion **122** than to the air blowoff portion **14** in the discharge air-flow path **13**.

[0062] The dimension in the axial direction AD of the adjacent airflow path **131** is determined such that sudden expansion or sudden contraction does not occur in the airflow path defined by the centrifugal fan **20** and the blower casing **10**.

[0063] As shown in FIG. 3, the dimension La in the axial direction AD of the adjacent airflow path **131** is determined with reference to the dimension (blade height Lb) in the axial direction AD of each blade **21** at the trailing edge **21b**, and the dimension (fan height Lf) in the axial direction AD of the centrifugal fan **20** at the trailing edge **21b**. The fan height Lf is obtained by adding the thickness of the shroud **22** and the thickness of the main plate **23** in the axial direction AD to the blade height Lb. The dimension La in the axial direction AD of the adjacent airflow path **131** corresponds to the length of each blade **21** of the centrifugal fan **20** in the axial direction AD at the position closest to the trailing edge **21b** in the discharge airflow path **13**. In the following description, the length of the discharge airflow path **13** in the axial direction AD at the position closest to the trailing edge **21b** of each blade **21** of the centrifugal fan **20** may be simply referred to as airflow path height La.

[0064] A dimension La in the axial direction AD of the adjacent airflow path **131** of the first embodiment is set to be equal to or larger than the blade height Lb and equal to or smaller than the fan height Lf. In other words, the airflow path height La of the adjacent airflow path **131** is equal to or larger than the blade height Lb and equal to or smaller than the fan height. The dimension La in the axial direction AD of the adjacent airflow path **131** is set within a range in which the numerical expression F1 is satisfied.

$$Lb \leq La \leq Lf \quad (F1)$$

[0065] The dimension La in the axial direction AD of the adjacent airflow path **131** is preferably set to a dimension closer to the dimension of the blade height Lb than to the dimension of the fan height Lf. Specifically, the dimension La in the axial direction AD of the adjacent airflow path **131** is preferably set within a range in which the numerical expression F2 is satisfied.

$$La - Lb < Lf - La \quad (F2)$$

[0066] It is more preferable that the dimension La in the axial direction AD of the adjacent airflow path **131** is substantially equal to the blade height Lb (La Lb).

[0067] Operation of the centrifugal blower **1** of the first embodiment is now described. When electric power is supplied to the electric motor **30**, the electric motor **30** rotationally drives the centrifugal fan **20**. As a result, the centrifugal fan **20** rotates around the rotation shaft **20a** and sucks air from one side in the axial direction AD through the air suction port **111a** as indicated by bold arrows in FIG. 2. The centrifugal fan **20** blows the air sucked through the air suction port **111a** outward in the radial direction RD.

[0068] FIG. 4 is a sectional view showing a main part of a centrifugal blower as a comparative example of the first embodiment. In the centrifugal blower of the comparative example, as shown in FIG. 4, the dimension La in the axial direction AD of the adjacent airflow path **131** is larger than the fan height Lf. In the centrifugal blower of the comparative example, the shape of the airflow path defined by the centrifugal fan **20** and the blower casing **10** suddenly

expands. In the centrifugal blower having such an airflow path shape, an unstable vortex causing noise is generated on the outlet side of the centrifugal fan **20** (i.e., generated in the vicinity of the trailing edge **21b**).

[0069] On the other hand, in the centrifugal blower **1** of the first embodiment, the dimension La in the axial direction AD of the adjacent airflow path **131** is set to be equal to or larger than the blade height Lb and equal to or smaller than the fan height Lf. In other words, the airflow path height La of the adjacent airflow path **131** is equal to or larger than the blade height Lb and equal to or smaller than the fan height. The centrifugal blower **1** of the first embodiment can therefore suppress occurrence of unstable vortices in the adjacent airflow path **131** as shown in FIG. 5.

[0070] In the centrifugal blower **1** of the first embodiment as described above, the axial dimension (length) of the airflow path adjacent to the centrifugal fan **20** in the blower casing **10** is set between the blade height Lb at the trailing edge **21b** of the blade **21** and the fan height Lf. In other words, the airflow path height La of the adjacent airflow path **131** is equal to or larger than the blade height Lb and equal to or smaller than the fan height.

[0071] Consequently, the shape of the airflow path defined by the centrifugal fan **20** and the blower casing **10** becomes a shape having substantially no sudden expansion and no sudden contraction.

[0072] Hence, the centrifugal blower **1** of the first embodiment can suppress noise generated due to the shape of the airflow path defined by the blower casing **10** and the centrifugal fan **20** in the centrifugal blower **1** including the blower casing **10** opened over its entire circumference and the centrifugal fan **20**.

[0073] In the first embodiment, the adjacent airflow path **131** is formed by a pair of wall portions (the fan-side outer circumferential portion **113** and the motor-side outer circumferential portion **123**), which are opposed to each other in the axial direction AD, of the blower casing **10**. This makes it possible to reduce the body size in the axial direction AD of each of the portions, which define the adjacent airflow path **131**, of the blower casing **10**. Such a configuration is preferable for a case where the centrifugal blower **1** is disposed in a place with a setting space limited as in the inside of a vehicle seat.

[0074] Furthermore, in the first embodiment, the electric motor **30** is disposed on the back side of the main plate **23**. Consequently, the electric motor **30** itself does not cause a disturbance of airflow, making it possible to suppress occurrence of noise as compared with the case where the electric motor **30** is disposed on the surface side of the main plate **23**.

[0075] In the first embodiment, the discharge airflow path **13** has a shape extending along the radial direction RD such that the length in the axial direction AD is substantially uniform over the entire region in the radial direction RD. As a result, the whole area of the discharge airflow path **13** is set to have a height between the blade height Lb at the trailing edge **21b** of the blade **21** and the fan height Lf. Consequently, it is possible to suppress occurrence of noise while reducing the body size of the centrifugal blower **1**.

Second Embodiment

[0076] A second embodiment is now described with reference to FIG. 6. The second embodiment is different from the first embodiment in that an adjacent airflow path **131A** is defined by the shroud **22** of a centrifugal fan **20A** and the

main plate 23. In the second embodiment, descriptions of portions similar or equivalent to those of the first embodiment are omitted or simplified.

[0077] As shown in FIG. 6, a blower casing 10A of the second embodiment does not include the fan-side step portion 112 and the motor-side step portion 122 provided in the first embodiment. Specifically, in the blower casing 10A of the second embodiment, the fan-side inner circumferential portion 111 and the fan-side outer circumferential portion 113 are continuously formed, and the motor-side inner circumferential portion 121 and the motor-side outer circumferential portion 123 are also continuously formed.

[0078] In the centrifugal fan 20A of the second embodiment, the shroud 22 and the main plate 23 extend outward in the radial direction RD from the trailing edge 21b of each blade 21.

[0079] Specifically, the shroud 22 of the second embodiment has a shroud-side extending portion 222 that extends outward in the radial direction RD from the trailing edge 21b of the blade 21. In the second embodiment, the shroud-side extending portion 222 configures a first extending portion extending outward in the radial direction RD of the rotating shaft 20a from the trailing edge 21b of the blade 21.

[0080] The main plate 23 of the second embodiment has a main-plate-side extending portion 232 that extends outward in the radial direction RD from the trailing edge 21b of each blade 21. In the second embodiment, the main-plate-side extending portion 232 configures a second extending portion extending outward in the radial direction RD of the rotating shaft 20a from the trailing edge 21b of the blade 21.

[0081] The whole area of the discharge airflow path 13 of the second embodiment including the adjacent airflow path 131A is configured by an airflow path formed between the shroud-side extending portion 222 and the main-plate-side extending portion 232.

[0082] The adjacent airflow path 131A of the second embodiment is closer to the trailing edge 21b of each blade 21 than to the air blowoff portion 14 in the discharge airflow path 13. The dimension La in the axial direction AD of the adjacent airflow path 131A of the second embodiment is substantially equal to the blade height Lb (La Lb). In other words, the airflow path height La of the adjacent airflow path 131A is substantially equal to the blade height Lb.

[0083] Other configurations are the same as those of the first embodiment. The centrifugal blower 1 of the second embodiment is designed such that the adjacent airflow path 131A is defined by the respective extending portions 222 and 232 of the shroud 22 and the main plate 23. As a result, the adjacent airflow path 131A has a continuous shape. It is therefore possible to further suppress the noise generated due to the shape of the airflow path defined by the blower casing 10A and the centrifugal fan 20.

[0084] The configuration of the second embodiment makes it possible to suppress backward flow of the air discharged from the centrifugal fan 20 to the air suction port 111a side of the centrifugal fan 20 through a gap formed between the shroud 22 and the fan cover 11 of the blower casing 10A.

[0085] The configuration of the second embodiment further makes it possible to suppress entering of foreign matters such as water into an electric motor 30 side through a gap formed between the main plate 23 and the motor cover 12 of the blower casing 10A.

Third Embodiment

[0086] A third embodiment is now described with reference to FIG. 7. The third embodiment is different from the first and second embodiments in that an adjacent airflow path 131B is defined by the main plate 23 of a centrifugal fan 20B and the fan cover 11 of a blower casing 10B. In the third embodiment, descriptions of portions similar or equivalent to those of the first or second embodiment are omitted or simplified.

[0087] As shown in FIG. 7, the blower casing 10B of the third embodiment does not include the motor-side step portion 122 in the first embodiment. Specifically, the blower casing 10B of the third embodiment has the motor-side inner circumferential portion 121 and the motor-side outer circumferential portion 123 in a continuous manner.

[0088] In a centrifugal fan 20B of the third embodiment, the main plate 23 extends outward in the radial direction RD from the trailing edge 21b of each blade 21. Specifically, the main plate 23 of the third embodiment has a main-plate-side extending portion 232 that extends outward in the radial direction RD from the trailing edge 21b of the blade 21. In the third embodiment, the main-plate-side extending portion 232 configures an extending portion extending outward in the radial direction RD of the rotating shaft 20a from the trailing edge 21b of the blade 21. Moreover, in the third embodiment, the fan cover 11 configures a wall portion closer to the shroud 22 than to the main plate 23.

[0089] The whole area of the discharge airflow path 13 of the third embodiment including the adjacent airflow path 131B is configured by an airflow path formed between the fan-side outer circumferential portion 113 and the main-plate-side extending portion 232. The adjacent airflow path 131B of the third embodiment is closer to the fan-side step portion 112 than to the air blowoff portion 14 in the discharge airflow path 13.

[0090] The dimension La in the axial direction AD of the adjacent airflow path 131B of the third embodiment is set to be equal to or larger than the blade height Lb and equal to or smaller than the fan height Lf. In other words, the airflow path height La of the adjacent airflow path 131B is equal to or larger than the blade height Lb and equal to or smaller than the fan height Lf. In the third embodiment, the dimension La in the axial direction AD of the adjacent airflow path 131B is also preferably set to be closer to the blade height Lb than to the fan height Lf.

[0091] Other configurations are the same as those of the first or second embodiment. The centrifugal blower 1 of the third embodiment is designed such that the adjacent airflow path 131B is defined by the fan-side outer circumferential portion 113 of the blower casing 10B and the main-plate-side extending portion 232 of the main plate 23.

[0092] As a result, a main plate 23 side of the adjacent airflow path 131B has a continuous shape. It is therefore possible to further suppress the noise generated due to the shape of the airflow path formed by the blower casing 10B and the centrifugal fan 20B.

[0093] Furthermore, the configuration of the third embodiment makes it possible to suppress entering of foreign matters such as water into an electric motor 30 side through a gap formed between the main plate 23 and the motor cover 12 of the blower casing 10B.

Fourth Embodiment

[0094] A fourth embodiment is now described with reference to FIG. 8. The fourth embodiment is different from the first to third embodiments in that an adjacent airflow path 131C is defined by the shroud 22 of a centrifugal fan 20C and the motor cover 12 of a blower casing 10C. In the fourth embodiment, descriptions of portions similar or equivalent to those of at least one of the first to third embodiments are omitted or simplified.

[0095] As shown in FIG. 8, the fan-side step portion 112 in the first embodiment is omitted in a blower casing 10C of the fourth embodiment. Specifically, the blower casing 10C of the fourth embodiment has the fan-side inner circumferential portion 111 and the fan-side outer circumferential portion 113 in a continuous manner.

[0096] In the centrifugal fan 20C of the fourth embodiment, the shroud 22 extends outward in the radial direction RD from the trailing edge 21b of each blade 21. Specifically, the shroud 22 of the fourth embodiment has a shroud-side extending portion 222 that extends outward in the radial direction RD from the trailing edge 21b of the blade 21.

[0097] In the fourth embodiment, the shroud-side extending portion 222 configures an extending portion extending outward in the radial direction RD of the rotating shaft 20a from the trailing edge 21b of the blade 21. Moreover, in the fourth embodiment, the motor cover 12 configures a wall portion closer to the main plate 23 than to the shroud 22.

[0098] The whole area of the discharge airflow path 13 of the fourth embodiment including the adjacent airflow path 131C is configured by an airflow path formed between the motor-side outer circumferential portion 123 and the shroud-side extending portion 222. The adjacent airflow path 131C of the fourth embodiment is closer to the motor-side step portion 122 than to the air blowoff portion 14 in the discharge airflow path 13.

[0099] The dimension La in the axial direction AD of the adjacent airflow path 131C of the fourth embodiment is set to be equal to or larger than the blade height Lb and equal to or smaller than the fan height Lf. In other words, the airflow path height La of the adjacent airflow path 131C is equal to or larger than the blade height Lb and equal to or smaller than the fan height. In the fourth embodiment, the dimension La in the axial direction AD of the adjacent airflow path 131C is also preferably set to be closer to the blade height Lb than to the fan height Lf.

[0100] Other configurations are the same as those of at least one of the first to third embodiments. The centrifugal blower 1 of the fourth embodiment is designed such that the adjacent airflow path 131C is defined by the motor-side outer circumferential portion 123 of the blower casing 10C and the shroud-side extending portion 222 of the shroud 22. As a result, the adjacent airflow path 131C has a continuous shape on its shroud 22 side. It is therefore possible to further suppress the noise generated due to the shape of the airflow path defined by the blower casing 10C and the centrifugal fan 20C.

[0101] Furthermore, the configuration of the fourth embodiment makes it possible to suppress backflow of the air discharged from the centrifugal fan 20C to the air suction port 111a side of the centrifugal fan 20C through a gap formed between the shroud 22 and the fan cover 11 of the blower casing 10C.

Fifth Embodiment

[0102] A fifth embodiment is now described with reference to FIG. 9. The fifth embodiment is different from the first embodiment in that the shape of the discharge airflow path 13 is changed. In the fifth embodiment, descriptions of portions similar or equivalent to those of the first embodiment are omitted or simplified.

[0103] A blower casing 10D of the fifth embodiment is shaped such that the fan-side outer circumferential portion 113 and the motor-side outer circumferential portion 123 are gradually away from each other toward the outer side in the radial direction RD. Specifically, the fan-side outer circumferential portion 113 is shaped such that its position in the axial direction AD is gradually away from the motor cover 12 toward the outer side in the radial direction RD. Similarly, the motor-side outer peripheral portion 123 is shaped such that its position in the axial direction AD is gradually away from the fan cover 11 toward the outer side in the radial direction

[0104] RD.

[0105] The length in the axial direction AD of the discharge airflow path 13 of the fifth embodiment gradually increases toward the airflow downstream side. The discharge airflow path 13 of the fifth embodiment has the smallest length in the axial direction AD in the vicinity of the trailing edge 21b of each blade 21. In addition, the discharge airflow path 13 of the fifth embodiment has the largest length in the axial direction AD in the vicinity of the air blowoff portion 14. Furthermore, in the discharge airflow path 13 of the fifth embodiment, a length Lc in the axial direction AD in the vicinity of the air blowoff portion 14 is set to be equal to or smaller than the maximum length Lfmax in the axial direction AD of the centrifugal fan 20 ($Lc < Lfmax$).

[0106] Other configurations are the same as those of the first embodiment. In the centrifugal blower 1 of the fifth embodiment, the length in the axial direction AD of the discharge airflow path 13 is gradually increased toward the airflow downstream side. This makes it possible to suppress sudden expansion between an outlet side of the discharge airflow path 13 and a discharge target space into which air is discharged. As a result, it is possible to suppress occurrence of noise between the outlet side of the discharge airflow path 13 and the discharge target space into which air is discharged.

[0107] In the fifth embodiment, the length in the axial direction AD of the discharge airflow path 13 is set to be equal to or smaller than the maximum length in the axial direction AD of the centrifugal fan 20. Consequently, it is possible to suppress occurrence of noise while reducing the body size of the centrifugal blower 1. For example, such a configuration is preferable for a case where the centrifugal blower 1 is disposed in a place with a setting space limited as in the inside of a vehicle seat.

Sixth Embodiment

[0108] A sixth embodiment is now described with reference to FIG. 10. The sixth embodiment is different from the second embodiment in that the shape of the discharge airflow path 13 is changed. In the sixth embodiment, descriptions of portions similar or equivalent to those of the second embodiment are omitted or simplified.

[0109] A blower casing 10E of the sixth embodiment is shaped such that the fan-side outer circumferential portion

113 and the motor-side outer circumferential portion **123** are gradually away from each other toward the outer side in the radial direction RD. Specifically, the fan-side outer circumferential portion **113** is shaped such that its position in the axial direction AD is gradually away from the motor cover **12** toward the outer side in the radial direction RD. Similarly, the motor-side outer peripheral portion **123** is shaped such that its position in the axial direction AD is gradually away from the fan cover **11** toward the outer side in the radial direction RD.

[0110] A centrifugal fan **20E** of the sixth embodiment is shaped such that the shroud-side extending portion **222** and the main-plate-side extending portion **232** are gradually away from each other toward the outer side in the radial direction RD as with the fan-side outer circumferential portion **113** and the motor-side outer circumferential portion **123**. Specifically, the shroud-side extending portion **222** is shaped such that its position in the axial direction AD is gradually away from the motor cover **12** toward the outer side in the radial direction RD as with the fan-side outer circumferential portion **113**. The main-plate-side extending portion **232** is shaped such that its position in the axial direction AD is gradually away from the fan cover **11** toward the outer side in the radial direction RD as with the motor-side outer circumferential portion **123**.

[0111] The length in the axial direction AD of the discharge airflow path **13** of the sixth embodiment gradually increases toward the airflow downstream side. The discharge airflow path **13** of the sixth embodiment has the smallest length in the axial direction AD in the vicinity of the trailing edge **21b** of each blade **21**. The discharge airflow path **13** of the sixth embodiment has the largest length in the axial direction AD in the vicinity of the air blowoff portion **14**. Furthermore, in the discharge airflow path **13** of the sixth embodiment, a length L_d in the axial direction AD in the vicinity of the air blowoff portion **14** is set to be equal to or smaller than the maximum length L_{max} in the axial direction AD of the centrifugal fan **20** ($L_d < L_{max}$).

[0112] Other configurations are the same as those of the second embodiment. In the centrifugal blower **1** of the sixth embodiment, as in the fifth embodiment, the length in the axial direction AD of the discharge airflow path **13** is gradually increased toward the airflow downstream side. Hence, the configuration of the sixth embodiment provides effects similar to those of the fifth embodiment.

[0113] Furthermore, in the sixth embodiment, as in the fifth embodiment, the length in the axial direction AD of the discharge airflow path **13** is set to be equal to or smaller than the maximum length in the axial direction AD of the centrifugal fan **20**. The configuration of the sixth embodiment therefore further provides effects similar to those of the fifth embodiment.

[0114] Although some embodiments of the disclosure have been described hereinbefore, the disclosure should not be limited thereto, and various modifications or alterations of the embodiments may be appropriately made. For example, the embodiments can be variously modified as follows. The modifications of the above-described embodiments are now described.

[0115] (1) Although the above-described embodiments have been described with an example where the centrifugal blower **1** is applied to air blowing means in a vehicle, the disclosure is not limited thereto. For example, the centrifu-

gal blower **1** may be applied to air blowing means of a stationary air conditioner used in homes, factories, and the like.

[0116] (2) Although the above-described embodiments have been described with an example where a backward fan is used as the centrifugal fan **20**, the disclosure is not limited thereto. For example, a radial fan, in which an outlet side of a fan faces in the radial direction RD, may be used.

[0117] (3) Although the above-described embodiments have been described with an example where an outer-rotor-type brushless DC motor is used as the electric motor **30**, the disclosure is not limited thereto. An inner-rotor-type DC motor may be used as the electric motor **30**. In addition, an AC motor may be used as the electric motor **30**.

[0118] (4) Although it is preferable that the electric motor **30** is disposed on the back side of the main plate **23** as in the above-described embodiments, the disclosure is not limited thereto. For example, the electric motor **30** may be disposed on the surface side of the main plate **23**. In addition, the electric motor **30** may not be disposed in the inside of the blower casing **10**, but may be disposed at least partially outside of the blower casing **10**.

[0119] (5) Although the above-described fifth and sixth embodiments have been described with an example where the respective lengths in the axial direction AD of the discharge airflow path **13** are gradually increased toward the airflow downstream side in the configurations of the first and second embodiments, the disclosure is not limited thereto. For example, the respective lengths in the axial direction AD of the discharge airflow path **13** may be gradually increased toward the airflow downstream side in the configuration of the third or fourth embodiment.

[0120] (6) Although it is desirable that the length in the axial direction AD of the discharge airflow path **13** is set to be equal to or smaller than the maximum length in the axial direction AD of the centrifugal fan **20** as in the above-described fifth or sixth embodiment, the disclosure is not limited thereto. For example, the length in the axial direction AD of the discharge airflow path **13** may be partially longer than the maximum length in the axial direction AD of the centrifugal fan **20**.

[0121] (7) It will be appreciated that in each of the above-described embodiments, a constitutional element of the embodiment is not necessarily indispensable except for the particularly defined case and for the case where the constitutional element is considered to be indispensable in principle. The above-described embodiments can be appropriately combined within the limits of possibility.

[0122] (8) In each of the above-described embodiments, when a numerical value such as the number, a numerical value, amount, or a range of a constitutional element of the embodiment is mentioned, the numerical value is not limited to a specified number except for the case where the number is particularly defined to be indispensable and for the case where the number is principally clearly limited to the mentioned number.

[0123] (9) In each of the above-described embodiments, when a shape, a positional relationship, or the like of a constitutional element is described, the constitutional element does not exclusively have the shape, the positional relationship, or the like except for the particularly defined case and for the case where the constitutional element exclusively has the shape, the positional relationship, or the like in principle.

What is claimed is:

1.-10. (canceled)

11. A centrifugal blower for blowing air, comprising:
a centrifugal fan that sucks air from one side of a rotating shaft in its axial direction and discharges the air radially outward of the rotating shaft; and

a blower casing that accommodates the centrifugal fan and opens along an entire circumference of the blower casing around the rotating shaft, wherein:

the centrifugal fan includes:

a plurality of blades arranged side by side in a circumferential direction of the rotating shaft;

a shroud that connects together one sides of the plurality of blades in the axial direction; and

a main plate that connects together the other sides of the plurality of blades in the axial direction and is connected to the rotating shaft;

the blower casing includes therein a discharge airflow path, which extends radially outward of the rotating shaft, on an airflow downstream side of a trailing edge of each of the plurality of blades;

the discharge airflow path includes an adjacent airflow path adjacent to the trailing edge of each of the plurality of blades; and

provided that:

a length of the trailing edge of each of the plurality of blades in the axial direction is a blade height; and

a length of the centrifugal fan at the trailing edge in the axial direction is a fan height,

a length of the adjacent airflow path in the axial direction is equal to or larger than the blade height, and is equal to or smaller than the fan height.

12. The centrifugal blower according to claim **11**, wherein the adjacent airflow path is an airflow path defined by a pair of wall portions of the blower casing that are opposed to each other in the axial direction.

13. The centrifugal blower according to claim **11**, wherein:

one member of the shroud and the main plate includes an extending portion that extends radially outward of the trailing edge of each of the plurality of blades;

the blower casing includes a pair of wall portions opposed to each other in the axial direction; and

the adjacent airflow path is an airflow path defined by the extending portion and one of the pair of wall portions.

14. The centrifugal blower according to claim **13**, wherein:

the one member is the main plate; and

the adjacent airflow path is an airflow path defined by the extending portion of the main plate, and a wall portion of the pair of wall portions that is closer to the shroud than to the main plate.

15. The centrifugal blower according to claim **13**, wherein:

the one member is the shroud; and

the adjacent airflow path is an airflow path defined by the extending portion of the shroud, and a wall portion of the pair of wall portions that is closer to the main plate than to the shroud.

16. The centrifugal blower according to claim **11**, wherein:

the shroud includes a first extending portion that extends radially outward of the trailing edge of each of the plurality of blades;

the main plate includes a second extending portion that extends radially outward of the trailing edge of each of the plurality of blades; and

the adjacent airflow path is an airflow path defined by the first extending portion and the second extending portion.

17. The centrifugal blower according to claim **11**, further comprising an electric motor that rotates the centrifugal fan, wherein the electric motor is disposed on a back side of a surface of the main plate that is opposed to the plurality of blades and the shroud.

18. The centrifugal blower according to claim **11**, wherein a length of the discharge airflow path in the axial direction becomes larger toward the airflow downstream side.

19. The centrifugal blower according to claim **18**, wherein the length of the discharge airflow path in the axial direction is set to be equal to or smaller than a maximum length of the centrifugal fan in the axial direction.

20. A centrifugal blower for blowing air, comprising:

a centrifugal fan that sucks air from one side of a rotating shaft in its axial direction and discharges the air radially outward of the rotating shaft; and

a blower casing that accommodates the centrifugal fan and opens along an entire circumference of the blower casing around the rotating shaft, wherein:

the centrifugal fan includes:

a plurality of blades arranged side by side in a circumferential direction of the rotating shaft;

a shroud that connects together one sides of the plurality of blades in the axial direction; and

a main plate that connects together the other sides of the plurality of blades in the axial direction and is connected to the rotating shaft;

the blower casing includes therein a discharge airflow path, which extends radially outward of the rotating shaft, on an airflow downstream side of a trailing edge of each of the plurality of blades;

the discharge airflow path includes an adjacent airflow path adjacent to the trailing edge of each of the plurality of blades; and

provided that:

a length of the discharge airflow path in the axial direction at a position closest to the trailing edge of each of the plurality of blades is an airflow path height;

a length of the trailing edge of each of the plurality of blades in the axial direction is a blade height; and

a length of the centrifugal fan at the trailing edge in the axial direction is a fan height,

the airflow path height of the adjacent airflow path is equal to or larger than the blade height, and is equal to or smaller than the fan height.

21. The centrifugal blower according to claim **20**, wherein the adjacent airflow path is an airflow path defined by a pair of wall portions of the blower casing that are opposed to each other in the axial direction.

22. The centrifugal blower according to claim **20**, wherein:

one member of the shroud and the main plate includes an extending portion that extends radially outward of the trailing edge of each of the plurality of blades;

the blower casing includes a pair of wall portions opposed to each other in the axial direction; and

the adjacent airflow path is an airflow path defined by the extending portion and one of the pair of wall portions.

23. The centrifugal blower according to claim **22**, wherein:

the one member is the main plate; and

the adjacent airflow path is an airflow path defined by the extending portion of the main plate, and a wall portion of the pair of wall portions that is closer to the shroud than to the main plate.

24. The centrifugal blower according to claim **22**, wherein:

the one member is the shroud; and

the adjacent airflow path is an airflow path defined by the extending portion of the shroud, and a wall portion of the pair of wall portions that is closer to the main plate than to the shroud.

25. The centrifugal blower according to claim **20**, wherein:

the shroud includes a first extending portion that extends radially outward of the trailing edge of each of the plurality of blades;

the main plate includes a second extending portion that extends radially outward of the trailing edge of each of the plurality of blades; and

the adjacent airflow path is an airflow path defined by the first extending portion and the second extending portion.

26. The centrifugal blower according to claim **20**, further comprising an electric motor that rotates the centrifugal fan, wherein the electric motor is disposed on a back side of a surface of the main plate that is opposed to the plurality of blades and the shroud.

27. The centrifugal blower according to claim **20**, wherein a length of the discharge airflow path in the axial direction becomes larger toward the airflow downstream side.

28. The centrifugal blower according to claim **27**, wherein the length of the discharge airflow path in the axial direction is set to be equal to or smaller than a maximum length of the centrifugal fan in the axial direction.

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