



(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 153(4) EPC

(43) Date of publication:
19.04.2023 Bulletin 2023/16

(51) International Patent Classification (IPC):
F24F 1/38 (2011.01)

(21) Application number: **20939687.8**

(52) Cooperative Patent Classification (CPC):
F24F 1/38

(22) Date of filing: **12.06.2020**

(86) International application number:
PCT/JP2020/023211

(87) International publication number:
WO 2021/250889 (16.12.2021 Gazette 2021/50)

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
KH MA MD TN

(72) Inventors:
• **ADACHI, Naho**
Tokyo 1008310 (JP)
• **TADOKORO, Takahide**
Tokyo 1008310 (JP)

(71) Applicant: **MITSUBISHI ELECTRIC CORPORATION**
Chiyoda-ku
Tokyo 100-8310 (JP)

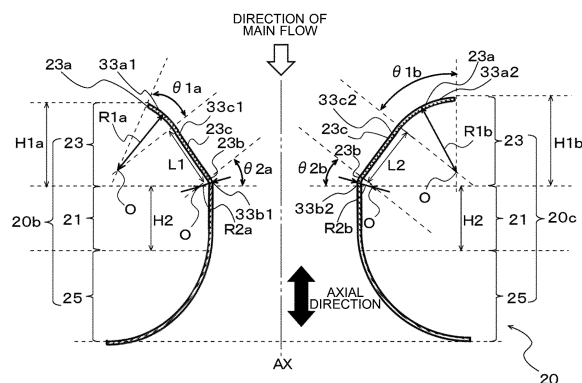
(74) Representative: **Pfenning, Meinig & Partner mbB**
Patent- und Rechtsanwälte
Joachimsthaler Straße 10-12
10719 Berlin (DE)

(54) **OUTDOOR UNIT OF AIR CONDITIONING DEVICE**

(57) An outdoor unit for an air-conditioning apparatus includes a bellmouth having a first tapered portion with an inner diameter in upstream of the bellmouth from which air flows being larger than that in downstream of the bellmouth, and a straight pipe portion extending straight from the first tapered portion to the downstream side of airflow. The first tapered portion includes a first bend portion forming an air inlet, a second bend portion

connecting to the straight pipe portion and having an inner diameter smaller than that of the first bend portion, and a connection portion connecting to the first bend portion and the second bend portion and having an inner surface extending straight. A length of at least a part of the first tapered portion along an axial direction of the straight pipe portion is larger than the straight pipe portion along the axial direction of the straight pipe portion.

FIG. 5



Description

Technical Field

[0001] The present disclosure relates to an outdoor unit, including a bellmouth, for an air-conditioning apparatus.

Background Art

[0002] Patent Literature 1 discloses an outdoor unit, including a bellmouth, for an air-conditioning apparatus. The bellmouth is provided upstream of a main flow of air and has a contraction portion whose pipe diameter is reduced from the upstream side toward the downstream side of the main flow of air and that is formed by a bend surface, and a straight pipe portion connecting to the downstream side of the contraction portion. In Patent Literature 1, interference between the bellmouth and a heat exchanger is inhibited by changing the curvature radius of the contraction portion in a circumferential direction.

Citation List

Patent Literature

[0003] Patent Literature 1: Japanese Unexamined Patent Application Publication No. 2013-96622

Summary of Invention

Technical Problem

[0004] In the bellmouth, contraction of flow of air in the contraction portion generates contracted flow in the straight pipe portion, and a vortex may thus be generated at an inner surface of the straight pipe portion. In addition, due to the change in the curvature radius of the contraction portion in the circumferential direction, the bellmouth in Patent Literature 1 has a part in which the length of the contraction portion along the direction of the main flow of air is shorter than the length of the straight pipe portion along the direction of the main flow of air. In the part in which the length of the contraction portion along the direction of the main flow of air is shorter, when air flowing in a direction different from the direction of the main flow of air flows into the bend surface of the contraction portion, a directing angle for directing, in the direction of the main flow of air, the air flowing thereinto in the direction different from the direction of the main flow of air is large. When the directing angle is large, it is not possible to direct, in the direction of the main flow of air, air flowing in a direction different from the direction of the main flow of air. Thus, air separation occurs at the straight pipe portion, resulting in generation of a vortex. Such a vortex generated at the straight pipe portion increases in size as the straight pipe portion becomes longer. The vortex at the straight pipe portion substantially narrows

an air passage in the straight pipe portion. As a result, pressure loss may occur in the straight pipe portion of the bellmouth in Patent Literature 1 due to the air passage in the straight pipe portion being substantially narrowed.

[0005] The present disclosure is made to solve the above problem, and an object of the present disclosure is to provide an outdoor unit for an air-conditioning apparatus capable of inhibiting pressure loss from occurring in a bellmouth.

Solution to Problem

[0006] An outdoor unit for an air-conditioning apparatus of an embodiment of the present disclosure includes: a heat exchanger; an axial flow fan configured to generate flow of air passing through the heat exchanger; a casing having an opening through which the air passes, the casing accommodating the heat exchanger, and accommodating the axial flow fan between the opening and the heat exchanger; and a bellmouth having an annular shape and provided around the axial flow fan inside the casing to guide the air into the opening of the casing. The bellmouth has a first tapered portion in which an inner diameter of an upstream side of the bellmouth from which the air flows in is larger than an inner diameter of a downstream side of the bellmouth, and a straight pipe portion extending straight from the first tapered portion to the downstream side of the flow of the air. The first tapered portion includes a first bend portion forming an inlet for the air, a second bend portion connecting to the straight pipe portion and having an inner diameter smaller than that of the first bend portion, and a connection portion connecting to the first bend portion and the second bend portion and having an inner surface extending straight. A length of at least a part of the first tapered portion along an axial direction of the straight pipe portion is larger than a length of the straight pipe portion along the axial direction of the straight pipe portion.

Advantageous Effects of Invention

[0007] In the above configuration of the embodiment of the present disclosure, the first tapered portion includes the connection portion having the inner surface extending straight, and the length of at least a part of the first tapered portion along the axial direction of the straight pipe portion is larger than the length of the straight pipe portion along the axial direction of the straight pipe portion. That is, the first tapered portion, which is a contraction portion, has a straight inner surface, and the length of a passage in the first tapered portion in the direction of a main flow of air is larger than the length of a passage in the straight pipe portion in the direction of the main flow of air. Accordingly, this configuration enables flow of air in the first tapered portion to be smoothly contracted and enables, even when air flowing in a direction different from the direction of the main flow of air flows into the first tapered portion, the air to be

smoothly directed, in the first tapered portion, in the direction of the main flow of air. As a result, with the configuration of the embodiment of the present disclosure, it is possible to inhibit the air passage in the straight pipe portion from being substantially narrowed due to generation of a vortex at the straight pipe portion and to thus provide an outdoor unit for an air-conditioning apparatus capable of inhibiting pressure loss from occurring in a bellmouth.

Brief Description of Drawings

[0008]

[Fig. 1] Fig. 1 is a schematic top view of an example of the internal structure of an outdoor unit for an air-conditioning apparatus according to Embodiment.

[Fig. 2] Fig. 2 is an enlarged schematic view of a part of a section of a bellmouth in Fig. 1.

[Fig. 3] Fig. 3 is a schematic diagram illustrating the relationship between a first curvature radius and a first central angle at a first edge line according to Embodiment.

[Fig. 4] Fig. 4 is a schematic diagram illustrating the relationship between the first curvature radius and a second curvature radius at a first tapered portion according to Embodiment.

[Fig. 5] Fig. 5 is an enlarged schematic view of a first section and a second section of the bellmouth in Fig. 1.

Description of Embodiments

Embodiment

[0009] The structure of an outdoor unit 100 for an air-conditioning apparatus according to Embodiment will be described. Fig. 1 is a schematic top view of an example of the internal structure of the outdoor unit 100 for an air-conditioning apparatus according to Embodiment. In Fig. 1, the direction of a main flow of air when the outdoor unit 100 is driven is represented by white block arrows, and directions of air flow different from the direction of the main flow of air are represented by dot-patterned block arrows.

[0010] In the following drawings including Fig. 1, the size relationships or the shapes of the components of the outdoor unit 100 may differ from those of actual ones. In addition, basically, the positional relationships between the components of the outdoor unit 100 in, for example, an up-down direction, a left-right direction, or a front-rear direction are those when the outdoor unit 100 is set in a usable state. In the following drawings including Fig. 1, the same or similar components or parts have the same reference signs or have no reference signs.

[0011] The outdoor unit 100 includes a casing 10, which accommodates a heat exchanger 1, an axial flow fan 3, and a compressor 5. The casing 10 is formed by

combining a plurality of sheet metal panels, for example. The casing 10 has an opening 10a in communication with the inside of the casing 10. As illustrated in Fig. 1, for example, the opening 10a is disposed at the front of the casing 10. In addition, a grille 10b, which covers the opening 10a, is disposed at the casing 10.

[0012] The heat exchanger 1 exchanges heat between airflow passing through the heat exchanger 1 and refrigerant flowing in the heat exchanger 1. For example, an air-cooled heat exchanger 1 such as a finned tube heat exchanger that includes a plurality of plate-like fins disposed side by side and a plurality of heat transfer tubes passing through the plate-like fins is used as the heat exchanger 1. In Fig. 1, the heat exchanger 1 is formed as a heat exchanger 1 having an L shape in top view and including a first portion 1a, which is disposed at the rear of the casing 10, and a second portion 1b, which is disposed at the left of the casing 10. The heat exchanger 1 having an L shape is merely an example of the heat exchanger 1. The heat exchanger 1 can have a different shape.

[0013] The axial flow fan 3 is disposed between the heat exchanger 1 and the opening 10a provided in the casing 10. For example, a propeller fan is used as the axial flow fan 3. The axial flow fan 3 includes a plurality of blades 3a, which are configured to rotate to generate flow of air, a hub 3b, which is configured to support and rotate the blades 3a, a shaft 3c, which has one tip end connected to the hub 3b, and a motor 3d, which is connected to the other tip end of the shaft 3c and is configured to rotate the shaft 3c. The one tip end of the shaft 3c of the axial flow fan 3 is disposed to face the opening 10a. For example, a three-phase induction motor or a brushless DC motor capable of controlling the rotation speed of the shaft 3c on the basis of voltage is used as the motor 3d.

[0014] The compressor 5 compresses suctioned low-pressure refrigerant into high-pressure refrigerant and discharges the high-pressure refrigerant. For example, a rotary compressor or a scroll compressor is used as the compressor 5. Although not illustrated, the compressor 5 is connected to the heat exchanger 1 by a refrigerant pipe.

[0015] In addition, a partition plate 15 is set in the casing 10. The inside of the casing 10 is partitioned into a fan chamber 15a and a machine chamber 15b with the partition plate 15. The heat exchanger 1 and the axial flow fan 3 are disposed in the fan chamber 15a. The compressor 5 is disposed in the machine chamber 15b. In Fig. 1, the partition plate 15 is formed as a plate-like component having a section shaped by a single straight line but can be a plate-like component having a section having a different shape. For example, the partition plate 15 may be a plate-like component having a section shaped by one or more curved surfaces, a plate-like component having a section shaped by a plurality of straight lines, or a plate-like component having both a section shaped by a straight line and a section shaped by a

curved line. The partition plate 15 can be omitted according to the use of the outdoor unit 100, for example.

[0016] In addition, the outdoor unit 100 includes a bellmouth 20, which is accommodated in the casing 10. The bellmouth 20 is an annular component having an air passage along which airflow generated by rotation of the axial flow fan 3 is guided into the opening 10a. The bellmouth 20 connects to the casing 10 at the front of the casing 10, for example, around the periphery of the opening 10a provided in a front panel thereof. For example, the bellmouth 20 is integrally formed with the front panel of the casing 10 by subjecting sheet metal to plastic deformation by press working or other methods. Fig. 1 illustrates an inlet 20a, into which air generated by rotation of the axial flow fan 3 flows, of the bellmouth 20. In addition, Fig. 1 illustrates a first section 20b, which is located between the axial flow fan 3 and the second portion 1b of the heat exchanger 1, and a second section 20c, which is located between the axial flow fan 3 and the partition plate 15, of the bellmouth 20.

[0017] The bellmouth 20 is formed to guide air suctioned into the casing 10 to the axial flow fan 3 and to optimize the angle at which air flows to the blades 3a. The axial flow fan 3 is surrounded by the bellmouth 20 and accommodated in the casing 10. A part of the axial flow fan 3 is accommodated in the bellmouth 20 by surrounding the axial flow fan 3 by the bellmouth 20. Thus, it is possible to reduce the width of the outdoor unit 100 in the front-rear direction. Other parts of the structure of the bellmouth 20 will be described later.

[0018] When the outdoor unit 100 is driven, air outside the outdoor unit 100 is guided into the casing 10, for example, into the fan chamber 15a, by rotation of the axial flow fan 3 and is subjected to heat exchange in the heat exchanger 1. In addition, the air that is in the outdoor unit 100 and that has been subjected to heat exchange in the heat exchanger 1 is discharged to the outside of the outdoor unit 100 via the bellmouth 20, the opening 10a of the casing 10, and the grille 10b by rotation of the axial flow fan 3.

[0019] Next, the structure of the bellmouth 20 will be described. Fig. 2 is an enlarged schematic view of a part of a section of the bellmouth 20 in Fig. 1. The section in Fig. 2 is a section taken along an axis AX of a straight pipe portion 21, which will be described later. In Fig. 2, the direction along the shaft 3c of the axial flow fan 3 in Fig. 1 is represented by a black block arrow. Similarly to Fig. 1, in Fig. 2, the direction of the main flow of air is represented by a white block arrow.

[0020] The bellmouth 20 has the straight pipe portion 21 and a first tapered portion 23, which connects to the straight pipe portion 21 at a position upstream in the direction of the main flow of air.

[0021] The straight pipe portion 21 has an end portion 21a, which is closer to the heat exchanger 1, and an end portion 21b, which is closer to the opening 10a of the casing 10. As illustrated in Fig. 2, an inner surface of the straight pipe portion 21 is straight. The inner diameter of

the straight pipe portion 21, in which the axis AX represented by a chain double-dashed line is centered, is the same at any position in the direction from the end portion 21a to the end portion 21b. As illustrated in Fig. 2, the direction in which the axis AX of the straight pipe portion 21 extends is substantially parallel to the direction of the main flow of air. As illustrated in Fig. 2, the direction along the shaft 3c of the axial flow fan 3 can be set to be substantially parallel to the direction of the main flow of air and the direction in which the axis AX of the straight pipe portion 21 extends. Although not illustrated in Fig. 2, the straight pipe portion 21 is disposed closer to the peripheries of the blades 3a of the axial flow fan 3.

[0022] The first tapered portion 23 is a contraction pipe portion whose inner diameter is reduced from the upstream side toward the downstream side in the direction of the main flow of air. The first tapered portion 23 is disposed at a position that is upstream of the straight pipe portion 21 and that is downstream of the heat exchanger 1 in the direction of the main flow of air. That is, the first tapered portion 23 connects to the end portion 21a, which is closer to the heat exchanger 1, of the straight pipe portion 21. The specific structure of the first tapered portion 23 will be described later.

[0023] In the following description, flow of air along an inner surface of the first tapered portion 23 in the bellmouth 20 is referred to as a branch flow of air.

[0024] In addition, the bellmouth 20 can include a second tapered portion 25, which connects to the straight pipe portion 21 and the opening 10a of the casing 10 to be located therebetween and whose inner diameter is increased in a direction from the straight pipe portion 21 toward the opening 10a.

[0025] The second tapered portion 25 has an end portion 25b, which is closer to the heat exchanger 1, and an end portion 25a, which is closer to the opening 10a of the casing 10. The second tapered portion 25 is an expanding pipe portion whose inner diameter is increased in the direction from the end portion 25b disposed upstream in the direction of the main flow of air toward the end portion 25a disposed downstream in the direction of the main flow of air. The second tapered portion 25 is disposed at a position that is downstream of the straight pipe portion 21 and that is upstream of the opening 10a of the casing 10. That is, the end portion 25b of the second tapered portion 25 connects to the end portion 21b of the straight pipe portion 21. In addition, the end portion 25a of the second tapered portion 25 connects to the casing 10, for example, an edge of the opening 10a in the front panel of the casing 10.

[0026] For example, a second opening length D2 of the end portion 25a, which is located downstream of the second tapered portion 25, can be set to be larger than a first opening length D1 of an end portion 23a1, which is located upstream of the first tapered portion 23. The first opening length D1 is a distance between the axis AX and the end portion 23a1 of the first tapered portion 23 and is half the inner diameter of the first tapered portion

23 at the end portion 23a1. The second opening length D2 is a distance between the axis AX and the end portion 25a of the second tapered portion 25 and is half the inner diameter of the second tapered portion 25 at the end portion 25a.

[0027] As described above, the bellmouth 20 may be integrally formed with the front panel of the casing 10 by subjecting sheet metal to plastic deformation by, for example, press working in which a metal mold is used. In such press working with a metal mold, the front panel of the casing 10 is held by a lower die of the metal mold, and the sheet metal is bent in a direction toward the lower die of the metal mold by, for example, bending work to form the bellmouth 20. The second tapered portion 25 is formed at a position closer to the front panel. The first tapered portion 23 is formed at a position apart from the front panel. When the second opening length D2 of the end portion 25a located downstream of the second tapered portion 25 is set to be larger than the first opening length D1 of the end portion 23a1 located upstream of the first tapered portion 23, it is possible to inhibit the end portion 23a1 located upstream of the first tapered portion 23 from interfering with the lower die of the metal mold during release of the front panel of the casing 10 from the lower die of the metal mold. Thus, when the second opening length D2 of the end portion 25a located downstream of the second tapered portion 25 is set to be larger than the first opening length D1 of the end portion 23a1 located upstream of the first tapered portion 23, it is possible to improve the manufacturing efficiency of the bellmouth 20.

[0028] In Fig. 2, an inner surface of the second tapered portion 25 has a shape that bulges toward the inside of the bellmouth 20. However, the shape of the inner surface of the second tapered portion 25 is not limited to this shape and may be, for example, straight. In addition, the inner surface of the second tapered portion 25 may be shaped by combining a straight inner surface and an inner surface having a shape that bulges toward the inside of the bellmouth 20.

[0029] The second tapered portion 25 can be omitted according to, for example, the shape or the size of the outdoor unit 100. That is, the end portion 21b of the straight pipe portion 21 may directly connect to the opening 10a of the casing 10.

[0030] Next, the structure and the shape of the first tapered portion 23 will be described.

[0031] As described above, the first tapered portion 23 is a contraction portion whose inner diameter is reduced from the upstream side toward the downstream side in the direction of the main flow of air. The first tapered portion 23 is formed such that a length H1 of at least a part of the first tapered portion 23 along the direction along the axis AX is larger than a length H2 of the straight pipe portion 21 along the direction along the axis AX. The first tapered portion 23 may be formed such that the length H1 of the first tapered portion 23 is larger than the length H2 of the straight pipe portion 21 along the direc-

tion along the axis AX throughout in the circumferential direction of the first tapered portion 23.

[0032] The expression "the length H1 of at least a part of the first tapered portion 23 is larger than the length H2 of the straight pipe portion 21" means that the length of a passage in the first tapered portion 23 in the direction of the main flow of air is larger than the length of a passage in the straight pipe portion 21 in the direction of the main flow of air. Accordingly, the configuration in which the length H1 of the first tapered portion 23 is larger than the length H2 of the straight pipe portion 21 enables flow of air in the first tapered portion 23, which is a contraction portion, to be smoothly contracted. Thus, it is possible to inhibit vortices from being generated at the straight pipe portion 21 due to contracted flow.

[0033] When the length of the passage in the straight pipe portion 21 is long, the degree of air flow separation at the inner surface of the straight pipe portion 21 is increased toward the downstream side in the direction of the main flow of air. Thus, when the length of the passage in the straight pipe portion 21 is long, a vortex generated upstream of the straight pipe portion 21 may be enlarged. Generation of a vortex at the straight pipe portion 21 substantially narrows the air passage in the straight pipe portion 21.

[0034] However, in the above configuration, the length H2 of the straight pipe portion 21 is shorter than the length H1 of the first tapered portion 23. Thus, it is possible to inhibit a vortex generated at the straight pipe portion 21 from being enlarged. As a result, the above configuration enables provision of the outdoor unit 100 for an air-conditioning apparatus capable of inhibiting pressure loss from occurring in the bellmouth 20.

[0035] Air flow separation occurs at the straight pipe portion 21 due to a branch flow of air into the end portion 21a of the straight pipe portion 21. As a result, a vortex is generated upstream of the straight pipe portion 21. In addition, it becomes difficult to direct a branch flow of air in the direction of the main flow of air with increasing the angle between the direction of the branch flow of air and the direction of the main flow of air. As a result, a vortex generated at the straight pipe portion 21 is enlarged.

[0036] However, the configuration in which the length H1 of at least a part of the first tapered portion 23 is larger than the length H2 of the straight pipe portion 21 enables the first tapered portion 23 to have a sufficient air passage length for directing a branch flow of air in the direction of the main flow of air. Thus, it is possible to inhibit vortices from being generated due to air flow separation at the end portion 21a of the straight pipe portion 21. In addition, the ratio of the length H2 of the straight pipe portion 21 to the length H1 of the first tapered portion 23 is low, and it is thus possible to inhibit vortices generated at the straight pipe portion 21 from being enlarged. Accordingly, the configuration in which the length H1 of the first tapered portion 23 is larger than the length H2 of the straight pipe portion 21 enables inhibition of generation of vortices due to air flow separation at the straight pipe portion

21. As a result, this configuration enables provision of the outdoor unit 100 for an air-conditioning apparatus capable of inhibiting pressure loss from occurring in the bellmouth 20.

[0037] Furthermore, the configuration in which the length H1 of at least a part of the first tapered portion 23 is larger than the length H2 of the straight pipe portion 21 enables a branch flow of air to be directed, in the first tapered portion 23, in the direction of the main flow of air. Thus, it is possible to reduce the load on each leading edge of the blades 3a of the axial flow fan 3. As a result, it is possible to design the axial flow fan 3 to use low power input and to thus achieve power saving of the outdoor unit 100 for an air-conditioning apparatus.

[0038] The first tapered portion 23 can be formed to include a first bend portion 23a, which forms the inlet 20a for air of the bellmouth 20, and a second bend portion 23b, which connects to the straight pipe portion 21 and has an inner diameter smaller than that of the first bend portion 23a. The first bend portion 23a and the second bend portion 23b are located at respective ends of the first tapered portion 23 in the direction along the axis AX. The first bend portion 23a is located upstream of the second bend portion 23b in the direction of the main flow of air. As illustrated in Fig. 2, the end portion 23a1 of the first bend portion 23a, which is located upstream in the direction of the main flow of air, forms the inlet 20a for air. In addition, an end portion 23b1 of the second bend portion 23b, which is located downstream in the direction of the main flow of air, connects to the end portion 21a of the straight pipe portion 21.

[0039] When the first tapered portion 23 includes the first bend portion 23a and the second bend portion 23b, the shape or the size of the bellmouth 20 can be optimally set by separately adjusting the shapes or the sizes of the first bend portion 23a and the second bend portion 23b. For example, the first bend portion 23a enables a branch flow of air to enter the first tapered portion 23 along an inner surface of the first bend portion 23a, and the second bend portion 23b enables a branch flow of air to be directed in the direction of the main flow of air.

[0040] In addition, the first tapered portion 23 can be formed to include a connection portion 23c, which connects to the first bend portion 23a and the second bend portion 23b. The connection portion 23c has an end portion 23c1, which is located upstream in the direction of the main flow of air, and an end portion 23c2, which is located downstream in the direction of the main flow of air. The end portion 23c1 of the connection portion 23c connects to an end portion 23a2, which is located downstream of the first bend portion 23a in the direction of the main flow of air. The end portion 23c2 of the connection portion 23c connects to an end portion 23b2, which is located upstream of the second bend portion 23b in the direction of the main flow of air. The inner diameter of the connection portion 23c is reduced from the end portion 23c1 toward the end portion 23c2.

[0041] When the first tapered portion 23 includes the

connection portion 23c, a branch flow of air that has entered the first tapered portion 23 along the inner surface of the first bend portion 23a can enter the second bend portion 23b along the inner surface of the connection portion 23c. Thus, when the first tapered portion 23 includes the connection portion 23c, it is possible to inhibit air flow separation from occurring at the first tapered portion 23.

[0042] The connection portion 23c can be omitted according to, for example, the shape or the size of the outdoor unit 100. That is, the first tapered portion 23 can be formed such that the end portion 23a2, which is located downstream of the first bend portion 23a, directly connects to the end portion 23b2 of the second bend portion 23b.

[0043] For example, as illustrated in Fig. 2, the inner surface of the first bend portion 23a extending from the upstream side from which air flows in toward the downstream side can have a shape that bulges toward the inside of the bellmouth 20, that is, a shape that is bent to be a curved shape toward the inside of the bellmouth 20 in a radial direction of the bellmouth 20. In addition, an inner surface of the second bend portion 23b in the direction along the axis AX has a shape that bulges toward the inside of the bellmouth 20, that is, a shape that is bent to be a curved shape toward the inside of the bellmouth 20 in the radial direction. Furthermore, the shape of the inner surface of the connection portion 23c is, for example, straight as illustrated in Fig. 2.

[0044] For example, according to the internal structure of the outdoor unit 100, a part or the whole of the first bend portion 23a can have a shape that bulges toward the outside of the bellmouth 20, that is, a shape that is bent to be a curved shape toward the outside of the bellmouth 20 in the radial direction. When the first bend portion 23a is bent toward the outside of the bellmouth 20 in the radial direction, it is easy to inhibit an increase in the opening length of the inlet 20a of the bellmouth 20 compared with a case in which the first bend portion 23a is bent toward the inside of the bellmouth 20 in the radial direction. Accordingly, it is possible to reduce the size of the bellmouth 20.

[0045] For example, in the second section 20c in Fig. 1, the first bend portion 23a can have a shape that is bent to be a curved shape toward the outside of the bellmouth 20 in the radial direction. In the second section 20c, when the first bend portion 23a is bent toward the outside of the bellmouth 20 in the radial direction, it is possible to extend, along a surface of the partition plate 15 in Fig. 1, part of an inner surface of the bellmouth 20 closer to the inlet. This enables air flowing along the partition plate 15 to smoothly flow into the bellmouth 20.

[0046] In the following description, a line forming the inner surface of the first bend portion 23a is referred to as a first edge line 23a3. The first edge line 23a3 extends from the upstream side of the first bend portion 23a from which air flows in toward the downstream side of the first bend portion 23a. In addition, a line forming an inner sur-

face of the second bend portion 23b is referred to as a second edge line 23b3. The second edge line 23b3 is disposed on an extension of the first edge line 23a3. Furthermore, a line that forms the inner surface of the connection portion 23c and that connects to the first edge line 23a3 and the second edge line 23b3 to be located therebetween is referred to as a third edge line 23c3.

[0047] Fig. 3 is a schematic diagram illustrating the relationship between a first curvature radius R1 and a first central angle θ_1 at the first edge line 23a3 according to Embodiment. In Fig. 3, the curvature center of the first edge line 23a3 is represented by a point O, the end portion 23a1, which is located at one end of the first bend portion 23a, is represented by a point P1, and the end portion 23a2, which is located at the other end of the first bend portion 23a, is represented by a point P2. A line segment OP1 and a line segment OP2 are equal in length and can be determined as the first curvature radius R1 of the first edge line 23a3. The first central angle θ_1 can be determined as the angle between the line segment OP1 and the line segment OP2 whose vertex is the point O.

[0048] The shape and the size of the first tapered portion 23 can be determined on the basis of the first curvature radius R1 and the first central angle θ_1 of the first edge line 23a3 and a second curvature radius R2 and a second central angle θ_2 of the second edge line 23b3.

[0049] For example, the bent shape of the first edge line 23a3 becomes straighter with increasing the first curvature radius R1 when the first central angle θ_1 is fixed. Accordingly, the bent shape of the first edge line 23a3 becomes gentler. The length of the first edge line 23a3 is reduced with reducing the first central angle θ_1 when the first curvature radius R1 is fixed. Accordingly, it is possible to reduce the size of the first bend portion 23a.

[0050] As illustrated in Fig. 4, the relationship between the second curvature radius R2 and the second central angle θ_2 at the second edge line 23b3 is similar to the relationship in Fig. 3 described above with reference to Fig. 3. Fig. 4 is a schematic diagram illustrating the relationship between the first curvature radius R1 and the second curvature radius R2 at the first tapered portion 23 according to Embodiment. In Fig. 4, each length of the first curvature radius R1 of the first edge line 23a3 and the second curvature radius R2 of the second edge line 23b3 is represented by an arrow.

[0051] That is, the bent shape of the second edge line 23b3 becomes straighter with increasing the second curvature radius R2 when the second central angle θ_2 is fixed. Accordingly, the bent shape of the second edge line 23b3 becomes gentler. The length of the second edge line 23b3 is reduced with reducing the second central angle θ_2 when the second curvature radius R2 is fixed. Accordingly, it is possible to reduce the size of the second bend portion 23b.

[0052] In addition, when the inner surface of the connection portion 23c is straight, the shape and the size of the first tapered portion 23 can be determined on the

basis of a length L of the third edge line 23c3. The width of the connection portion 23c in the direction along the shaft 3c of the axial flow fan 3 is reduced with reducing the length L. Accordingly, it is possible to reduce the size of the connection portion 23c.

[0053] As illustrated in Fig. 4, the first tapered portion 23 can be formed such that the first curvature radius R1 of the first edge line 23a3 is larger than the second curvature radius R2 of the second edge line 23b3. That is, in the first tapered portion 23, the curvature of the first bend portion 23a formed by the first edge line 23a3 can be smaller than the curvature of the second bend portion 23b formed by the second edge line 23b3. A curvature is the reciprocal of a curvature radius.

[0054] This configuration enables air to flow along the first edge line 23a3 even when a branch flow of air that has entered the first tapered portion 23 has to be greatly deflected due to the first central angle θ_1 of the first edge line 23a3 being large. In addition, air that has passed through the first tapered portion 23 can flow along the second edge line 23b3 of the second bend portion 23b and then flow into the axial flow fan 3 in the direction along the shaft 3c of the axial flow fan 3. That is, the bellmouth 20 includes the first tapered portion 23 and thus enables a branch flow of air to be guided to the axial flow fan 3 without separation of the branch flow of air and to enter the straight pipe portion 21 in the same direction as the direction of the main flow of air.

[0055] The outdoor unit 100 normally includes the axial flow fan 3, which is configured to generate flow of air. In the outdoor unit 100, when the blades 3a of the axial flow fan 3 are disposed in the straight pipe portion 21, it is possible to reduce the size of the outdoor unit 100. However, when pressure loss of flow of air occurs in the straight pipe portion 21, the blowing performance of the axial flow fan 3 is impaired. Thus, power consumption of the axial flow fan 3 has to be increased to compensate the impairment of the blowing performance.

[0056] However, with this configuration, it is possible to inhibit vortices from being generated due to air flow separation at the first tapered portion 23 and to inhibit pressure loss of flow of air from occurring in the straight pipe portion 21. In addition, it is possible to uniform the distribution of flow of air in the straight pipe portion 21 and to thus inhibit impairment of the blowing performance of the axial flow fan 3. Furthermore, even when the blades 3a of the axial flow fan 3 are disposed in the straight pipe portion 21 to reduce the size of the outdoor unit 100, power consumption of the axial flow fan 3 does not have to be increased to maintain the blowing performance of the axial flow fan 3. Thus, this configuration enables provision of the outdoor unit 100 whose size and power consumption can be reduced.

[0057] In addition, the first tapered portion 23 can be formed to include the connection portion 23c, which connects to the first bend portion 23a and the second bend portion 23b. When the first tapered portion 23 includes the connection portion 23c, it is possible to inhibit sepa-

ration of flow of air that has entered along the first edge line 23a3 of the first bend portion 23a from occurring at the boundary between the first bend portion 23a and the second bend portion 23b. In particular, when the connection portion 23c is formed to include the third edge line 23c3, which extends straight between the first bend portion 23a and the second bend portion 23b, it is possible to smoothly guide the flow of air described above along the third edge line 23c3. Thus, it is possible to further inhibit air flow separation at the first tapered portion 23.

[0058] Furthermore, when the shape of the first tapered portion 23 varies in a circumferential direction around the shaft 3c of the axial flow fan 3, it is possible to further uniform the distribution of flow of air entering the straight pipe portion 21 and to more flexibly reduce the size of the bellmouth 20.

[0059] For example, as described above, the shape and the size of the first tapered portion 23 can be determined on the basis of the length L of the third edge line 23c3. Thus, when the length L of the third edge line 23c3 varies in the circumferential direction of the first tapered portion 23, it is possible to flexibly set the shape and the size of the first tapered portion 23. For example, when the length L of the third edge line 23c3 is reduced with the shapes and the sizes of the first bend portion 23a and the second bend portion 23b maintained in the circumferential direction, it is possible to reduce the width of the first tapered portion 23 in the radial direction with air flow separation inhibited from occurring at the first tapered portion 23.

[0060] The bellmouth 20 provided around the axial flow fan 3 such as a propeller fan used in the outdoor unit 100 for an air-conditioning apparatus may be set in a small space due to the influence of a size reduction of the outdoor unit 100. However, when the length L of the third edge line 23c3 is reduced with the shapes and the sizes of the first bend portion 23a and the second bend portion 23b maintained in the circumferential direction, it is possible to inhibit impairment of the blowing performance and to reduce the size of the bellmouth 20 even in such a small space.

[0061] In addition, the shape and the size of the first tapered portion 23 can be determined on the basis of the length H1 of the first tapered portion 23 along the direction along the axis AX. When the length H1 varies in the circumferential direction of the first tapered portion 23, it is possible to flexibly set the shape and the size of the first tapered portion 23.

[0062] Furthermore, the shape and the size of the first tapered portion 23 can be determined on the basis of at least one of the first curvature radius R1 of the first edge line 23a3, the first central angle θ_1 of the first edge line 23a3, the second curvature radius R2 of the second edge line 23b3, and the second central angle θ_2 of the second edge line 23b3. When at least one of the first curvature radius R1, the first central angle θ_1 , the second curvature radius R2, and the second central angle θ_2 varies in the circumferential direction of the first tapered portion 23, it

is possible to flexibly set the shape and the size of the first tapered portion 23.

[0063] Embodiment, in which the shape of the first tapered portion 23 varies in the circumferential direction around the axis AX, will be described by taking, as an example, the outdoor unit 100 including the heat exchanger 1 having an L shape in top view as illustrated in Fig. 1. The following description of Embodiment is merely an example, and Embodiment is not intended to limit the content of the present disclosure.

[0064] As described above, the heat exchanger 1 includes the first portion 1a, which is disposed at the rear of the casing 10, and the second portion 1b, which is disposed at the left of the casing 10. At the rear of the casing 10, the first portion 1a extends in a direction crossing the direction along the shaft 3c of the axial flow fan 3. The second portion 1b extends in a direction crossing the first portion 1a and is disposed with a space between the second portion 1b and the first tapered portion 23. The partition plate 15 is set in the casing 10.

[0065] In such an outdoor unit 100, components disposed in the circumferential direction of the bellmouth 20 differ from each other. Thus, rotation of the axial flow fan 3 generates a branch flow of air in a direction different from the direction of the main flow of air. When a branch flow of air enters the axial flow fan 3, blowing performance such as fan efficiency may be impaired compared with a case in which air flows in a single direction.

[0066] Fig. 1 illustrates the first section 20b, which is located between the second portion 1b and the axial flow fan 3, and the second section 20c, which is located between the axial flow fan 3 and the partition plate 15, of the bellmouth 20. Fig. 5 is an enlarged schematic view of the first section 20b and the second section 20c of the bellmouth 20 in Fig. 1. In the first section 20b, the second portion 1b is disposed on an extension of the first edge line 23a3 forming the inner surface of the first bend portion 23a. In the second section 20c, the second portion 1b is not disposed on an extension of the first edge line 23a3 forming the inner surface of the first bend portion 23a.

[0067] In Embodiment, the inner surface of the first bend portion 23a is formed by a first upstream region 33a1 and a second upstream region 33a2. The first upstream region 33a1 and the second upstream region 33a2 are formed by respective first edge lines 23a3. The second portion 1b is disposed on an extension of the first edge line 23a3 forming the first upstream region 33a1. That is, the part of the inner surface of the first bend portion 23a in the first section 20b in Fig. 5 is an example of the first upstream region 33a1. The second portion 1b is not disposed on an extension of the first edge line 23a3 forming the second upstream region 33a2. That is, the part of the inner surface of the first bend portion 23a in the second section 20c in Fig. 5 is an example of the second upstream region 33a2. In Embodiment, the shape of the first edge line 23a3 forming the first upstream region 33a1 is a shape that bulges toward the

inside of the bellmouth 20. In Fig. 5, the shape of the first edge line 23a3 forming the second upstream region 33a2 bulges toward the inside of the bellmouth but is not limited to this shape. For example, the first edge line 23a3 forming the second upstream region 33a2 may have a shape that bulges toward the outside of the bellmouth 20.

[0068] The inner surface of the second bend portion 23b is formed by a first downstream region 33b1 and a second downstream region 33b2. The first downstream region 33b1 and the second downstream region 33b2 are formed by respective second edge lines 23b3. The second edge line 23b3 forming the first downstream region 33b1 is disposed on an extension of the first edge line 23a3 of the first upstream region 33a1. That is, the part of the inner surface of the second bend portion 23b in the first section 20b in Fig. 5 is an example of the first downstream region 33b1. The second edge line 23b3 forming the second downstream region 33b2 is disposed on an extension of the first edge line 23a3 of the second upstream region 33a2. That is, the part of the inner surface of the second bend portion 23b in the second section 20c in Fig. 5 is an example of the second downstream region 33b2. The first downstream region 33b1 and the second downstream region 33b2 have respective shapes that bulge toward the inside of the bellmouth 20.

[0069] The inner surface of the connection portion 23c is formed by a first intermediate region 33c1 and a second intermediate region 33c2. The first intermediate region 33c1 and the second intermediate region 33c2 are formed by respective third edge lines 23c3. The third edge line 23c3 forming the first intermediate region 33c1 connects to the first edge line 23a3 forming the first upstream region 33a1 and the second edge line 23b3 forming the first downstream region 33b1 to be located therebetween. That is, the part of the inner surface of the connection portion 23c in the first section 20b in Fig. 5 is an example of the first intermediate region 33c1. The third edge line 23c3 forming the second intermediate region 33c2 connects to the first edge line 23a3 forming the second upstream region 33a2 and the second edge line 23b3 forming the second downstream region 33b2 to be located therebetween. That is, the part of the inner surface of the connection portion 23c in the second section 20c in Fig. 5 is an example of the second intermediate region 33c2. For example, the third edge lines 23c3 have a straight shape.

[0070] In Embodiment, a first central angle $\theta 1a$ of the first edge line 23a3 forming the first upstream region 33a1 can differ from a first central angle $\theta 1b$ of the first edge line 23a3 forming the second upstream region 33a2. For example, the first central angle $\theta 1a$ of the first edge line 23a3 forming the first upstream region 33a1 can be formed to be smaller than the first central angle $\theta 1b$ of the first edge line 23a3 forming the second upstream region 33a2. A branch flow of air enters the second portion 1b in a direction different from the direction of the main flow of air by rotation of the axial flow fan 3. When the first central angle $\theta 1a$ of the first edge line 23a3 form-

ing the first upstream region 33a1 is reduced, the first edge line 23a3 forming the first upstream region 33a1 is shortened. However, when the first curvature radius R1 of the first edge line 23a3 is maintained to be fixed, a branch flow of air can be carried along the first edge line 23a3 forming the first upstream region 33a1. Thus, it is possible to reduce air separation occurring at the first tapered portion 23. In addition, when the first central angle $\theta 1a$ of the first edge line 23a3 forming the first upstream region 33a1 is smaller than the first central angle $\theta 1b$ of the first edge line 23a3 of the second upstream region 33a2, it is possible to reduce the width of the first tapered portion 23 in the radial direction. Thus, even when the space between the bellmouth 20 and the heat exchanger 1 is narrow, this configuration enables impairment of blowing performance to be inhibited and enables the size of the bellmouth 20 to be reduced.

[0071] The first central angle $\theta 1a$ of the first edge line 23a3 forming the first upstream region 33a1 may be changed in the circumferential direction of the first tapered portion 23 as long as the above relationship is satisfied. For example, the first bend portion 23a can be formed such that the first central angle $\theta 1a$ of the first edge line 23a3 is minimum in the first section 20b, in which the distance between the second portion 1b and the first bend portion 23a is minimum. In addition, the first central angle $\theta 1b$ of the first edge line 23a3 forming the second upstream region 33a2 may be changed in the circumferential direction of the first tapered portion 23 as long as the above relationship is satisfied. Furthermore, the first curvature radius R1 of the first edge line 23a3 can be changed in the circumferential direction of the first tapered portion 23.

[0072] Furthermore, in Embodiment, a second central angle $\theta 2a$ of the second edge line 23b3 forming the first downstream region 33b1 can differ from a second central angle $\theta 2b$ of the second edge line 23b3 forming the second downstream region 33b2. For example, the second central angle $\theta 2a$ of the second edge line 23b3 forming the first downstream region 33b1 can be formed to be larger than the second central angle $\theta 2b$ of the second edge line 23b3 forming the second downstream region 33b2. Air flowing in a direction different from the direction of the main flow of air, the air passing through the second portion 1b and flowing in along the first edge line 23a3 of the first upstream region 33a1, flows into the straight pipe portion 21 along the second edge line 23b3 forming the first downstream region 33b1. In this case, when the second central angle $\theta 2a$ of the second edge line 23b3 forming the first downstream region 33b1 is increased, the second edge line 23b3 forming the first downstream region 33b1 can be lengthened. When the second edge line 23b3 forming the first downstream region 33b1 is lengthened, air flowing along the second edge line 23b3 of the first downstream region 33b1 can more reliably flow in a direction similar to the direction along the shaft 3c of the axial flow fan 3. Thus, when the second central angle $\theta 2a$ of the second edge line 23b3 forming the first

downstream region 33b1 is increased, it is possible to further uniform the distribution of flow of air in the straight pipe portion 21. Accordingly, it is possible to inhibit impairment of the blowing performance of the axial flow fan 3. In addition, when the second central angle $\theta 2b$ of the second edge line 23b3 forming the second downstream region 33b2 is reduced, it is possible to reduce the size of the first tapered portion 23. Thus, it is possible to reduce the size of the outdoor unit 100.

[0073] The second central angle $\theta 2a$ of the second edge line 23b3 forming the first downstream region 33b1 may be changed in the circumferential direction of the first tapered portion 23 as long as the above relationship is satisfied. For example, the second bend portion 23b can be formed such that the second central angle $\theta 2a$ of the second edge line 23b3 is maximum in the first section 20b, in which the distance between the second portion 1b and the second bend portion 23b is minimum. In addition, the second central angle $\theta 2b$ of the second edge line 23b3 forming the second downstream region 33b2 may be changed in the circumferential direction of the first tapered portion 23 as long as the above relationship is satisfied. Furthermore, the second curvature radius R2 of the second edge line 23b3 can be changed in the circumferential direction of the first tapered portion 23.

[0074] Furthermore, in Embodiment, a length L1 of the third edge line 23c3 forming the first intermediate region 33c1 can differ from a length L2 of the third edge line 23c3 of the second intermediate region 33c2. For example, the length L1 of the third edge line 23c3 forming the first intermediate region 33c1 can be set to be shorter than the length L2 of the third edge line 23c3 forming the second intermediate region 33c2. When the length L1 of the third edge line 23c3 forming the first intermediate region 33c1 is shorter than the length L2 of the third edge line 23c3 of the second intermediate region 33c2, it is possible to reduce the size of the first tapered portion 23. Thus, it is possible to reduce the size of the outdoor unit 100. In particular, in Embodiment, when the length L1 of the third edge line 23c3 of the first intermediate region 33c1 is reduced, it is possible to narrow the space between the axial flow fan 3 and the second portion 1b of the heat exchanger 1.

[0075] Furthermore, when the length L1 of the third edge line 23c3 of the first intermediate region 33c1 is reduced with the shapes and the sizes of the first upstream region 33a1 and the first downstream region 33b1 maintained, it is possible to reduce the width of the first tapered portion 23 in the radial direction. Thus, even when the space between the heat exchanger 1 and the bellmouth 20 is narrow, it is possible to inhibit impairment of blowing performance and to reduce the size of the bellmouth 20.

[0076] Furthermore, in Embodiment, the connection portion 23c can be omitted to reduce the size of the outdoor unit 100.

[0077] Furthermore, a length H1a, along the direction along the axis AX, of the part of the first tapered portion

23 where the first upstream region 33a1 is located can differ from a length H1b, along the direction along the axis AX, of the part of the first tapered portion 23 where the second upstream region 33a2 is located. The length H1a and the length H1b different from each other enable a size reduction of the bellmouth 20 even when the space between the heat exchanger 1 and the bellmouth 20 is narrow. This is because the size of the bellmouth 20 in the direction of the main flow of air can be set flexibly.

[0078] Embodiment described above can be variously modified without departing from the gist of the present disclosure. For example, even when the outdoor unit 100 is a chiller unit, Embodiment described above can be applied thereto in a similar manner. Even when the air-conditioning apparatus is formed by integrating the outdoor unit 100 and an indoor unit, Embodiment described above can be applied thereto in a similar manner.

Reference Signs List

[0079] 1: heat exchanger, 1a: first portion, 1b: second portion, 3: axial flow fan, 3a: blade, 3b: hub, 3c: shaft, 3d: motor, 5: compressor, 10: casing, 10a: opening, 10b: grille, 15: partition plate, 15a: fan chamber, 15b: machine chamber, 20: bellmouth, 20a: inlet, 20b: first section, 20c: second section, 21: straight pipe portion, 21a: end portion, 21b: end portion, 23: first tapered portion, 23a: first bend portion, 23a1: end portion, 23a2: end portion, 23a3: first edge line, 23b: second bend portion, 23b1: end portion, 23b2: end portion, 23b3: second edge line, 23c: connection portion, 23c1: end portion, 23c2: end portion, 23c3: third edge line, 25: second tapered portion, 25a: end portion, 25b: end portion, 33a1: first upstream region, 33a2: second upstream region, 33b1: first downstream region, 33b2: second downstream region, 33c1: first intermediate region, 33c2: second intermediate region, 100: outdoor unit

Claims

1. An outdoor unit for an air-conditioning apparatus, comprising:

a heat exchanger;
an axial flow fan configured to generate flow of air passing through the heat exchanger;
a casing having an opening through which the air passes, the casing accommodating the heat exchanger, and accommodating the axial flow fan between the opening and the heat exchanger; and
a bellmouth having an annular shape and provided around the axial flow fan inside the casing to guide the air into the opening of the casing, the bellmouth having

a first tapered portion in which an inner di-

ameter of an upstream side of the first tapered portion from which the air flows in is larger than an inner diameter of a downstream side of the first tapered portion, and a straight pipe portion extending straight from the first tapered portion to the downstream side of the flow of the air,

wherein

the first tapered portion includes

a first bend portion forming an inlet for the air,
a second bend portion connecting to the straight pipe portion and having an inner diameter smaller than that of the first bend portion, and
a connection portion connecting to the first bend portion and the second bend portion and having an inner surface extending straight, and

a length of at least a part of the first tapered portion along an axial direction of the straight pipe portion is larger than a length of the straight pipe portion along the axial direction of the straight pipe portion.

2. The outdoor unit for an air-conditioning apparatus of claim 1, wherein a first curvature radius of the first bend portion is larger than a second curvature radius of the second bend portion.
3. The outdoor unit for an air-conditioning apparatus of claim 2, wherein the first curvature radius of the first bend portion or the second curvature radius of the second bend portion varies in a circumferential direction of the bellmouth.
4. The outdoor unit for an air-conditioning apparatus of any one of claims 1 to 3, wherein a length of the inner surface of the connection portion, the inner surface extending straight, varies in the circumferential direction of the bellmouth.
5. The outdoor unit for an air-conditioning apparatus of any one of claims 1 to 4, wherein a first central angle of the first bend portion varies in the circumferential direction of the bellmouth.
6. The outdoor unit for an air-conditioning apparatus of any one of claims 1 to 5, wherein a second central angle of the second bend portion varies in the circumferential direction of the bellmouth.
7. The outdoor unit for an air-conditioning apparatus of claim 1, wherein

the heat exchanger has an L shape in top view, the heat exchanger includes

a first portion extending in a direction crossing a direction along a shaft of the axial flow fan, and
a second portion extending in a direction crossing the first portion, the second portion being spaced apart from the first tapered portion,

an inner surface of the first bend portion is formed by a first upstream region and a second upstream region,
the first upstream region and the second upstream region are formed by respective first edge lines extending from the upstream side of the bellmouth from which the air flows in toward the downstream side of the bellmouth,
one of the first edge lines forming the first upstream region bulges toward an inside of the bellmouth,
the second portion is disposed on an extension of the one of the first edge lines forming the first upstream region,
the second portion is not disposed on an extension of an other of the first edge lines forming the second upstream region,
an inner surface of the second bend portion is formed by a first downstream region and a second downstream region,
the first downstream region and the second downstream region are formed by respective second edge lines bulging toward the inside of the bellmouth,
one of the second edge lines forming the first downstream region is disposed on an extension of the one of the first edge lines forming the first upstream region, and
an other of the second edge lines forming the second downstream region is disposed on an extension of the other of the first edge lines forming the second upstream region.

8. The outdoor unit for an air-conditioning apparatus of claim 7, wherein a first curvature radius of each of the first edge lines is larger than a second curvature radius of each of the second edge lines.
9. The outdoor unit for an air-conditioning apparatus of claim 8, wherein a first central angle of the one of the first edge lines forming the first upstream region differs from a first central angle of the other of the first edge lines forming the second upstream region.
10. The outdoor unit for an air-conditioning apparatus of claim 9, wherein the first central angle of the one of the first edge lines forming the first upstream region

is smaller than the first central angle of the other of the first edge lines forming the second upstream region.

11. The outdoor unit for an air-conditioning apparatus of any one of claims 7 to 10, wherein the first curvature radius of the one of the first edge lines forming the first upstream region differs from the first curvature radius of the other of the first edge lines forming the second upstream region. 5
12. The outdoor unit for an air-conditioning apparatus of any one of claims 7 to 11, wherein a second central angle of the one of the second edge lines forming the first downstream region differs from a second central angle of the other of the second edge lines forming the second downstream region. 10
13. The outdoor unit for an air-conditioning apparatus of any one of claims 7 to 12, wherein the second curvature radius of the one of the second edge lines forming the first downstream region differs from the second curvature radius of the other of the second edge lines forming the second downstream region. 15
14. The outdoor unit for an air-conditioning apparatus of any one of claims 7 to 13, wherein 20

the inner surface of the connection portion is formed by a first intermediate region and a second intermediate region, 30

the first intermediate region and the second intermediate region are formed by respective third edge lines that are straight, 35

one of the third edge lines forming the first intermediate region connects to the one of the first edge lines forming the first upstream region and the one of the second edge lines forming the first downstream region to be located between the one of the first edge lines and the one of the second edge lines, 40

an other of the third edge lines forming the second intermediate region connects to the other of the first edge lines forming the second upstream region and the other of the second edge lines forming the second downstream region to be located between the other of the first edge lines and the other of the second edge lines, and 45

a length of the one of the third edge lines forming the first intermediate region differs from a length of the other of the third edge lines forming the second intermediate region. 50
15. The outdoor unit for an air-conditioning apparatus of claim 14, wherein the length of the one of the third edge lines forming the first intermediate region is shorter than the length of the other of the third edge lines forming the second intermediate region. 55

16. The outdoor unit for an air-conditioning apparatus of any one of claims 1 to 15, wherein a length of the first tapered portion along the axial direction of the straight pipe portion varies in the circumferential direction.

17. The outdoor unit for an air-conditioning apparatus of any one of claims 1 to 16, wherein the bellmouth further has a second tapered portion connecting to the straight pipe portion and the opening of the casing, the second tapered portion having an inner diameter increasing in a direction from the straight pipe portion located at the upstream side toward the opening located at the downstream side.

18. The outdoor unit for an air-conditioning apparatus of claim 17, wherein a second opening length of an end portion located downstream of the second tapered portion is larger than a first opening length of an end portion located upstream of the first tapered portion.

FIG. 1

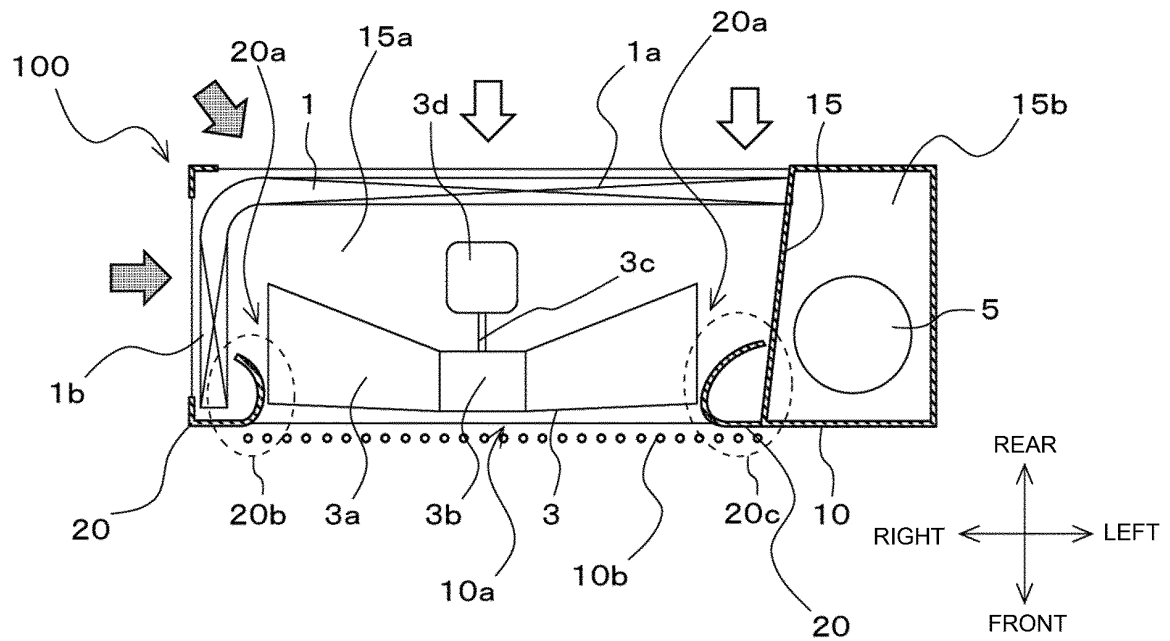


FIG. 2

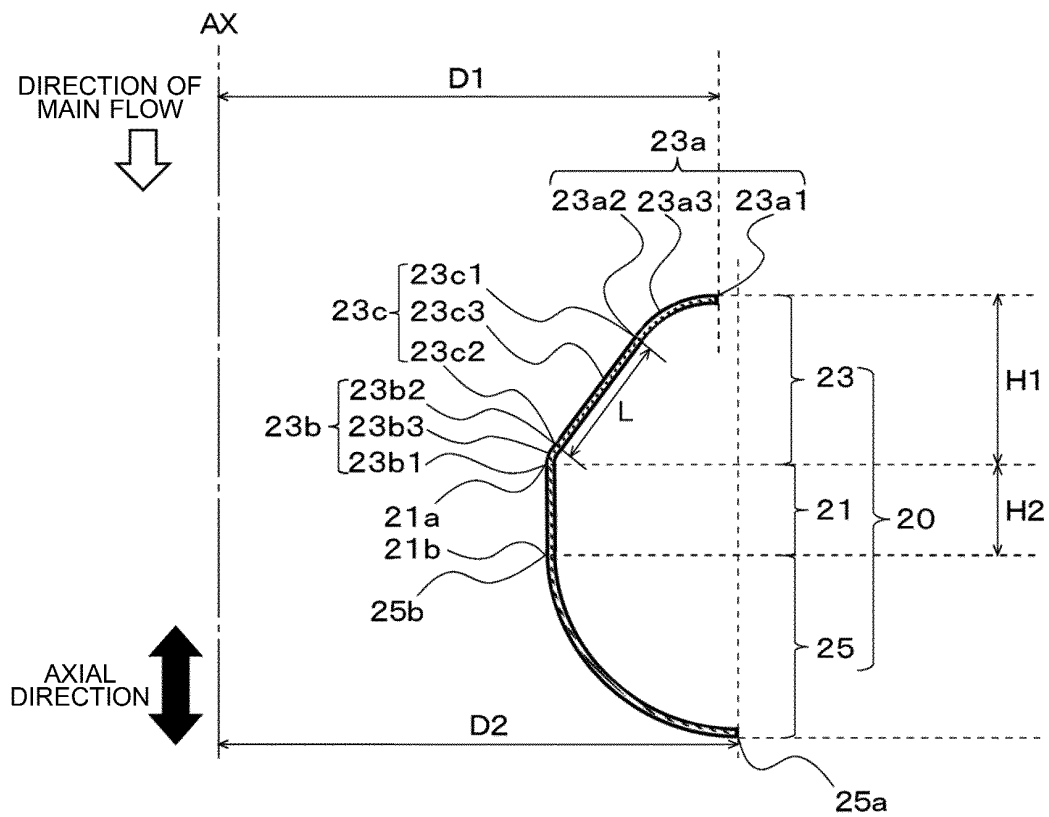


FIG. 3

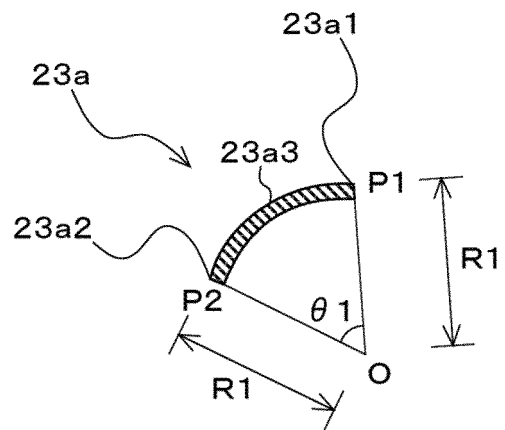


FIG. 4

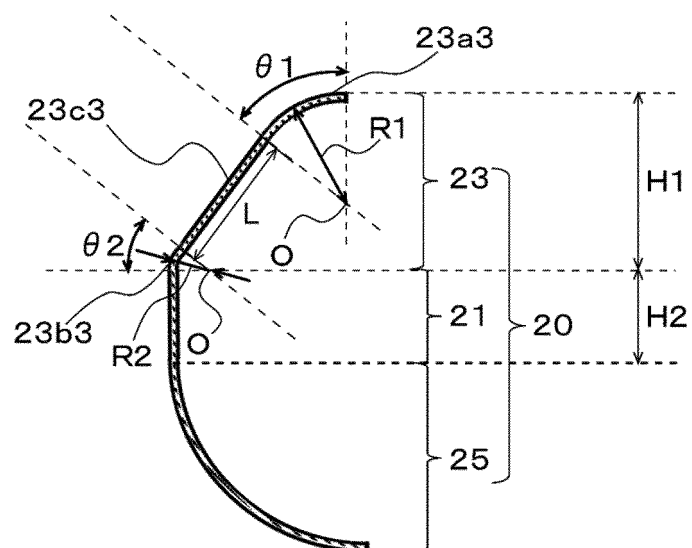
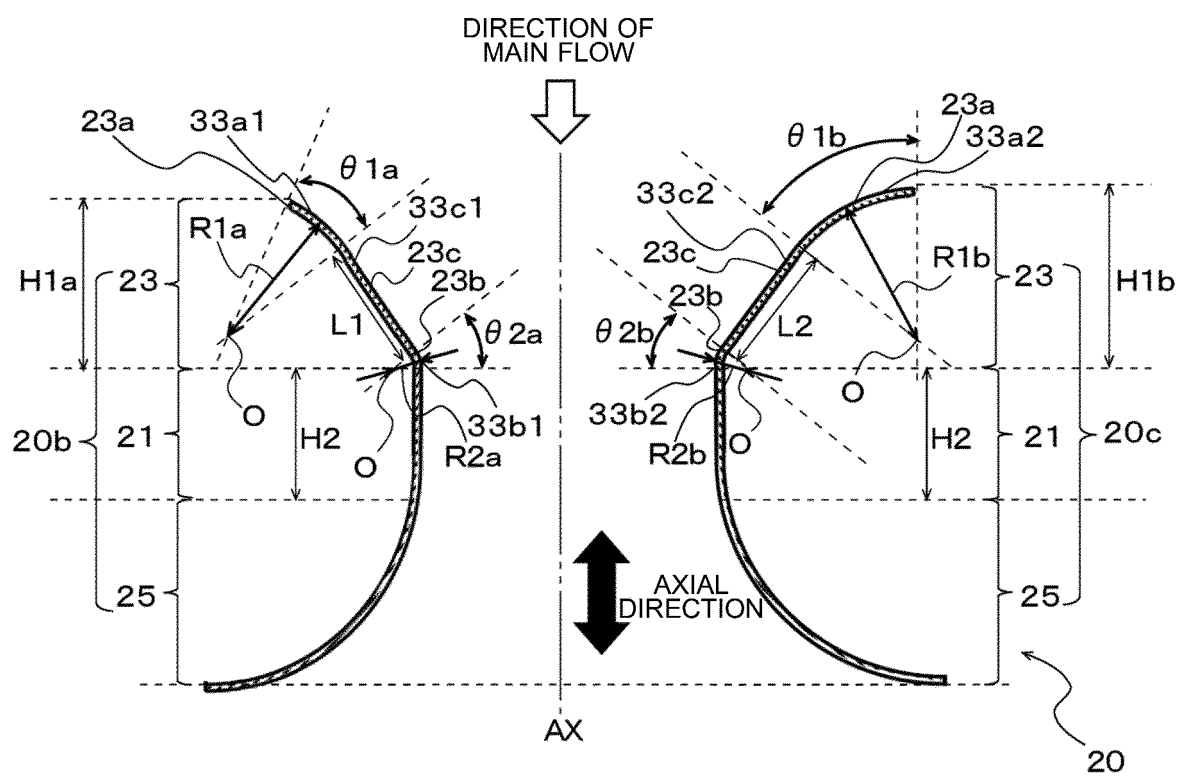


FIG. 5



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2020/023211

A. CLASSIFICATION OF SUBJECT MATTER

F24F 1/38 (2011.01) i

FI: F24F1/38

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)

F24F1/38

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

Published examined utility model applications of Japan 1922-1996

Published unexamined utility model applications of Japan 1971-2020

Registered utility model specifications of Japan 1996-2020

Published registered utility model applications of Japan 1994-2020

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 2010-236372 A (DAIKIN INDUSTRIES, LTD.) 21	1-2, 7-8, 17
Y	October 2010 (2010-10-21) paragraphs [0004],	4-6, 9-10, 12,
A	[0053], fig. 6, 9	14-18
		3, 11, 13
X	Microfilm of the specification and drawings	1-2, 7-8
Y	annexed to the request of Japanese Utility Model	4-6, 9-10, 12,
	Application No. 168530/1985 (Laid-open No.	14-18
	77735/1987) (MITSUBISHI ELECTRIC CORP.) 18 May	
	1987 (1987-05-18) specification, page 8, lines 9-	
	20, fig. 1, 3	
Y	WO 2009/113338 A1 (MITSUBISHI ELECTRIC CORP.) 17	4-6, 14-18
	September 2009 (2009-09-17) paragraphs [0011]-	
	[0013], [0022]-[0023], fig. 1-2, 9	

☒ Further documents are listed in the continuation of Box C.☒ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

27 August 2020 (27.08.2020)

Date of mailing of the international search report

08 September 2020 (08.09.2020)

Name and mailing address of the ISA/
Japan Patent Office
3-4-3, Kasumigaseki, Chiyoda-ku,
Tokyo 100-8915, Japan

Authorized officer

Telephone No.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2020/023211

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2010-112204 A (MITSUBISHI ELECTRIC CORP.) 20 May 2010 (2010-05-20) paragraphs [0010], [0026]-[0027], fig. 5-6, 13-14	5-6, 9-10, 12, 14-18

Form PCT/ISA/210 (continuation of second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/JP2020/023211

Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
JP 2010-236372 A	21 Oct. 2010	(Family: none)	
JP 62-77735 U1	18 May 1987	(Family: none)	
WO 2009/113338 A1	17 Sep. 2009	US 2010/0269537 A1 paragraphs [0032]- [0037], [0055]- [0058], fig. 1-2, 9 EP 2233847 A1 EP 2824333 A2 CN 101925783 A ES 2586440 T3 ES 2720776 T3	
JP 2010-112204 A	20 May 2010	US 2011/0192186 A1 paragraphs [0033]- [0035], [0083]- [0087], fig. 5-6, 13- 14 WO 2010/053037 A1 EP 2343458 A1 CN 102203430 A	

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- JP 2013096622 A [0003]