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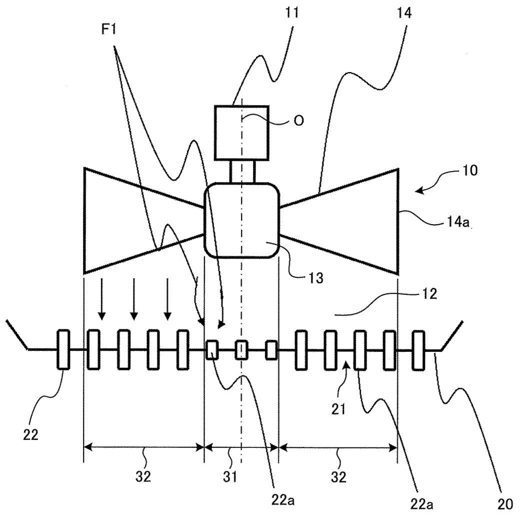
(54) BLOWER DEVICE, AND OUTDOOR UNIT FOR AIR CONDITIONER

(57) An air-sending device includes: a propeller fan including a shaft located on a rotational axis of the propeller fan and a blade located on a circumferential portion of the shaft; and a fan guard provided leeward of the propeller fan, and including a rib unit in which a plurality of openings are provided to allow air to pass through the openings. The fan guard includes a first region that is located in such a manner as to overlap with the shaft as viewed from a point in a direction parallel to the rotational axis, and a second region that is located outward of the shaft and inward of a rotational trajectory of the blade as viewed from a point in the direction parallel to the rotational axis. Where a dimension of the rib unit in a direction parallel to the rotational axis is a height of the rib unit, a height of part of the rib unit that is located in the first region is smaller than a height of part of the rib unit that is located in the second region.

FIG. 1



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Description

Technical Field

[0001] The present disclosure relates to an air-sending device including a fan guard, and an outdoor unit of an air-conditioning apparatus.

Background Art

[0002] Patent Literature 1 describes a fan guard of an air-sending unit. The fan guard includes a large number of annular ribs concentrically arranged and a large number of radial ribs arranged at regular intervals in a circumferential direction of the fan guard. Each of the radial ribs and each of annular ribs are inclined along the flow of air blown from a blower fan. It is therefore possible to reduce interference between the flow of the blown air and the radial and annular ribs, and thus reduce noise.

Citation List

Patent Literature

[0003] Patent Literature 1: Japanese Patent No. 4403691

Summary of Invention

Technical Problem

[0004] In a region located downstream of a boss of the blower fan, however, the flow direction of air irregularly changes with time. Thus, in the ribs are provided in the region downstream of the boss, there is a possibility of a large disturbance occurring in the flow of air on the downstream side of the ribs, regardless of the angle of inclination each of the ribs. Therefore, in the above configuration of the fan guard, noise cannot be sufficiently reduced.

[0005] The present disclosure is applied to solve the above problem, and relates to an air-sending device and an outdoor unit of an air-conditioning apparatus, which can further reduce nose.

[0006] An air-sending device according to an embodiment of the present disclosure includes: a propeller fan including a shaft located on a rotational axis of the propeller fan and a blade located on a circumferential portion of the shaft; and a fan guard provided leeward of the propeller fan, and including a rib unit in which a plurality of openings are provided to allow air to pass through the openings. The fan guard includes a first region that is located in such a manner as to overlap with the shaft as viewed from a point in a direction parallel to the rotational axis, and a second region that is located outward of the shaft and inward of a rotational trajectory of the blade as viewed from a point in parallel to the rotational axis. Where a dimension of the rib unit in a direction parallel to the rotational axis is a height of the rib unit, a height of part of the rib unit that is located in the first region is smaller than a height of part of the rib unit that is located in the second region.

[0007] An outdoor unit of an air-conditioning apparatus, according to another embodiment of the present disclosure, includes the air-sending device according to the embodiment of the present disclosure.

Advantageous Effects of Invention

[0008] In the embodiment of the present disclosure, the height of the part of the rib unit that is located in the first region that is located to overlap with the shaft as viewed from a point in the direction parallel to the rotational axis is smaller than the height of the part of the rib unit that is located in the second region that is located outward of the first region. Therefore, regardless of the flow direction of air that flows into the first region, a projection width of the first region on a plane perpendicular to the flow direction of air, that is, the width of a projection obtained when the shape of the first region is projected on the plane perpendicular to the flow direction of air, is small. Therefore, according to the embodiment of the present disclosure, even when the flow direction of air irregularly changes with time in a region located downward of the shaft, it is possible to reduce the disturbance of the flow of air on the downstream side of the part of the rib unit that is located in the first region. It is thus possible to further reduce noise that is made by the air-sending device.

Brief Description of Drawings

[0009]

[Fig. 1] Fig. 1 is a schematic view illustrating a configuration of an air-sending device according to Embodiment 1 of the present disclosure that is taken along a plane that includes a rotational axis O.

[Fig. 2] Fig. 2 is a view for use in explanation of the dimensions and the angle of an example of a linear rib in a rib 22 in the air-sending device according to Embodiment 1 of the present disclosure.

[Fig. 3] Fig. 3 is a view for use in explanation of the dimensions and the angle of another linear rib in the rib unit 22 in the air-sending device according to Embodiment 1 of the present disclosure.

[Fig. 4] Fig. 4 describes the definition of the dimensions and the angle of a further liner rib in the in the rib unit 22 in the air-sending device according to Embodiment 1 of the present disclosure.

[Fig. 5] Fig. 5 describes the definition of the dimensions and the angle of still another linear rib of the rib unit 22 in the air-sending device according to Embodiment 1 of the present disclosure.

[Fig. 6] Fig. 6 is a view for use in explanation of a disturbance of the flow of air on a downstream side of a linear rib 22a.

[Fig. 7] Fig. 7 describes a disturbance of the flow of air on the downstream side of another rib 22a.

[Fig. 8] Fig. 8 is a front view illustrating a configuration of an outdoor unit 100 of an air-conditioning apparatus, which includes the air-sending device according to Embodiment 1 of the present disclosure.

[Fig. 9] Fig. 9 is a front view illustrating another configuration of the outdoor unit 100 of the air-conditioning apparatus, which includes the air-sending device according to Embodiment 1 of the present disclosure.

[Fig. 10] Fig. 10 is a front view illustrating a further configuration of the outdoor unit 100 of the air-conditioning apparatus, which includes the air-sending device according to Embodiment 1 of the present disclosure.

[Fig. 11] Fig. 11 is a schematic view illustrating a configuration of an air-sending device according to a modification of Embodiment 1 of the present disclosure that is taken along a plane including the rotational axis O.

[Fig. 12] Fig. 12 is a schematic view of a configuration of an air-sending device according to Embodiment 2 of the present disclosure that is taken along a plane including the rotational axis O.

[Fig. 13] Fig. 13 is a view for use in explanation of a disturbance of the flow of air on the downstream side of linear ribs 22a in the air-sending device according to Embodiment 2 of the present disclosure.

[Fig. 14] Fig. 14 is a schematic view illustrating a configuration of an air-sending device according to Embodiment 3 of the present disclosure that is taken along a plane including the rotational axis O.

[Fig. 15] Fig. 15 is a view for use in explanation of a disturbance of the flow of air on the downstream side of a linear rib 22a.

[Fig. 16] Fig. 16 describes a disturbance of the flow on the downstream side of the linear ribs 22a.

[Fig. 17] Fig. 17 is a schematic view illustrating a configuration of linear ribs 22a in an air-sending device according to a first modification of Embodiment 3 of the present disclosure.

[Fig. 18] Fig. 18 is a schematic view illustrating a configuration of linear ribs 22a in an air-sending device according to a second modification of Embodiment 3 of the present disclosure.

[Fig. 19] Fig. 19 illustrates an example of a linear rib that includes a first linear rib and a second linear rib that are arranged so as not to overlap with each other in the air-sending device according to Embodiment 3 of the present disclosure.

[Fig. 20] Fig. 20 is a schematic view illustrating a configuration of an air-sending device according to Embodiment 4 of the present disclosure that is taken along a plane including the rotational axis O.

[Fig. 21] Fig. 21 is a front view illustrating a configuration of a propeller fan 10 of the air-sending device according to Embodiment 4 of the present disclosure. Description of Embodiments

Embodiment 1

[0010] An air-sending device according to Embodiment 1 of the present disclosure will be described. The air-sending device according to Embodiment 1 is applied to an outdoor unit of an air-conditioning apparatus, an outdoor unit of a water heater, a ventilation apparatus, or other apparatuses. Fig. 1 is a schematic view illustrating a configuration of an air-sending device according to Embodiment 1 of the present disclosure that is taken along a plane including a rotational axis O. Upper part of Fig. 1 corresponds to a windward side, and lower part of Fig. 1 corresponds to a leeward side. As illustrated in Fig. 1, the air-sending device according to Embodiment 1 includes a propeller fan 10, a fan motor 11 that drives the propeller fan 10, and a fan guard 20 provided leeward of the propeller fan 10. The propeller fan 10 includes a boss 13 (an example of a shaft) located on the rotational axis O, and a plurality of blades 14 provided on an outer circumferential portion of the boss 13. The fan guard 20 is provided in such a manner as to cover an air outlet 12 for the propeller fan 10. As described later, in the case where the air-sending device is provided in an outdoor unit 100 of an air-conditioning apparatus, the propeller fan 10 and the fan motor 11 are provided in a housing 101 of the outdoor unit 100 of the air-conditioning apparatus, and the air outlet 12 and the fan guard 20 are provided on a front side of the housing 101 (see Fig. 8, etc.).

[0011] The fan guard 20 includes a rib unit 22 in which a plurality of openings 21 are provided to allow air to pass therethrough. The rib unit 22 has a configuration in which a plurality of linear ribs 22a extending straightly or curvedly are combined together as viewed from a point in a direction parallel to the rotational axis O of the propeller fan 10. In other words, the linear ribs 22a form part of the rib unit 22. The rib unit 22 may be made of resin or metal. The fan guard 20 includes a first region 31 that is located to overlap with the boss 13 as viewed from a point in the direction parallel to the rotational axis O, and a second region 32 that is located outward of the boss 13 and inward of a rotational trajectory of outer circumferential edges 14a of the blades 14 as viewed from a point in the direction parallel to the rotational axis O. The height of part of the rib unit 22 that is located in the first region 31 is smaller than the height of part of the rib unit 22 that is located in the second region 32. The height of the part of the rib unit 22 that is located in the second region 32 may be constant from one end of the part to the other.

[0012] Figs. 2 to 5 are views for use in explanation of the dimensions and the angles of linear ribs in the rib unit 22 in the air-sending device according to Embodiment 1. Figs. 2 to 5 illustrate configurations of sections of linear ribs 22a that are taken along a direction perpendicular to the extending direction of the linear ribs 22a. It should be noted that an up/down direction in each of Figs. 2 to

5 is the direction parallel to the rotational axis O; and upper part of each of the figures is the windward side, and lower part of each figure is the leeward side.

[0013] The linear rib 22a as illustrated in Fig. 2 has an ellipsoidal sectional shape that is elongated in one direction. In the section of the linear rib 22a that is perpendicular to the extending direction of the linear rib 22a, the major axis of the linear rib 22a is substantially parallel to the rotational axis O. In Embodiment 1, the dimension of the linear rib 22a in the direction parallel to the rotational axis O is defined as a height Ld of the linear rib 22a. The height Ld of the linear rib 22a is equal to a distance between an end point 22a1 of the linear rib 22a that is located on the windward side and an end point 22a2 of the linear rib 22a that is located on the leeward side, in the direction parallel to the rotational axis O. The height of part of the rib unit 22 that is located in a certain region is the height Ld of a linear rib or ribs 22a located in the certain region. In the section perpendicular to the extending direction of the linear rib 22a, the maximum value of the dimension of the linear rib 22a in a direction perpendicular to the rotational axis O is defined as a width Lw of the linear rib 22a.

[0014] The linear rib 22a as illustrated in Fig. 3 has a rectangular sectional shape that is elongated in one direction. In the section of the linear rib 22a that is perpendicular to the extending direction of the linear rib 22a, the major axis of the linear rib 22a is substantially parallel to the rotational axis O. The height Ld of the linear rib 22a is equal to a distance between a center 22a5 of an end 22a3 of the linear rib 22a on the windward side and a center 22a6 of an end 22a4 of the linear rib 22a on the leeward side in the direction parallel to the rotational axis O.

[0015] The linear rib 22a as illustrated in Fig. 4 has an ellipsoidal sectional shape that is elongated in one direction. The height Ld of the linear rib 22a is equal to a distance between the end point 22a1 of the linear rib 22a on the windward side and the end point 22a2 of the linear rib 22a on the leeward side in the direction parallel to the rotational axis O. In the section of the linear rib 22a that is perpendicular to the extending direction of the linear rib 22a, the major axis of the linear rib 22a is inclined relative to the rotational axis O or a straight line parallel to the rotational axis O. In the section perpendicular to the extending direction of the linear rib 22a, an angle formed by a straight line (for example, a straight line connecting the end point 22a1 and the end point 22a2) parallel to the major axis and the rotational axis O or the straight line parallel to the rotational axis O is defined as an inclination angle θ of the linear rib 22a.

[0016] The linear rib 22a as illustrated in Fig. 5 has a parallelogrammatical sectional shape that is elongated in a single direction. The height Ld of the linear rib 22a is equal to a distance between the center 22a5 of the end 22a3 on the windward side and the center 22a6 of the end 22a4 on the leeward side in the direction parallel to the rotational axis O. In a section of the linear rib 22a that is perpendicular to the extending direction of the linear rib 22a, the major axis of the linear rib 22a is inclined at the inclination angle θ relative to the rotational axis O or the straight line parallel to the rotational axis O.

[0017] The direction of a local flow of air blown from the propeller fan 10 is inclined relative to the rotational axis O, such that the inclination angle of the flow of air depends on from which part of each blade 14 in a radial direction thereof the air is blown. Linear ribs 22a located in the second region 32 are formed in such a manner as to be inclined based on the flow direction of air. Therefore, it is possible to cause air blown from the propeller fan 10 to flow along the linear ribs 22a, and thus possible to reduce a disturbance of the flow of air that occurs on a downstream side of the linear ribs 22a. However, a flow direction F1 of air (see Fig. 1) in a region downstream from the boss 13 irregularly varies with time. Therefore, regardless of the direction and the angle of the inclination of the linear ribs 22a, in the first region 31 that is located downstream of the boss 13, it is hard to cause air to constantly flow along the linear ribs 22a. Thus, a large disturbance occurs in the flow of air on the downstream side of the linear ribs 22a located in the second region 32.

[0018] In contrast, in Embodiment 1, the height of the part of the rib unit 22 that is located in the first region 31 of the fan guard 20 is smaller than the part of the rib unit 22 that is located in the second region 32 of the fan guard 20. Thus, in the first region 31, even when the flow direction of air is not coincident with a direction along the major axis of each of the linear ribs 22a, a projection width of each linear rib 22a with which the air flows to collide is small. Therefore, in Embodiment 1, it is possible to reduce the disturbance of the flow of air on the downstream side of the linear ribs 22a.

[0019] Figs. 6 and 7 are views for use in explanation of the disturbance of the flow of air on the downstream side of linear ribs 22a. Fig. 6 illustrates a linear rib 22a having a relatively great height. Fig. 7 illustrates a linear rib 22a having a relatively small height. In Figs 6 and 7, the up/down direction therein is the direction parallel to the rotational axis O; and the upper part of each of the figures corresponds to the windward side, and the lower part of each figure corresponds to the leeward side. As illustrated in Fig. 6, in the linear rib 22a having a relatively great height, when the flow direction F1 of air and the major axis direction of the linear rib 22a are not coincident with each other, the projection width of the linear rib 22a on a plane perpendicular to the flow direction of the air is great. Therefore, on the downstream side of the liner rib 22a, the degree to which the air flows away from the linear rib 22a is great. In contrast, as illustrated in Fig. 7, in the linear rib 22a having a relative small height, even when the air-flow direction F1 and the linear rib 22a are not coincident with each other, the projection width of the linear rib 22a on the plane perpendicular to the flow direction of air is small. Therefore, on the downstream side of the linear rib 22a, the degree to which the air flows away from the linear rib 22a is small.

[0020] Figs. 8 to 10 are front views each illustrating a configuration of the outdoor unit 100 of the air-conditioning apparatus including the air-sending device according to Embodiment 1. Also, Figs. 8 to 10 illustrates respective examples of the shape of the rib unit 22 in Embodiment 1. In each of Figs. 8 to 10, the first region 31 of the rib unit 22 is outlined, and the second region 32 of the rib unit 22 is hatched.

[0021] As illustrated in Figs. 8 to 10, the outdoor unit 100 of the air-conditioning apparatus includes the housing 101 and the propeller fan 10 that is housed in the housing 101. On the front side of the housing 101, the fan guard 20 including the rib unit 22 is provided. In Figs. 8 to 10, of the fan guard 20, only the rib unit 22 is illustrated. The housing 101 houses an outdoor heat exchanger (not illustrated) that forms part of a refrigeration cycle apparatus and transfers heat between refrigerant and outdoor air. The outdoor heat exchanger is provided upstream of the propeller fan 10 in the flow of air that is sent by the propeller fan 10.

[0022] In the example illustrated in Fig. 8, the rib unit 22 includes a plurality of linear ribs 22a that linearly extend in a lateral direction. In Fig. 8, eight linear ribs 22a are illustrated. The rib unit 22 may include a plurality of linear ribs 22a extending in the up/down direction. In the example illustrated in Fig. 9, the rib unit 22 includes a plurality of linear ribs 22a that radially extend from a center portion (for example, the rotational axis O of the propeller fan 10) of the fan guard 20 toward an outer circumferential portion thereof, and that are each linearly or curvedly shaped . In Fig. 9, eight linear ribs 22a are illustrated. In the example illustrated in Fig. 10, the rib unit 22 includes a plurality of linear ribs 22a that are concentrically arranged with respect to a center portion (for example, the rotational axis O of the propeller fan 10) of the fan guard 20. In Fig. 10, five linear ribs 22a are illustrated. The fan guard 20 of Embodiment 1 may include only one of the rib units 22 as illustrated in Figs. 8 to 10 or may include a combination of two or more of the rib units 22 as illustrated in Figs. 8 to 10.

[0023] Fig. 11 schematically illustrates a configuration of a section of an air-sending device according to a modification of Embodiment 1 that is taken along a plane including the rotational axis O. As illustrated in Fig. 11, the fan guard 20 of the present modification includes a flat plate portion 23 that has a flat plate shape and that is provided at a center portion of the fan guard 20, and the rib unit 22 provided around the flat plate portion 23. The flat plate portion 23 has a diameter smaller than the diameter of the boss 13 as viewed from a point in the direction parallel to the rotational axis O. As viewed from a point in the direction parallel to the rotational axis O, part of the boss 13 coincides with the flat plate portion 23, and the other part of the boss 13 projects from the flat plate portion 23. At least part of the rib unit 22 is located in the first region 31 that coincides with the boss 13 in such a manner as described above. In the present modification, the height of part of the rib unit 22 that is located in the first region 31 is also smaller than the height of part of the rib unit 22 that is located in the second region 32.

[0024] As described above, the air-sending device according to Embodiment 1 includes: the propeller fan 10 that includes the boss 13 located on the rotational axis O, and the blades 14 provided on the outer circumferential portion of the boss 13; and the fan guard 20 provided leeward of the propeller fan 10 and including the rib unit 22 in which the plurality of the openings 21 are provided to allow air to pass therethrough. The fan guard 20 includes the first region 31 that is located in such a manner as to overlap with the boss 13 as viewed from a point in the direction parallel to the rotational axis O, and the second region 32 that is located outward of the boss 13 and inward of the rotational trajectory of the outer circumferential edges 14a of the blades 14, as viewed from a point in the direction parallel to the rotational axis O. Where the dimension of the rib unit 22 in the direction parallel to the rotational axis O is defined as the height of the rib unit 22, the height of the part of the rib unit 22 that is located in the first region 31 (for example, the height Ld of the linear ribs 22a located in the first region 31) is smaller than the height of the part of the rib unit 22 that is located in the second region 32 (for example, the height Ld of the linear ribs 22a located in the second region 32). The boss 13 is an example of a shaft.

[0025] In the above configuration, regardless of the flow direction of air that flows into the first region 31 of the fan guard 20, the projection width of the part of the rib unit 22 that is located in the first region 31, on the plane perpendicular to the flow direction of the air, is small. Therefore, in Embodiment 1, even when the flow direction of air in the region located downstream of the boss 13 irregularly varies with time, it is possible to reduce the disturbance of the flow of air that occurs in the region located downstream of the part of the rib unit 22 that is located in the first region 31. It is thus possible to further reduce noise that is made by the air-sending device.

[0026] In the air-sending device according to Embodiment 1, the height of the part of the rib unit 22 that is located in the second region 32 may be set constant. The flow direction of air that flows into the second region 32 does not greatly vary with time. Therefore, in the case where the linear ribs 22a are inclined based on the flow direction of air, even if the height of the part of the rib unit 22 that is located in the second region 32 is set constant, it is possible to reduce the disturbance of the flow of air that occurs in the region downstream from the rib unit 22.

[0027] The outdoor unit 100 of the air-conditioning apparatus according to Embodiment 1 includes the above air-sending device. Therefore, in the outdoor unit 100 of the air-conditioning apparatus, it is possible to obtain the same advantage as described above.

[0028] In Embodiment 1, it is preferable that as illustrated in, for example, Fig. 1, the height of the entirety of the part of the rib unit 22 that is located in the first region 31 be smaller than the height of the part of the rib unit 22 that is located in the second region 32. However, if the height of part of the part of the rib unit 22 that is located in the first region 31 is smaller than the height of the part of the rib unit 22 that is located in the second region 32, it is possible to obtain the same advantage as described above. In other words, in the case where the height of part of the part of the rib unit 22 that is located in the first region 31 is smaller than the height of the part of the rib unit 22 that is located in the second region 32, the height of the other part of the part of the rib unit 22 that is located in located in the first region 31 may be greater than or equal to the height of the part of the rib unit 22 that is located in the second region 32.

Embodiment 2

[0029] An air-sending device according to Embodiment 2 of the present disclosure will be described. Fig. 12 schematically illustrates a configuration of the air-sending device according to Embodiment 1 that is taken along a plane including the rotational axis O. Embodiment 2 is different from Embodiment 1 in the shape of part of the rib unit 22 that is located in the first region 31. It should be noted that regarding Embodiment 2, components having the same functions as those in Embodiment 1 will be denoted by the same reference signs, and their descriptions will thus be omitted. As illustrated in Fig. 12, each of the linear ribs 22a located in the first region 31 has a circular sectional shape. Each of these linear ribs 22a has, for example, a columnar shape. The width and height of each of the linear ribs 22a located in the first region 31 are equal to each other. However, in the first region 31, the width of each linear rib 22a may be greater than the height of each linear rib 22a.

[0030] Fig. 13 is a view for use in explanation of a disturbance of the flow of air on the downstream side of linear ribs 22a in the air-sending device according to Embodiment 2. In Fig. 13, the up/down direction therein is the direction parallel to the rotational axis O. Upper part of Fig. 13 corresponds to the windward side, and lower part of Fig. 13 corresponds to the leeward side. As illustrated in Fig. 13, in the case where a section of each of linear ribs 22a that is taken along a certain plane is circular, it is possible to further reduce the projection widths of the linear ribs 22a regardless of the flow direction of inflow air. Therefore, even when the flow direction of air varies in the region downward from the boss 13, it is possible to further reduce the degree to which the air flows away from each of the linear ribs 22a on the downstream side of the linear ribs 22a. For the flow of air in the above plane, the projection widths of the linear ribs 22a are equal to each other regardless of the flow direction of the air. Therefore, regardless of how the flow direction of air varies, it is possible to reduce the degree of a disturbance of the flow that occurs on the downstream side of the linear ribs 22a to a small degree.

[0031] As described above, in the air-sending device according to Embodiment 2, the part of the rib unit 22 that is located in the first region 31 has a circular sectional shape. In this configuration, even when the flow direction of air varies in the region downstream from the boss 13, it is possible to further reduce the degree to which the air flows away from the linear ribs 22a on the downstream side of the linear ribs 22a.

[0032] In the air-sending device according to Embodiment 2, where the dimension of the rib unit 22 in the direction perpendicular to the rotational axis O and also perpendicular to the extending direction of the rib unit 22 is defined as the width of the rib unit 22, the width (for example, the width of each of the linear ribs 22a located in the first region 31) of the part of the rib unit 22 that is located in the first region 31 is greater than or equal to the height (for example, the height of each of the above linear ribs 22a) of the above part of the rib unit 22. In this configuration, even when the flow direction of air varies in the region downstream from the boss 13, it is possible to further reduce the degree to which the air flows away from the linear ribs 22a on the downstream side of the linear ribs 22a.

Embodiment 3

[0033] An air-sending device according to Embodiment 3 of the present disclosure will be described. Fig. 14 schematically illustrates a configuration of a configuration of the air-sending device according to Embodiment 3 that is taken along a plane including the rotational axis O. Embodiment 3 is different from Embodiment 2 in the shape of part of the rib unit 22 that is located in the second region 32. It should be noted that regarding Embodiment 3, components that have the same functions as those in Embodiment 1 or 2 will be denoted by the same reference signs, and their descriptions will thus be omitted.

[0034] As illustrated in Fig. 14, the part of the rib unit 22 that is located in the second region 32 includes a first rib unit 24 and a second rib unit 25 that are arranged to overlap with each other as viewed from a point in parallel to the rotational axis O. The second rib unit 25 is provided leeward of the first rib unit 24. The first rib unit 24 has a configuration in which a plurality of first linear ribs 24a straightly or curvedly extending are combined together, as viewed from a point in the direction parallel to the rotation axis O. Each of the plurality of first linear ribs 24a has a circular sectional shape. The second rib unit 25 has a configuration in which a plurality of second linear ribs 25a straightly or curvedly extending along the plurality of first linear ribs 24a are combined together, as viewed from a point in the direction parallel to the rotational axis O. Each of the plurality of second linear ribs 25a has a circular sectional shape.

[0035] Each of the linear ribs 22a located in the second region 32 includes the first linear rib 24a and the second linear rib 25a that are arranged to overlap with each other as viewed from a point in the direction parallel to the rotational axis O. In such a case, in a section perpendicular to the extending direction of the linear rib 22a, a distance between an end point of the first linear rib 24a that is located on the windward side and an end point of the second linear rib 25a that is located on the leeward side in the direction parallel to the rotational axis O is the height of the linear rib 22a. In the section perpendicular to the extending direction of the linear rib 22a, an angle formed by a straight line that connects the center of the first linear rib 24a and the center of the second linear rib 25a and the rotational axis O or a straight line parallel to the rotational axis O is the inclination angle of the linear rib 22a.

[0036] The first linear rib 24a and the second linear rib 25a, which form the linear rib 22a, may have different sectional areas. The sectional area of at least one of the first linear rib 24a and the second linear rib 25a may be equal to the sectional area of each of the linear ribs 22a located in the first region 31. Each of the linear ribs 22a may have a configuration in which three or more linear ribs each having a circular sectional shape are arranged to overlap with each other.

[0037] Figs. 15 and 16 are views for use in explanation of a disturbance of the flow of air on the downstream side of the linear ribs 22a. Fig. 15 illustrates a linear rib 22a having an ellipsoidal sectional shape. Fig. 16 illustrates a linear rib 22a that includes a first linear rib 24a and a second linear rib 25a as in Embodiment 3. In Figs. 15 and 16 and Figs. 17 to 19 which will be referred to later, the up/down direction in these figures is the direction parallel to the rotational axis O; and the upper part of each of the figures is the windward side, and the lower part of each figure is the leeward side.

[0038] As illustrated in Fig. 15, in the case where the linear rib 22a has an ellipsoidal sectional shape, air that flows in a direction not along the inclination of the linear rib 22a collides with the linear rib 22a and then flows round along an upstream-side end face and a downstream-side end face of the linear rib 22a. Since the upstream-side end face and the downstream-side end face are curved while their curvatures greatly vary, the air that has flowed round flows away from the upstream-side end face and the downstream-side end face. Thus, a disturbance having a width substantially equivalent to the projection width of the linear rib 22a occurs in the flow of the air in the region downstream from the linear rib 22a. Consequently, the air-sending device makes a bigger noise.

[0039] In contrast, in the embodiment as illustrated in Fig. 16, each of the first linear rib 24a and the second linear rib 25a, which form the linear rib 22a, has a circular sectional shape. Air that flows in a direction not along the inclination of the linear rib 22a collides with the first linear rib 24a and the second linear rib 25a and then flows round along the upstream-side end face of the first linear rib 24a and the downstream-side end face of the second linear rib 25a. Since the upstream-side end face of the first linear rib 24a and the downstream-side end face of the second linear rib 25a each has a constant curvature, the air that has flowed round thus does not easily flow away from the end faces, that is, the air easily flows while being in contact with the end faces. Thus, the width of the disturbance that occurs in the region downstream from the linear rib 22a can be made smaller than the projection width of the linear rib 22a. Therefore, the noise that is made by the air-sending device can be reduced.

[0040] Fig. 17 is a schematic view illustrating a configuration of a linear rib 22a in an air-sending device according to a first modification of Embodiment 1. In the case where the first linear rib 24a and the second linear rib 25a are formed of steel wires, the first linear rib 24a and the second linear rib 25a may be subjected to coating for preventing rust. As illustrated in Fig. 17, the linear rib 22a subjected to coating includes the first linear rib 24a, the second linear rib 25a, and a coating film 26 formed on surfaces of the first linear rib 24a and the second linear rib 25a. The section of the linear rib 22a is formed in the shape of a peanut. Even in such a case, it is possible to obtain the same advantages as described above, as long as each of the upstream-side end face and the downstream-side surface of the linear rib 22a has an arc shape.

[0041] Fig. 18 is a schematic view illustrating a configuration of a linear rib 22a in an air-sending device according to a second modification of Embodiment 1. As illustrated in Fig. 18, the first linear rib 24a and the second linear rib 25a are separated from each other, with a space 27 interposed between the first linear rib 24a and the second linear rib 25a. Even in such a case, in the section perpendicular to the extending direction of the linear rib 22a, a distance between an end point of the first linear rib 24a that is located on the windward side and an end point of the second linear rib 25a that is located on the leeward side in the direction parallel to the rotational axis O is the height Ld of the linear rib 22a. In the section perpendicular to the extending direction of the linear rib 22a, an angle formed by a straight line that connects the center of the first linear rib 24a and the center of the second linear rib 25a and the rotational axis O or a straight line parallel to the rotational axis O is the inclination angle θ of the linear rib 22a.

[0042] In the configuration as illustrated in Fig. 18, when air flows in a direction not along the inclination of the linear rib 22a, part of air that has collided with the first linear rib 24a and the second linear rib 25a passes through the space 27. Consequently, it is possible to further reduce the disturbance of the flow in the region downstream from the linear rib 22a.

[0043] As described above, in the air-sending device according to Embodiment 3, part of the rib unit 22 (for example, the linear rib 22a) that is located in the second region 32 includes a first rib (for example, the first linear rib 24a) and a second rib (for example, the second linear rib 25a) that are arranged to overlap with each other as viewed from a point in the direction parallel to the rotational axis O. Each of the first rib and the second rib has a circular sectional shape. In this configuration, the upstream-side end face and the downstream-side end face of the linear rib 22a located in the second region 32 can be each made to have to a constant curvature. Therefore, even when air flows in a direction not along the inclination of the linear rib 22a in the second region 32, it is possible to reduce the disturbance of the flow in the region downstream from the linear rib 22a.

[0044] In the air-sending device according to Embodiment 3, the first rib and the second rib are separated from each other, with the space 27 interposed between the first rib and the second rib. In this configuration, since part of air that has collided with the first linear rib 24a and the second linear rib 25a passes through the space 27, it is possible to further reduce the disturbance of the flow in the region downstream from the linear rib 22a.

[0045] In the above examples, the first linear rib 24a and the second linear rib 25a that forms a single linear rib 22a are arranged to overlap with each other as viewed from a point in the direction parallel to the rotational axis O. This, however, is not limiting. Each linear rib 22a may be formed to include a first linear rib 24a and a second linear rib 25a that are arranged not to overlap with each other as viewed from a point in the direction parallel to the rotational axis O.

[0046] Fig. 19 illustrates an example of a linear rib that includes a first linear rib and a second linear rib that are arranged not to overlap with each other, in the air-sending device according to Embodiment 3. As illustrated in Fig. 19, when shapes of first linear ribs 24b1 and 24b2 and second linear ribs 25b1 and 25b2 are projected on a plane perpendicular to the rotational axis O, in these projections, the first linear rib 24b1 is adjacent to each of the second linear rib 25b1 and the second linear rib 25b2, with a space interposed between the first linear rib 24b1 and each of the second linear rib 25b1 and the second linear rib 25b2. To be more specific, a space S1 between the first linear rib 24b1 and the second linear rib 25b1 is smaller than a space S2 between the first linear rib 24b1 and the second linear rib 25b2. In this case, each linear rib 22b1 is formed to include the first linear rib 24b1 and the second linear rib 25b1. That is, the distance between an end point of the first linear rib 24b1 that is located the windward side and an end point of the second linear rib 25b1 that is located on the leeward side in the direction parallel to the rotational axis O is the height Ld of the linear rib 22b1. An angle formed by a straight line that connects the center of the first linear rib 24b1 and the center of the second linear rib 25b1 and the rotational axis O or a straight line parallel to the rotational axis O is the inclination angle θ of the linear rib 22b1.

Embodiment 4

[0047] An air-sending device according to Embodiment 4 of the present disclosure will be described. Fig. 20 is a schematic view illustrating a configuration of the air-sending device according to Embodiment 1 that is taken along a plane including the rotational axis O. Fig. 21 is a front view illustrating a configuration of the propeller fan 10 of the air-sending device according to Embodiment 1. Embodiment 4 is different from Embodiments 1 to 3 in the shape of the propeller fan 10. It should be noted that regarding Embodiment 4, components that have the same functions as any of Embodiments 1 to 3 will be denoted by the same reference signs, and their descriptions will thus be omitted.

[0048] As illustrated in Figs. 20 and 21, the propeller fan 10 according to Embodiment 4 is a so-called bossless propeller fan, which includes no boss or includes a boss made smaller. The propeller fan 10 includes a plurality of the blades 14 and a plurality of connection portions 15 each of which connects associated two of the plurality of blades 14 that are adjacent to each other in the circumferential direction. Each connection portion 15 has, for example, a plate shape. An edge portion 15a of each connection portion 15 on an outer circumferential side thereof connects a trailing edge 14b of one of associated two blades 14 and a leading edge 14c of the other of the two blades 14, the above one blade 14 being located in front of the above other blade 14 in a rotation direction of the propeller fan 10. In the propeller fan 10 having such a configuration, an inner circumferential region that is located inward of an imaginary cylinder surface C1 circularly inscribed in the edge portions 15a with respect to the rotation axis O corresponds to a shaft 16 of the propeller fan 10.

[0049] The fan guard 20 includes the first region 31 that is located in such a manner to overlap with the shaft 16 as viewed from a point in the direction parallel to the rotational axis O, and the second region 32 that is located outward of the shaft 16 and inward of a rotational trajectory of the outer circumferential edges 14a of the blades 14 as viewed from a point in the direction parallel to the rotational axis O. The height of part of the rib unit 22 that is located in the first region 31 is smaller than the height of part of the rib unit 22 that s located in the second region 32, as in Embodiment 1. According to Embodiment 4, it is possible to obtain the same advantages as in Embodiment 1. The propeller fan 10 according to Embodiment 4 can be combined with the fan guard 20 according to Embodiment 2 or 3.

Reference Signs List

[0050] 10 propeller fan 11 fan motor 12 air outlet 13 boss 14 blade 14a outer circumferential edge 14b trailing edge 14c leading edge 15 connection portion 15a edge portion 16 shaft 20 fan guard 21 opening 22 rib 22a, 22b1 linear rib 22a1, 22a2 end point 22a3, 22a4 end 22a5, 22a6 center 23 flat plate portion 24 first rib unit 24a, 24b1, 24b2 first linear rib 25 second rib unit 25a, 25b1, 25b2 second linear rib 26 coating film 27 space 31 first region 32 second region 100 outdoor unit of air-conditioning apparatus 101 housing C1 imaginary cylinder surface O rotational axis

Claims

1. An air-sending device comprising:

   a propeller fan including a shaft located on a rotational axis of the propeller fan and a blade located on a circumferential portion of the shaft; and
   a fan guard provided leeward of the propeller fan, and including a rib unit in which a plurality of openings are provided to allow air to pass through the openings,
   wherein the fan guard includes a first region that is located in such a manner as to overlap with the shaft as viewed from a point in a direction parallel to the rotational axis, and a second region that is located outward of the shaft and inward of a rotational trajectory of the blade as viewed from a point in the direction parallel to the rotational axis,
   where a dimension of the rib unit in the direction parallel to the rotational axis is a height of the rib unit, a height of part of the rib unit that is located in the first region is smaller than a height of part of the rib unit that is located in the second region.

2. The air-sending device of claim 1, wherein the part of the rib unit that is located in the first region has a circular sectional shape.

3. The air-sending device of claim 1 or claim 2,
   wherein the part of the rib unit that is located in the second region includes a first rib unit and a second rib unit that are arranged in such a manner as to overlap with each other as viewed from a point in the direction parallel to the rotational axis, and
   wherein each of the first rib unit and the second rib unit has a circular sectional shape.

4. The air-sending device of claim 3, wherein the first rib unit and the second rib unit are separated from each other, with a space interposed the first rib unit and the second rib unit.

5. The air-sending device of any one of claims 1 to 4, wherein the height of the part of the rib unit that is located in the second region is constant throughout the part.

6. The air-sending device of any one of claims 1 to 5, wherein where a dimension of the rib unit in a direction perpendicular to the rotational axis and perpendicular to a direction in which the rib unit extends is defined as a width of the rib unit, a width of the part of the rib unit that is located in the first region is greater than or equal to the height of the rib unit.

7. An outdoor unit of an air-conditioning apparatus comprising the air-sending device of any one of claims 1 to 6.

FIG. 1

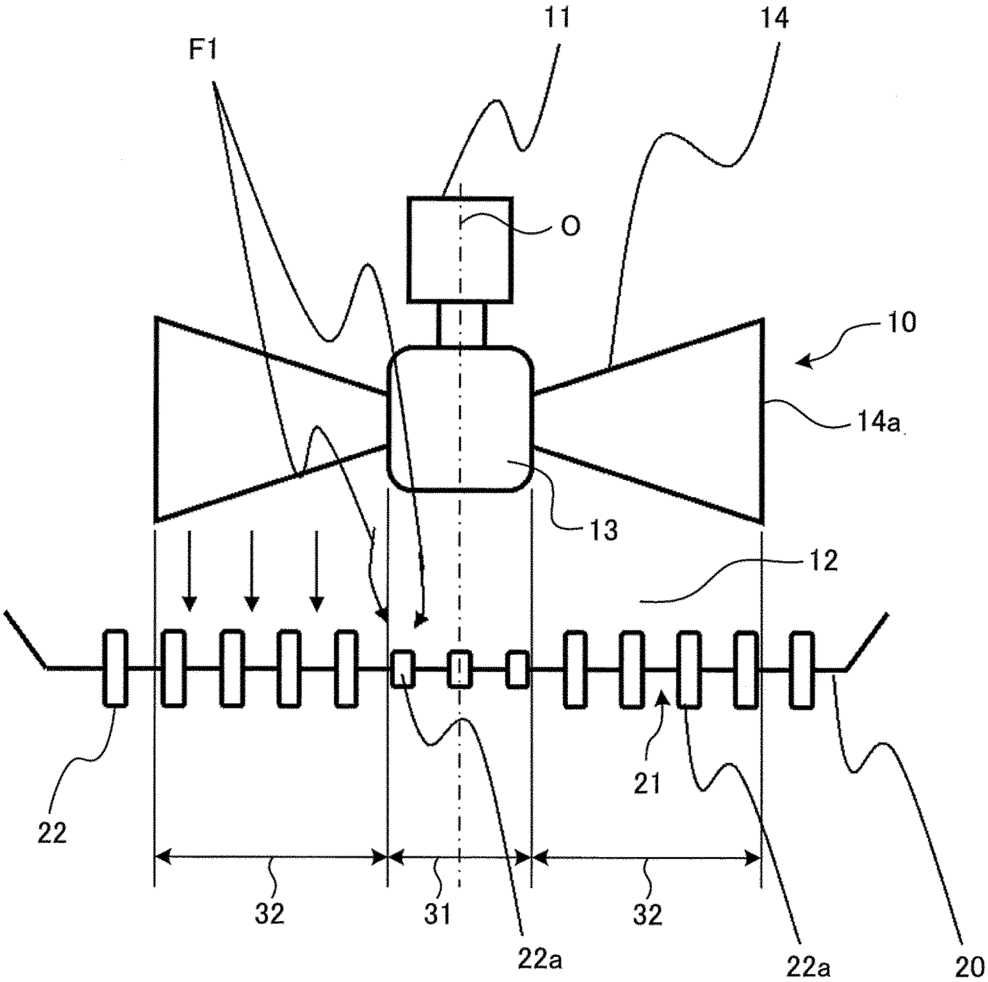


FIG. 2

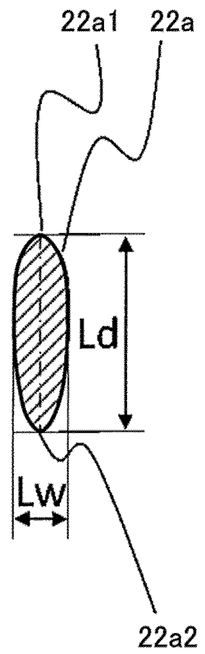


FIG. 3

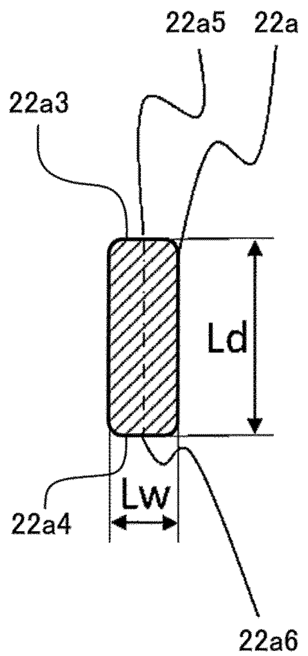


FIG. 4

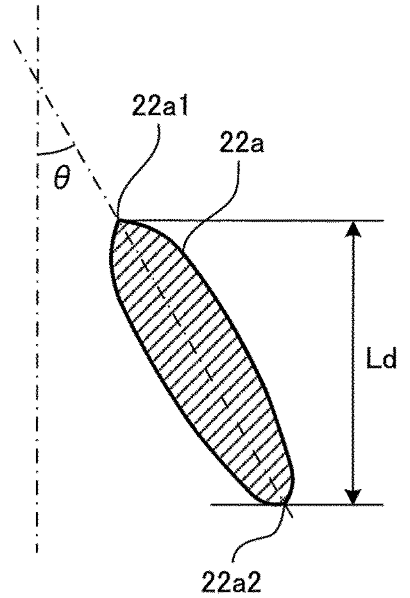


FIG. 5

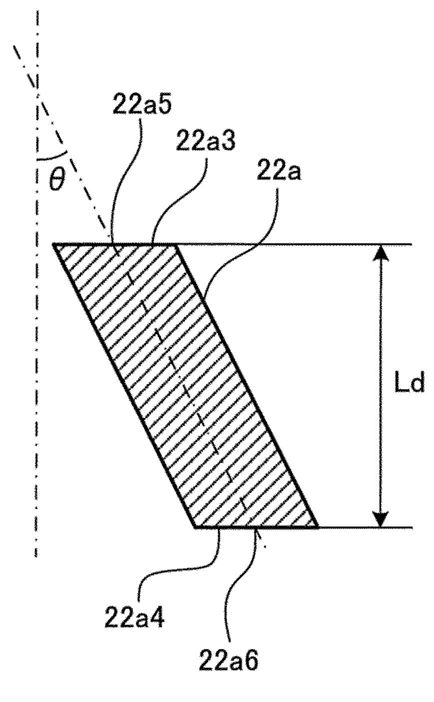


FIG. 6

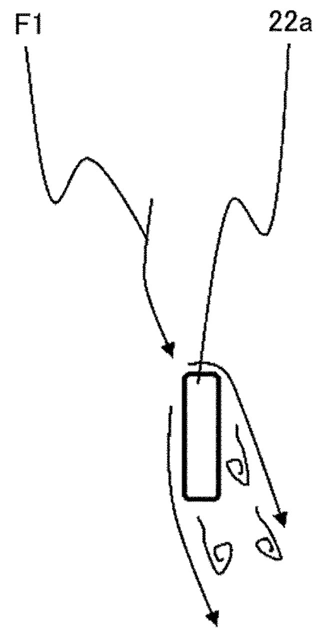


FIG. 7

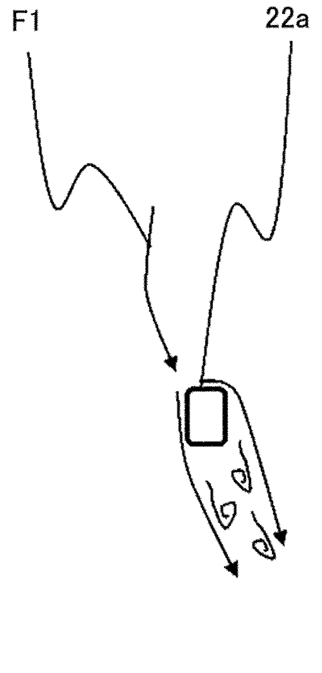


FIG. 8

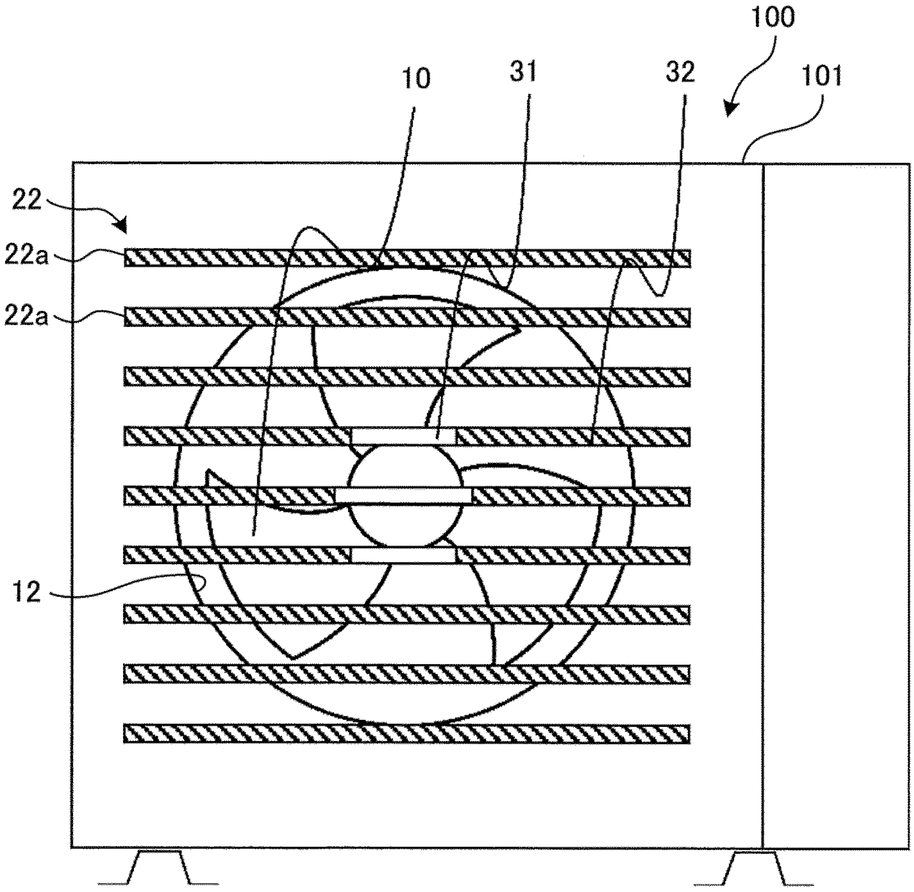


FIG. 9

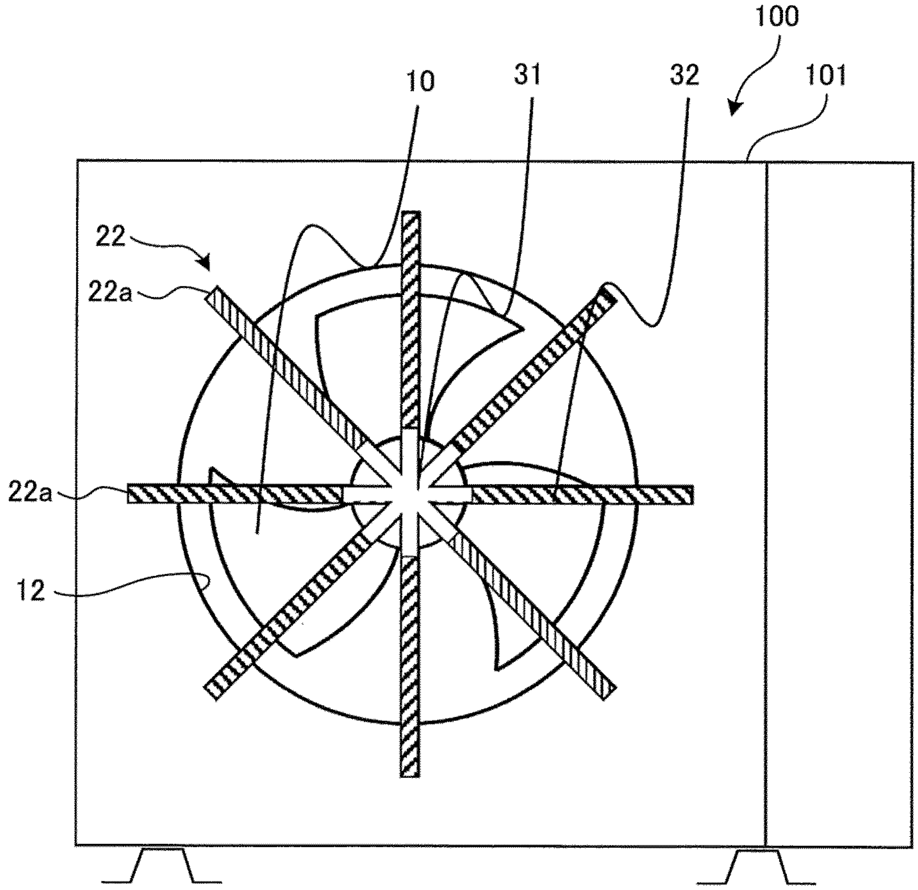


FIG. 10

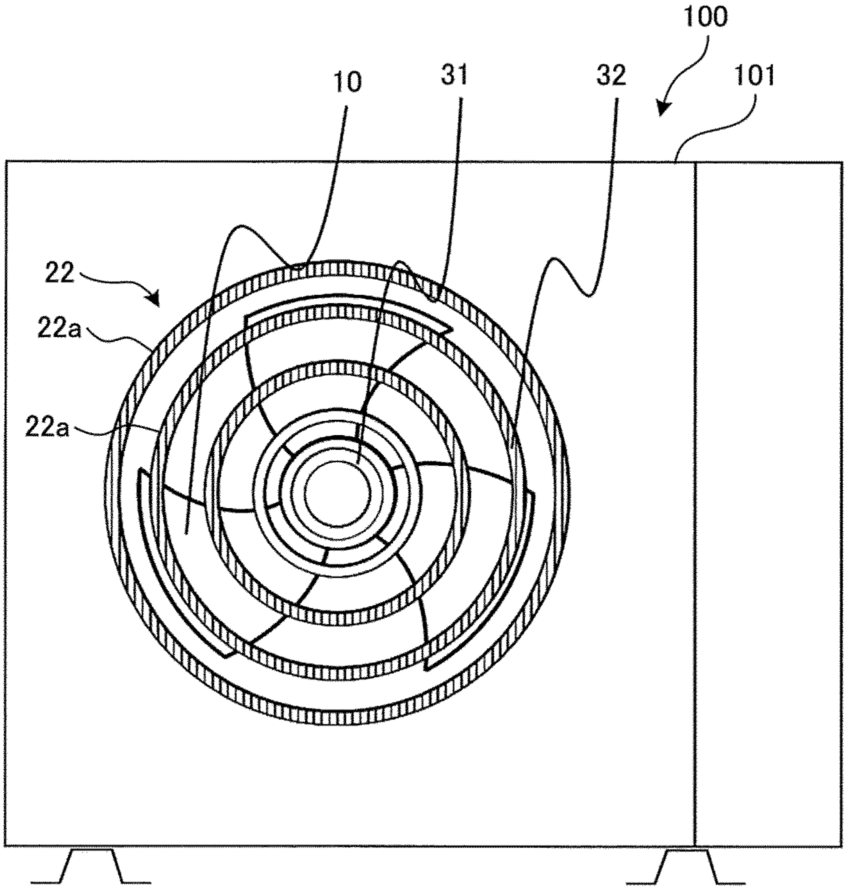


FIG. 11

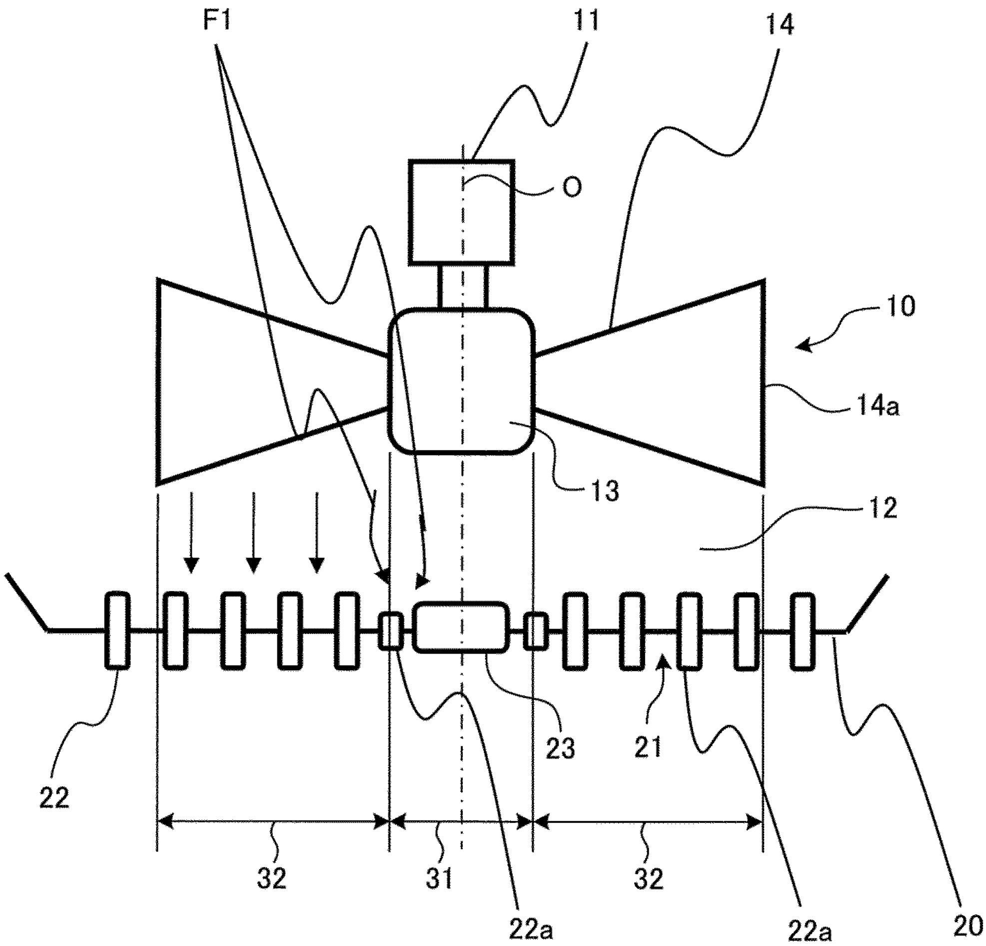


FIG. 12

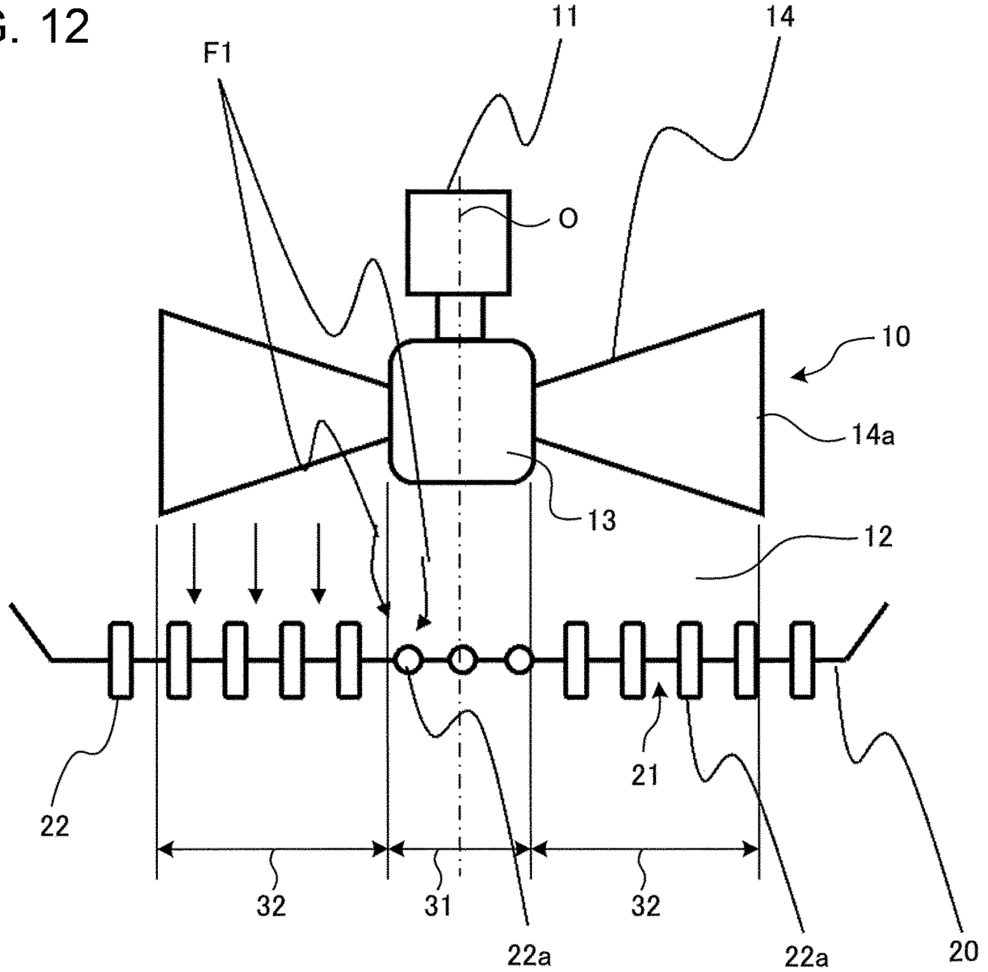


FIG. 13

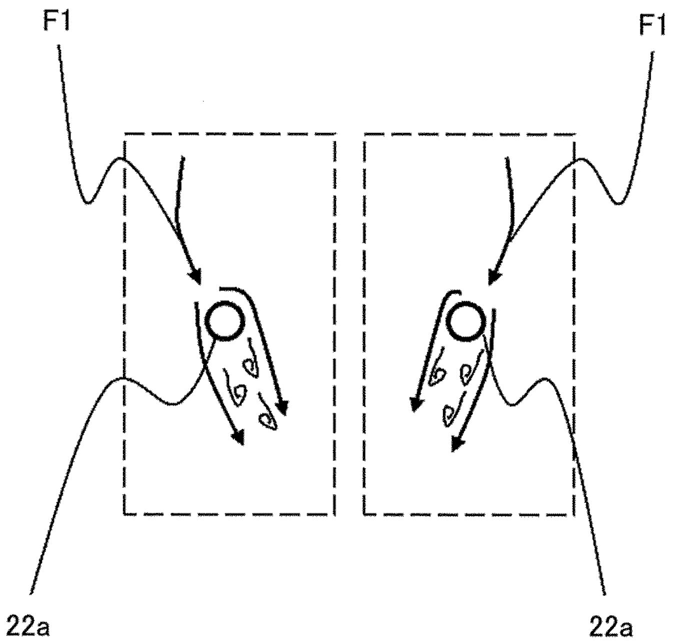


FIG. 14

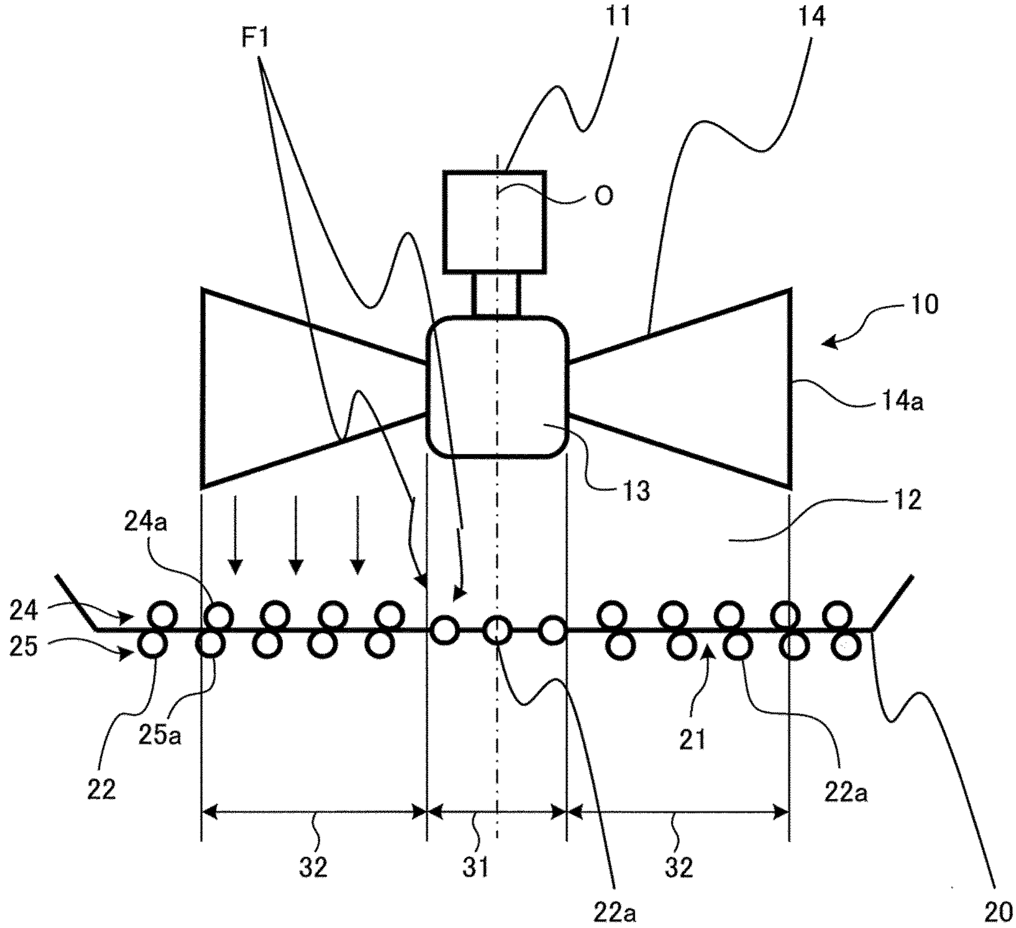


FIG. 15

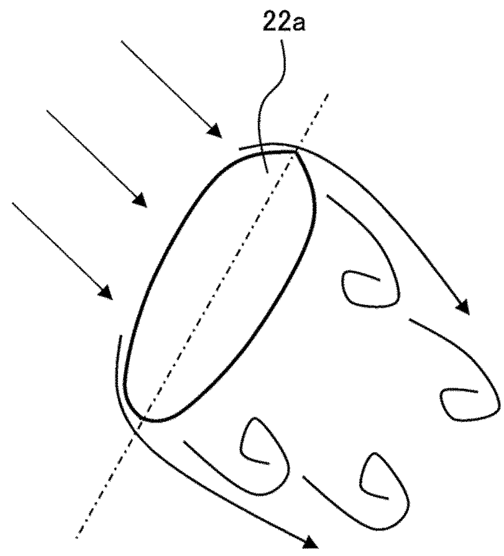


FIG. 16

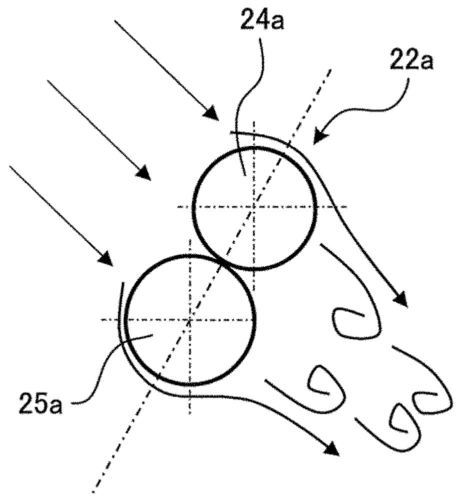


FIG. 17

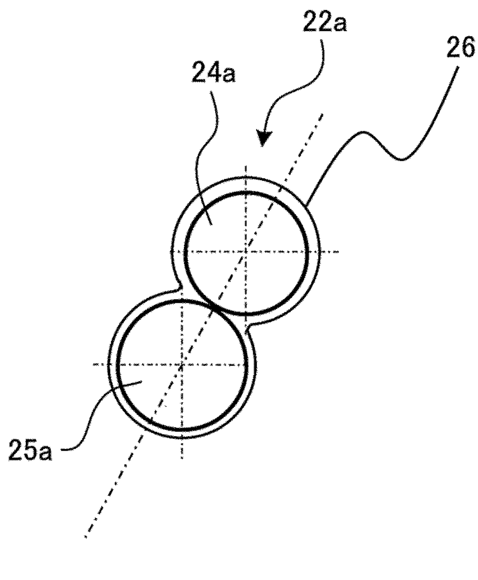


FIG. 18

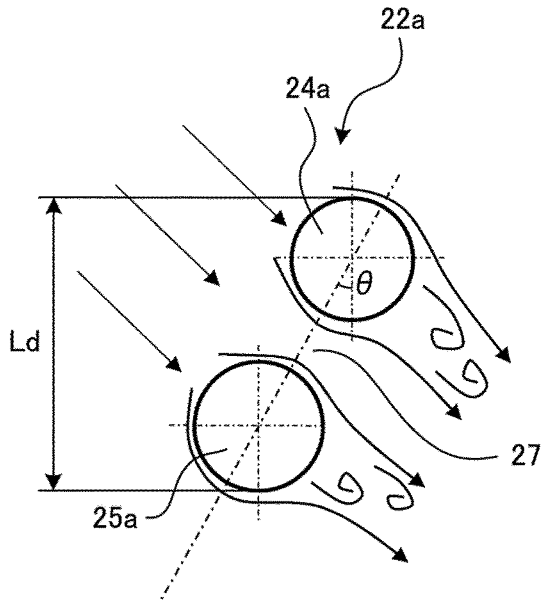


FIG. 19

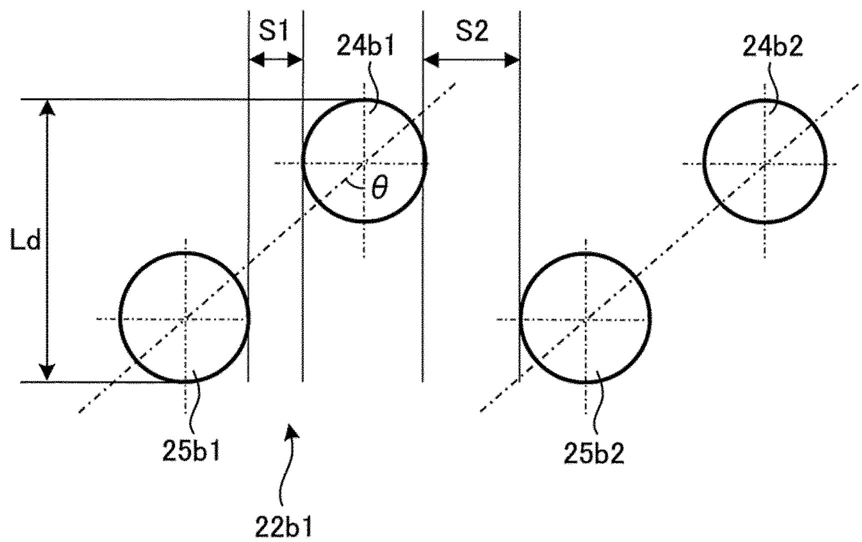


FIG. 20

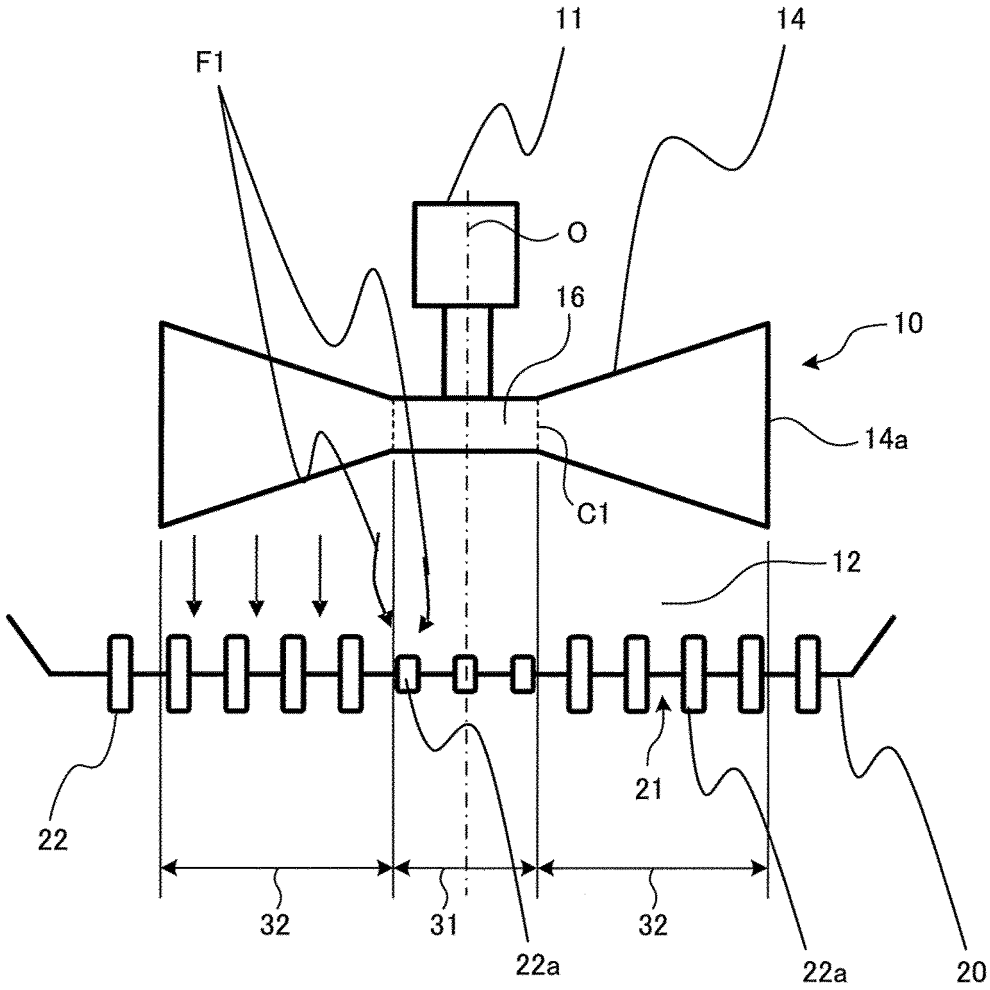
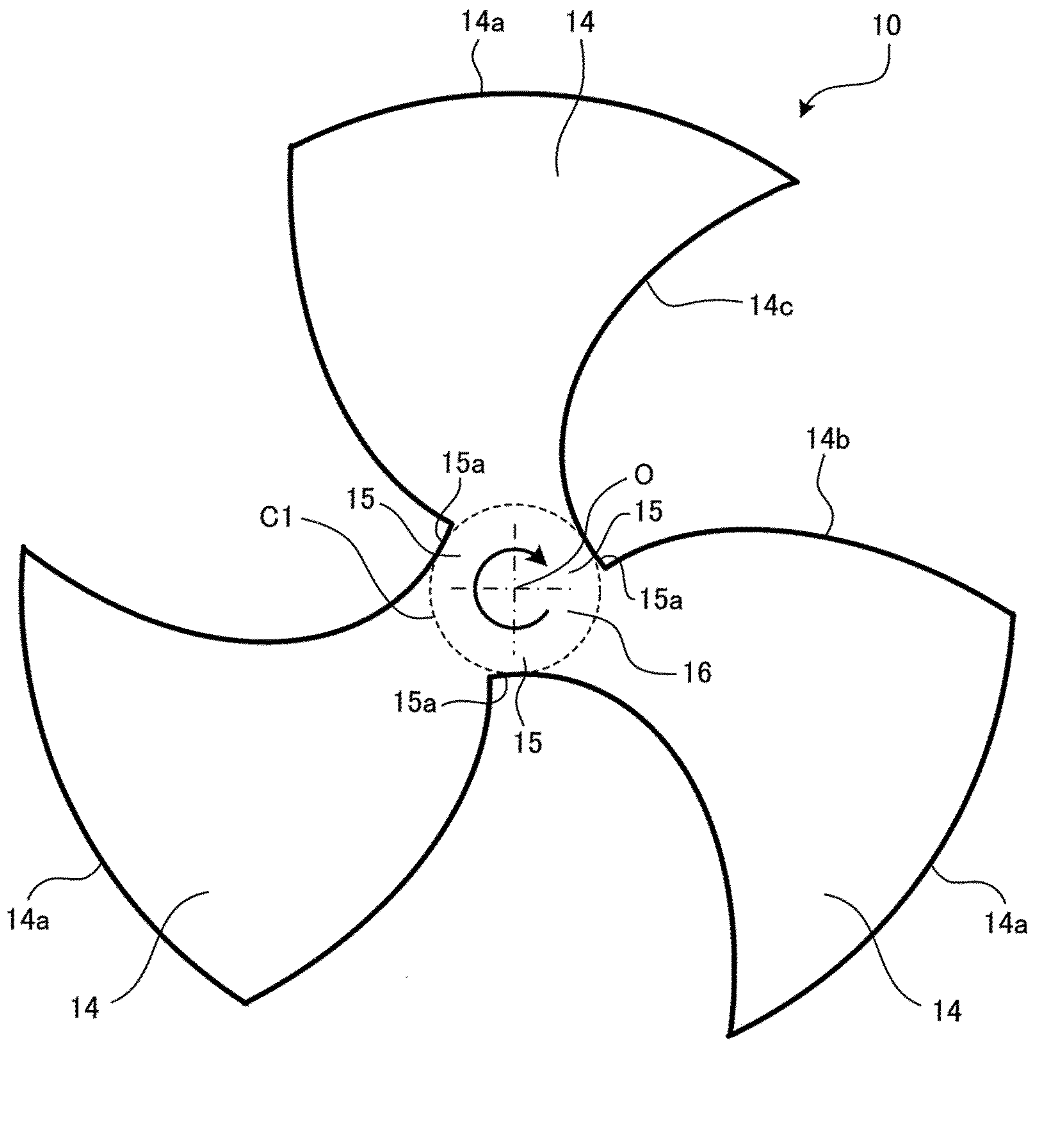


FIG. 21



INTERNATIONAL SEARCH REPORT

International application No. PCT/JP2018/017631

A. CLASSIFICATION OF SUBJECT MATTER
Int. Cl. F04D29/00(2006.01)i, F24F1/56(2011.01)i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int. Cl. F04D29/00, F24F1/56

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	1971-2018
Registered utility model specifications of Japan	1996-2018
Published registered utility model applications of Japan	1994-2018

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.
A	JP 6-74196 A (HITACHI, LTD.) 15 March 1994, fig. 5 (Family: none)	1-7
A	JP 2013-119816 A (SAMSUNG YOKOHAMA RESEARCH INSTITUTE) 17 June 2013, fig. 1 (Family: none)	1-7
A	JP 11-223362 A (HITACHI, LTD.) 17 August 1999, fig. 11 (Family: none)	1-7
A	JP 5-296495 A (DAIKIN INDUSTRIES, LTD.) 09 November 1993, fig. 1 (Family: none)	1-7

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

* Special categories of cited documents:
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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
18.07.2018	31.07.2018

Name and mailing address of the ISA/	Authorized officer
Japan Patent Office 3-4-3, Kasumigaseki, Chiyoda-ku, Tokyo 100-8915, Japan	Telephone No.

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Patent documents cited in the description

- JP 4403691 B **[0003]**