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(54) **CENTRIFUGAL FAN IMPELLER**

(57) A shroud (80) has: a curved plate-like shroud curved plate portion (81); and flat plate-like shroud flat plate portions (82) corresponding to just parts of sections of the shroud (80) that oppose shroud-side blade axial end portions (72). In the blade axial end portions (72) are formed blade flat surfaces (72a) that follow the shroud flat plate portions (82) and blade curved surfaces (72b, 72c) that follow the shroud curved plate portion (81). Welded portions (8b) resulting from the blade flat surfaces (72a) and the shroud flat plate portions (82) being welded to each other are formed between the blade axial end portions (72) and the shroud (80).

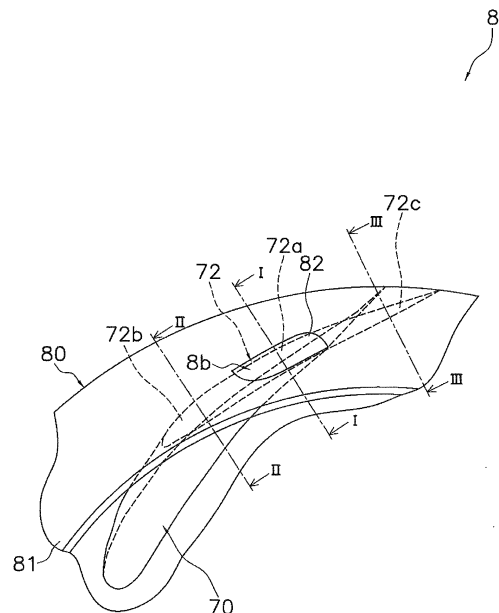


FIG. 6

Description

TECHNICAL FIELD

[0001] The present invention relates to a centrifugal fan impeller, and particularly a centrifugal fan impeller equipped with plural blades that are annularly disposed around a rotational axis and a main plate and a shroud that are disposed so as to sandwich the rotational axis direction sides of the blades, with blade axial end portions, which are end portions of the blades on one side in the rotational axis direction, and the shroud being welded to each other.

BACKGROUND ART

[0002] In air conditioning apparatuses and air purifiers, for example, centrifugal fans are sometimes used for the purpose of sucking in, supplying, and exhausting air. An impeller configuring the centrifugal fan mainly has plural blades that are annularly disposed around a rotational axis and a main plate and a shroud that are disposed so as to sandwich the rotational axis direction sides of the blades.

[0003] Additionally, as such a centrifugal fan impeller, there are, as disclosed in patent documents 1 and 2 (JP-A No. 2005-155510 and JP-A No. 2015-86827), centrifugal fan impellers where blade axial end portions, which are end portions of the blades on one side in the rotational axis direction, and the shroud are welded to each other. In these centrifugal fan impellers, the blade axial end portions along the entire chord length direction and the corresponding sections of the shroud are given staircase shapes, and flat surfaces of the staircase shapes are welded to each other.

SUMMARY OF INVENTION

[0004] In patent documents 1 and 2, it is easy for the airflow in the vicinity of the shroud to be obstructed by the staircase shapes formed in the blades and the shroud, which sometimes leads to the occurrence of a reduction in blowing performance and an increase in blowing noise.

[0005] It is a problem of the present invention to achieve an improvement in blowing performance and a reduction in blowing noise in a centrifugal fan impeller equipped with plural blades that are annularly disposed around a rotational axis and a main plate and a shroud that are disposed so as to sandwich the rotational axis direction sides of the blades, with blade axial end portions, which are end portions of the blades on one side in the rotational axis direction, and the shroud being welded to each other.

[0006] A centrifugal fan impeller pertaining to a first aspect has plural blades that are annularly disposed around a rotational axis and a main plate and a shroud that are disposed so as to sandwich the rotational axis

direction sides of the blades, with blade axial end portions, which are end portions of the blades on one side in the rotational axis direction, and the shroud being welded to each other. Additionally, here, the shroud has a curved plate-like shroud curved plate portion curved in such a way that its diameter becomes smaller heading away from the blades in the rotational axis direction and flat plate-like shroud flat plate portions formed in correspondence to just parts of the sections of the shroud that oppose the blade axial end portions. In the blade axial end portions are formed blade flat surfaces being flat surfaces that follow the shroud flat plate portions and blade curved surfaces being curved surfaces that follow the shroud curved plate portion. Welded portions resulting from the blade flat surfaces and the shroud flat plate portions being welded to each other are formed between the blade axial end portions and the shroud.

[0007] Here, as described above, the centrifugal fan impeller employs a structure where the sections at which the blades and the shroud oppose each other are largely left as a curved plate portion (the shroud curved plate portion) and curved surfaces (the blade curved surfaces) and where flat plate portions (the shroud flat plate portions) and flat surfaces (the blade flat surfaces) are formed, and welded to each other, in just parts of the sections at which the blades and the shroud oppose each other. For this reason, here, in comparison to a case where the impeller employs a conventional structure where staircase shapes are formed in the blades and the shroud and welded to each other, it becomes difficult for the airflow in the vicinity of the shroud to be obstructed.

[0008] Because of this, here, the airflow in the vicinity of the shroud can be improved to thereby achieve an improvement in blowing performance and a reduction in blowing noise.

[0009] A centrifugal fan impeller pertaining to a second aspect is the centrifugal fan impeller pertaining to the first aspect, wherein the blade flat surfaces are disposed in the vicinities of chord length direction centers of the blade axial end portions.

[0010] Here, as described above, in employing a structure where the flat plate portions (the shroud flat plate portions) and the flat surfaces (the blade flat surfaces) are formed, and welded to each other, in just parts of the sections at which the blades and the shroud oppose each other, the welding of the blades and the shroud to each other is performed at the sections in the vicinities of the chord length direction centers of the blade axial end portions, so in comparison to a case where the welding of the blades and the shroud to each other is performed at the sections on the leading edge sides and/or the trailing edge-side sections of the blade axial end portions, robust welding becomes possible.

[0011] Because of this, here, the area of the blade flat surfaces required for welding and the area of the shroud flat plate portion corresponding thereto can be reduced.

[0012] A centrifugal fan impeller pertaining to a third aspect is the centrifugal fan impeller pertaining to the

second aspect, wherein leading edge-side recessed portions, into which leading edge-side sections of the blade axial end portions are insertable, are formed in the shroud in such a way as to follow the blade curved surfaces.

[0013] In employing a structure where, as described above, the flat plate portions (the shroud flat plate portions) and the flat surfaces (the blade flat surfaces) are formed, and welded to each other, in just parts of the sections at which the blades and the shroud oppose each other, when the welding of the blades and the shroud to each other is performed at the sections in the vicinities of the chord length direction centers of the blade axial end portions, there is the concern that gaps will form between the leading edge-side sections of the blade axial end portions and the shroud curved plate portion because of, for example, strain during the molding of the blades and the shroud. Such gaps at the leading edge-side sections of the blade axial end portions cause a disruption in the airflow heading through the opening in the central portion of the shroud toward the leading edges of the blades, so there is the concern that this will increase blowing noise.

[0014] Thus, here, as described above, the leading edge-side recessed portions, into which the leading edge-side sections of the blade axial end portions are insertable, are formed in the shroud. For this reason, disruption of the airflow caused by gaps between the leading edge-side sections of the blade axial end portions and the shroud can be curbed. Here, when the leading edge-side recessed portions are formed in the shroud, there is an adverse impact on blowing performance and blowing noise, but here, as described above, by forming the leading edge-side recessed portions in such a way as to follow the blade curved surfaces, the adverse impact on blowing performance and blowing noise caused by the leading edge-side recessed portions is curbed.

[0015] Because of this, here, disruption of the airflow caused by gaps between the leading edge-side sections of the blade axial end portions and the shroud curved plate portion can be curbed to thereby curb an increase in blowing noise caused by the gaps.

[0016] A centrifugal fan impeller pertaining to a fourth aspect is the centrifugal fan impeller pertaining to the third aspect, wherein the leading edge-side recessed portions project from the shroud curved plate portion in such a way as to form curved plate portions parallel to the shroud curved plate portion.

[0017] Here, the adverse impact on blowing performance and blowing noise caused by the leading edge-side recessed portions can be effectively curbed.

[0018] A centrifugal fan impeller pertaining to a fifth aspect is the centrifugal fan impeller pertaining to any of the second to fourth aspects, wherein trailing edge-side raised portions are formed in the shroud in such a way as to line trailing edge-side sections of the blade axial end portions.

[0019] In employing a structure where, as described above, the flat plate portions (the shroud flat plate por-

tions) and the flat surfaces (the blade flat surfaces) are formed, and welded to each other, in just parts of the sections at which the blades and the shroud oppose each other, when the welding of the blades and the shroud to each other is performed at the sections in the vicinities of the chord length direction centers of the blade axial end portions, there is the concern that gaps will form between the trailing edge-side sections of the blade axial end portions and the shroud curved plate portion because of, for example, strain during the molding of the blades and the shroud. Such gaps at the trailing edge-side sections of the blade axial end portions cause some of the airflow heading along the positive pressure surfaces of the blades from the leading edges to the trailing edges to leak midway from the positive pressure surface sides to the negative pressure surface sides, so there is the concern that this will reduce blowing performance.

[0020] Thus, here, as described above, the trailing edge-side raised portions are formed in the shroud in such a way as to line the trailing edge-side sections of the blade axial end portions. For this reason, leakage of the airflow caused by gaps between the trailing edge-side sections of the blade axial end portions and the shroud curved plate portion can be curbed.

[0021] Because of this, here, leakage of the airflow caused by gaps between the trailing edge-side sections of the blade axial end portions and the shroud curved plate portion can be curbed to thereby curb a reduction in blowing performance caused by the gaps.

[0022] A centrifugal fan impeller pertaining to a sixth aspect is the centrifugal fan impeller pertaining to the fifth aspect, wherein the trailing edge-side raised portions are disposed in correspondence to just positive pressure surface sides of the blade axial end portions.

[0023] Here, leakage of the airflow caused by gaps between the trailing edge-side sections of the blade axial end portions and the shroud curved plate portion can be effectively curbed.

BRIEF DESCRIPTION OF DRAWINGS

[0024]

FIG. 1 is an external perspective view of an air conditioning apparatus in which a centrifugal fan equipped with an impeller pertaining to an embodiment of the present invention is employed.

FIG. 2 is a general side sectional view of the air conditioning apparatus.

FIG. 3 is an external perspective view of the impeller.

FIG. 4 is a view seen in the direction of arrow A in FIG. 3 (with part of a shroud being excluded).

FIG. 5 is a view seen in the direction of arrow B in FIG. 3 (with part of a main plate being excluded).

FIG. 6 is an enlarged view of portion C in FIG. 4.

FIG. 7 is an enlarged view of portion D in FIG. 5.

FIG. 8 is a view showing a cross section along line IV-IV of FIG. 7.

FIG. 9 is a view showing a cross section along line I-I of FIG. 6.

FIG. 10 is a view showing a cross section along line II-II of FIG. 6.

FIG. 11 is a view showing a cross section along line III-III of FIG. 6.

FIG. 12 is an external perspective view of the impeller pertaining to an example modification.

FIG. 13 is a view seen in the direction of arrow A in FIG. 12 (with part of the shroud being excluded).

FIG. 14 is an enlarged view of portion C in FIG. 13.

FIG. 15 is a view showing a cross section along line II-II of FIG. 14.

FIG. 16 is a view showing a cross section along line III-III of FIG. 14.

DESCRIPTION OF EMBODIMENT

[0025] An embodiment of a centrifugal fan impeller pertaining to the present invention will be described below on the basis of the drawings. It will be noted that the specific configurations of the centrifugal fan impeller pertaining to the present invention are not limited to those in the following embodiment and example modification and can be changed in a range that does not depart from the spirit of the invention.

(1) Overall Configuration of Air Conditioning Apparatus

[0026] In FIG. 1 is shown an external perspective view (with a ceiling being omitted) of an air conditioning apparatus 1 in which a centrifugal fan 4 equipped with an impeller 8 pertaining to an embodiment of the present invention is employed. The air conditioning apparatus 1 here is an air conditioning apparatus installed in a ceiling and mainly has a casing 2, which houses various constituent devices inside, and a decorative panel 3, which is disposed on the lower side of the casing 2.

[0027] The casing 2 of the air conditioning apparatus 1 is a box-like member whose undersurface is open. As shown in FIG. 2 (a general side sectional view of the air conditioning apparatus 1), the casing 2 is inserted and disposed in an opening formed in a ceiling of an air-conditioned room. Additionally, the decorative panel 3 has an air inlet 3a, which is disposed in the substantial center of the decorative panel 3 in order to suck the air in the air-conditioned room into the casing 2, and air outlets 3b, which are disposed so as to surround the outer periphery of the air inlet 3a in order to blow the air out from the casing 2 to the air-conditioned room. The decorative panel 3 is disposed in such a way as to be fitted into the opening in the ceiling.

[0028] Mainly disposed inside the casing 2 are a centrifugal fan 4 that sucks the air in the air-conditioned room into the casing 2 through the air inlet 3a in the decorative panel 3 and blows the air out in an outer peripheral direction, a heat exchanger 5 that surrounds the outer periphery of the centrifugal fan 4, and a bell mouth 6 for

guiding the air sucked in from the air inlet 3a to the centrifugal fan 4. The centrifugal fan 4 has a fan motor 7, which is provided in the substantial center of a top plate 2a of the casing 2, and the impeller 8, which is coupled to and driven to rotate by the fan motor 7.

[0029] It will be noted that the air conditioning apparatus 1 provided with the centrifugal fan 4 is not limited to an apparatus installed in a ceiling and may also be another type. Furthermore, the configuration of the impeller 8 will be described later.

(2) Configuration of Impeller

[0030] Next, the configuration of the impeller 8 will be described using FIG. 3 to FIG. 11. Here, FIG. 3 is an external perspective view of the impeller 8. FIG. 4 is a view seen in the direction of arrow A in FIG. 3 (with part of a shroud 80 being excluded). FIG. 5 is a view seen in the direction of arrow B in FIG. 3 (with part of a main plate 60 being excluded). FIG. 6 is an enlarged view of portion C in FIG. 4. FIG. 7 is an enlarged view of portion D in FIG. 5. FIG. 8 is a view showing a cross section along line IV-IV of FIG. 7. FIG. 9 is a view showing a cross section along line I-I of FIG. 6. FIG. 10 is a view showing a cross section along line II-II of FIG. 6. FIG. 11 is a view showing a cross section along line III-III of FIG. 6.

[0031] The impeller 8 mainly has a disc-shaped main plate 60 that is coupled to the fan motor 7, plural (here, seven) blades 70 that are annularly disposed around a rotational axis O of the main plate 60 on the side of the main plate 60 opposite the fan motor 7 side, and an annular shroud 80 that is disposed so as to sandwich the plural blades 70 between itself and the main plate 60 in the direction of the rotational axis O. Here, R denotes the rotational direction of the impeller 8.

[0032] The main plate 60 is a member made of resin having a substantially circular truncated cone-shaped hub portion 61 formed in the central portion thereof so as to project toward the air inlet 3a side. Formed in the hub portion 61 are, for example, plural (here, three) cooling-use air holes 62 being long holes formed adjacent to each other on a circle concentric with the main plate 60. Furthermore, the section of the main plate 60 on the outer peripheral side of the hub portion 61 is an annular flat plate-like flat plate portion 63.

[0033] The shroud 80 is a bell-shaped member made of resin that projects while curving toward the air inlet 3a side heading from its outer peripheral portion toward an opening in its central portion. Here, the curved plate-like section of the shroud 80 that curves in such a way that its diameter becomes smaller heading away from the blades 70 in the rotational axis O direction (i.e., heading toward the air inlet 3a side) is a shroud curved plate portion 81.

[0034] The blades 70 here are members made of resin molded separately from the main plate 60 and the shroud 80. End portions of the blades 70 on one side in the rotational axis O direction are main plate-side blade axial

end portions 71 disposed opposing the main plate 60 and are secured to the main plate 60. End portions of the blades 70 on the other side in the rotational axis O direction are shroud-side blade axial end portions 72 disposed opposing the shroud 80 and are secured to the shroud 80. Here, the blades 70 have a shape where, when the impeller 8 is viewed along the rotational axis O direction, the main plate-side blade axial end portions 71 are rearwardly inclined beyond the shroud-side blade axial end portions 72. Furthermore, the blades 70 are hollow blades mainly having blade bodies 73 and blade covers 74, and the blade covers 74 are attached to the blade bodies 73 by being fitted therein and form hollow spaces S between themselves and the blade bodies 73, whereby the blades 70 are reduced in weight. It will be noted that the hollowing of the blades 70 may also be accomplished by blow molding, for example, rather than being accomplished by a structure where the two members 73 and 74 are fitted together. Furthermore, here, concavo-convex shapes for improving the performance of the centrifugal fan 4 are formed in the trailing edge portions of the blades 70, but in a case where sufficient performance can be obtained without forming the concavo-convex shapes, it is not invariably necessary to form the concavo-convex shapes. Furthermore, here, the blades 70 are members separate from the main plate 60 and the shroud 80, but the blades 70 are not limited to this and may also be molded integrally with the main plate 60. In this case, it suffices simply to secure the blades 70 to the shroud 80.

[0035] Additionally, the securing of the main plate-side blade axial end portions 71 of the blades 70 to the main plate 60 is performed by welding the main plate-side blade axial end portions 71 and the main plate 60 to each other, and the welded sections form main plate-side welded portions 8a. Here, as the method of welding the blades 70 to the main plate 60, a method that applies ultrasonic waves to the flat plate portion 63 of the main plate 60 and flat surfaces 71a of the main plate-side blade axial end portions 71 of the blades 70 to thereby weld the flat plate portion 63 and the flat surfaces 71a to each other (ultrasonic welding) is employed. However, the method of welding the blades 70 to the main plate 60 is not limited to ultrasonic welding so long as it is a method of welding the flat plate portion 63 and the flat surfaces 71a to each other, and another welding method may also be employed, such as, for example, employing a method that applies a laser to the flat plate portion 63 and the flat surfaces 71a to thereby weld the flat plate portion 63 and the flat surfaces 71a to each other (laser welding).

[0036] Furthermore, the securing of the shroud-side blade axial end portions 72 of the blades 70 to the shroud 80 is performed by welding the shroud-side blade axial end portions 72 and the shroud 80 to each other, and the welded sections form shroud-side welded portions 8b. Here, flat plate-like shroud flat plate portions 82 are formed in the shroud 80 in correspondence to just parts of the sections of the shroud 80 that oppose the shroud-side blade axial end portions 72, and the shroud-side

welded portions 8b are disposed in the shroud flat plate portions 82. That is, the shroud 80 is largely configured by the curved plate-like shroud curved plate portion 81 curved in such a way that its diameter becomes smaller heading away from the blades 70 in the rotational axis O direction, but the flat plate-like flat plate portions 82 perpendicular to the rotational axis O direction are formed in just parts of the sections of the shroud curved plate portion 81 corresponding to the shroud-side blade axial end portions 72. Additionally, in the shroud-side blade axial end portions 72 of the blades 70 are formed blade flat surfaces 72a being flat surfaces that follow the shroud flat plate portions 82 and blade curved surfaces 72b and 72c being curved surfaces that follow the shroud curved plate portion 81. The blade flat surfaces 72a oppose the shroud flat plate portions 82 and, like the shroud flat plate portions 82, are surfaces perpendicular to the rotational axis O direction. Consequently, the blade flat surfaces 72a of the shroud-side blade axial end portions 72 oppose the shroud flat plate portions 82, and the blade curved surfaces 72b and 72c of the shroud-side blade axial end portions 72 oppose the shroud curved plate portion 81, whereby the shroud-side blade axial end portions 72 entirely follow the shroud 80. The shroud-side welded portions 8b are formed as a result of the blade flat surfaces 72a and the shroud flat plate portions 82 being welded to each other. Here, as the method of welding the blades 70 to the shroud 80, a method that applies ultrasonic waves to the shroud flat plate portions 82 of the shroud 80 and the blade flat surfaces 72a of the shroud-side blade axial end portions 72 of the blades 70 to thereby weld the shroud flat plate portions 82 and the blade flat surfaces 72a to each other (ultrasonic welding) is employed. However, the method of welding the blades 70 to the shroud 80 is not limited to ultrasonic welding so long as it is a method of welding the shroud flat plate portions 82 and the blade flat surfaces 72a to each other, and another welding method may also be employed, such as, for example, employing a method that applies a laser to the shroud flat plate portions 82 and the blade flat surfaces 72a to thereby weld the shroud flat plate portions 82 and the blade flat surfaces 72a to each other (laser welding).

[0037] Here, the blade flat surfaces 72a are disposed so as to correspond to the vicinities of chord length direction centers of the shroud-side blade axial end portions 72. For this reason, the shroud flat plate portions 82 are also disposed in the vicinities of the chord length direction centers of the shroud-side blade axial end portions 72. Additionally, of the blade curved surfaces 72b and 72c, the ones on the leading edge sides—that is, the curved surfaces on the leading edge sides of the blade flat surfaces 72a—are leading edge-side blade curved surfaces 72b, and of the blade curved surfaces 72b and 72c, the ones on the trailing edge sides—that is, the curved surfaces on the trailing edge sides of the blade flat surfaces 72a—are trailing edge-side blade curved surfaces 72c.

[0038] Furthermore, shroud step portions 83 that interconnect the shroud flat plate portions 82 and the shroud curved plate portion 81 are formed in the shroud 80 on the peripheral sections of the shroud flat plate portions 82, and blade stepped portions 72d that can fit together with the shroud stepped portions 83 and interconnect the blade curved surfaces 72b and 72c are formed in the shroud-side blade axial end portions 72 on the peripheral sections of the blade flat surfaces 72a. Additionally, the blade stepped portions 77 are configured to fit together with the shroud stepped portions 83 in a state in which the shroud flat plate portions 82 and the blade flat plate portions 72a lie on top of each other in the rotational axis O direction. That is, the blades 70 are positioned in predetermined positions on the shroud 80 because of the shroud stepped portions 83 and the blade stepped portions 72d.

(3) Characteristics of Centrifugal Fan Impeller

[0039] The impeller 8 of the centrifugal fan 4 has the following characteristics in relation to the structure in the vicinity of the shroud-side welded portions 8b formed between the shroud-side blade axial end portions 72 of the blades 70 and the shroud 80.

<A>

[0040] Here, as described above, the shroud 80 has the curved plate-like shroud curved plate portion 81 and the flat plate-like shroud flat plate portions 82 formed in correspondence to just parts of the sections of the shroud 80 that oppose the blade axial end portions 72. In the blade axial end portions 72 are formed the blade flat surfaces 72a being flat surfaces that follow the shroud flat plate portions 82 and the blade curved surfaces 72b and 72c being curved surfaces that follow the shroud curved plate portion 81. The welded portions 8b resulting from the blade flat surfaces 72a and the shroud flat plate portions 82 being welded to each other are formed between the blade axial end portions 72 and the shroud 80. That is, here, the impeller 8 employs a structure where the sections at which the blades 70 and the shroud 80 oppose each other are largely left as a curved plate portion (the shroud curved plate portion 81) and curved surfaces (the blade curved surfaces 72b and 72c) and where flat plate portions (the shroud flat plate portions 82) and flat surfaces (the blade flat surfaces 72a) are formed, and welded to each other, in just parts of the sections at which the blades 70 and the shroud 80 oppose each other. For this reason, here, in comparison to a case where the impeller employs a conventional structure where staircase shapes are formed in the blades and the shroud and welded to each other, it becomes difficult for the airflow in the vicinity of the shroud 80 to be obstructed.

[0041] Because of this, here, the airflow in the vicinity of the shroud 80 can be improved to thereby achieve an improvement in blowing performance and a reduction in

blowing noise.

[0042] Here, as described above, in employing a structure where the flat plate portions (the shroud flat plate portions 82) and the flat surfaces (the blade flat surfaces 72a) are formed, and welded to each other, in just parts of the sections at which the blades 70 and the shroud 80 oppose each other, the welding of the blades 70 and the shroud 80 to each other is performed at the sections in the vicinities of the chord length direction centers of the blade axial end portions 72. For this reason, in comparison to a case where the welding of the blades 70 and the shroud 80 to each other is performed at the leading edge-side sections and/or the trailing edge-side sections of the blade axial end portions 72, robust welding becomes possible.

[0043] Because of this, here, the area of the blade flat surfaces 72a required for welding and the area of the shroud flat plate portions 82 corresponding thereto can be reduced.

(4) Example Modification

[0044] In employing a structure where, as described above, the flat plate portions (the shroud flat plate portions 82) and the flat surfaces (the blade flat surfaces 72a) are formed, and welded to each other, in just parts of the sections at which the blades 70 and the shroud 80 oppose each other, when the welding of the blades 70 and the shroud 80 to each other is performed at the sections in the vicinities of the chord length direction centers of the blade axial end portions (see FIG. 9), there is the concern that gaps will form between the leading edge-side sections of the shroud-side blade axial end portions 72 and the shroud curved plate portion 81 because of, for example, strain during the molding of the blades 70 and the shroud 80 (see FIG. 10). Additionally, such gaps at the leading edge-side sections of the shroud-side blade axial end portions 72 cause a disruption in the airflow heading through the opening in the central portion of the shroud 80 toward the leading edges of the blades 70, so there is the concern that this will increase blowing noise.

[0045] Thus, here, as shown in FIG. 12 to FIG. 15, leading edge-side recessed portions 84, into which the leading edge-side sections of the shroud-side blade axial end portions 72 are insertable, are formed in the shroud 80. For this reason, disruption of the airflow caused by gaps between the leading edge-side sections of the shroud-side blade axial end portions 72 and the shroud curved plate portion 81 can be curbed. Here, when the leading edge-side recessed portions 84 are formed in the shroud 80, there is an adverse impact on blowing performance and blowing noise, but here, by forming the leading edge-side recessed portions 84 in such a way as to follow the blade curved surfaces 72b, the adverse

impact on blowing performance and blowing noise caused by the leading edge-side recessed portions 84 is curbed.

[0046] Because of this, here, disruption of the airflow caused by gaps between the leading edge-side sections of the shroud-side blade axial end portions 72 and the shroud curved plate portion 81 can be curbed to thereby curb an increase in blowing noise caused by the gaps.

[0047] In particular, here, as shown in FIG. 15, the leading edge-side recessed portions 84 project from the shroud curved plate portion 81 toward the side opposite the blade 70 side in the rotational axis O direction in such a way as to form curved plate portions parallel to the shroud curved plate portion 81.

[0048] Because of this, here, the adverse impact on blowing performance and blowing noise caused by the leading edge-side recessed portions 84 can be effectively curbed.

[0049] It will be noted that although it is not employed here, a seal material may be disposed between the leading edge-side sections of the shroud-side blade axial end portions 72 and the leading edge-side recessed portions 84 in order to further enhance the effect of curbing disruption of the airflow caused by gaps between the leading edge-side sections of the shroud-side blade axial end portions 72 and the shroud curved plate portion 81. Furthermore, in a case where it is possible to satisfy the blowing performance and the blowing noise required of the impeller 8 without forming the leading edge-side recessed portions 84, it is alright not to form the leading edge-side recessed portions 84.

[0050] Furthermore, when the welding of the blades 70 and the shroud 80 to each other is performed at the sections in the vicinities of the chord length direction centers of the blade axial end portions (see FIG. 9), there is the concern that gaps will also form between the trailing edge-side sections of the shroud-side axial end portions 72 and the shroud curved plate portion 81 because of, for example, strain during the molding of the blades 70 and the shroud 80. Additionally, such gaps at the trailing edge-side sections of the shroud-side blade axial end portions 72 cause some of the airflow heading along the positive pressure surfaces of the blades 70 from the leading edges to the trailing edges to leak midway from the positive pressure surface sides to the negative pressure surface sides, so there is the concern that this will reduce blowing performance.

[0051] Thus, here, as shown in FIG. 12 to FIG. 14 and FIG. 16, trailing edge-side raised portions 85 are formed in the shroud 80 in such a way as to line the trailing edge-side sections of the shroud-side blade axial end portions 72. For this reason, leakage of the airflow caused by gaps between the trailing edge-side sections of the shroud-side blade axial end portions 72 and the shroud curved plate portion 81 can be curbed.

[0052] Because of this, here, leakage of the airflow caused by gaps between the trailing edge-side sections of the shroud-side blade axial end portions 72 and the

shroud curved plate portion 81 can be curbed to thereby curb a reduction in blowing performance caused by the gaps.

[0053] In particular, here, as shown in FIG. 16, the trailing edge-side raised portions 85 are disposed in correspondence to just the positive pressure surface sides of the shroud-side blade axial end portions 72.

[0054] Because of this, here, leakage of the airflow caused by gaps between the trailing edge-side sections of the shroud-side blade axial end portions 72 and the shroud curved plate portion 81 can be effectively curbed.

[0055] It will be noted that in a case where it is possible to satisfy the blowing performance and the blowing noise required of the impeller 8 without forming the trailing edge-side raised portions 85, it is alright not to form the trailing edge-side raised portions 85.

INDUSTRIAL APPLICABILITY

[0056] The present invention is widely applicable to a centrifugal fan impeller equipped with plural blades that are annularly disposed around a rotational axis and a main plate and a shroud that are disposed so as to sandwich the rotational axis direction sides of the blades, with blade axial end portions, which are end portions of the blades on one side in the rotational axis direction, and the shroud being welded to each other.

REFERENCE SIGNS LIST

[0057]

4	Centrifugal Fan
8	Impeller
8b	Shroud-side Welded Portions
60	Main Plate
70	Blades
72	Shroud-side Blade Axial End Portions
72a	Blade Flat Surfaces
72b, 72c	Blade Curved Surfaces
80	Shroud
81	Shroud Curved Plate Portion
82	Shroud Flat Plate Portions
84	Leading Edge-side Recessed Portions
85	Trailing Edge-side Raised Portions

CITATION LIST

<Patent Literature>

[0058]

Patent Document 1: JP-A No. 2005-155510
Patent Document 2: JP-A No. 2015-86827

Claims

posed in correspondence to just positive pressure surface sides of the blade axial end portions.

1. A centrifugal fan (4) impeller (8) comprising:

plural blades (70) that are annularly disposed 5
around a rotational axis; and
a main plate (60) and a shroud (80) that are dis-
posed so as to sandwich the rotational axis di-
rection sides of the blades,
with blade axial end portions (72), which are end 10
portions of the blades on one side in the rota-
tional axis direction, and the shroud being weld-
ed to each other,
wherein
the shroud has a curved plate-like shroud curved 15
plate portion (81) curved in such a way that its
diameter becomes smaller heading away from
the blades in the rotational axis direction and flat
plate-like shroud flat plate portions (82) formed 20
in correspondence to just parts of the sections
of the shroud that oppose the blade axial end
portions,
in the blade axial end portions are formed blade
flat surfaces (72a) being flat surfaces that follow 25
the shroud flat plate portions and blade curved
surfaces (72b, 72c) being curved surfaces that
follow the shroud curved plate portion, and
welded portions (8b) resulting from the blade flat
surfaces and the shroud flat plate portions being 30
welded to each other are formed between the
blade axial end portions and the shroud.

2. The centrifugal fan impeller according to claim 1,
wherein the blade flat surfaces are disposed in the 35
vicinities of chord length direction centers of the
blade axial end portions.

3. The centrifugal fan impeller according to claim 2,
wherein leading edge-side recessed portions (84),
into which leading edge-side sections of the blade 40
axial end portions are insertable, are formed in the
shroud in such a way as to follow the blade curved
surfaces.

4. The centrifugal fan impeller according to claim 3, 45
wherein the leading edge-side recessed portions
project from the shroud curved plate portion in such
a way as to form curved plate portions parallel to the
shroud curved plate portion.

5. The centrifugal fan impeller according to any one of 50
claims 2 to 4, wherein trailing edge-side raised por-
tions (85) are formed in the shroud in such a way as
to line trailing edge-side sections of the blade axial
end portions.

6. The centrifugal fan impeller according to claim 5,
wherein the trailing edge-side raised portions are dis-

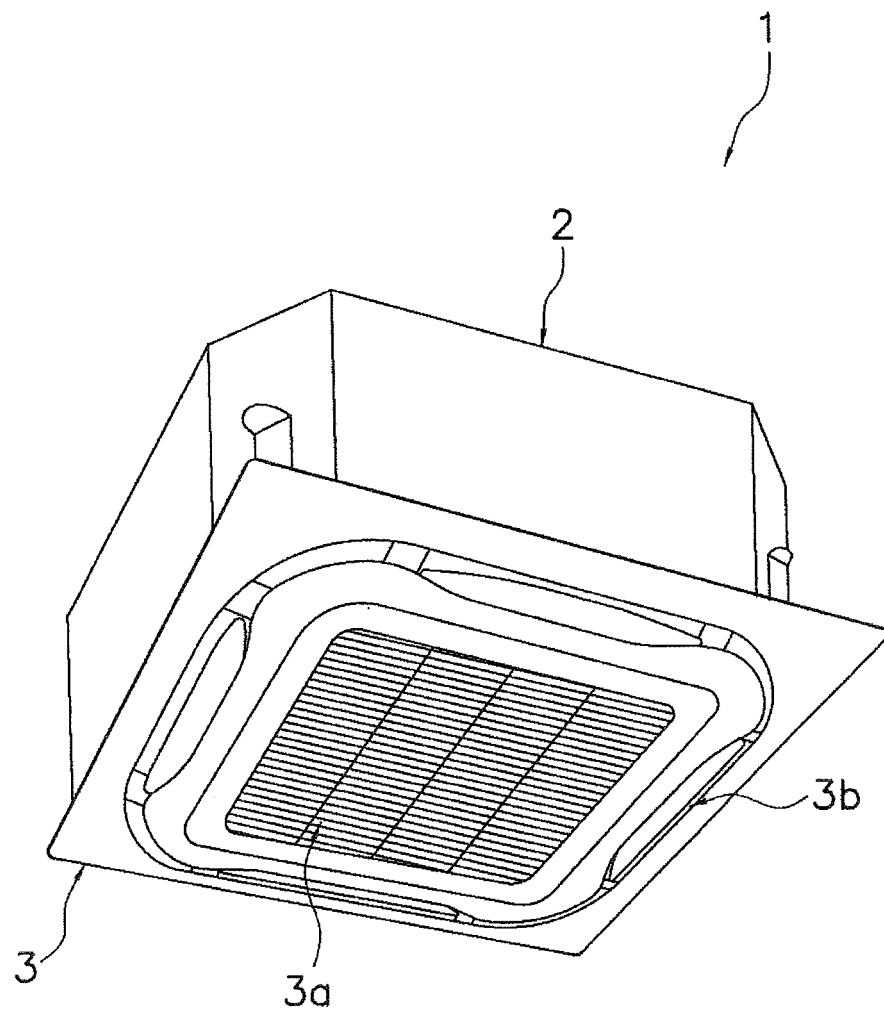


FIG. 1

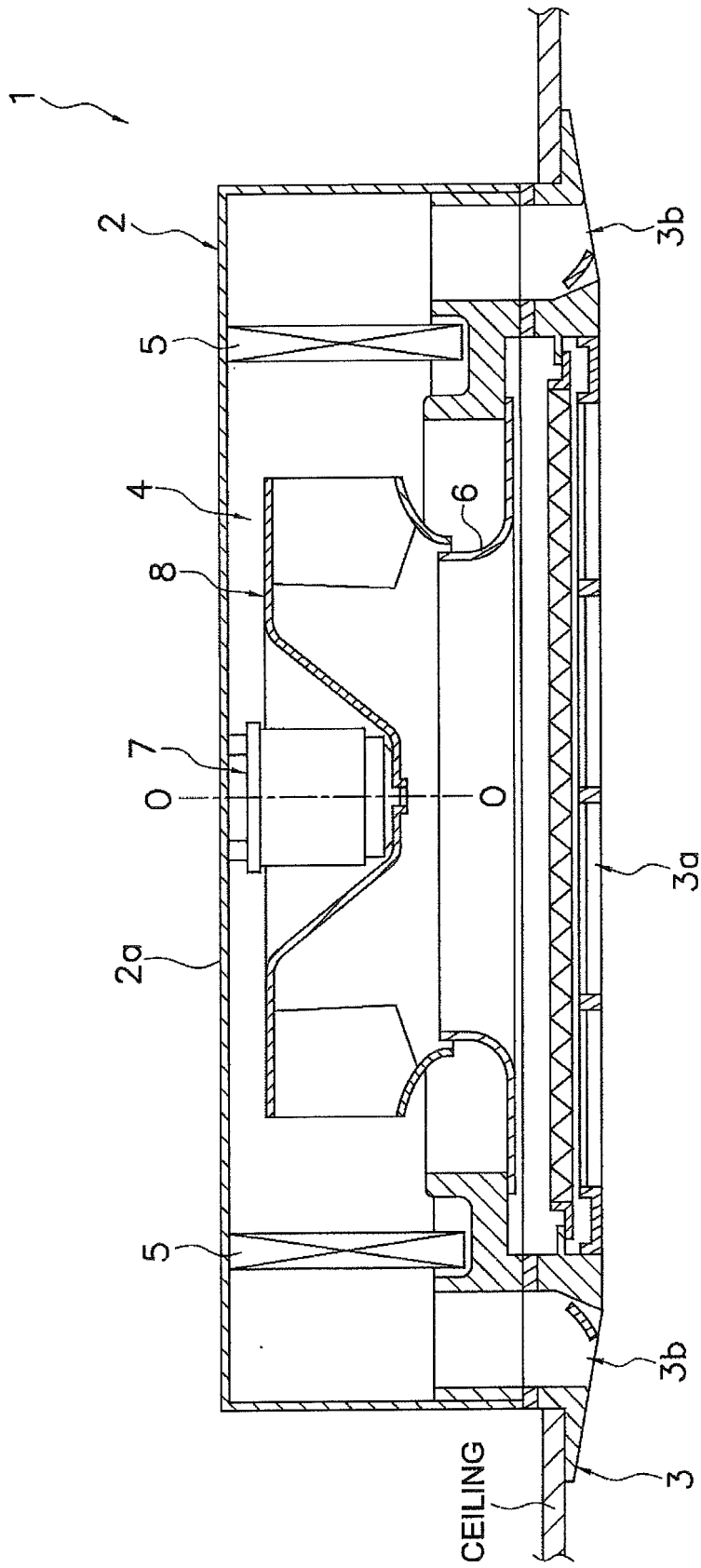


FIG. 2

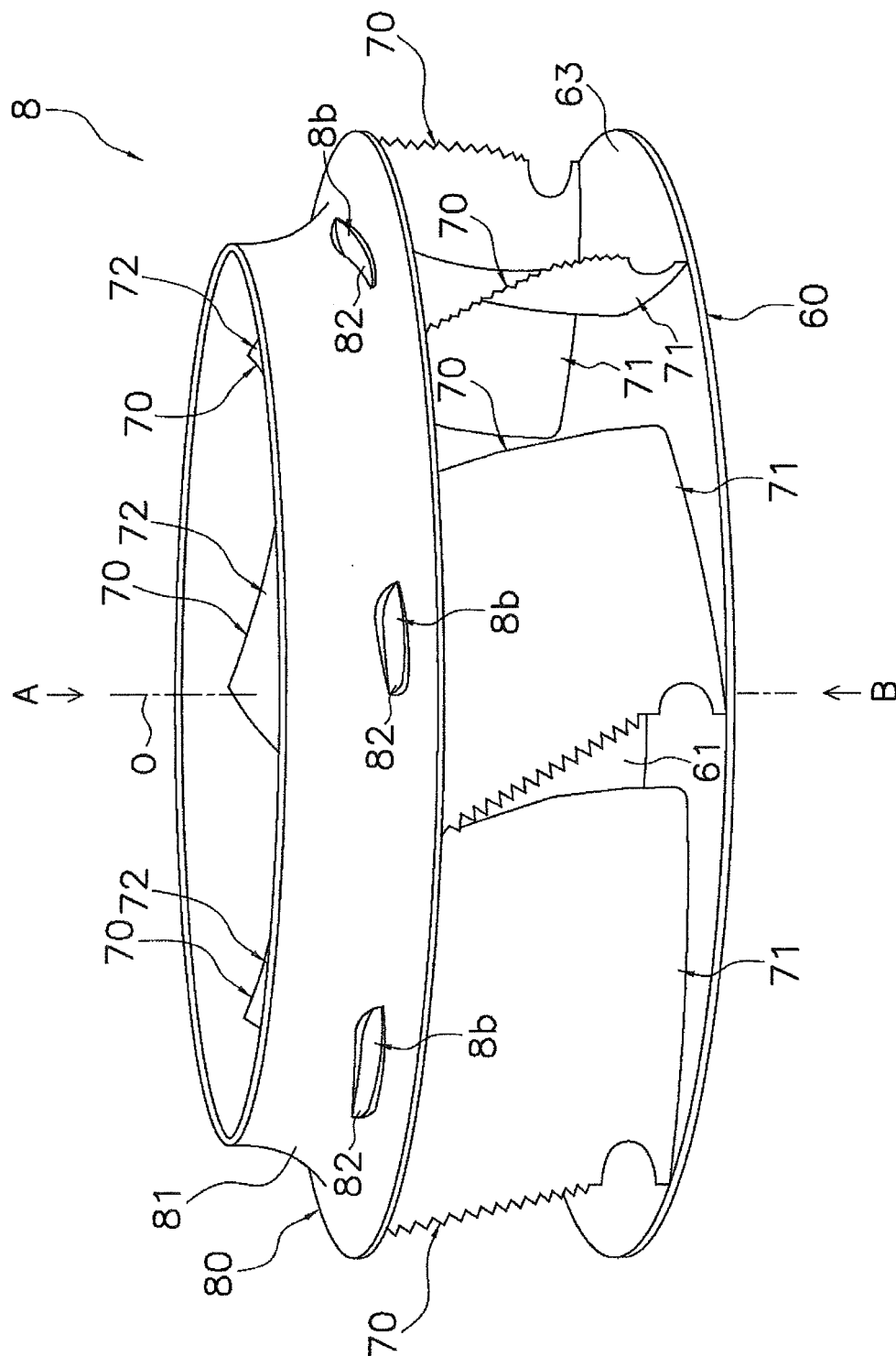


FIG. 3

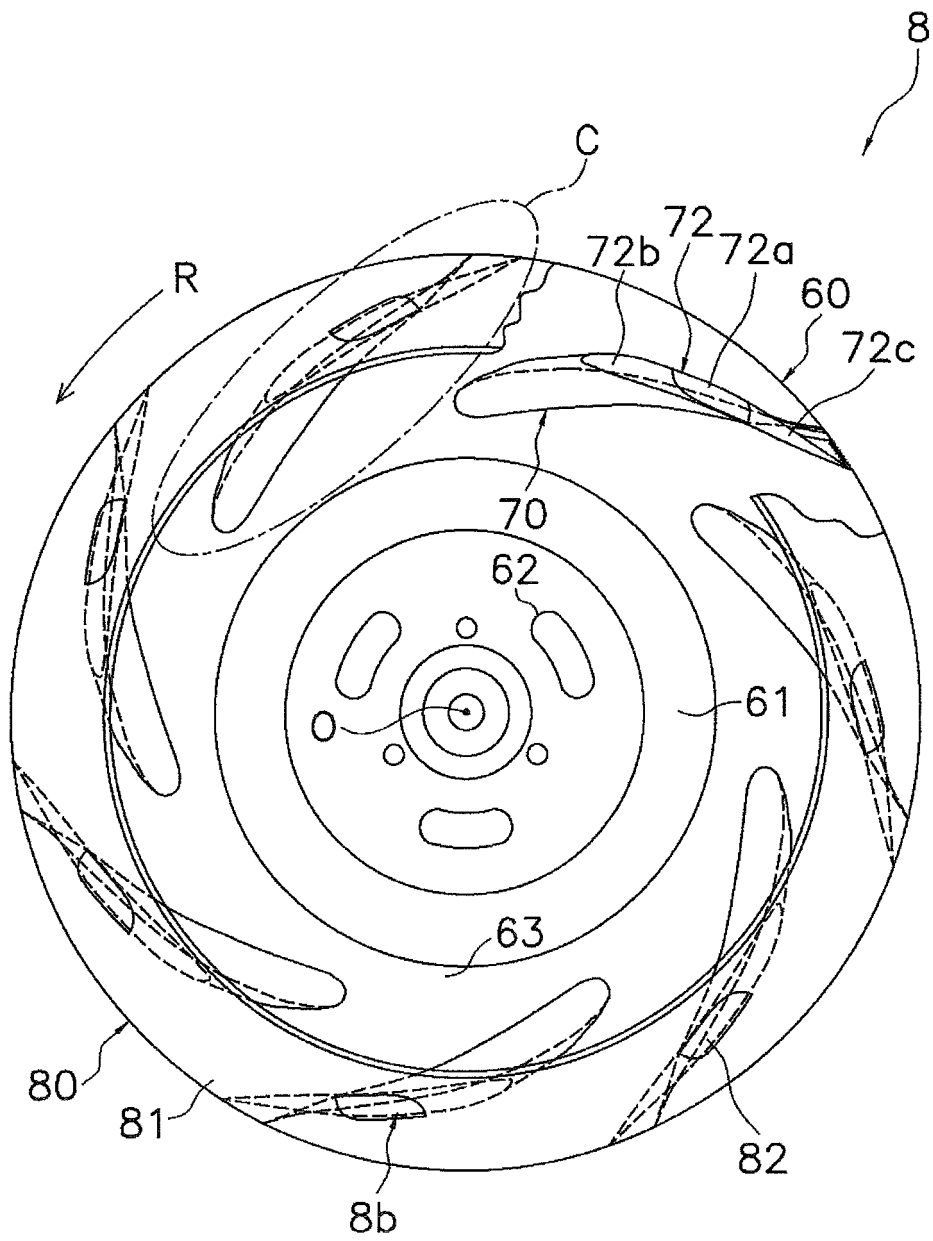


FIG. 4

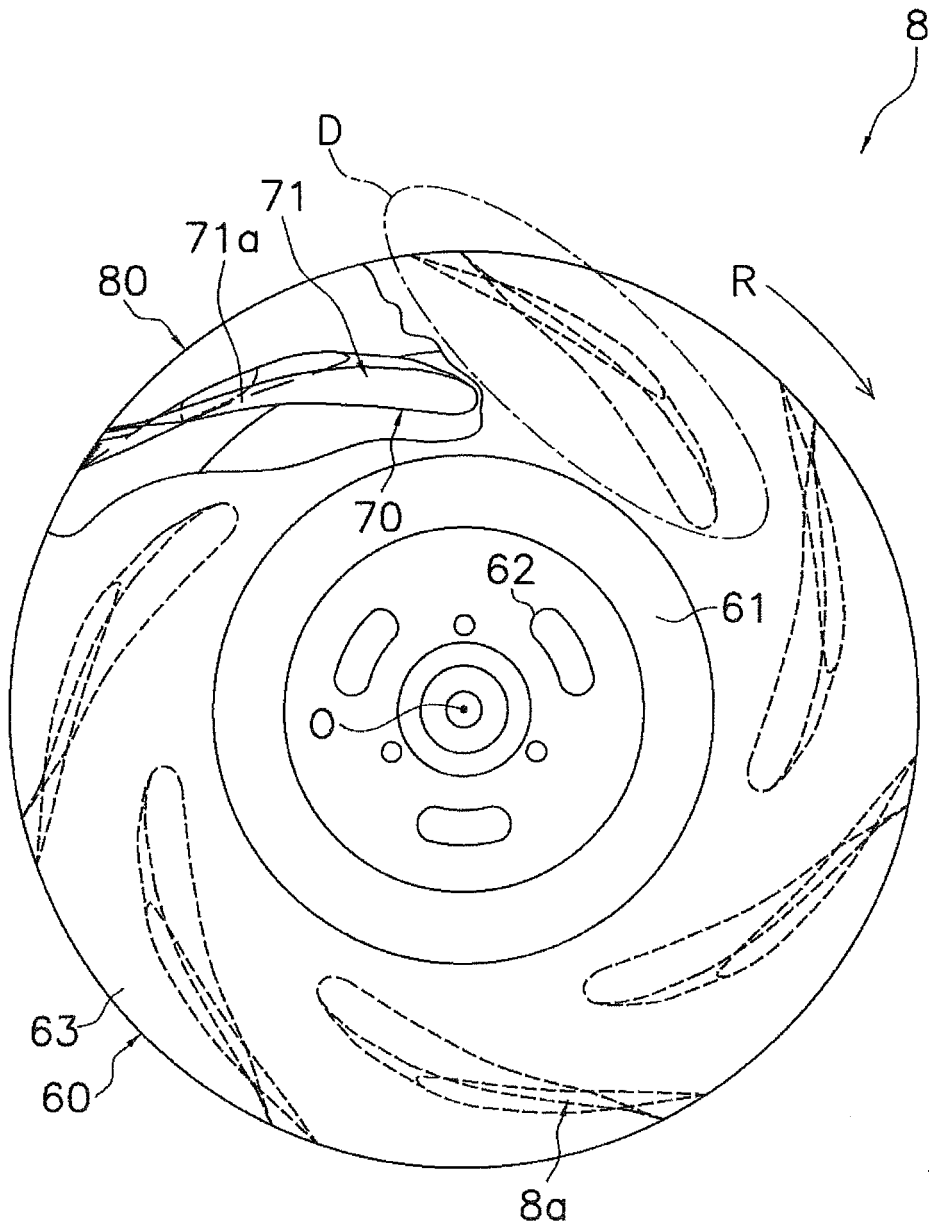


FIG. 5

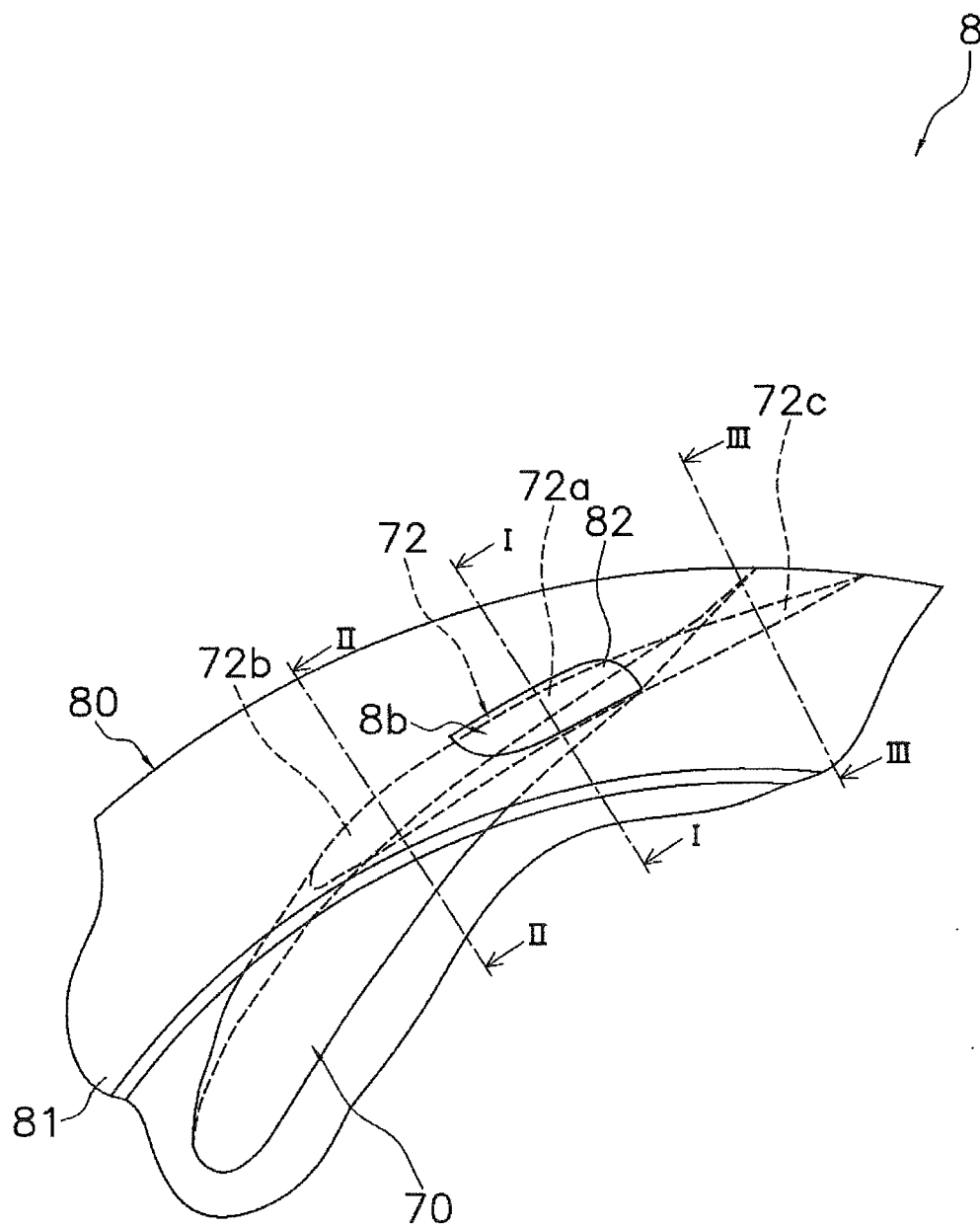


FIG. 6

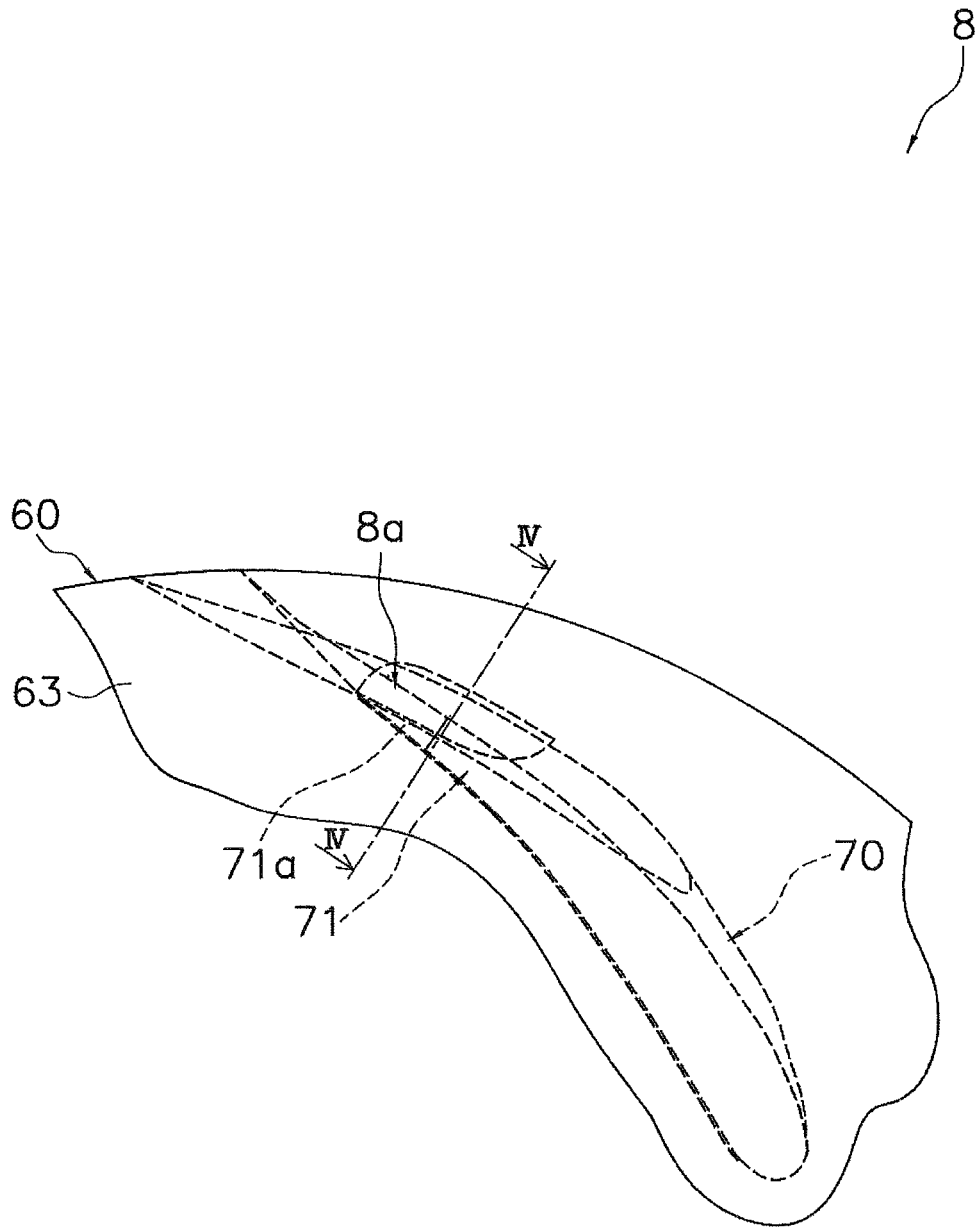


FIG. 7

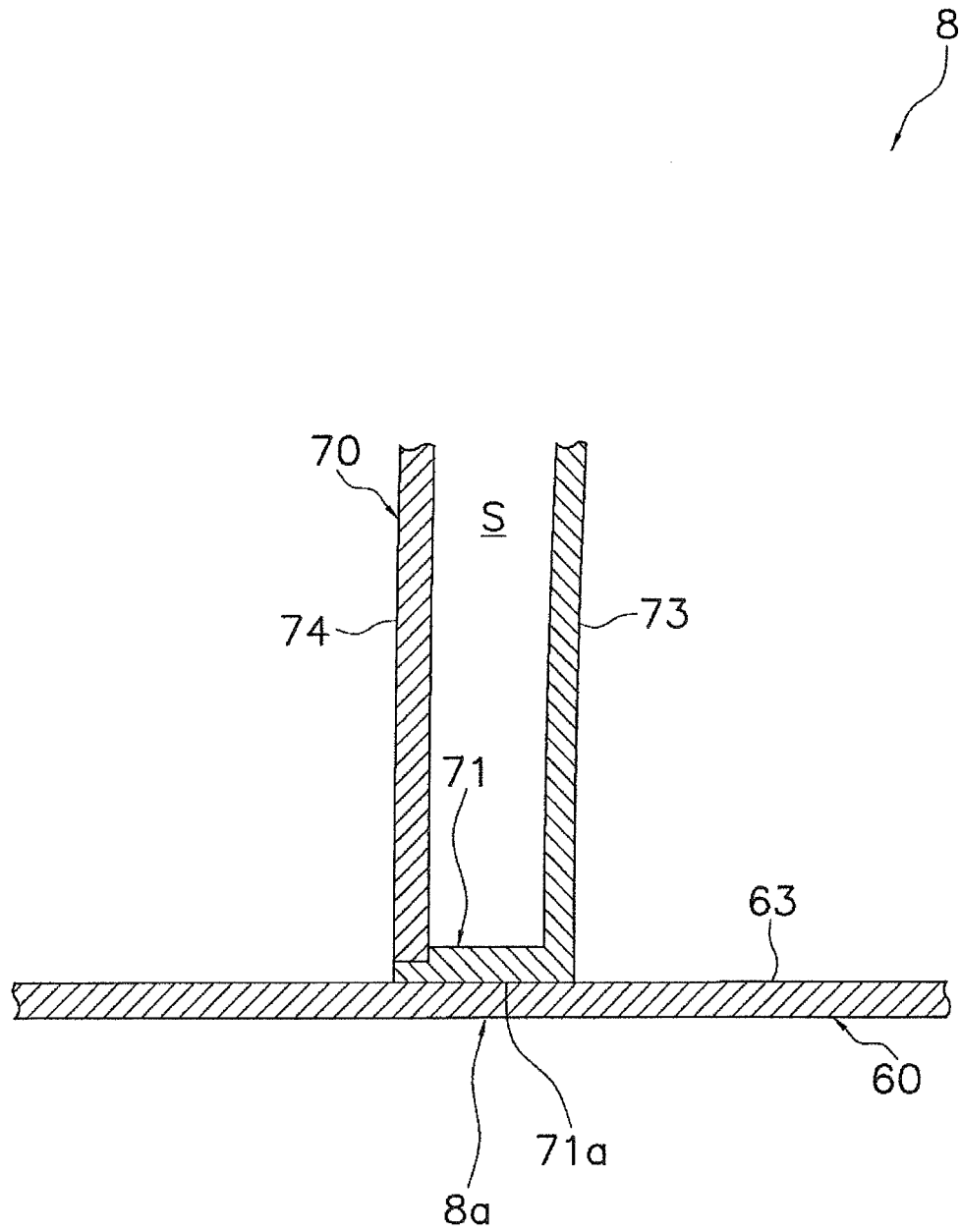


FIG. 8

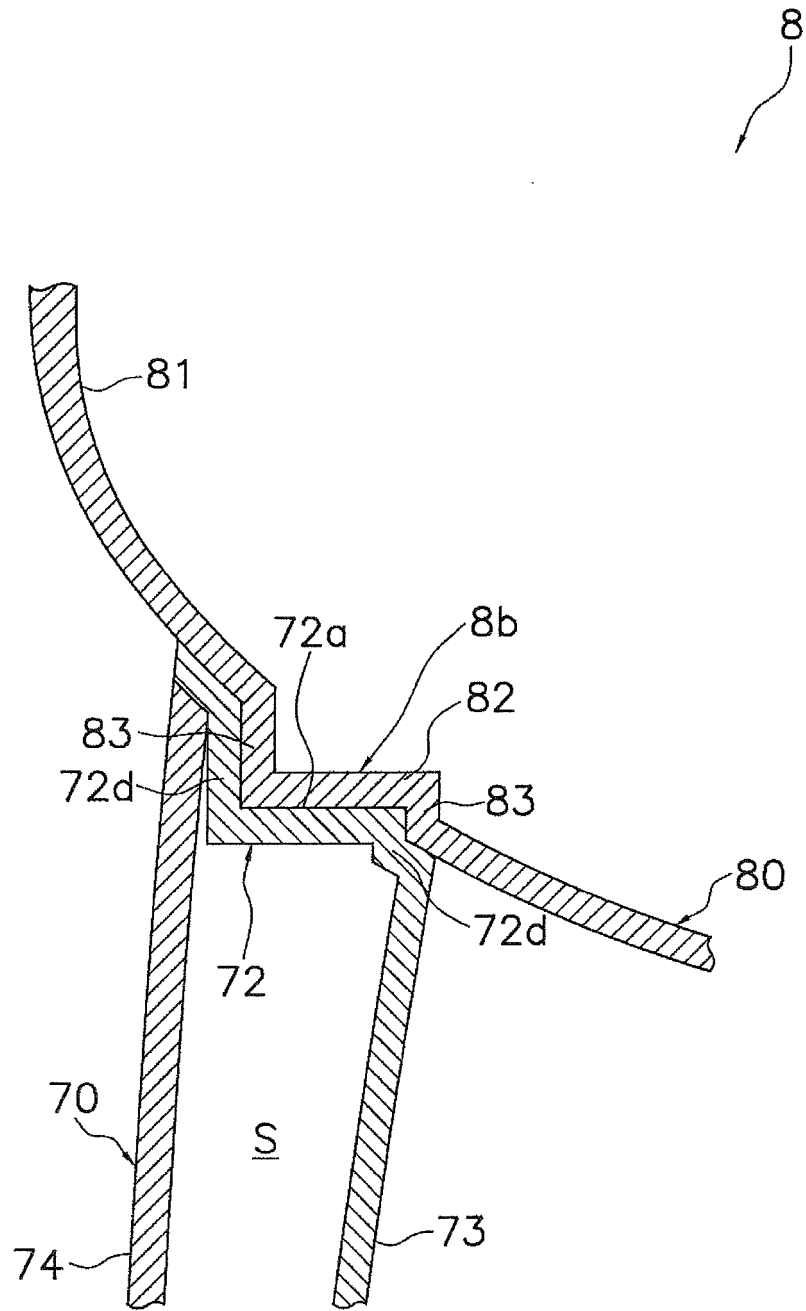


FIG. 9

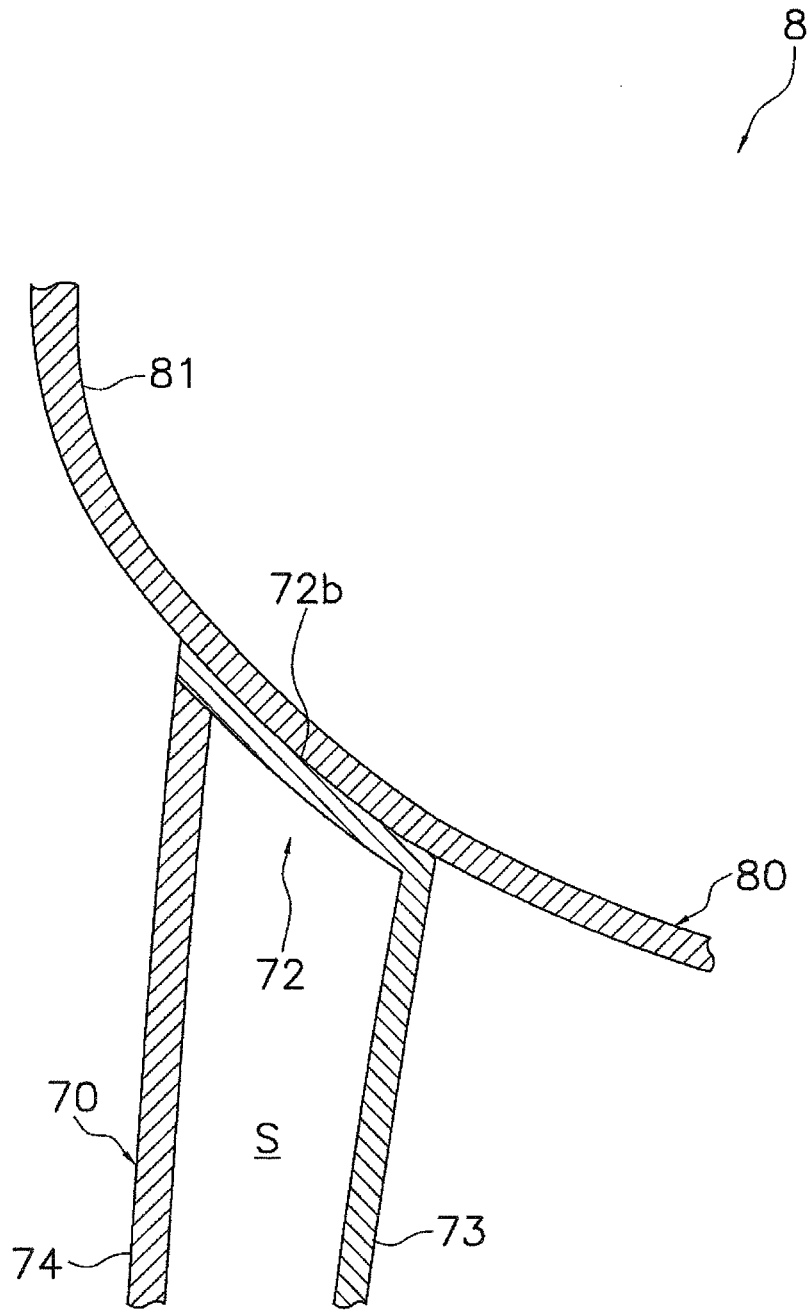


FIG. 10

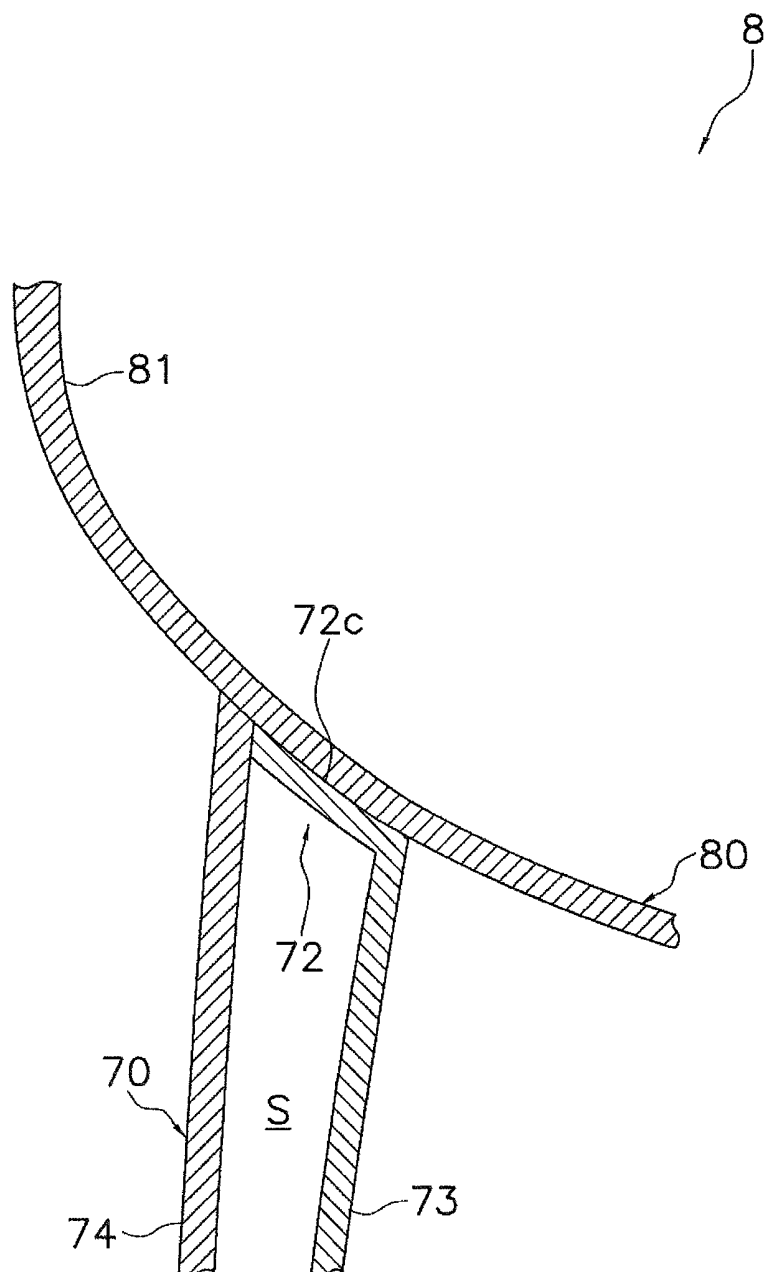


FIG. 11

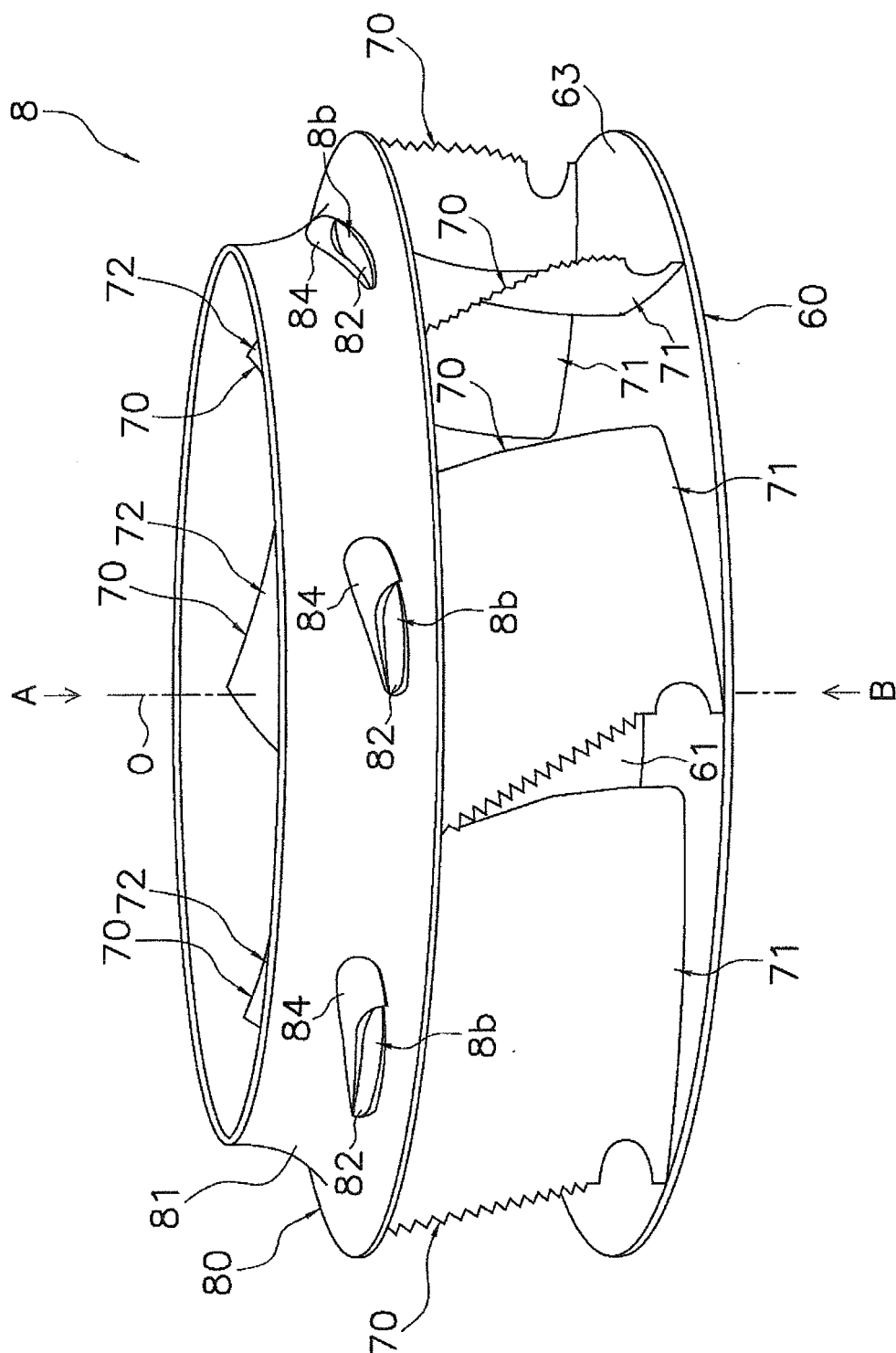


FIG. 12

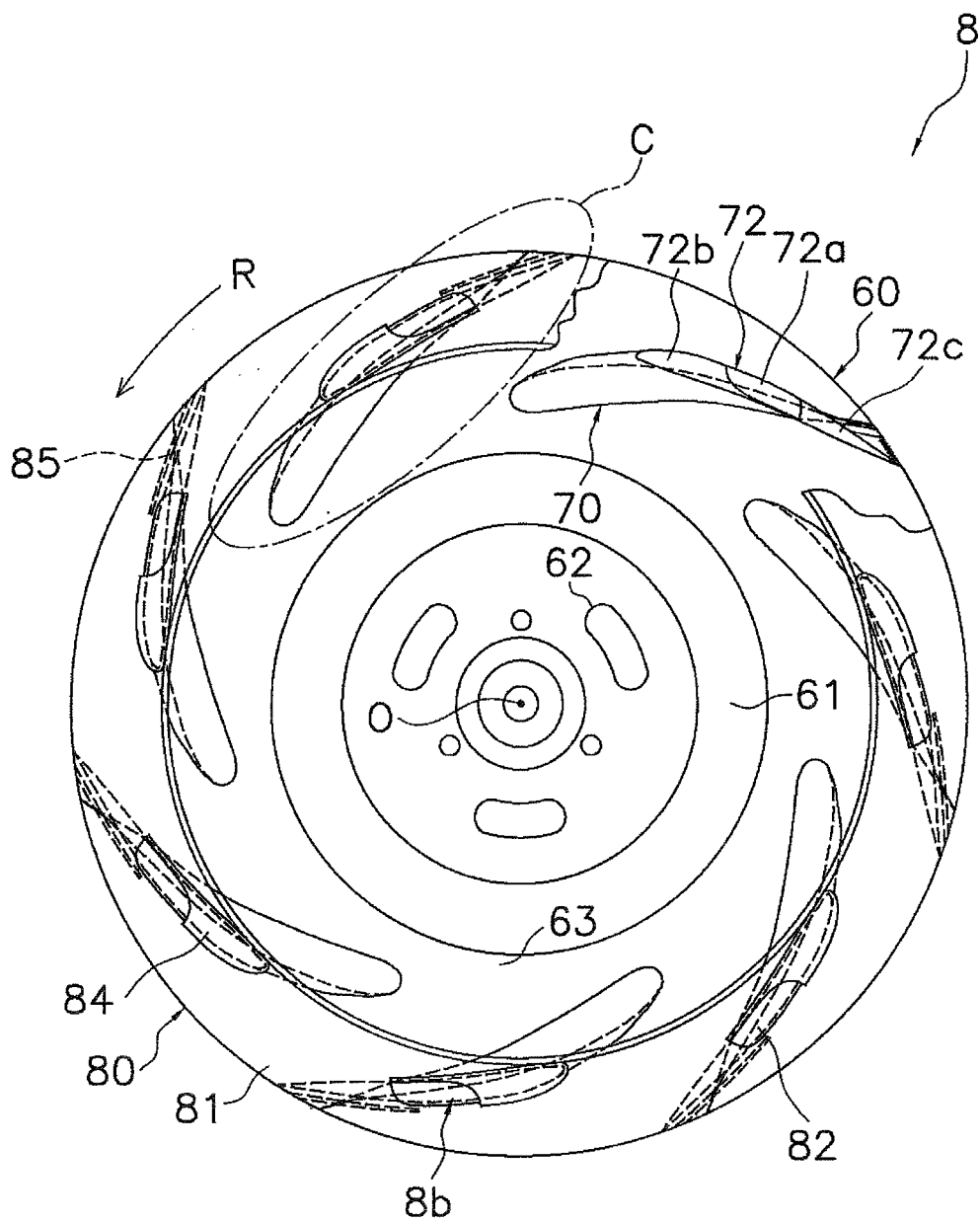


FIG. 13

8

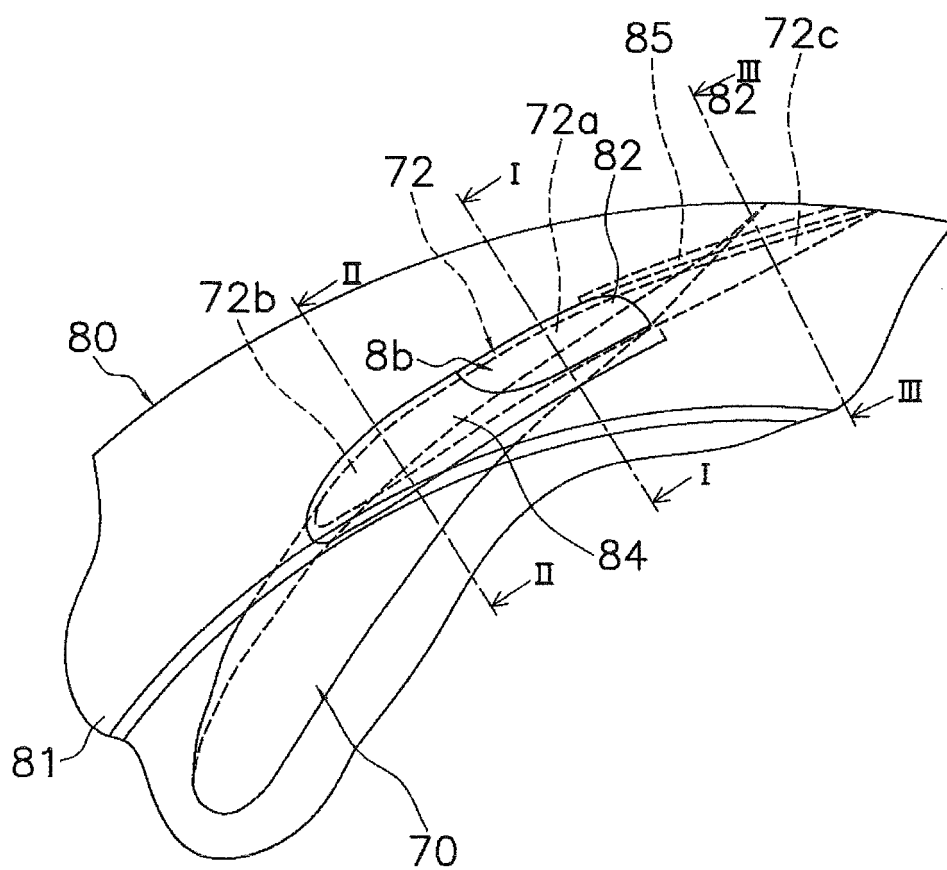


FIG. 14

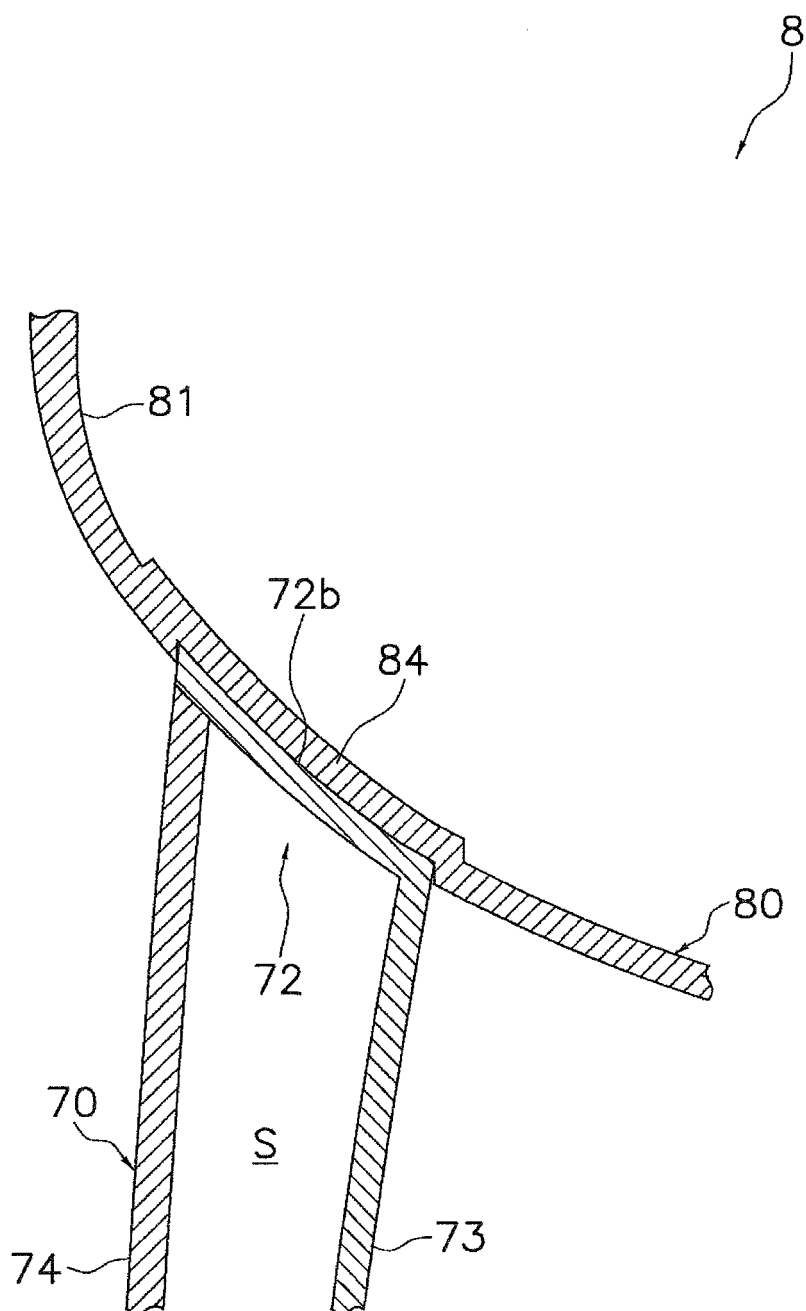


FIG. 15

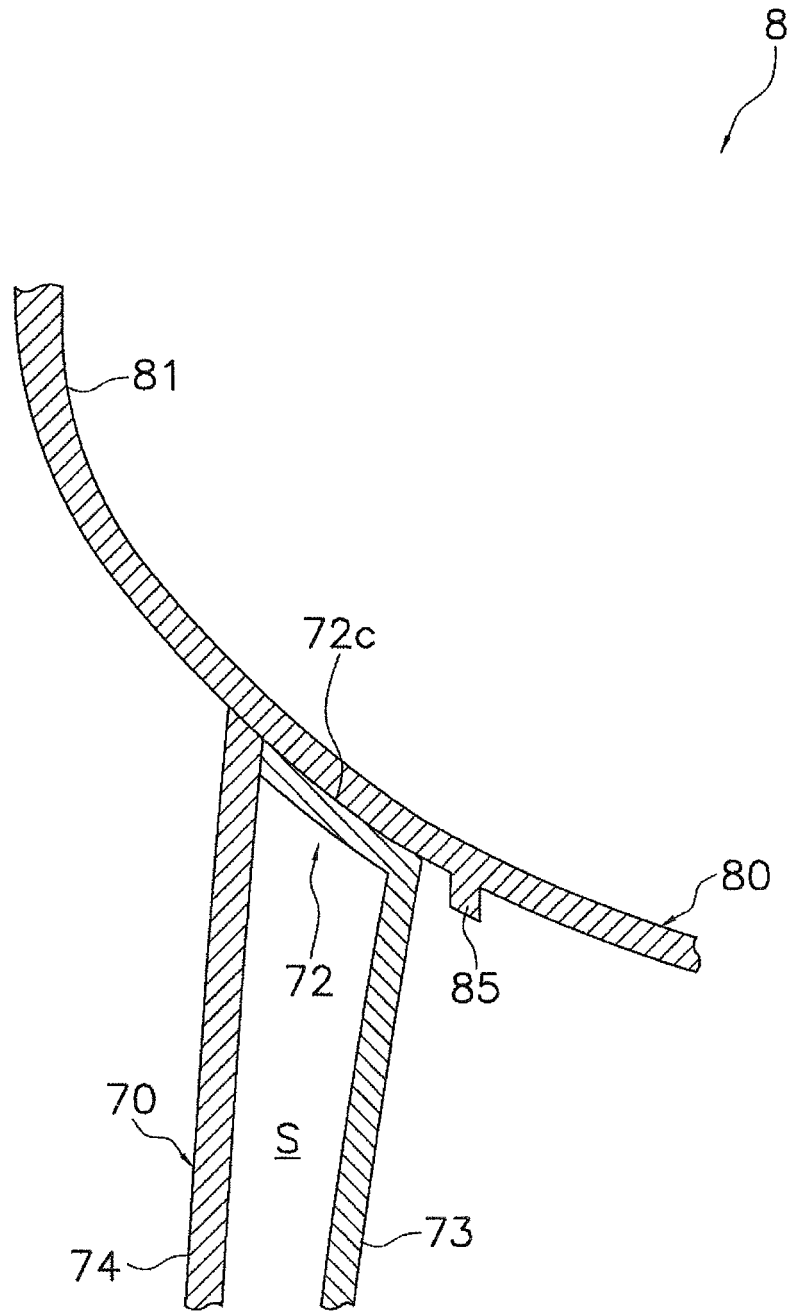


FIG. 16

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2017/001105

A. CLASSIFICATION OF SUBJECT MATTER

F04D29/28(2006.01)i, F04D29/66(2006.01)i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

F04D29/28, F04D29/66

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

Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2017

Kokai Jitsuyo Shinan Koho 1971-2017 Toroku Jitsuyo Shinan Koho 1994-2017

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 2007-120445 A (Mitsubishi Electric Corp.),	1-2
Y	17 May 2007 (17.05.2007), paragraphs [0010] to [0012]; fig. 1 to 6 (Family: none)	3-6
Y	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 116573/1988(Laid-open No. 037296/1990)	3-6
A	(Matsushita Electric Industrial Co., Ltd.), 12 March 1990 (12.03.1990), specification, page 5, lines 1 to 12 (Family: none)	1-2

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

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"&" document member of the same patent family

Date of the actual completion of the international search
01 March 2017 (01.03.17)Date of mailing of the international search report
14 March 2017 (14.03.17)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/JP2017/001105

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2011-080409 A (Mitsubishi Electric Corp.), 21 April 2011 (21.04.2011), fig. 5 to 7 (Family: none)	1-6
A	JP 2006-017063 A (Matsushita Electric Industrial Co., Ltd.), 19 January 2006 (19.01.2006), fig. 18 (Family: none)	1-6
P,A	JP 6056952 B1 (Daikin Industries, Ltd.), 11 January 2017 (11.01.2017), claims 4 to 5 (Family: none)	1-6
P,A	JP 6056953 B1 (Daikin Industries, Ltd.), 11 January 2017 (11.01.2017), fig. 3 (Family: none)	1-6

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

REFERENCES CITED IN THE DESCRIPTION

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- JP 2005155510 A [0003] [0058]
- JP 2015086827 A [0003] [0058]