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(54) **AXIAL FLOW FAN**

(57) An axial-flow fan (70) is integrally resin-molded with a hub (71) and a plurality of blades (72) formed so as to project from an outer perimeter edge of the hub (71). A first blade thinned-out part (74) is formed in a joint (73) of the blade (72) with the hub (71) so that a radial rib (75) extending radially toward the outer perimeter side is left.

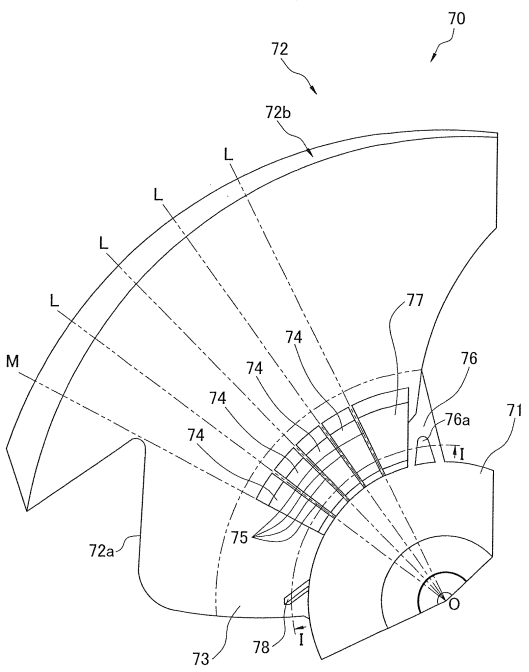

FIG. 7

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Description

TECHNICAL FIELD

[0001] The present invention relates to an axial-flow fan, and relates in particular to an axial-flow fan with which a hub and a plurality of blades are integrally resin-molded, the blades being formed so as to project from an outer perimeter edge of the hub.

BACKGROUND ART

[0002] An axial-flow fan with which a hub and a plurality of blades are integrally resin-molded, the blades being formed so as to project from an outer perimeter edge of the hub has hitherto been used in an outdoor unit, or the like, of an air conditioning apparatus.

[0003] One such axial-flow fan has a thinned-out part formed in a joint of the blade with the hub, as illustrated in patent document 1 (Japanese Unexamined Patent Application Publication No. 2011-74817).

SUMMARY OF THE INVENTION

[0004] However, formation of the thinned-out part in the joint of the blade leads to narrowing of a space in which the resin injected into the mold flows toward the outer perimeter side during molding of the axial-flow fan. Therefore, in the axial-flow fan having the thinned-out part formed in the joint of the blade, the resin does not readily flow into a portion further toward the outer perimeter side from the thinned-out part during molding, and there is a possibility that molding failure might occur in the outer perimeter portion of the blade.

[0005] An object of the present invention is to form a thinned-out part in a joint of a blade while minimizing molding failure in an outer perimeter portion of the blade in an axial-flow fan with which a hub and a plurality of blades are integrally resin-molded.

[0006] An axial-flow fan according to a first aspect is integrally resin-molded with a hub and a plurality of blades formed so as to project from an outer perimeter edge of the hub. A first blade thinned-out part is formed in a joint of the blade with the hub so that a radial rib extending radially toward the outer perimeter side is left.

[0007] The present inventors studied the shape of a rib left when forming a thinned-out part on a joint of a blade, considering an inflow of resin during molding to a portion further toward an outer perimeter side from the thinned-out part when forming the thinned-out part. As a result, the present inventors discovered that a first blade thinned-out part is formed so that a radial rib extending radially toward the outer perimeter side is left as mentioned above.

[0008] Such radial rib accelerates the flow toward the outer perimeter side of resin injected in the mold during molding, and therefore allows a favorable inflow of resin to the portion further toward the outer perimeter side from the first blade thinned-out part during molding. The radial rib also allows resin injected into the mold during molding to flow more easily toward the outer perimeter side, compared to the case when a rib not extending radially is left.

[0009] The thinned-out part can thereby be formed in the joint of the blade while minimizing molding failure in the outer perimeter portion of the blade in this axial-flow fan.

[0010] An axial-flow fan according to a second aspect is the axial-flow fan according to the first aspect, wherein a plurality of radial ribs are disposed in a circumferential direction.

[0011] When a plurality of radial ribs are disposed in a circumferential direction as mentioned above, the portion where the resin flows to the portion further toward the outer perimeter side from the first blade thinned-out part can be increased in the circumferential direction during molding.

[0012] The flow toward the outer perimeter side of resin injected into the mold during molding can thereby be further accelerated in this axial-flow fan. The resin also can be allowed to flow in uniformly to any position in the circumferential direction of the portion further toward the outer perimeter side from the first blade thinned-out part during molding.

[0013] An axial-flow fan according to a third aspect is the axial-flow fan according to the first or second aspect, wherein the radial rib extends on a straight line extending radially toward the outer perimeter side from an axial center of the hub when viewing the hub and the blade from an axial direction.

[0014] When the radial rib is configured to extend on a straight line extending radially toward the outer perimeter side from the axial center of the hub as mentioned above, the resin injected into the mold during molding can be controlled to flow directly toward the outer perimeter side.

[0015] The resin injected into the mold can thereby be allowed to flow more easily toward the outer perimeter side during molding in this axial-flow fan.

[0016] An axial-flow fan according to a fourth aspect is the axial-flow fan according to any of the first to third aspects, wherein a front edge rib continuing on a front edge of the blade is formed in the joint in a portion further toward the front edge side of the blade from the radial rib. A second blade thinned-out part larger than the first blade thinned-out part is formed between the front edge rib and the radial rib in the circumferential direction.

[0017] Forming the front edge rib continuing on the front edge of the blade in a portion further toward the front edge side of the blade from the radial rib in this axial-flow fan as mentioned above improves strength at the front edge of the blade. However, when such front edge rib is formed, there is a possibility that the front edge rib and the vicinity thereof might be less likely to be cooled during molding.

[0018] Therefore, in this axial-flow fan, the front edge rib is formed and the second blade thinned-out part larger

than the first blade thinned-out part is formed between the front edge rib and the radial rib in the circumferential direction, as mentioned above, so that a situation in which the front edge rib and the vicinity thereof are less likely to be cooled during molding can be minimized.

[0019] The occurrence of sink marks during molding can thereby be minimized despite the fact that the front edge rib is formed in addition to the radial rib in this axial-flow fan.

[0020] An axial-flow fan according to a fifth aspect is the axial-flow fan according to any of the second to fourth aspects, wherein the radial ribs are equidistantly disposed in the circumferential direction.

[0021] When the radial ribs are equidistantly disposed in the circumferential direction as mentioned above, the resin easily flows in uniformly over the plurality of radial ribs during molding.

[0022] The resin can thereby be allowed to easily flow in more uniformly in the circumferential direction to the portion further toward the outer perimeter side from the first blade thinned-out part during molding in this axial-flow fan.

[0023] An axial-flow fan according to a sixth aspect is the axial-flow fan according to any of the first to fifth aspects, wherein an indented part going in toward the front edge side of the blade is formed on a rear edge of the blade. The first blade thinned-out part is positioned further toward the front edge side of the blade from the indented part when viewing the hub and the blade from an axial direction.

[0024] Forming the indented part going in toward the front edge side of the blade on the rear edge of the blade in this axial-flow fan as mentioned above designs for improvement of ventilating performance and/or suppression of noise. However, when such indented part is formed, the resin does not readily flow in to the indented part and the vicinity thereof, and there is a possibility that molding failure in the indented part and the vicinity thereof may occur.

[0025] Therefore, in this axial-flow fan, the first blade thinned-out part is positioned further toward the front edge side of the blade from the indented part as mentioned above, so that the resin flows in as far as the indented part and the vicinity thereof without passing the first blade thinned-out part during molding.

[0026] The inflow of resin to the indented part and the vicinity thereof is thereby ensured during molding and molding failure in the indented part and the vicinity thereof can be minimized, despite the fact that both the first blade thinned-out part and the indented part are formed in this axial-flow fan.

BRIEF DESCRIPTION OF THE DRAWINGS

[0027]

FIG. 1 is a plan view illustrating an outdoor unit in which is adopted an outdoor fan as an axial-flow fan according to one embodiment of the present invention, in a condition having removed a ceiling plate thereof.

FIG. 2 is a front view of the outdoor unit in which is adopted the outdoor fan according to one embodiment of the present invention.

FIG. 3 is a perspective view of the outdoor fan according to one embodiment of the present invention.

FIG. 4 is a plan view of a positive pressure face side of the outdoor fan according to one embodiment of the present invention.

FIG. 5 is a plan view of a negative pressure face side of the outdoor fan according to one embodiment of the present invention.

FIG. 6 is a side view of the outdoor fan according to one embodiment of the present invention.

FIG. 7 is an enlarged view of a joint of a blade and the vicinity thereof in FIG. 5.

FIG. 8 is a cross-sectional view along I-I in FIG. 7.

FIG. 9 is an enlarged view of a front edge rib and the vicinity thereof in FIG. 6.

FIG. 10 is a cross-sectional side view of a mold, for describing a process for molding the outdoor fan.

FIG. 11 is a cross-sectional view illustrating a portion of the mold for forming the joint of the blade and the vicinity thereof, for describing the process for molding the outdoor fan.

DESCRIPTION OF EMBODIMENTS

[0028] An embodiment of the axial-flow fan according to the present invention is described below based on the accompanying drawings. The specific configuration of the axial-flow fan according to the present invention is not limited to the embodiment below, and modifications are possible within a scope not deviating from the main point of the present invention. In the description below, an example in which the present invention is applied to an axial-flow fan configuring an outdoor unit is described, but the present invention is not limited to this; it may be applied to an axial-flow fan for another use.

(1) Overall configuration of the outdoor unit

[0029] FIGS. 1 and 2 are drawings illustrating an outdoor unit 2 of an air conditioning apparatus in which is adopted an outdoor fan 70 as an axial-flow fan according to one embodiment of the present invention. Here, FIG. 1 is a plan view of the outdoor unit 2 in a condition having removed a ceiling plate 57. FIG. 2 is a front view of the outdoor unit 2. In the description below, words expressing directions and/or faces including "up," "down," "left," and "right," and/or "front face," "side face," "back face," "top face," and "bottom face," unless otherwise specified, signify directions and/or faces in the case of regarding the outdoor unit 2 illustrated in FIG. 2 as a front face.

[0030] The outdoor unit 2 has a structure (so called "trunk-type" structure), in which an internal space of a

unit casing 51 is divided into left and right by a partitioning plate 58 extending in a vertical direction, whereby a blower compartment S1 and a machine compartment S2 are formed. The outdoor unit 2 is configured so that outside air is taken into the unit casing 51 from a back face and one part of a side face of the unit casing 51 and the outside air is blown out from a front face of the unit casing 51. The outdoor unit 2 mainly has the unit casing 51, refrigerant circuit-configuring parts including a compressor 21, an outdoor heat exchanger 24, and refrigerant pipes connecting these machines, an outdoor fan 70 (axial-flow fan), and a bell mouth 80. Here, an example is described, in which the blower compartment S1 is formed toward a left side face of the unit casing 51 and the machine compartment S2 is formed toward a right side face of the unit casing 51, but left and right may be reversed.

[0031] The unit casing 51 is formed in a roughly rectangular parallelepiped form, and mainly houses the refrigerant circuit-configuring parts including the compressor 21, the outdoor heat exchanger 24, and refrigerant pipes connecting these machines, and the outdoor fan 70. The unit casing 51 has a floor plate 52, a blower compartment-side side plate 53, a machine compartment-side side part 54, a blower compartment-side front plate 55, a machine compartment-side front plate 56, and a ceiling plate 57.

[0032] The floor plate 52 is a metal plate-form member configuring a bottom face of the unit casing 51. Two foundation legs 59 and 60 fixed to a site installation surface are provided beneath the floor plate 52.

[0033] The blower compartment-side side plate 53 is a metal plate-form member configuring a side face portion toward the blower compartment S1 of the unit casing 51. A lower part of the blower compartment-side side plate 53 is fixed to the floor plate 52. An intake port 53a for outside air taken into the unit casing 51 by the outdoor fan 70 is formed on the blower compartment-side side plate 53.

[0034] The machine compartment-side side plate 54 is a metal plate-form member configuring one part of a side face portion toward the machine compartment S2 of the unit casing 51 and a back face portion toward the machine compartment S2 of the unit casing 51. A lower part of the machine compartment-side side plate 54 is fixed to the floor plate 52. Here, the machine compartment-side side plate 54 covers a portion toward the back face of the side face of the machine compartment S2. An intake port 53b for outside air taken into the unit casing 51 by the outdoor fan 70 is formed between an end part on the back face side of the blower compartment-side side plate 53 and an end part on the blower compartment S1 side of the machine compartment-side side plate 54.

[0035] The blower compartment-side front plate 55 is a metal plate-form member configuring a front face portion of the blower compartment S1 of the unit casing 51 and one part of a front face portion of the machine compartment S2 of the unit casing 51. A blow-out port 55a for blowing out outside air taken into the unit casing 51 to the outside by the outdoor fan 70 is provided on the blower compartment-side front plate 55. A front side of the blow-out port 55a is covered by a fan grill 55b. A lower part of the blower compartment-side front plate 55 is fixed to the floor plate 52, and an end part on the left side face side thereof is fixed to an end part on the front face side of the blower compartment-side side plate 53.

[0036] The machine compartment-side front plate 56 is a metal plate-form member that is removed during test running and/or maintenance in order to access the machine compartment S2 from the front face side of the unit casing 51 and perform inspection, and the like, of the machines disposed inside the machine compartment S2. The machine compartment-side front plate 56 is a metal plate-form member configuring one part of a front face portion of the machine compartment S2 of the unit casing 51 and one part of a side face portion of the machine compartment S2 of the unit casing 51. An end part on the blower compartment S1 side of the machine compartment-side front plate 56 is fixed to an end part on the machine compartment S2 side of the blower compartment-side front plate 55, and an end part on a back face side thereof is fixed to an end part on the front face side of the machine compartment-side side plate 54. Here, one part of the front face portion of the machine compartment S2 of the unit casing 51 is configured by the blower compartment-side front plate 55, but that part may be configured by the machine compartment-side front plate 56. The blower compartment-side front plate 55 and the machine compartment-side front plate 56 also may be an integrated member.

[0037] The ceiling plate 57 is a metal plate-form member configuring a top face portion of the unit casing 51. The ceiling plate 57 is fixed to the blower compartment-side side plate 53, the machine compartment-side side plate 54, and the blower compartment-side front plate 55.

[0038] The partitioning plate 58 is a metal plate-form member being disposed on the floor plate 52 and extending in a vertical direction. The partitioning plate 58 divides the internal space of the unit casing 51 into left and right to form the blower compartment S1 toward the left side face and the machine compartment S2 toward the right side face. The partitioning plate 58 has a shape that is curved so that a central portion in a front-to-back direction thereof projects toward the blower compartment S1 side. A lower part of the partitioning plate 58 is fixed to the floor plate 52, an end part on a front face side thereof is fixed to the blower compartment-side front plate 55, and an end part on a back face side thereof is fixed to an end part on the machine compartment S2 side of the outdoor heat exchanger 24.

[0039] The outdoor fan 70 is a propeller fan mainly with which a hub 71 and a plurality of (here, three) blades 72 are integrally resin-molded, the plurality of blades 72 being formed so as to project from an outer perimeter edge of the hub 71. The outdoor fan 70 is provided so as to face opposite the front face of the unit casing 51 inside the blower compartment S1. More specifically, the out-

door fan 70 is provided so as to face opposite the blow-out port 55a formed on the blower compartment-side front plate 55 in a position on the front face side of the outdoor heat exchanger 24. Here, an indented part 72a going in toward the front edge side of the blade 72 is formed on a rear edge of the blade 72, for the purpose of improvement of ventilating performance and/or suppression of noise. The outdoor fan 70 is driven to rotate by a fan motor 79 disposed between the outdoor fan 70 and the outdoor heat exchanger 24 in the front-to-back direction. The fan motor 79 is supported by a fan motor mount 61 extending in a vertical direction between the ceiling plate 57 and the floor plate 52. A detailed configuration of the outdoor fan is to be described.

[0040] The bell mouth 80 is a member having a bell-shaped opening 81 having an open center, and is provided on the outer perimeter side of the outdoor fan 70. That is, the bell mouth 80 is provided so as to face opposite the front face of the unit casing 51 in the same manner as the outdoor fan 70 inside the blower compartment S1, and the outer perimeter of the outdoor fan 70 is surrounded by the opening 81. The bell mouth 80 is fixed to the front face of the unit casing 51. A portion of the bell mouth 80 toward the blower compartment-side side plate 53 is disposed proximally to a front-side end of the outdoor heat exchanger 24. A portion of the bell mouth 80 toward the machine compartment S1 is disposed proximally to the partitioning plate 58.

[0041] The outdoor heat exchanger 24 is a roughly L-shaped heat exchanger panel, and is disposed on the floor plate 52 so as to follow the left side face and the back face of the unit casing 51 inside the blower compartment S 1.

[0042] The compressor 21 is a sealed-type compressor having an upright cylindrical shape, and is disposed inside the machine compartment S2.

[0043] Although not illustrated here, the machines, refrigerant pipes, and/or other refrigerant circuit-configuring parts in addition to the compressor 21 also are disposed inside the machine compartment S2.

(2) Detailed configuration of the outdoor fan

[0044] A detailed configuration of the outdoor fan 70 as the axial-flow fan according to the present embodiment is next described using FIGS. 3 to 9. Here, FIG. 3 is a perspective view of the outdoor fan 70. FIG. 4 is a plan view of a positive pressure face side of the outdoor fan 70. FIG. 5 is a plan view of a negative pressure face side of the outdoor fan 70. FIG. 6 is a side view of the outdoor fan 70. FIG. 7 is an enlarged view of a joint 73 of the blade 72 and the vicinity thereof. FIG. 8 is a cross-sectional view along I-I in FIG. 7. FIG. 9 is an enlarged view of a front edge rib 76 and the vicinity thereof in FIG. 6. In the description below, an axial center (rotational center) of the outdoor fan 70 is indicated as axial center O, and the axis thereof is indicated as rotational axis O-O.

[0045] The outdoor fan 70 is a propeller fan mainly with which a hub 71 and a plurality of (here, three) blades 72 are integrally resin-molded, as mentioned above, the plurality of blades 72 being formed so as to project from an outer perimeter edge of the hub 71. The number of blades 72 are not limited to three, and may be four or more, or the like.

[0046] The blade 72 has a blade shape that is forward advancing and forward tilting (see FIGS. 4 and 5). The thickness of the blade 72 is greater at the joint 73 with the hub 71, and becomes smaller going toward the outer perimeter side (see FIG. 9). An indented part 72a formed on the rear edge of the blade 72 is disposed further toward the outer perimeter side from the joint 73 (see FIGS. 3, 5, and 7). Here, a face on the side where air flows in (upstream side in the direction of flow of air) when the outdoor fan 70 is rotated is indicated as a negative pressure face 72b, and a face on the opposite side (downstream side in the direction of flow of air) is indicated as a positive pressure face 72c.

[0047] A first blade thinned-out part 74 is formed on the joint 73 of the blade 72 so that a radial rib 75 extending radially toward the outer perimeter side is left. A front edge rib 76 continuing on a front edge of the blade 72 is formed in the joint 73 in a portion further toward the front edge side of the blade 72 from the radial rib 75. A second blade thinned-out part 77 larger than the first blade thinned-out part 74 is formed between the front edge rib 76 and the radial rib 75 in the circumferential direction.

[0048] Specifically, the blade thinned-out parts 74 and 77 are formed on the negative pressure face 72b of the blade 72. Instead of being formed on the negative pressure face 72b, the blade thinned-out parts 74 and 77 may be formed only on the positive pressure face 72c, or may be formed on both faces, being the negative pressure face 72b and the positive pressure face 72c.

[0049] The radial rib 75 has a thickness equal to that of the joint 73, and an end part in the axial direction thereof continues smoothly to the blade surface of the blade 72 (see FIGS. 8 and 9). A plurality of (here, four) radial ribs 75 are disposed in an array in the circumferential direction. That is, a plurality of (here, four) first blade thinned-out parts 74 are disposed going from the rear edge side to the front edge side of the blades 72 so as to be positioned on both sides in the circumferential direction of the radial ribs 75. The second blade thinned-out part 77 is disposed on the front edge side in the circumferential direction of the radial rib 75 disposed furthest on the front edge side among the plurality of radial ribs 75. Therefore, the end parts in the axial direction of two adjacent radial ribs 75 holding a first blade thinned-out part 74 between in the circumferential direction are smoothly continuous. The number of radial ribs is not limited to four, and may be three or fewer or five or more.

[0050] The radial rib 75 extends on a straight line L extending radially toward the outer perimeter side from the axial center O of the hub 71 when viewing the hub 71 and the blade 72 from the axial direction (see FIG. 7). The radial ribs 75 also are equidistantly disposed in the

circumferential direction. That is, all of the first blade thinned-out parts 74 have the same measurement in the circumferential direction regardless of the position in the radial direction, whereby the radial ribs 75 are equidistantly disposed in the circumferential direction.

[0051] The spacing in the circumferential direction between the second blade thinned-out part 77 and the first blade thinned-out part 74 is larger than the spacing in the circumferential direction between first blade thinned-out parts 74 (see FIGS. 5 and 7). That is, the second blade thinned-out part 77 has a larger measurement in the circumferential direction at the same position in the radial direction than the first blade thinned-out part 74.

[0052] The front edge rib 76 is formed so as to project in the axial direction from the blade surface of the blade 72 on the front edge of the joint 73, for the purpose of improving strength at the front edge of the blade 72. The front edge rib 76 here has a roughly triangular pyramidal shape, and is formed on both sides, being the negative pressure face 72b and the positive pressure face 72c, of the blade 72. A width in the circumferential direction of the front edge rib 76 is larger than a width in the circumferential direction of the radial rib 75 at the same position in the radial direction (see FIGS. 5 and 7). A depression 76a that is roughly triangular when viewing the hub 71 and the blade 72 from the axial direction is formed on a portion toward the hub 71 of the front edge rib 76. The front edge rib 76 may be formed only on the negative pressure face 72b or the positive pressure face 72c, instead of being formed on both the negative pressure face 72b and the positive pressure face 72c.

[0053] A rear edge rib 78 projecting in the axial direction from the blade surface of the blade 72 is formed on a portion further toward the rear edge side from the first blade thinned-out part 74 of the joint 73. The rear edge rib 78 is formed on the negative pressure face 72b and the positive pressure face 72c of the blade 72. That is, the first blade thinned-out part 74 and the radial rib 75 are formed on a portion toward the front edge of the joint 73, and are not formed on a portion toward the rear edge. The first blade thinned-out part 74 is positioned further toward the front edge of the blade 72 than the indented part 72a when viewing the hub 71 and the blade 72 from the axial direction (see the straight line M extending to the outer perimeter side from the first blade thinned-out part 74 disposed furthest toward the rear edge in FIG. 7).

(3) Formation of the outdoor fan

[0054] A process for molding the outdoor fan 70 as the axial-flow fan according to the present embodiment is next described using FIGS. 10 and 11. Here, FIG. 10 is a cross-sectional side view of a mold 90 for describing a process for molding the outdoor fan 70. FIG. 11 is a cross-sectional view illustrating a portion of the mold 90 for forming the joint 73 of the blade 72 and the vicinity thereof, for describing the process for molding the outdoor fan 70.

[0055] An injection-molding apparatus (not illustrated) having a mold 90 is first prepared. The mold 90 has a first mold 91 and a second mold 92 that is movable with respect to the first mold 91. A cavity 93 for configuring the shape of the outdoor fan 70 is formed by combining the first mold 91 and the second mold 92 (see FIG. 10).

[0056] Resin is next injected from a hot water port 94 provided on the first mold 91. The hot water port 94 is provided so as to inject resin into the cavity 93 from a position near the axial center O of the cavity 93 (here, a portion for forming the hub 71 of the outdoor fan 70). The resin thus flows from the inner perimeter portion of the cavity 93 to the outer perimeter side and travels throughout the cavity 93. At this time, the resin flows in to the outer perimeter side passing through portions, and the like, within the cavity 93 for forming the blade thinned-out parts 74 and 77, the radial rib 75, and the front edge rib 76.

[0057] The mold 90 is next cooled with cold water, or the like, and the resin is hardened.

[0058] The mold 90 is next opened by undoing the combination of the first mold 91 and second mold 92. The molded outdoor fan 70 is removed from the mold 90.

(4) Features of the outdoor fan

[0059] The outdoor fan 70 as the axial-flow fan of the present embodiment has features such as the following.

[0060] First, in the outdoor fan 70 of the present embodiment, a first blade thinned-out part 74 is formed in the joint 73 of the blade 72 with the hub 71 so that the radial rib 75 extending radially toward the outer perimeter side is left, as mentioned above. Here, the radial rib 75 extends on a straight line L extending radially toward the outer perimeter side from an axial center O of the hub when viewing the hub 71 and the blade 72 from an axial direction (see FIGS. 5 and 7).

[0061] This radial rib 75 was discovered as a result of the present inventors having studied a rib shape when forming a thinned-out part on the joint 73 of the blade 72, considering an inflow of resin during molding to a portion further toward an outer perimeter side from the thinned-out part.

[0062] Such radial rib 75 accelerates the flow toward the outer perimeter side of resin injected in the mold 90 during molding, and therefore allows a favorable inflow of resin to the portion further toward the outer perimeter side from the first blade thinned-out part 74 during molding. The radial rib 74 also allows resin injected into the mold during molding to flow more easily toward the outer perimeter side, compared to the case when a rib not extending radially is left. In particular, here, because the radial rib 75 is configured to extend on a straight line L, the resin injected into the mold 90 during molding can be controlled to flow directly toward the outer perimeter side, and the resin flows more easily toward the outer perimeter side (see FIG. 11).

[0063] The thinned-out part can thereby be formed in the joint 73 of the blade 72 while minimizing molding fail-

ure in the outer perimeter portion of the blade 72 in the outdoor fan 70 of the present embodiment.

[0064] In the outdoor fan 70 of the present embodiment, a plurality of (here, four) radial ribs 75 are disposed in a circumferential direction as mentioned above (see FIGS. 5 and 7).

[0065] Therefore, the portion where the resin flows to the portion further toward the outer perimeter side from the first blade thinned-out part 74 can be increased in the circumferential direction during molding (see FIG. 11).

[0066] The flow toward the outer perimeter side of resin injected into the mold 90 during molding can thereby be further accelerated in the outdoor fan 70 of the present embodiment. The resin also can be allowed to flow in uniformly to any position in the circumferential direction of the portion further toward the outer perimeter side from the first blade thinned-out part 74 during molding.

[0067] In the outdoor fan 70 of the present embodiment, a front edge rib 76 continuing on a front edge of the blade 72 is formed in the joint 73 on a portion further toward a front edge side of the blade 72 from the radial rib 75 as described above. A second blade thinned-out part 77 larger than the first blade thinned-out part 74 is formed between the front edge rib 76 and the radial rib 75 in the circumferential direction (see FIGS. 5 and 7).

[0068] Here, the front edge rib 76 is formed in order to increase strength at the front edge of the blade 72 as mentioned above, and a width in the circumferential direction is larger than the radial rib 75 (see FIGS. 5 and 7). Therefore, there is a possibility that the front edge rib 76 and the vicinity thereof might be less likely to be cooled during molding.

[0069] In the outdoor fan 70 of the present embodiment, a second blade thinned-out part 77 larger than the first blade thinned-out part 74 is formed between the front edge rib 76 and the radial rib 75 in the circumferential direction as mentioned above. Therefore, a situation in which the front edge rib 76 and the vicinity thereof are less likely to be cooled can be minimized.

[0070] The occurrence of sink marks during molding can thereby be minimized despite the fact that the front edge rib 75 is formed in addition to the radial rib 75 in the outdoor fan 70 of the present embodiment.

[0071] In the outdoor fan 70 of the present embodiment, the radial ribs 75 are equidistantly disposed in the circumferential direction (see FIGS. 5 and 7).

[0072] Therefore, the resin easily flows in uniformly over the plurality of (here, four) radial ribs 75 during molding (see FIG. 11).

[0073] The resin can thereby be allowed to easily flow in more uniformly in the circumferential direction to the portion further toward the outer perimeter side from the first blade thinned-out part 74 during molding in the outdoor fan 70 of the present embodiment.

[0074] In the outdoor fan 70 of the present embodiment, an indented part 72a going in toward the front edge side of the blade 72 is formed on a rear edge of the blade 72. The first blade thinned-out part 74 is positioned further toward the front edge side of the blade 72 from the indented part 72a when viewing the hub 71 and the blade 72 from an axial direction (see FIG. 7).

[0075] Here, the indented part 72a is formed in order to design for improvement of ventilating performance and/or suppression of noise as mentioned above, and resin does not readily flow in to the indented part 72a and the vicinity thereof. Therefore, there is a possibility that molding failure in the indented part 72a and the vicinity thereof may occur during molding.

[0076] As opposed to this, in the outdoor fan 70 of the present embodiment, the first blade thinned-out part 74 is positioned further toward the front edge side of the blade 72 from the indented part 72a as mentioned above. Therefore, the resin flows in as far as the indented part 72a and the vicinity thereof without passing the first blade thinned-out part 74 during molding.

[0077] The inflow of resin to the indented part 72a and the vicinity thereof is thereby ensured and molding failure in the indented part 72a and the vicinity thereof can be minimized, despite the fact that both the first blade thinned-out part 74 and the indented part 72a are formed in the outdoor fan 70 of the present embodiment.

INDUSTRIAL APPLICABILITY

[0078] The present invention is applicable to an axial-flow fan with which a hub and a plurality of blades are integrally resin-molded, the blades being formed so as to project from an outer perimeter edge of the hub.

REFERENCE SIGNS LIST

[0079]

70	Axial-flow fan
71	Hub
72	Blade
72a	Indented part
73	Joint
74	First blade thinned-out part
75	Radial rib
76	Front edge rib
77	Second blade thinned-out part

CITATION LIST

PATENT LITERATURE

[0080] <Patent Literature 1> Japanese Laid-open Patent Application No. 2011-74817

Claims

1. An axial-flow fan (70) with which a hub (71) and a plurality of blades (72) are integrally resin-molded, the plurality of blades (72) being formed so as to project from an outer perimeter edge of the hub (71), wherein:

   a first blade thinned-out part (74) is formed in a joint (73) of the blade with the hub so that a radial rib (75) extending radially toward the outer perimeter side is left.

2. The axial-flow fan (70) according to claim 1, wherein:

   a plurality of the radial ribs (75) is disposed in a circumferential direction.

3. The axial-flow fan (70) according to claim 1 or 2, wherein:

   the radial rib (75) extends on a straight line extending radially toward the outer perimeter side from an axial center of the hub (71) when viewing the hub and the blade (72) from an axial direction.

4. The axial-flow fan (70) according to any of claims 1 to 3, wherein:

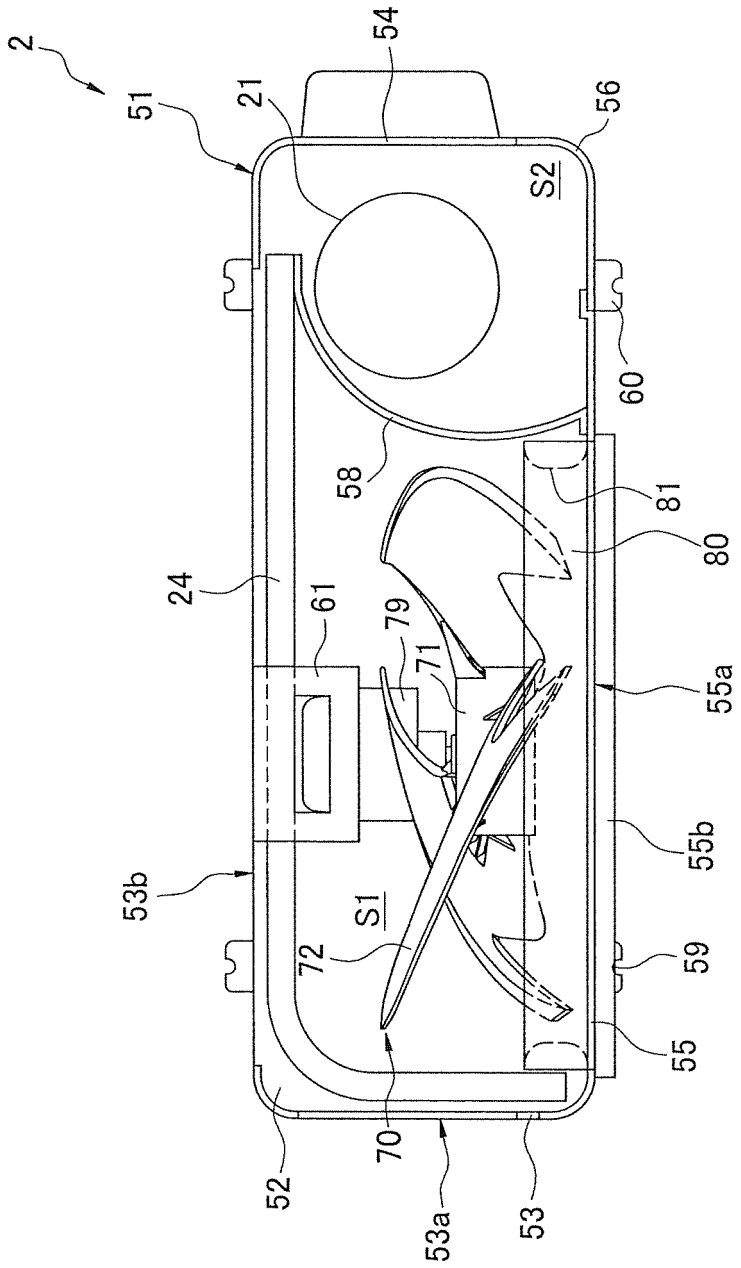
   a front edge rib (76) continuing on a front edge of the blade (72) is formed in the joint (73) in a portion further toward the front edge side of the blade (72) from the radial rib (75); and
   a second blade thinned-out part (77) larger than the first blade thinned-out part (74) is formed between the front edge rib and the radial rib in the circumferential direction.

5. The axial-flow fan (70) according to any of claims 2 to 4, wherein:

   the radial ribs (75) are equidistantly disposed in the circumferential direction.

6. The axial-flow fan (70) according to any of claims 1 to 5, wherein:

   an indented part (72a) going in toward the front edge side of the blade (72) is formed on a rear edge of the blade; and
   the first blade thinned-out part (74) is positioned further toward the front edge side of the blade (72) from the indented part when viewing the hub (71) and the blade (72) from an axial direction.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S2
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71
55a
55b
53b
S1
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53a
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FIG. 1

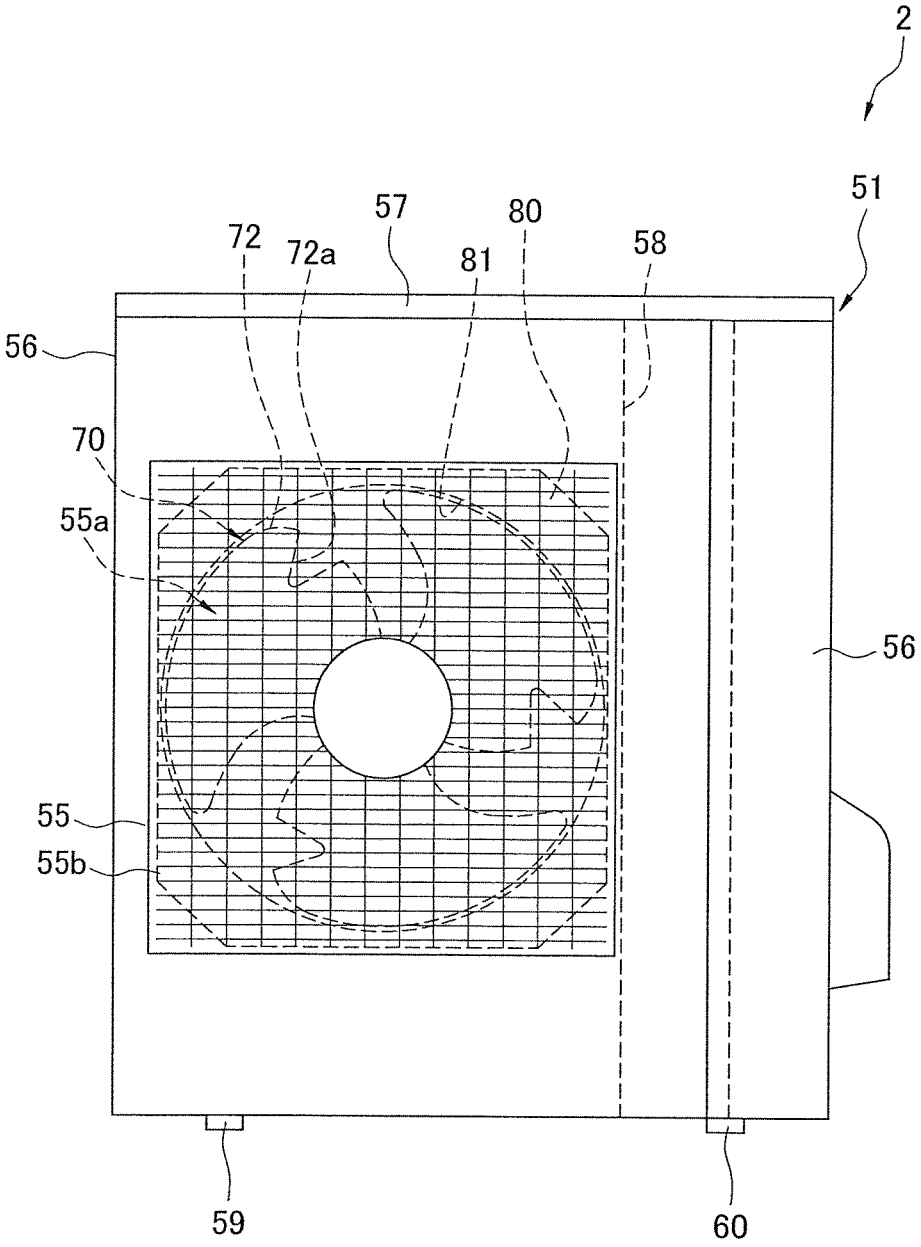


FIG. 2

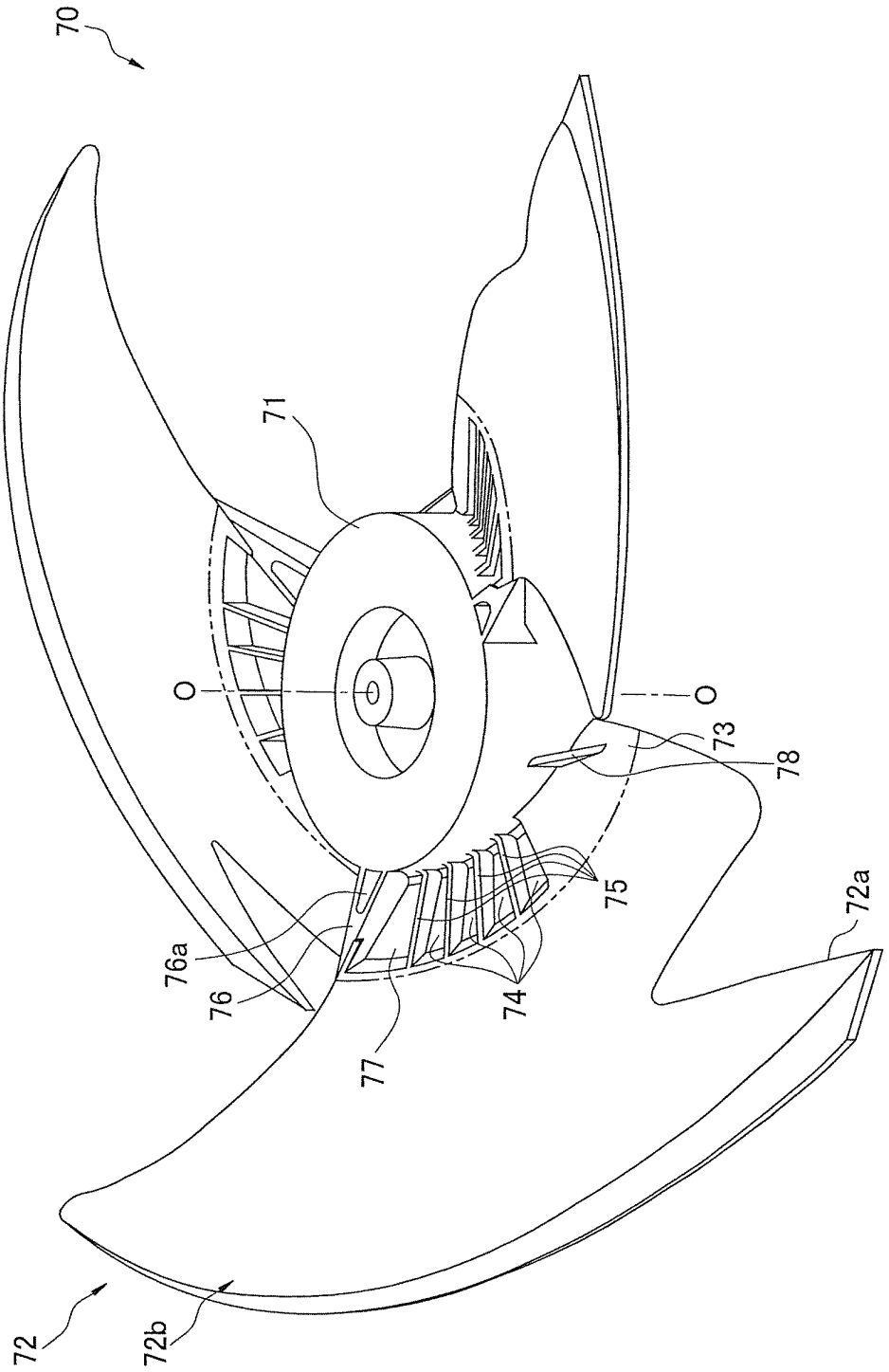


FIG. 3

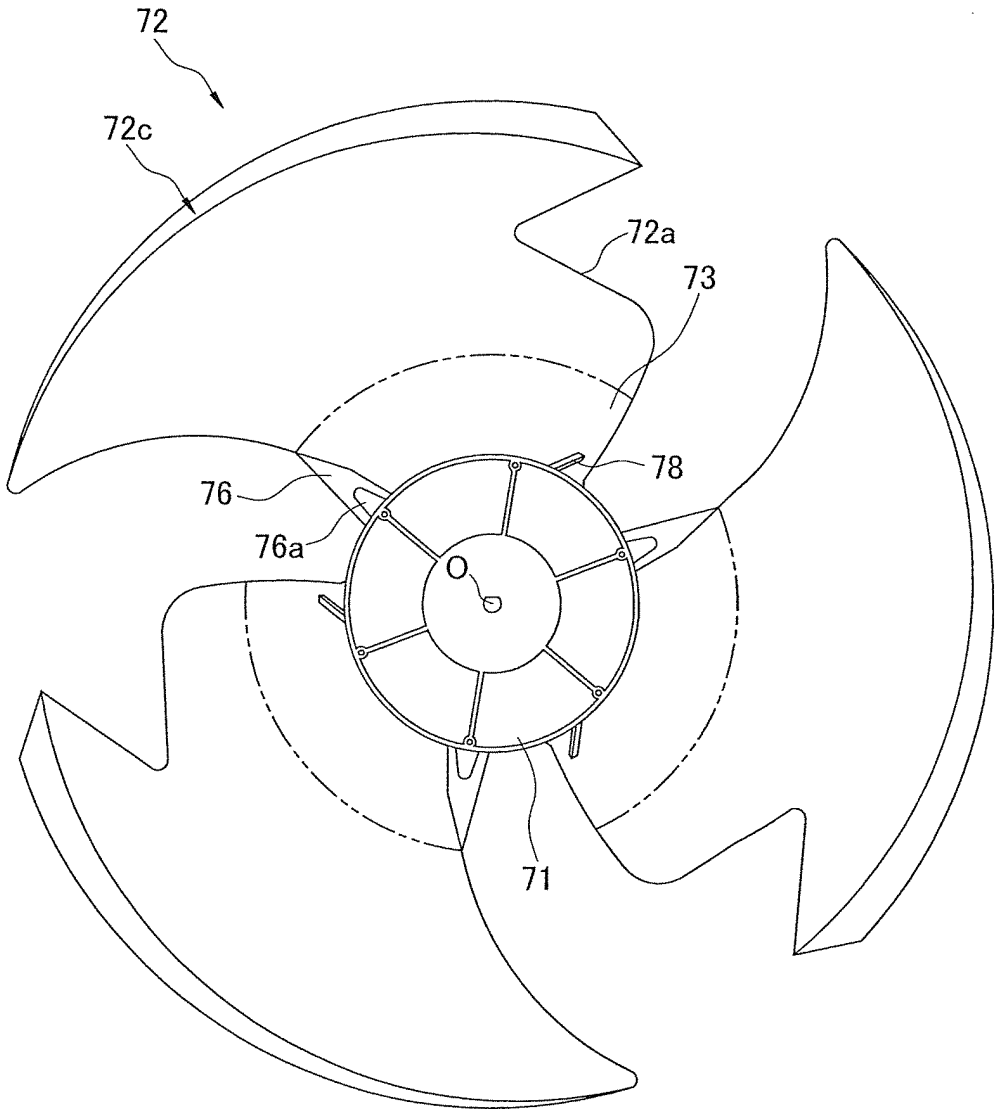


FIG. 4

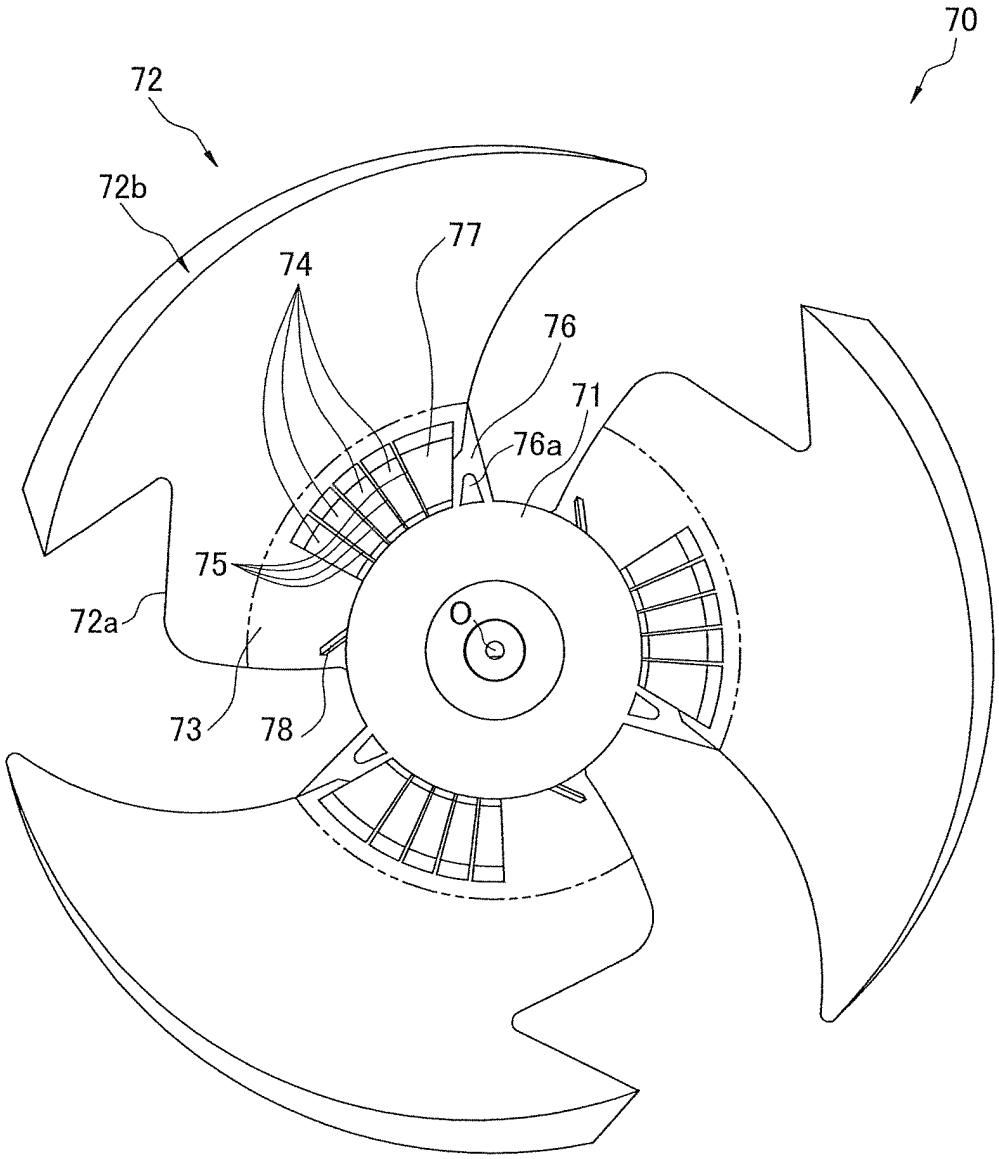


FIG. 5

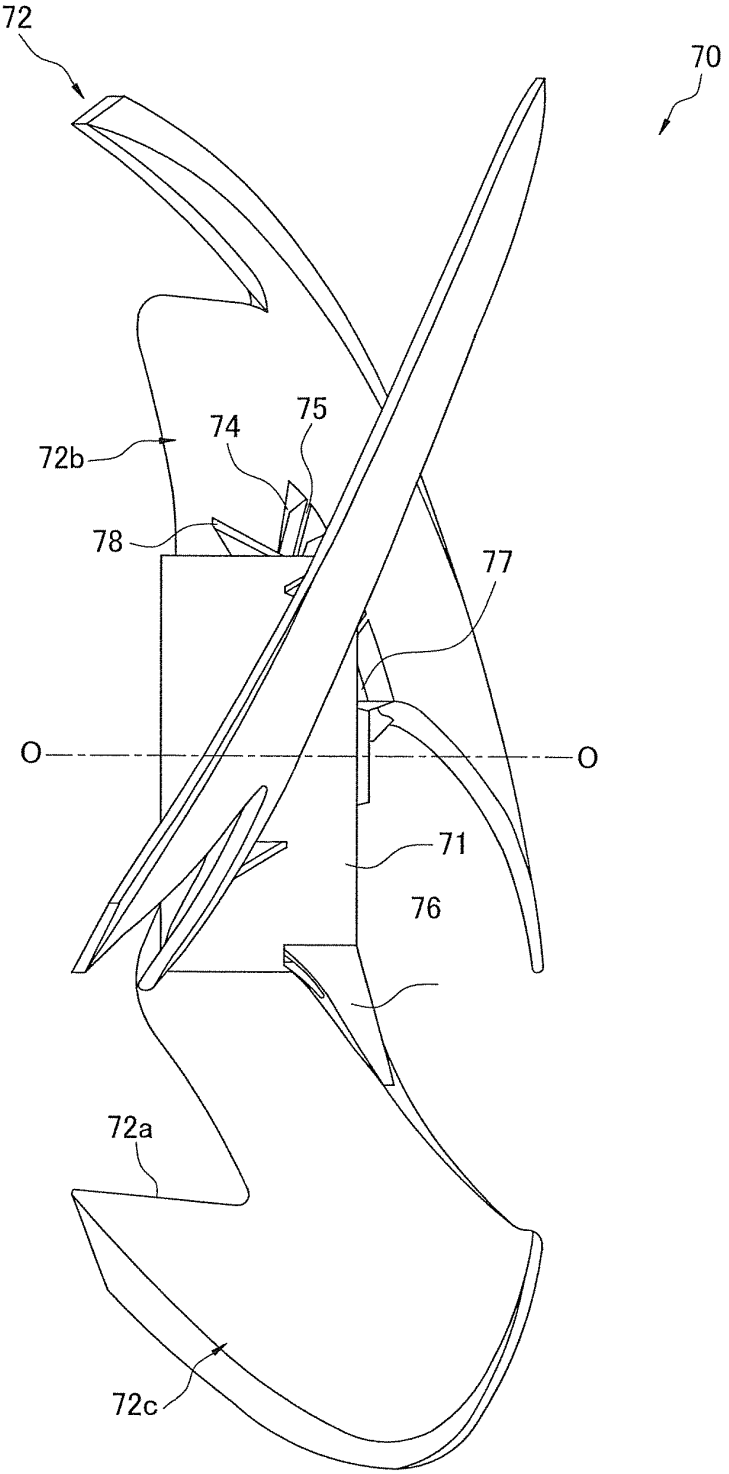


FIG. 6

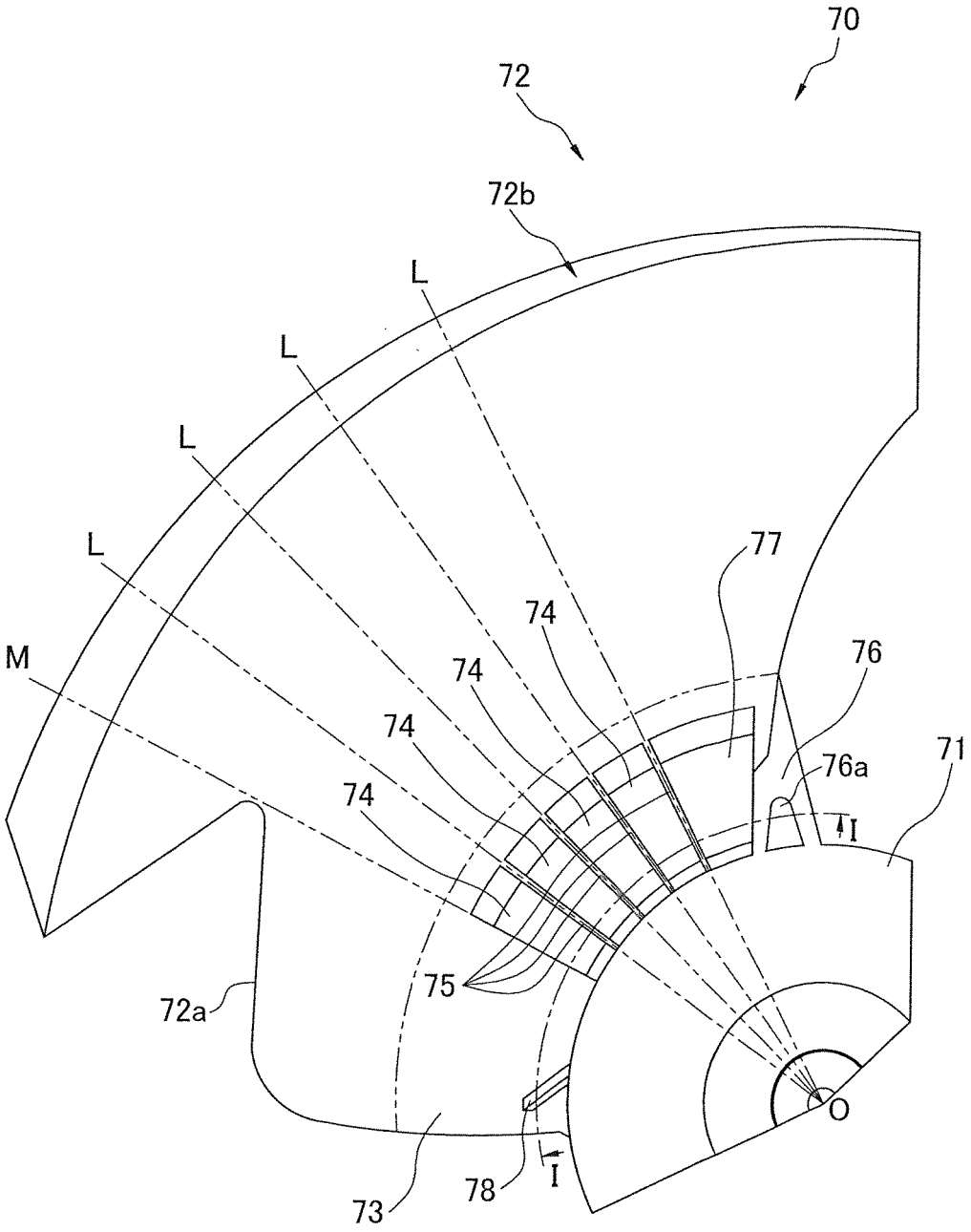


FIG. 7

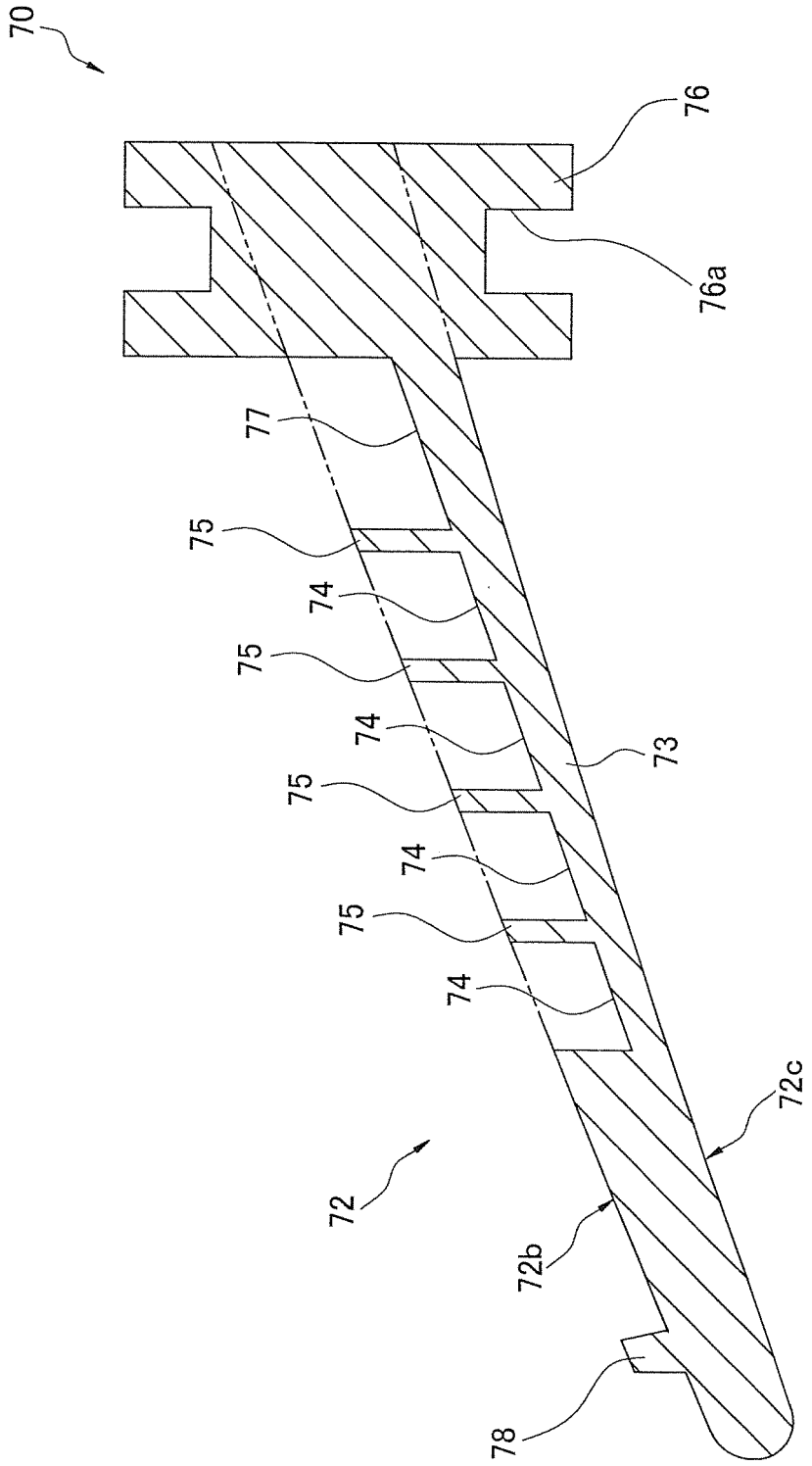


FIG. 8

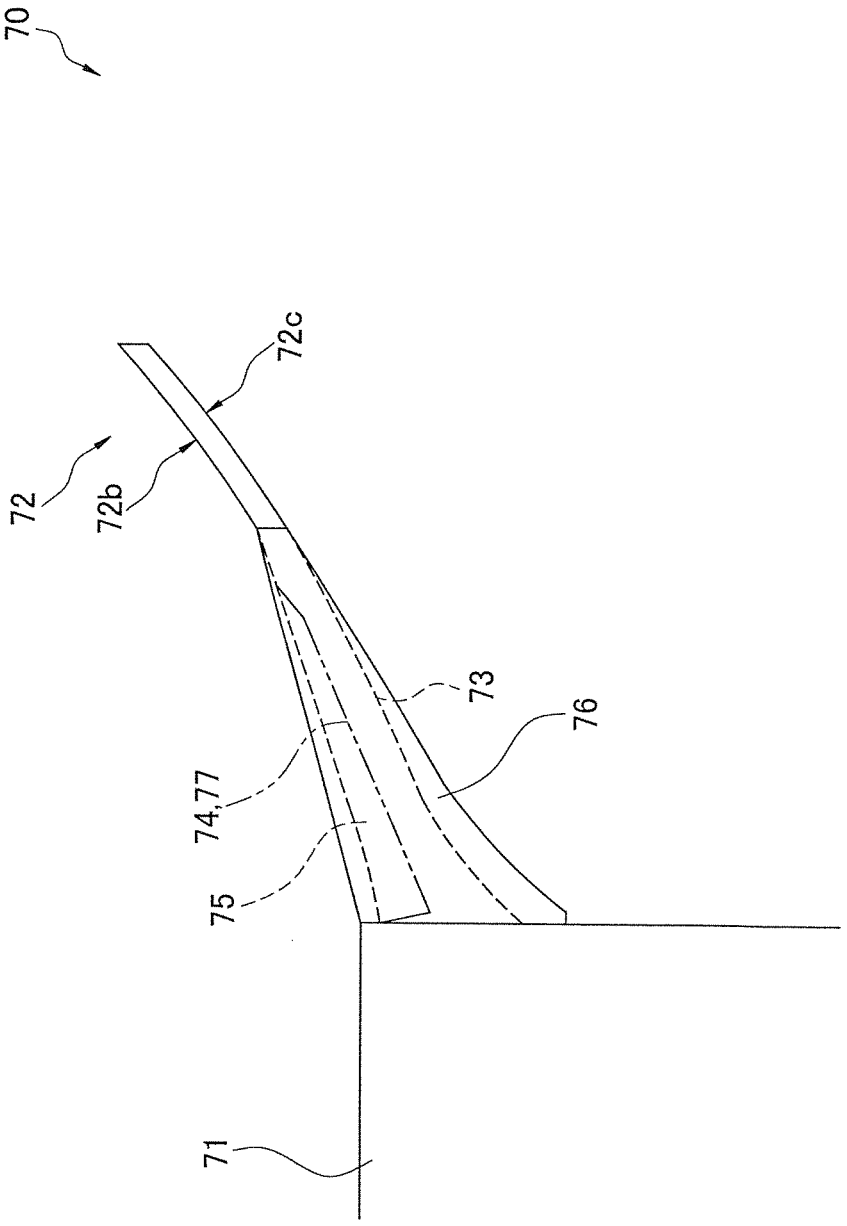
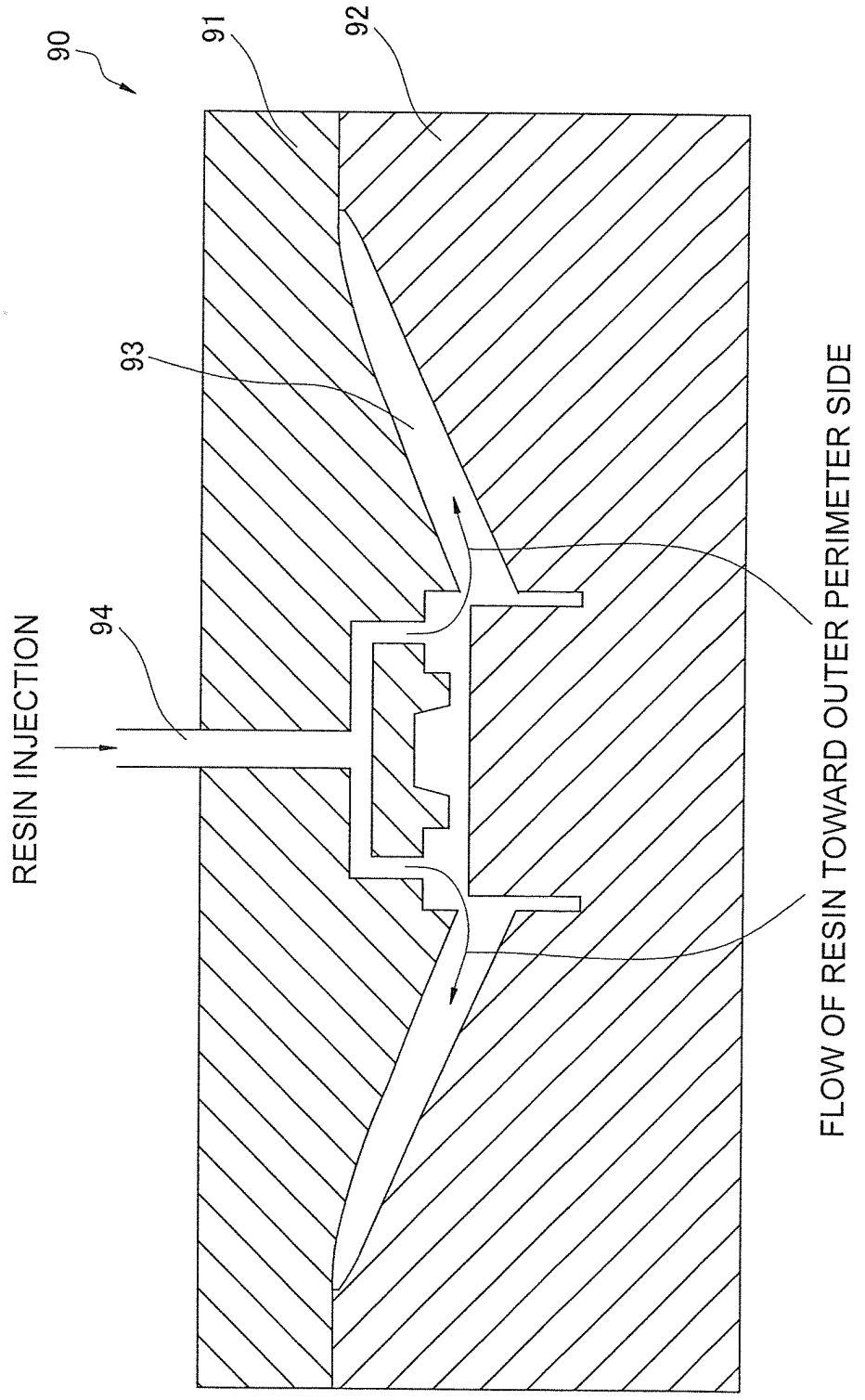


FIG. 9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RESIN INJECTION
FLOW OF RESIN TOWARD OUTER PERIMETER SIDE

FIG. 10

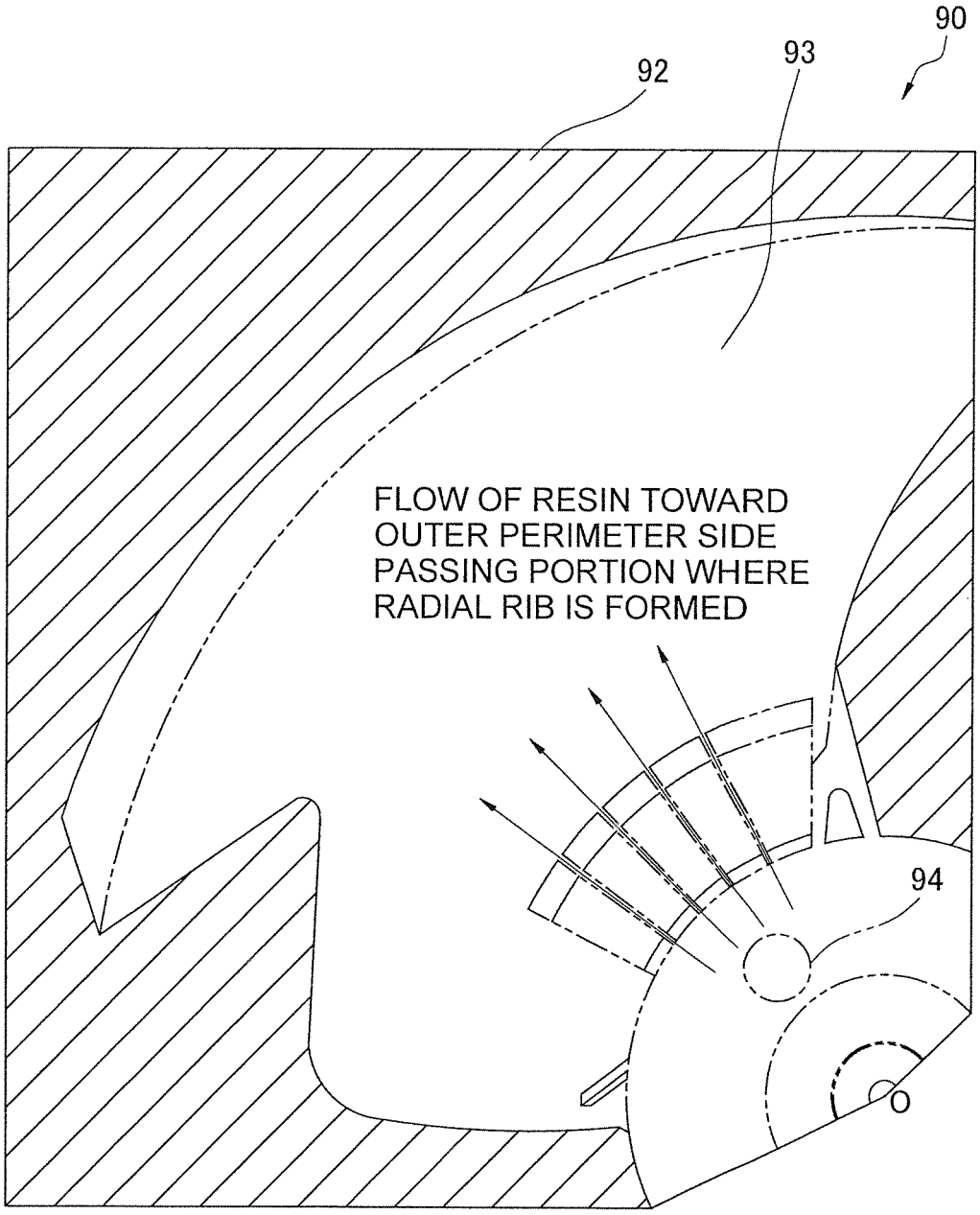
90
92
93
FLOW OF RESIN TOWARD
OUTER PERIMETER SIDE
PASSING PORTION WHERE
RADIAL RIB IS FORMED
94
O

FIG. 11

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2012/075924

A. CLASSIFICATION OF SUBJECT MATTER
F04D29/38(2006.01)i, *F04D29/34*(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)
F04D29/38, F04D29/34

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	1996-2012
Kokai Jitsuyo Shinan Koho	1971-2012	Toroku Jitsuyo Shinan Koho	1994-2012

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 Y A	JP 2011-74817 A (Sanyo Electric Co., Ltd.), 14 April 2011 (14.04.2011), entire text; all drawings (Family: none)	1-3,5 6 4
Y	JP 2005-140081 A (Toshiba Carrier Corp.), 02 June 2005 (02.06.2005), fig. 1 to 3 & CN 1616832 A	6
Y	JP 2004-124748 A (Toshiba Carrier Corp.), 22 April 2004 (22.04.2004), fig. 1 to 2 (Family: none)	6

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

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"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
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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
05 December, 2012 (05.12.12)	18 December, 2012 (18.12.12)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

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

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2012/075924

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 2001-115995 A (Daikin Industries, Ltd.), 27 April 2001 (27.04.2001), entire text; all drawings (Family: none)	1-6
A	JP 2000-320493 A (Daikin Industries, Ltd.), 21 November 2000 (21.11.2000), abstract; fig. 1 to 5 (Family: none)	1-6

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

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2011074817 A **[0003] [0080]**