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(54) **CENTRIFUGAL MULTI-BLADE BLOWER**

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(57) **ABSTRACT**

A centrifugal multi-blade blower includes an impeller, and a casing that accommodates the impeller, and draws in air at least from an inlet port of the casing which opens on one end side of a rotation shaft and blows out the air radially outward of the rotation shaft. The impeller includes a main plate that is joined to the rotation shaft, vanes which are arranged around the axis of the rotation shaft and the other end sides of which in the rotation axis direction are connected to the main plate, and a side plate that connects together the vanes on their one end sides in the rotation axis direction. The vanes are characterized in that an inlet angle on a cross-sectional surface crossing each inner peripheral edge part of the vanes on a meridian plane of the impeller in a predetermined direction is evenly made in the entire region from the side plate-side through the main plate-side, and that outer peripheral edge parts of the vanes are configured to be away from the axis of the rotation shaft from the main plate-side toward the side plate-side.

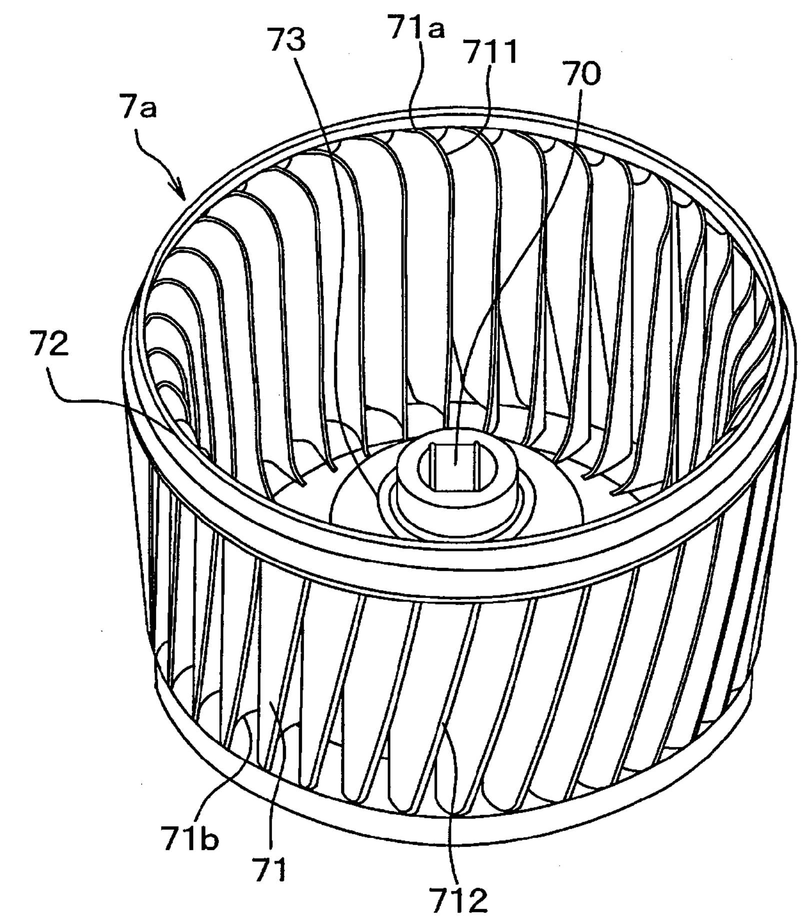


FIG. 1

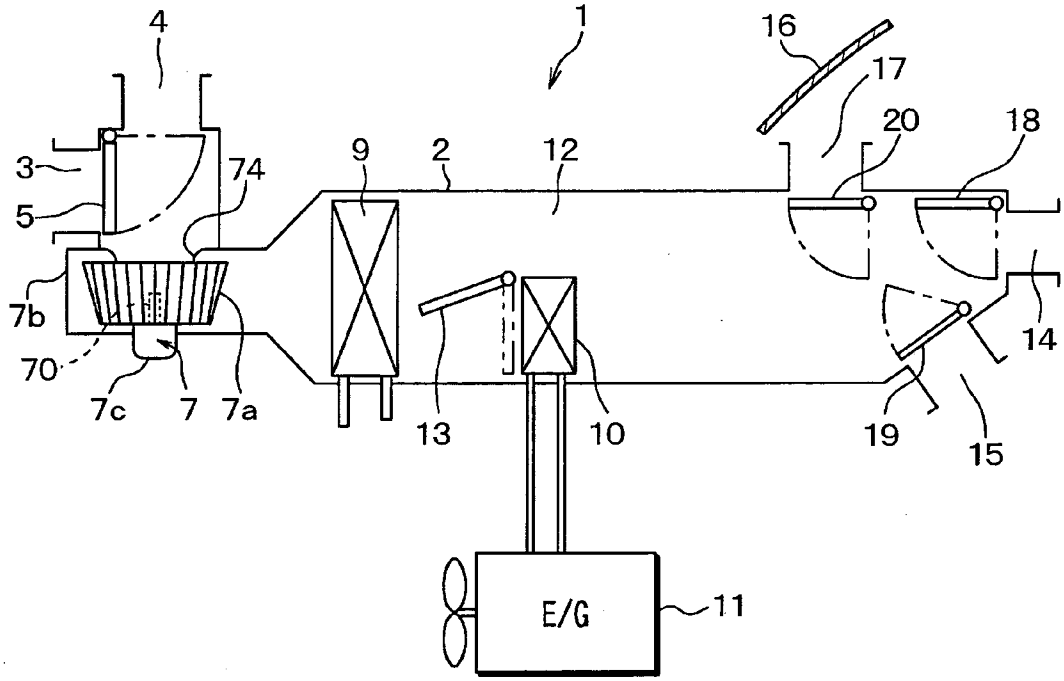

4
1
16
17
20
18
3
74
9
2
12
5
7b
70
7c
7
7a
13
10
19
15
14
E/G
11

FIG. 2

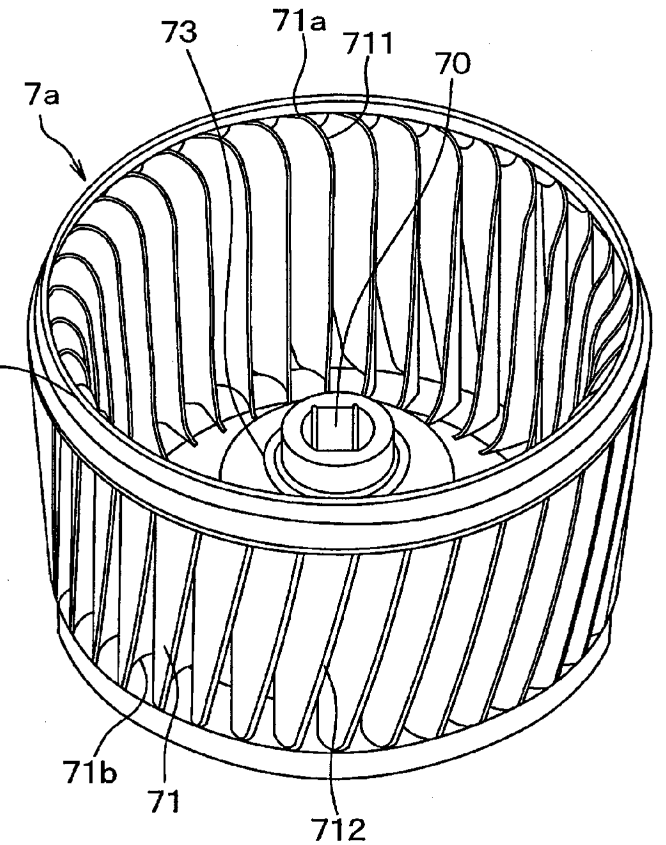

73
71a
711
70
7a
72
71b
71
712

FIG. 3

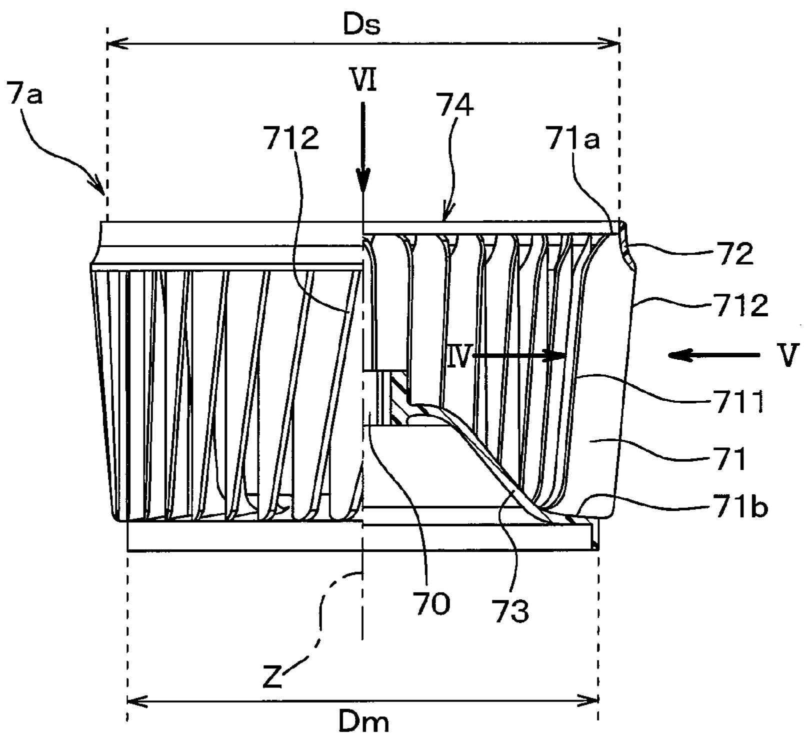

Ds
7a
VI
74
712
71a
72
712
IV
V
711
71
71b
70
73
Z
Dm

FIG. 4

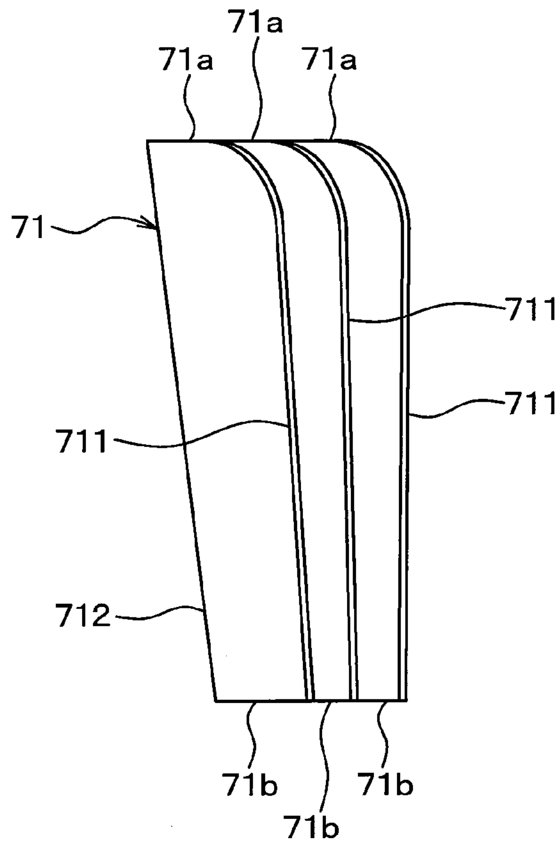

71a
71a
71a
71
711
711
711
712
71b
71b
71b

FIG. 5

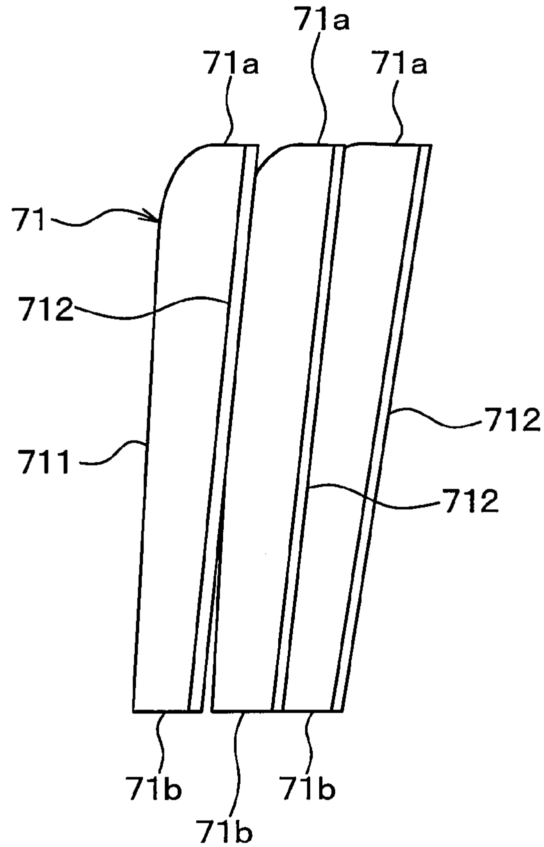

71a
71a
71a
71
712
711
712
712
71b
71b
71b

FIG. 6

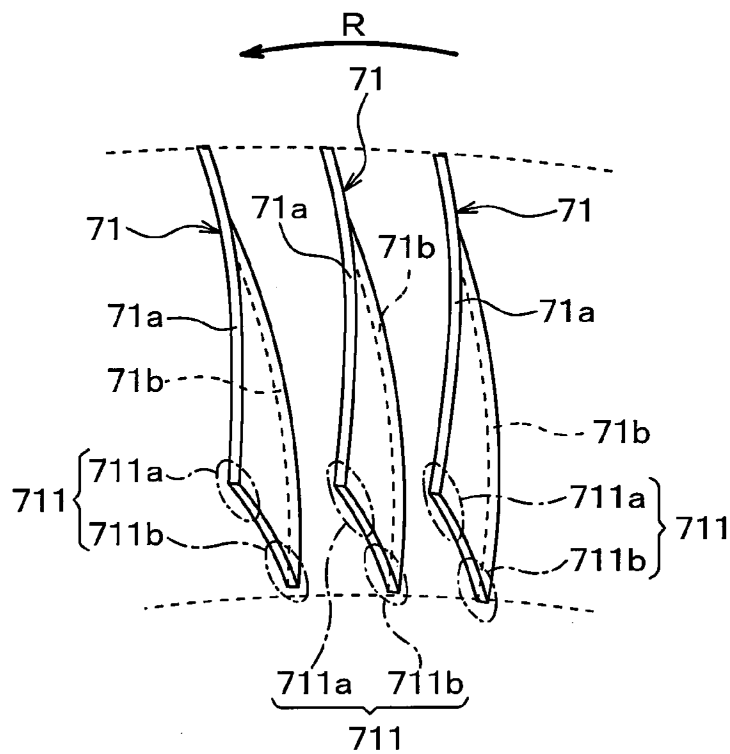

R
71
71
71a
71b
71
71a
71a
71b
71b
711
711a
711b
711a
711b
711
711a
711b
711

FIG. 7

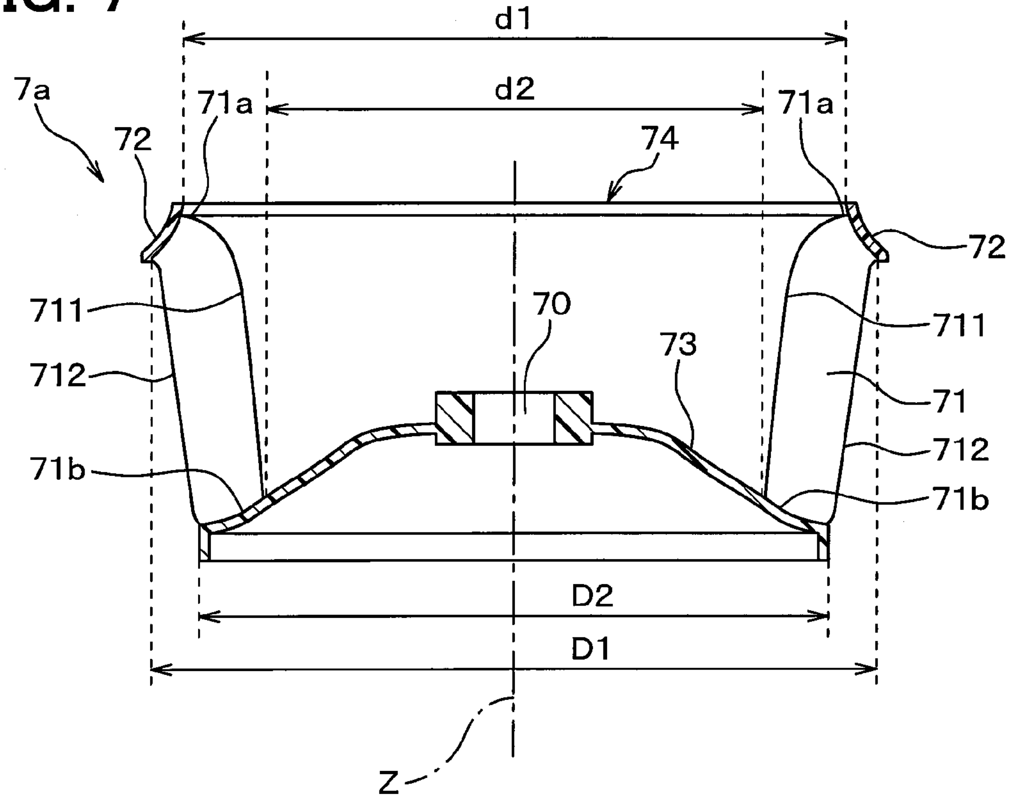

d1
d2
7a
72
71a
71a
74
72
711
70
711
73
712
71
712
71b
71b
D2
D1
Z

FIG. 8

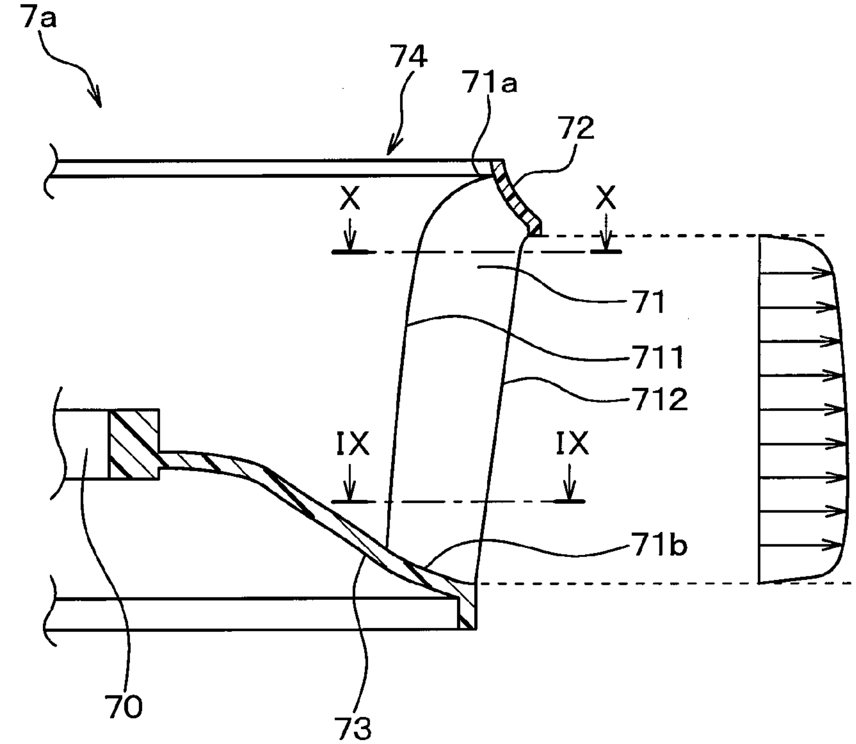

7a
74
71a
72
X
X
71
711
712
IX
IX
71b
70
73

FIG. 9

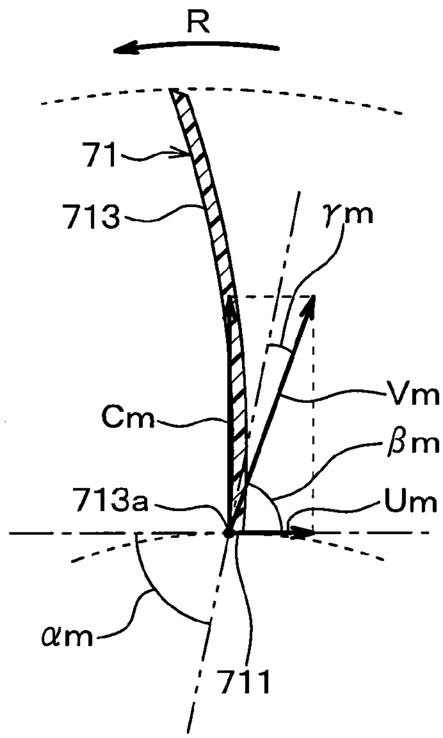

R
71
713
γm
Vm
Cm
βm
713a
Um
αm
711

FIG. 10

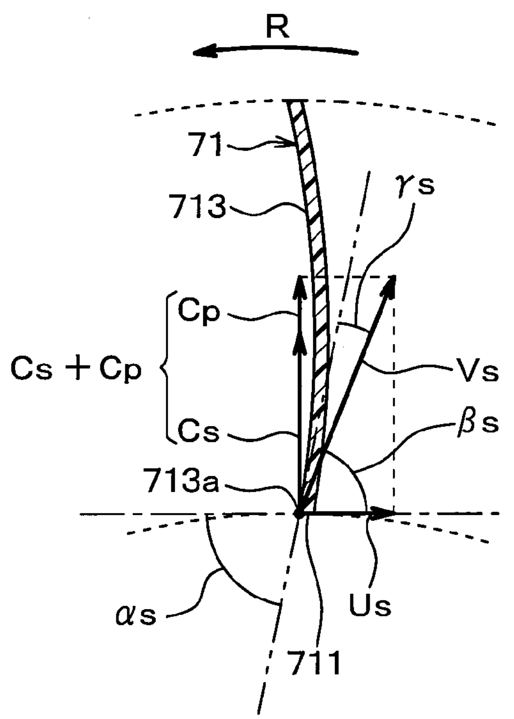

R
71
713
γs
Cp
Cs + Cp
Vs
Cs
βs
713a
αs
Us
711

FIG. 11

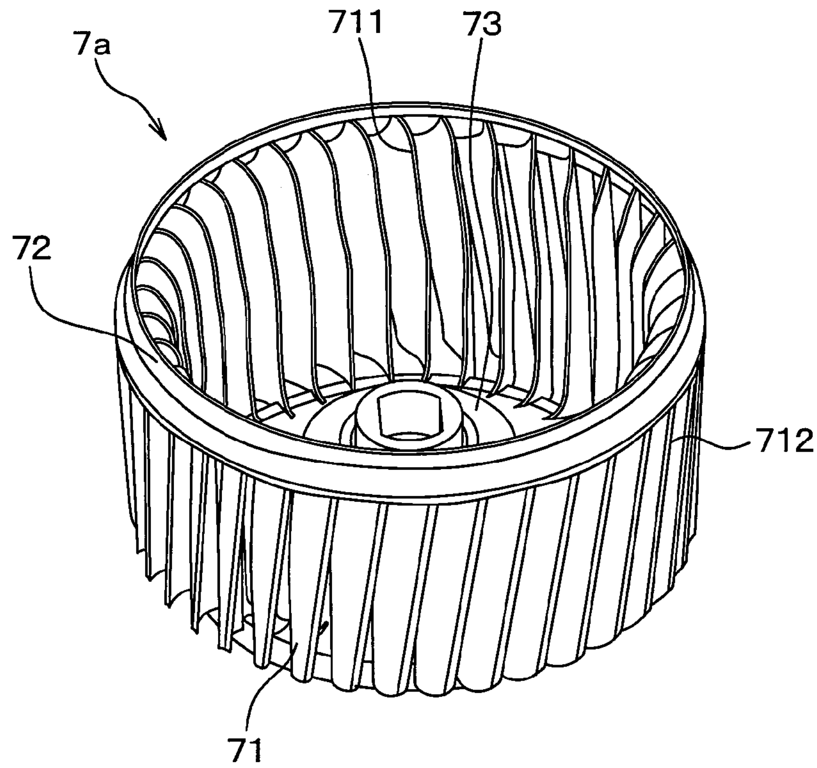


FIG. 12

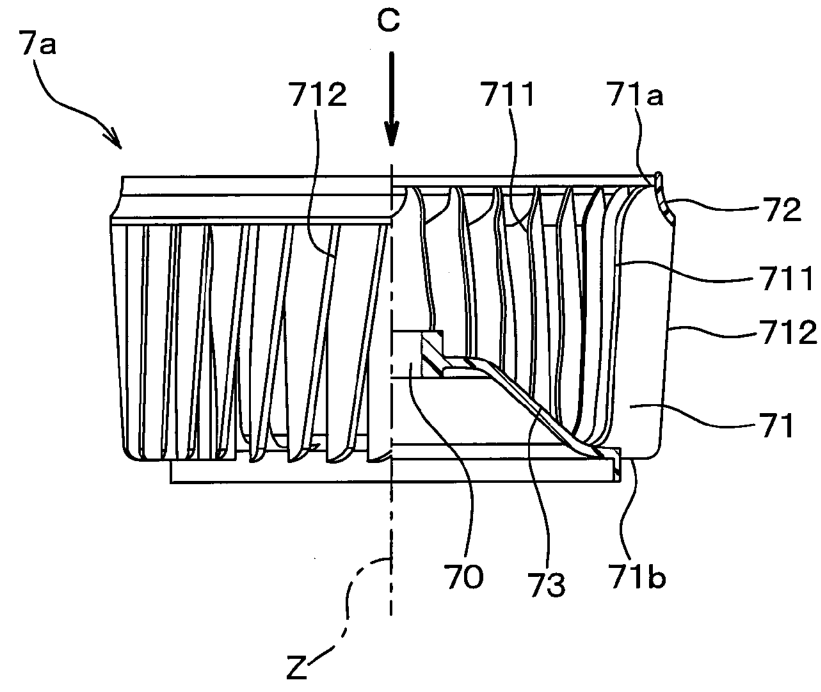
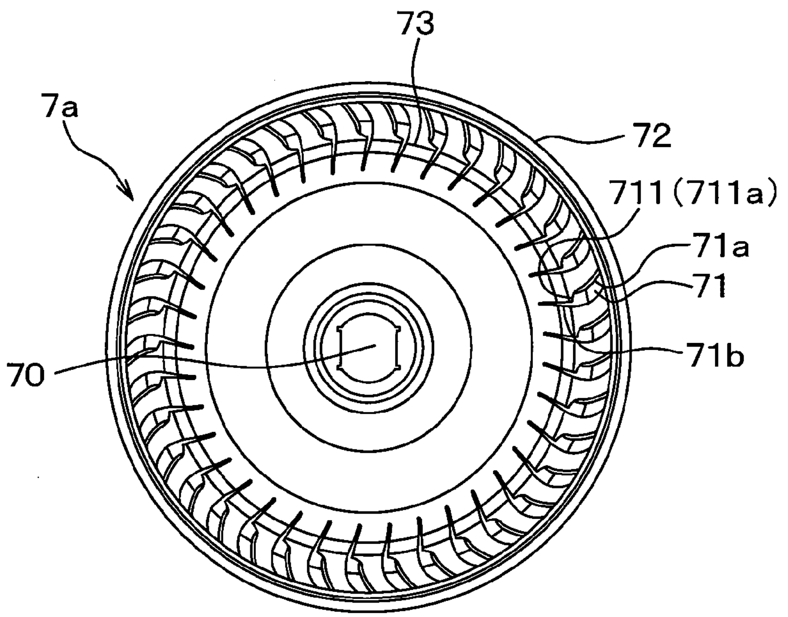
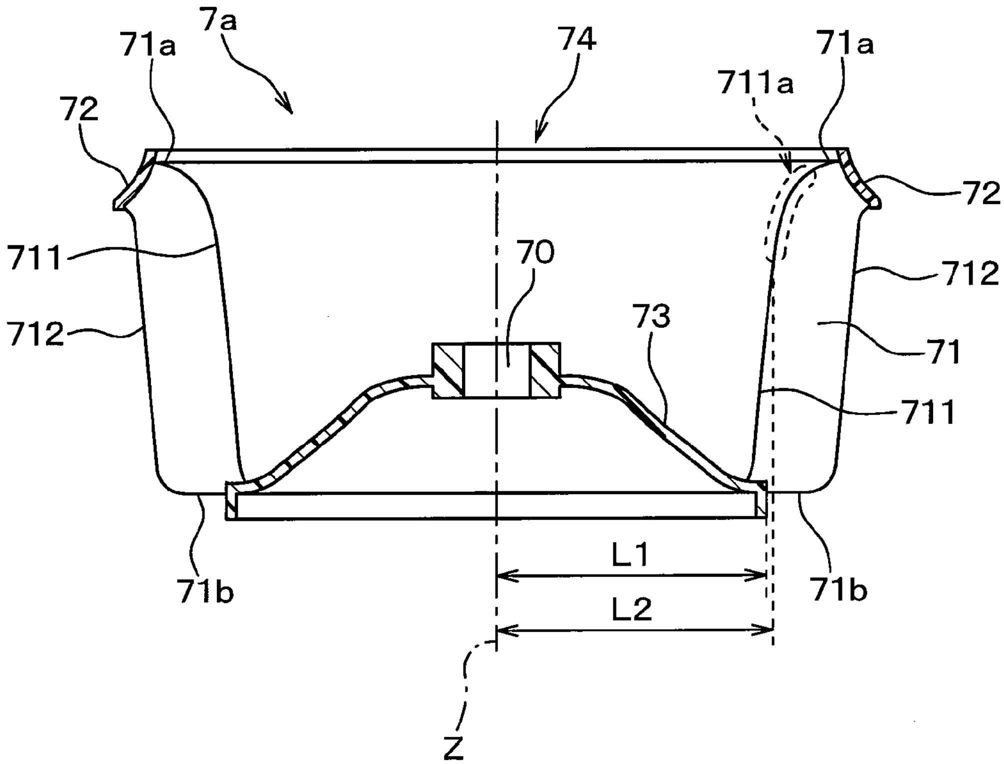


FIG. 13



73
7a
72
711 (711a)
71a
71
70
71b

FIG. 14



7a
71a
74
71a
711a
72
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711
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712
712
73
71
711
71b
L1
L2
71b
Z

FIG. 15

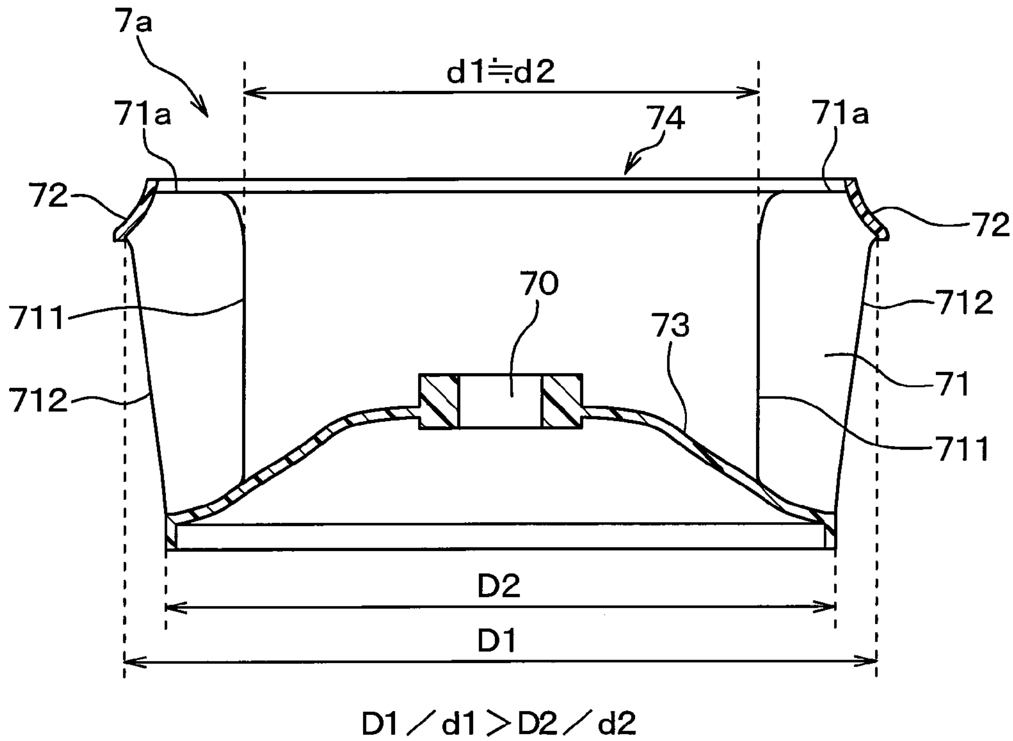


FIG. 16

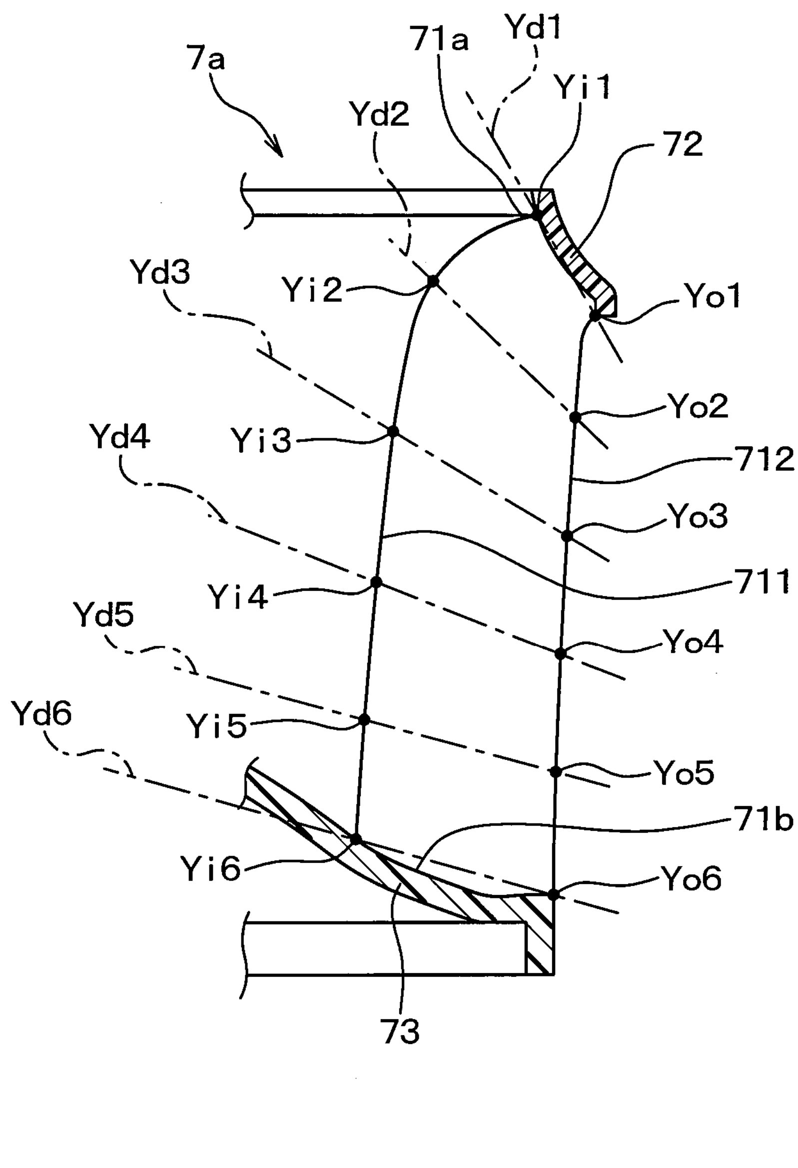
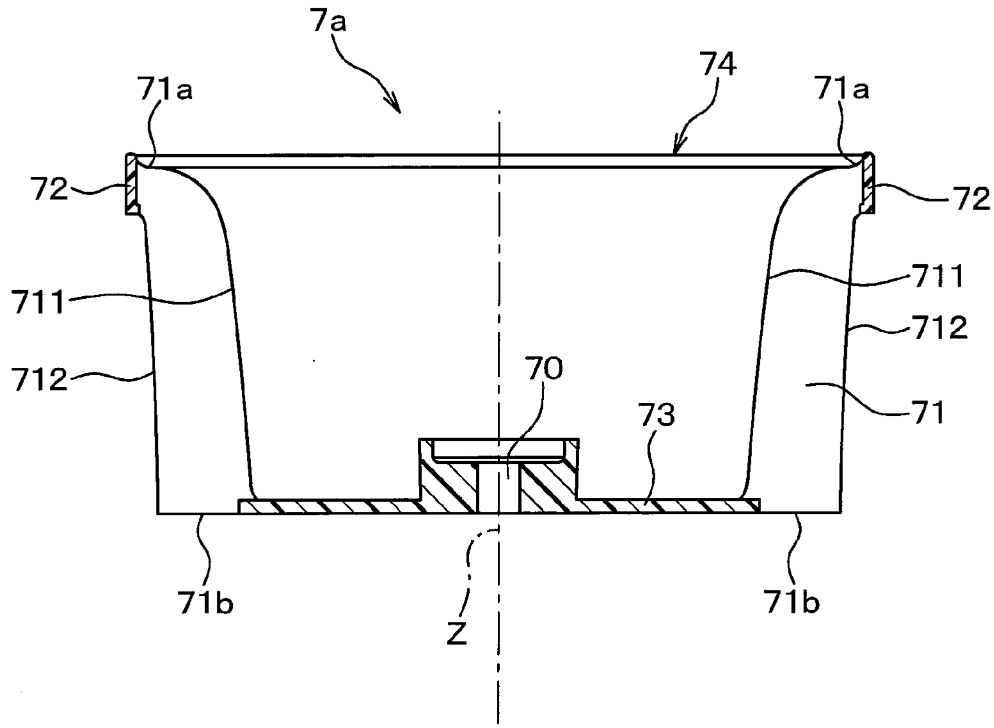

7a
71a
Yd1
Yi1
72
Yd2
Yd3
Yi2
Yo1
Yo2
Yi3
712
Yd4
Yo3
711
Yi4
Yo4
Yd5
Yi5
Yd6
Yo5
71b
Yi6
Yo6
73

FIG. 17


7a
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71a
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711
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712
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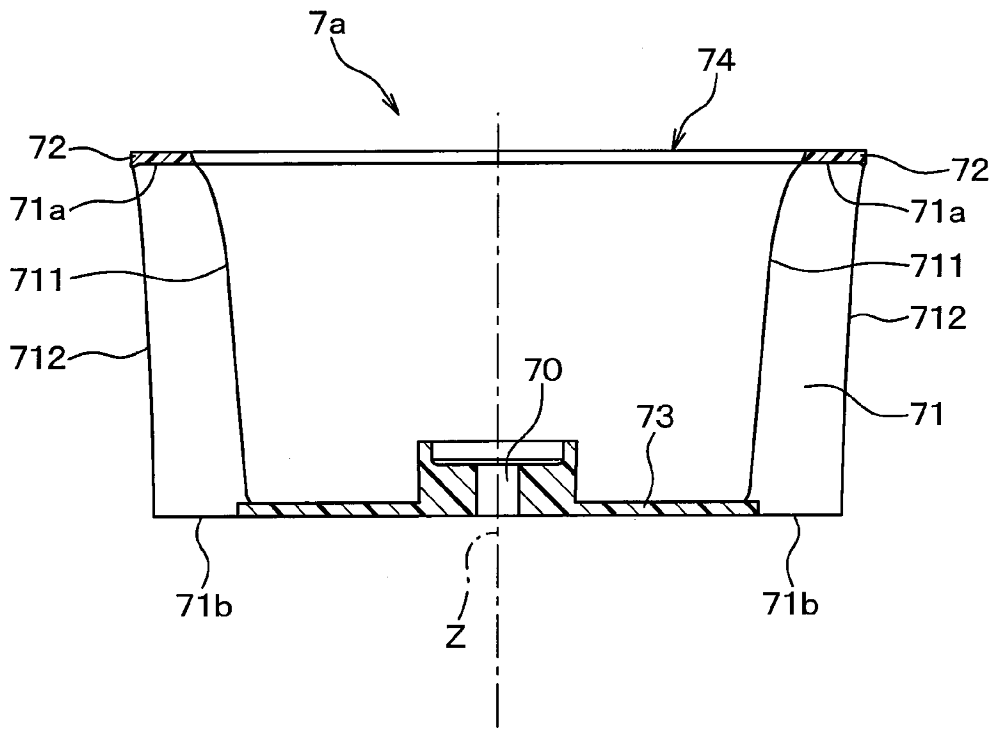
73
71b
71b
Z

FIG. 18


7a
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71a
711
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712
712
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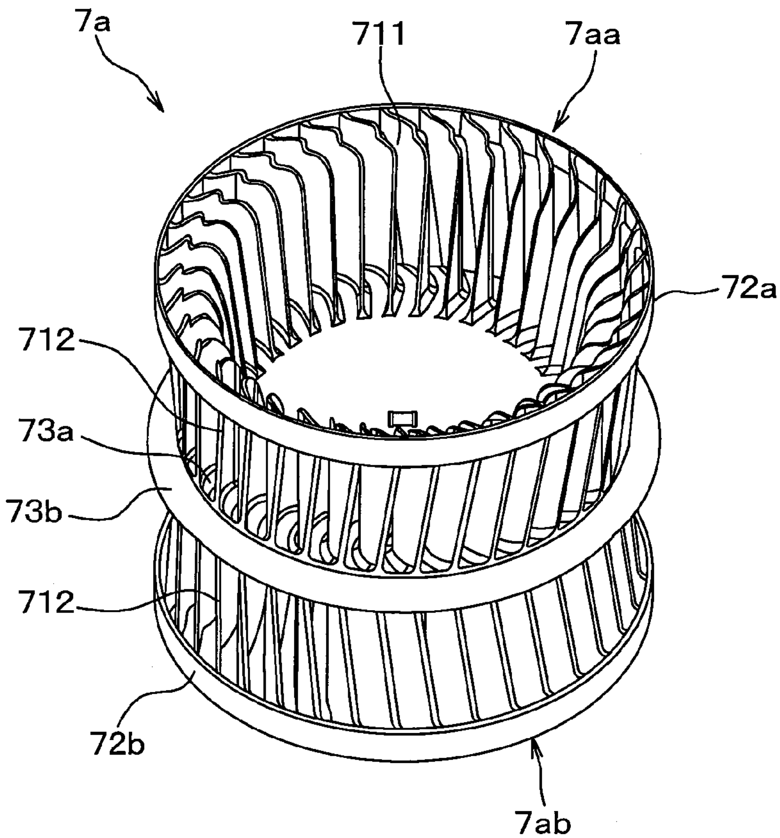
73
71b
71b
Z

FIG. 19


7a
711
7aa
72a
712
73a
73b
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72b
7ab

FIG. 20

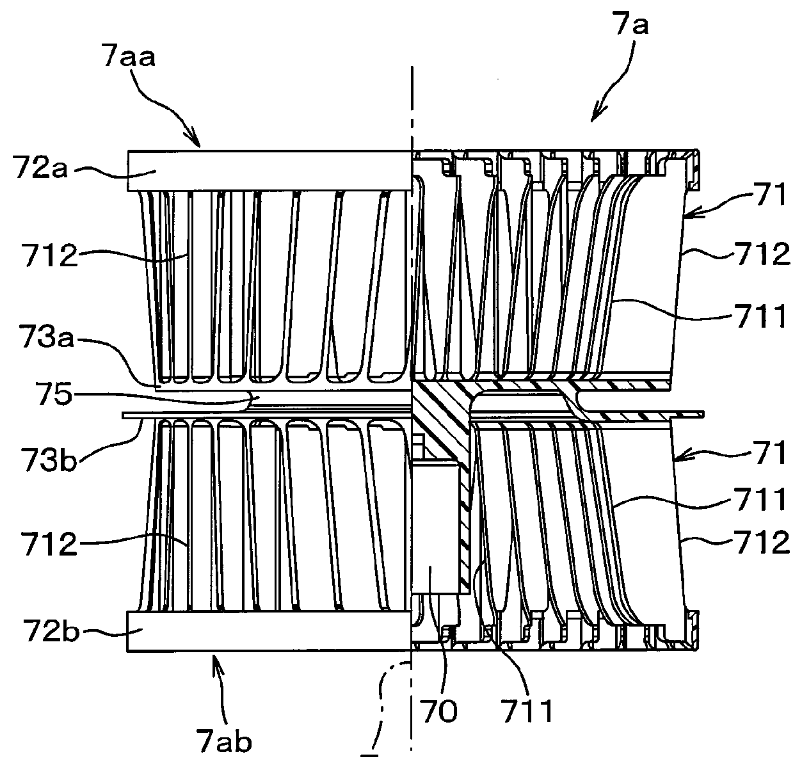

7a
7aa
72a
71
712
712
711
73a
75
73b
71
711
712
712
72b
70
711
7ab
Z

FIG. 21

PRIOR ART

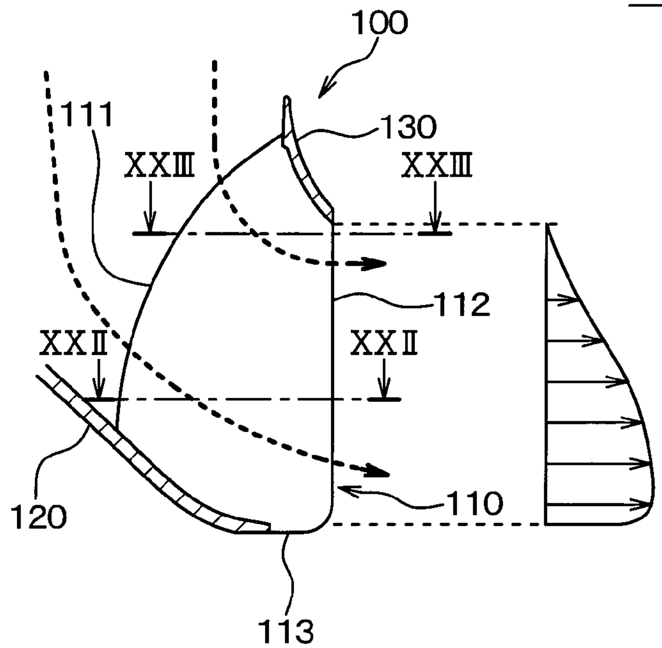


FIG. 22

PRIOR ART

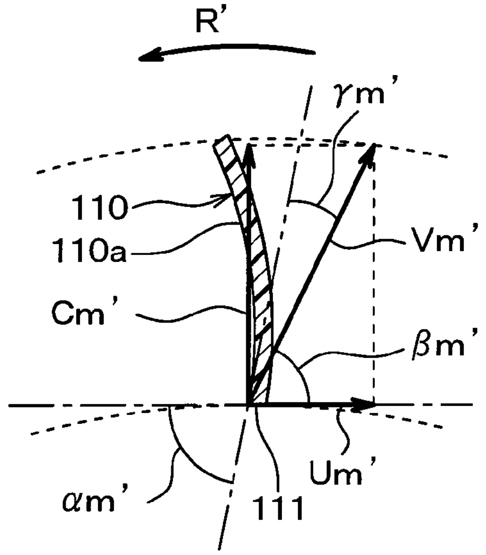
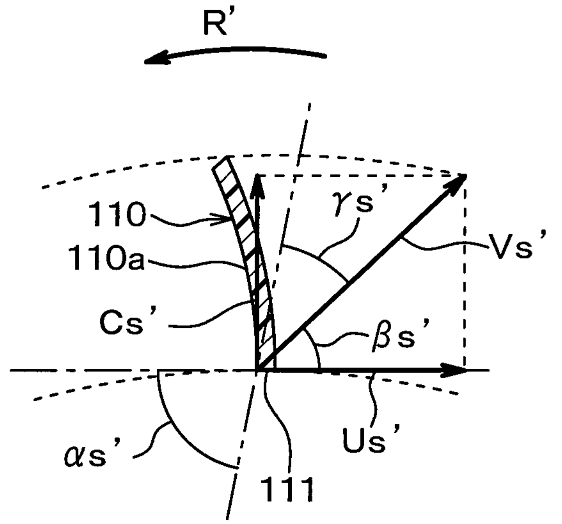


FIG. 23

PRIOR ART



CENTRIFUGAL MULTI-BLADE BLOWER

CROSS REFERENCE TO RELATED APPLICATION

[0001] This application is based on Japanese Patent Application No. 2012-142803 filed on Jun. 26, 2012 and Japanese Patent Application No. 2013-100170 filed on May 10, 2013, the disclosures of which are incorporated herein by reference.

TECHNICAL FIELD

[0002] The present disclosure relates to a centrifugal multi-blade blower that draws air from a direction of a rotation axis and blows out the air radially outward of the rotation axis.

BACKGROUND ART

[0003] An impeller of a conventional centrifugal multi-blade blower includes vanes arranged around the rotation axis, and blows out radially outward the air, which is drawn from the direction of the rotation axis.

[0004] In this impeller, a wind direction rapidly changes from the rotation axis direction to the radial direction at spaces between adjacent vanes (hereinafter referred to as an inter-vane space) near an air inlet. Accordingly, the air does not flow easily compared to on an opposite side from the inlet in the rotation axis direction.

[0005] In a case of a large difference (incidence angle) between an inlet angle (inlet condition) of an inner peripheral edge of the vane and an inflow angle (inflow condition) of the air flowing into the vane, there is a tendency that the air flow exfoliates in the inter-vane space, and the impeller of the centrifugal multi-blade blower loses speed. As the incidence angle becomes smaller, the impeller comes closer to its ideal state.

[0006] However, in a normal impeller, the inlet angle of the inner peripheral edge of the vane on the inlet side, on which the flow of air flowing into the vane rapidly changes, becomes significantly different from the inlet angle on the opposite side from the inlet on which the flow of air flowing into the vane gradually changes. For this reason, on the inlet side of the impeller, a difference easily becomes large between the inflow condition of the air flowing into the inner peripheral edge and the inflow condition of the air flowing into the vane. Accordingly, the exfoliation of an air flow is easily caused in the inter-vane space on the inlet side.

[0007] As measures against these issues, in, for example, Patent Document 1, as illustrated in FIG. **21**, an inner peripheral edge part **111** of a vane **110** on a side plate **130**-side is formed in a tapered shape so that an inner diameter of an impeller **100** on the side plate **130**-side (inlet side) is larger than on a main plate **120**-side (opposite side from the inlet). Accordingly, draft resistance on the inlet side of the impeller **100** is reduced to facilitate a flow of the air flowing from the rotation axis direction through the inter-vane space near the inlet.

[0008] Furthermore, in Patent Document 1, with a substantial inflow angle of air flowing into the vane **110** considered to be constant regardless of the position in the rotation axis direction, an inlet angle on each section crossing the inner peripheral edge part **111** of the vane **110** in a predetermined direction (e.g., perpendicular direction) is set within ±5 degrees. Accordingly, a difference between the inlet angle and the inflow angle at the inner peripheral edge part **111** on the side plate **130**-side is reduced to limit the exfoliation of an air flow on the side plate **130**-side. In addition, FIG. **21** is a meridian plane diagram corresponding to the impeller **100** illustrated in FIG. **20** of Patent Document 1. The meridian plane is a surface of section including the rotation axis of the impeller, onto which a shape of the vane is rotationally projected.

PRIOR ART DOCUMENT

Patent Document

[0009] Patent Document 1: JP-A-2006-200525

[0010] In the impeller **100** of the above-described conventional technology, although the air flows easily through the inter-vane space near the side plate **130**, it is still difficult to sufficiently curb the exfoliation of the air flow on the side plate **130**-side. As a consequence of this, there is an issue that a flow speed distribution is caused on an air outlet side of the impeller **100**.

[0011] An explanation as to this regard will be given below with reference to the drawings. FIGS. **22** and **23** are diagrams illustrating the issue of the above conventional technology. FIG. **22** is a cross-sectional view taken along a line XXII-XXII in FIG. **21** (sectional view of the vane **110** on the main plate **120**-side). FIG. **23** is a cross-sectional view taken along a line XXIII-XXIII in FIG. **21** (sectional view of the vane **110** on the side plate **130**-side). In FIGS. **22** and **23**, an inlet angle α of each vane **110** is an angle made between a tangent of an inscribed circle passing through the inner peripheral edge part **111** of each vane (alternate long and short dash line in FIGS. **22** and **23**), and a tangent at an inner end part of the inner peripheral edge part **111** on a positive pressure surface **110***a*-side (alternate long and two short dashes line in FIGS. **22** and **23**).

[0012] In the impeller **100** of the conventional technology, because the inner diameter of the impeller **100** on the side plate **130**-side is larger than on the main plate **120**-side, a circumferential speed Us' on the side plate **130**-side is faster than a circumferential speed Um' on the main plate **120**-side (Us'>Um').

[0013] In the impeller **100**, as indicated by short dashes arrows in FIG. **21**, a change of the flow direction of air flowing into the inter-vane space on the side plate **130**-side is greater than on the main plate **120**-side. Accordingly, as illustrated in FIGS. **22** and **23**, an absolute inflow speed Cs' of the air flowing into the inner peripheral edge part **111** of the vane **110** on the side plate **130**-side is slower than an absolute inflow speed Cm' of the air flowing into the inner peripheral edge part **111** of the vane **110** on the main plate **120**-side (Cs'<Cm').

[0014] When an angle made between a resultant relative inflow speed V of air between a circumferential speed component and an absolute inflow speed component, and the circumferential speed component is defined as an inflow angle β, as illustrated in FIGS. **22** and **23**, an inflow angle $\beta s'$ on the side plate **130**-side is smaller than an inflow angle $\beta m'$ on the main plate **120**-side.

[0015] Accordingly, if an inlet angle $\alpha s'$ on the side plate **130**-side is made the same as an inlet angle $\alpha m'$ on the main plate **120**-side as in the impeller **100** of the above conventional technology, a difference (incidence angle $\gamma s'$) between the inlet angle $\alpha s'$ and the inflow angle $\beta s'$ on the side plate **130**-side is larger than an incidence angle $\gamma m'$ on the main plate **120**-side.

[0016] As described above, even in the impeller **100** of the above conventional technology, the incidence angle γs' on the side plate **130**-side is still larger than the incidence angle γm' on the main plate **120**-side, and it is difficult to sufficiently restrain the exfoliation of the air flow on the side plate **130**-side. A flow speed on the side plate **130**-side of the impeller **100** on the air outlet side is reduced due to the exfoliation of the air flow on the side plate **130**-side.

[0017] As a result, for example, as in a flow speed distribution indicated on a right side of the impeller **100** in FIG. **21**, on the air outlet side of the impeller **100**, there is made such a flow speed distribution that a flow speed on the side plate **130**-side is slower than on the main plate **120**-side.

[0018] Such an issue arises similarly in the impeller **100** in which the inner diameter on the side plate **130**-side is the same as on the main plate **120**-side, i.e., the impeller **100** in which the inner peripheral edge part **111** does not have a tapered shape. This is because in the impeller **100** in which the inner peripheral edge part **111** does not have a tapered shape, the absolute inflow speed Cs' on the side plate **130**-side is slower than on the main plate **120**-side, so that the inflow angle βs' on the side plate **130**-side is smaller than the inflow angle βm' on the main plate **120**-side.

SUMMARY OF INVENTION

[0019] The present disclosure addresses the above issues. Thus, it is an objective of the present disclosure to provide a centrifugal multi-blade blower that can sufficiently evenly make a flow speed distribution in a rotation axis direction on an air outlet side of an impeller.

[0020] To achieve the above-described objective, the present inventors have earnestly given a great deal of consideration. As a result, with their attention turned to the fact that in a centrifugal multi-blade blower, a flow rate of an impeller on its air outlet side increases in proportion to the second power of an outer peripheral diameter of the impeller under conditions where rotating speed and draft resistance are constant, they have worked out a centrifugal multi-blade blower that can evenly make a flow speed distribution on the air outlet side of the impeller.

[0021] In one aspect of the present disclosure, the impeller includes a main plate that is joined to a rotation shaft, vanes which are arranged around the axis of the rotation shaft and the other end sides of which in the rotation axis direction are connected to the main plate, and a side plate that connects together the vanes on their one end sides in the rotation axis direction. The vanes are characterized in that the inlet angle on a cross-sectional surface crossing each inner peripheral edge part of the vanes on a meridian plane of the impeller in a predetermined direction is evenly made in the entire region from the side plate-side through the main plate-side, and that outer peripheral edge parts of the vanes are configured to be away from the axis of the rotation shaft from the main plate-side toward the side plate-side.

[0022] As described above, in such a configuration that the inlet angle is evenly made in the entire region from the side plate side through the main plate side, the outer peripheral diameter of the impeller is larger on the side plate side than on the main plate side. Accordingly, a flow rate on the air outlet side on the side plate side of the impeller can be increased. As a consequence, a flow speed on the air outlet side on the side plate side of the impeller can be increased compared to the impeller of the conventional technology.

[0023] Moreover, in accordance with the increase of the flow rate on the air outlet side on the side plate side of the impeller, a flow rate of air flowing into the inner peripheral edge part on the side plate side increases. This increase of the flow rate of air flowing into the inner peripheral edge part on the side plate side makes faster a flow speed (absolute inflow speed) on the side plate side. Accordingly, an inflow angle on the side plate side can be brought close to the inlet angle.

[0024] As a result, the exfoliation of the air flow on the side plate side can be restricted as compared with the impeller of the conventional technology, and there can be mitigated a reduction of the flow speed on the air outlet side on the side plate side in association with the exfoliation of the air flow on the side plate side.

[0025] For the above reason, the centrifugal multi-blade blower of the present disclosure can sufficiently evenly make a flow speed distribution in the rotation axis direction on an air outlet side of the impeller, which becomes an issue in the impeller of the conventional technology.

[0026] In the above description, "evenly" means a state where the inlet angle is not shifted or a state where there is only a minute difference within ±5 degrees in the entire region from the side plate side through the main plate side. The "meridian plane" is a surface of section including the rotation axis of the impeller, onto which a shape of the vane is rotationally projected In addition, the "inlet angle" is an intersecting angle between a tangent of a circle (inscribed circle) passing through each inner peripheral edge part of the vanes in a radial direction of the rotation axis, and the inner peripheral edge part of the vane.

BRIEF DESCRIPTION OF DRAWINGS

[0027] The above and other objects, features and advantages of the present disclosure will become more apparent from the following detailed description made with reference to the accompanying drawings. In the drawings:

[0028] FIG. **1** is a schematic view illustrating an air-conditioning system for a vehicle including a blower in accordance with a first embodiment;

[0029] FIG. **2** is a perspective view illustrating an impeller of the blower of the first embodiment;

[0030] FIG. **3** is a half sectional view illustrating the impeller of the blower of the first embodiment;

[0031] FIG. **4** is a diagram illustrating a vane part viewed from an arrowed line IV in FIG. **3**;

[0032] FIG. **5** is a diagram illustrating the vane part viewed from an arrowed line V in FIG. **3**;

[0033] FIG. **6** is a diagram illustrating the vane part viewed from an arrowed line VI in FIG. **3**;

[0034] FIG. **7** is a meridian plane diagram illustrating the entire impeller of the first embodiment;

[0035] FIG. **8** is a meridian plane diagram illustrating an essential part of the impeller of the first embodiment;

[0036] FIG. **9** is a cross-sectional view taken along a line IX-IX in FIG. **8**;

[0037] FIG. **10** is a cross-sectional view taken along a line X-X in FIG. **8**;

[0038] FIG. **11** is a perspective view illustrating an impeller of a blower in accordance with a second embodiment;

[0039] FIG. **12** is a half sectional view illustrating the impeller of the blower of the second embodiment;

[0040] FIG. **13** is a top view illustrating the impeller of the blower of the second embodiment;

[0041] FIG. **14** is a meridian plane diagram illustrating the impeller of the blower of the second embodiment;

[0042] FIG. **15** is a meridian plane diagram illustrating an impeller of a blower in accordance with a third embodiment;

[0043] FIG. **16** is a meridian plane diagram illustrating an essential part of an impeller of a blower in accordance with a fourth embodiment;

[0044] FIG. **17** is a meridian plane diagram illustrating an impeller of a blower in accordance with a modification;

[0045] FIG. **18** is a meridian plane diagram illustrating an impeller of a blower in accordance with another modification;

[0046] FIG. **19** is a perspective view illustrating an impeller of a blower in accordance with yet another modification;

[0047] FIG. **20** is a half sectional view illustrating the impeller of the blower of the yet another modification;

[0048] FIG. **21** is a meridian plane diagram illustrating an essential part of an impeller in accordance with a conventional technology;

[0049] FIG. **22** is a cross-sectional view taken along a line XXII-XXII in FIG. **21**; and

[0050] FIG. **23** is a cross-sectional view taken along a line XXIII-XXIII in FIG. **21**.

EMBODIMENTS FOR CARRYING OUT INVENTION

[0051] Embodiments of the present disclosure will be described below in reference to the drawings. For the same or equivalent component in the following embodiments, description may be omitted using its same corresponding reference numeral.

First Embodiment

[0052] A first embodiment will be described below. In the present embodiment, a centrifugal multi-blade blower of the present disclosure is applied to an air-conditioning system **1** for a vehicle including a water-cooled engine.

[0053] As illustrated in FIG. **1**, the air-conditioning system **1** includes an air-conditioning casing **2** that defines an air passage for blown air which is blown into a vehicle interior. At an uppermost stream side part of the air-conditioning casing **2** in an air flow direction, there are formed an inside air introduction port **3** for introducing inside air (vehicle interior air), and an outside air introduction port **4** for introducing outside air (vehicle exterior air), and there is provided an inside-outside air switch door **5** for selectively opening or closing these introduction ports **3**, **4**.

[0054] A blower **7** is disposed on a downstream side of the inside-outside air switch door **5** in an air flow direction, and the air introduced through the introduction ports **3**, **4** is blown by this blower **7** toward air outlets **14**, **15**, **17** which will be described later.

[0055] The blower **7** is a centrifugal multi-blade blower that blows out radially outward the air which is drawn from the direction of the rotation axis. In the present embodiment, for the blower **7**, there is employed a single-suction type blower that suctions air from its one end side in the rotation axis direction and blows out the air outward in the radial direction.

[0056] The blower **7** includes an impeller **7***a*, a scroll casing (casing) **7***b*, and an electric motor **7***c* that drives the impeller **7***a*. The impeller **7***a* rotates with a rotation shaft **70** as the center to blow out the air outward in the radial direction, and is configured from resin. The scroll casing **7***b* accommodates the impeller **7***a*, and includes a vortical passage through which the air blown out of the impeller **7***a* merges together. The scroll casing **7***b* includes an inlet port **74** that opens on one end side of the rotation shaft **70**. Details of the impeller **7***a* of the blower **7** of the present embodiment will be described later.

[0057] An evaporator **9** is disposed on a downstream side of the blower **7** in the air flow direction, and all the air blown by the blower **7** passes through this evaporator **9**. The evaporator **9** of the present embodiment is an air cooling means for exchanging heat between refrigerant flowing in the evaporator **9** and blown air which is blown by the blower **7** to cool the blown air. Together with a compressor, a condenser, a gas-liquid separation device, an expansion valve, and so forth which are not shown, this evaporator **9** constitutes a vapor-compression type refrigeration cycle.

[0058] A heater core **10** is disposed on a downstream side of the evaporator **9** in the air flow direction. The heater core **10** is an air heating means for exchanging heat between engine coolant for cooling an engine **11** and air after having passed through the evaporator **9** to heat the air after having passed through the evaporator **9**.

[0059] The air-conditioning casing **2** includes a bypass passage **12** through which the air after having passed through the evaporator **9** flows to bypass the heater core **10**. On an upstream side of the heater core **10** in the air flow direction, there is disposed an air mixing door **13** that adjusts an air volume ratio between the volume of air passing through the heater core **10** and the volume of air passing through the bypass passage **12** to adjust the temperature of air blown out into the vehicle interior.

[0060] At a downmost stream part of the air-conditioning casing **2** in the air flow direction, there are provided the face air outlet **14** for blowing out the air toward an upper half of a body of an occupant of the vehicle, the foot air outlet **15** for blowing out the air toward a foot of the occupant, and the defroster air outlet **17** for blowing out the air toward an inner surface of a window pane **16**.

[0061] Blowing-out mode switch doors **18**, **19**, and **20** are arranged respectively on an upstream side of these air outlets **14**, **15**, **17** in the air flow direction. These blowing-out mode switch doors **18** to **20** are switchingly opened or closed to switch between a face mode in which to blow out the air toward an upper body of the occupant, a foot mode in which to blow out the air toward a lower body of the occupant, and a defroster mode in which to blow out the air toward an inner surface of the window pane of the vehicle.

[0062] The impeller **7***a* of the blower **7** of the present embodiment will be described below. As illustrated in a perspective view of FIG. **2** and a half sectional view of FIG. **3**, the impeller **7***a* of the blower **7** includes vanes **71**, a side plate **72**, and a main plate **73**.

[0063] The main plate **73** is configured by a disc-like member that is joined to the rotation shaft **70**. The main plate **73** of the present embodiment is connected to a part **71***b* of each vane **71** on the other end side (lower side on a plane of paper) in the rotation axis direction, and is configured to overlap with the vanes **71** when viewed from the rotation axis direction.

[0064] The side plate **72** is connected to a part of each vane **71** radially outward of the rotation shaft **70** on one end side (upper side on a plane of paper) in the rotation axis direction. The side plate **72** of the present embodiment is connected to cover an outer peripheral edge part (vane rear edge) **712** of each vane **71** on the one end side in the rotation axis direction, from a radially outward side of the rotation shaft **70**. More specifically, the side plate **72** of the present embodiment has an annular shape (shroud shape) which is bent such that its part on the one end side in the rotation axis direction is located inward of the part on the other end side in the radial direction of the rotation shaft **70**. The side plate **72** of the present embodiment is configured such that its inner peripheral diameter Ds is larger than an outer peripheral diameter Dm of the main plate **73**, and has a shape that does not overlap with the main plate **73** when viewed from the rotation axis direction.

[0065] The vanes **71** are arranged around the axis Z of the rotation shaft **70**. The vanes **71**, the side plate **72**, and the main plate **73**, which constitute the impeller **7***a*, are integrally molded by resin molding or the like.

[0066] As a result of the rotation of the rotation shaft **70**, the impeller **7***a* configured in this manner blows out by centrifugal force radially outward of the impeller **7***a* the air, which has flowed from the inlet port **74** on the one end side in the rotation axis direction into inter-vane spaces (spaces between the vanes **71**) in the impeller **7***a*.

[0067] A shape of the vane **71** of the present embodiment will be described below. FIGS. **4** to **6** are diagrams viewed respectively from arrowed lines in FIG. **3** and illustrate the shape of the vane **71** of the present embodiment. For convenience of explanation, in FIGS. **4** to **6**, illustrations of the side plate **72** and the main plate **73** are omitted, and typical three vanes **71** in directions of the arrowed lines A to C in FIG. **3** are illustrated.

[0068] As illustrated in FIG. **4**, an inner peripheral edge part (vane front edge) **711** is provided for each vane **71** between parts **71***a*, **71***b* on both end sides of the vane **71** on an inner peripheral side of the impeller **7***a*. As illustrated in FIG. **5**, an outer peripheral edge part (vane rear edge) **712** is provided for each vane **71** between the parts **71***a*, **71***b* on both end sides of the vane **71** on an outer peripheral side of the impeller **7***a*.

[0069] In each vane **71** of the present embodiment, as illustrated in FIG. **6**, when viewed from the rotation axis direction, a part **711***a* of the inner peripheral edge part **711** on the one end side in the rotation axis direction is located further on a front side than a part **711***b* of the inner peripheral edge part **711** on the other end side in the rotation axis direction, in a rotation direction R of the impeller **7***a*.

[0070] As described above, the impeller **7***a* of the present embodiment is configured to blow out radially outward the air which is drawn from the rotation axis direction. Accordingly, the part **711***a* of the inner peripheral edge part **711** on the one end side in the rotation axis direction is located on a front side of the part **711***b* of the inner peripheral edge part **711** on the other end side in the rotation axis direction, in the rotation direction R, so that the air is suctioned easily into the inter-vane spaces from the rotation axis direction on the side plate **72**-side. As a result, the flow rate of air flowing into the inter-vane spaces on the side plate **72**-side can be increased. The part **711***a* of the inner peripheral edge part **711** on the one end side in the rotation axis direction may be hereinafter referred to as a forward part **711***a*, and the part **711***b* of the inner peripheral edge part **711** on the other end side in the rotation axis direction may be hereinafter referred to as a backward part **711***b*.

[0071] The specific shapes of the inner peripheral edge part **711** and the outer peripheral edge part **712** of each vane **71** will be described with reference to the meridian plane diagrams in FIGS. **7** and **8**. The "meridian plane" is a surface of section including the rotation shaft **70** of the impeller **7***a*, onto which a shape of the vane **71** is rotationally projected.

[0072] As illustrated in FIGS. **7** and **8**, the inner peripheral edge part **711** of the vane **71** of the present embodiment is configured to separate from the axis Z of the rotation shaft **70** from the main plate **73**-side toward the side plate **72**-side such that the inner peripheral diameter of the impeller **7***a* on the side plate **72**-side is larger than the inner peripheral diameter on the main plate **73**-side. The inner peripheral diameter of the impeller **7***a* is a diameter of an inscribed circle passing through the inner peripheral edge parts **711** of the vanes **71** in the radial direction of the rotation shaft **70**.

[0073] In the case of a large difference (incidence angle γ) between an inlet angle α at the inner peripheral edge part **711** of the vane **71**, and an inflow angle β of air flowing into the inner peripheral edge part **711**, an exfoliation region is formed in the inter-vane space, so that the centrifugal multi-blade blower loses its speed. Accordingly, the centrifugal multi-blade blower is put into its ideal state when the incidence angle γ is small.

[0074] However, in a normal centrifugal multi-blade blower, there is a tendency that a difference between an inlet angle α and an inflow angle β at the inner peripheral edge part **711** on the side plate **72**-side easily becomes large in comparison to on the main plate **73**-side, and the exfoliation of the air flow is thereby easily produced in the inter-vane space on the side plate **72**-side.

[0075] Accordingly, in the present embodiment, the inlet angle α on each cross-sectional surface crossing the inner peripheral edge part **711** of the vane **71** that appears on the meridian plane of the impeller **7***a* in a predetermined direction is set to be evenly made in the entire region from the side plate **72**-side through the main plate **73**-side. "Evenly" means a state where the inlet angle α is not shifted or a state where there is only a minute difference within ±5 degrees in the entire region from the side plate **72**-side through the main plate **73**-side.

[0076] FIG. **9** is a cross-sectional view taken along a line IX-IX in FIG. **8**, and FIG. **10** is a cross-sectional view taken along a line X-X in FIG. **8**. The cross-section surface along the line IX-IX is a surface of section obtained by cutting a part of the vane **71** on the main plate **73**-side in a direction perpendicular to the rotation axis direction. The cross-section surface along the line X-X is a surface of section obtained by cutting a part of the vane **71** on the side plate **72**-side in a direction perpendicular to the rotation axis direction.

[0077] Specifically, in the present embodiment, as illustrated in FIGS. **9** and **10**, an inlet angle αm, as at the inner peripheral edge part **711** of each vane **71** on each cross-section perpendicular to the rotation axis direction is set at an angle (e.g., angle ranging from 55 degrees to 76 degrees) that is even in the entire region from the side plate **72**-side through the main plate **73**-side.

[0078] In the present embodiment, the inlet angle αm, as is an angle made between a tangent line (alternate long and short dash line in FIGS. **9** and **10**) of the inscribed circle passing through the inner peripheral edge parts **711** of the vanes **71**, and a tangent line (alternate long and two short dashes line in FIGS. **9** and **10**) at an inner end part **713***a* of the vane **71** on a positive pressure surface **713**-side.

[0079] As described for the above issue, it is difficult to sufficiently inhibit the exfoliation of the air flow on the side plate **72**-side only by evenly making the inlet angle αm, as at the inner peripheral edge part **711** of each vane **71** in the entire region from the side plate **72**-side through the main plate **73**-side.

[0080] Accordingly, in the present embodiment, as illustrated in FIG. **7**, the outer peripheral edge parts **712** of the vanes **71** are shaped to be away from the axis Z of the rotation shaft **70** from the main plate **73**-side toward the side plate **72**-side such that the outer peripheral diameter of the impeller *7a* on the side plate **72**-side is larger than the outer peripheral diameter of the impeller *7a* on the main plate **73**-side. The outer peripheral diameter of the impeller *7a* is a diameter of a circumscribed circle passing through the outer peripheral edge parts **712** of the vanes **71** in the radial direction of the rotation shaft **70**.

[0081] Specifically, the vanes **71** of the present embodiment are configured to have the inner peripheral diameter increased from the main plate **73**-side toward the side plate **72**-side, and to have the outer peripheral diameter increased from the main plate **73**-side toward the side plate **72**-side (d**1**>d**2**, D**1**>D**2**). For this reason, an outer configuration of the impeller *7a* of the present embodiment has a shape of an inverted trapezoid.

[0082] In the present embodiment, a side-plate side inner-outer diameter ratio is smaller than a main-plate side inner-outer diameter ratio. The side-plate side inner-outer diameter ratio is a ratio of an outer peripheral diameter D**1** to an inner peripheral diameter d**1** (=D**1**/d**1**) of the impeller *7a* on the side plate **72**-side, and the main-plate side inner-outer diameter ratio is a ratio of an outer peripheral diameter D**2** to an inner peripheral diameter d**2** (D**2**/d**2**) of the impeller *7a* on the main plate **73**-side.

[0083] Operation of the air-conditioning system **1** of the present embodiment will be described below. When the operation of the air-conditioning system **1** is started by operation by the occupant, for example, the air introduced into the air-conditioning casing **2** through the introduction ports **3**, **4** is blown toward the air outlets **14**, **15**, **17** by the blower **7**. The blown air which is blown by the blower **7** is adjusted to have a desired temperature by the evaporator **9**, the heater core **10**, and the air mixing door **13**, and is blown out into the vehicle interior through any air outlet of the air outlets **14**, **15**, **17**.

[0084] In the blower **7** of the present embodiment, the inner peripheral edge parts **711** of the vanes **71** are shaped to separate from the axis Z of the rotation shaft **70** from the main plate **73**-side toward the side plate **72**-side such that the inner peripheral diameter of the impeller *7a* becomes large from the main plate **73**-side toward the side plate **72**-side. Accordingly, draft resistance on the side plate **72**-side of the impeller *7a* can be reduced to make the air flowing from the rotation axis direction flow easily into the inter-vane spaces on the side plate **72**-side.

[0085] In the blower **7** of the present embodiment, the inlet angle αm, as at the inner peripheral edge part **711** of each vane **71** on each cross-section perpendicular to the axis of the rotation shaft **70** is made evenly in the entire region from the side plate **72**-side through the main plate **73**-side. Accordingly, as compared to a normal centrifugal multi-blade blower, the exfoliation of the air flow on the side plate **72**-side can be limited to make the air flowing from the rotation axis direction flow easily into the inter-vane spaces near the inlet port **74**.

[0086] In the blower **7** of the present embodiment, the outer peripheral edge parts **712** of the vanes **71** are shaped to be away from the axis Z of the rotation shaft **70** from the main plate **73**-side toward the side plate **72**-side. Accordingly, there is evenly made a flow speed distribution in the rotation axis direction on an air outlet side of the impeller *7a,* which comes to an issue when the inlet angle αm, as at the inner peripheral edge part **711** of each vane **71** is made evenly in the entire region from the side plate **72**-side through the main plate **73**-side.

[0087] To explain this regard, in the centrifugal multi-blade blower, the flow rate of the impeller *7a* on its air outlet side increases in proportion to the second power of the outer peripheral diameter of the impeller *7a* under conditions where rotating speed and draft resistance are constant. Accordingly, by increasing the outer peripheral diameter of the impeller *7a* on the side plate **72**-side compared with on the main plate **73**-side, the flow rate on the air outlet side of the impeller *7a* on its side plate **72**-side increases, whereupon the flow speed on the air outlet side of the impeller *7a* on its side plate **72**-side becomes fast. Thus, the flow speed on the side plate **72**-side of the impeller *7a* on its air outlet side can be brought close to the flow speed on the main plate **73**-side.

[0088] Moreover, the flow rate of air flowing into the inner peripheral edge parts **711** on the side plate **72**-side increases in accordance with the increase of the flow rate on the air outlet side of the impeller *7a* on its side plate **72**-side. This increase of the flow rate of air flowing into the inner peripheral edge parts **711** on the side plate **72**-side makes faster the flow speed on the side plate **72**-side. Accordingly, a difference between the inlet angle and the inflow angle on the side plate **72**-side can be reduced.

[0089] In the present embodiment, because the inner diameter of the impeller *7a* on its side plate **72**-side is larger than on the main plate **73**-side, a circumferential speed Us on the side plate **72**-side is faster than a circumferential speed Um on the main plate **73**-side (Us>Um) as illustrated in FIGS. **9** and **10**.

[0090] On the other hand, an absolute inflow speed of the air flowing into the inner peripheral edge parts **711** of the vanes **71** on the side plate **72**-side is faster by an increase Cp of the flow speed (=Cs+Cp) due to the increase of the flow rate of air flowing into the inner peripheral edge parts **711**.

[0091] When an angle made between a resultant relative inflow speed V of air between a circumferential speed component and an inflow speed component, and the circumferential speed component is defined as an inflow angle β, an inflow angle βs on the side plate **72**-side is an angle that is close to an inflow angle βm on the main plate **73**-side.

[0092] In the impeller *7a* of the present embodiment, the inlet angle αs on the side plate **72**-side is made (almost) the same as the inlet angle αm on the main plate **73**-side. Accordingly, a difference (incidence angle γs) between the inlet angle αs and the inflow angle βs on the side plate **72**-side is reduced.

[0093] As a result, the exfoliation of the air flow on the side plate **72**-side is sufficiently curbed, so that there can be alleviated a reduction of the flow speed on the air outlet side on the side plate **72**-side associated with the exfoliation of the air flow on the side plate **72**-side. Consequently, the flow speed on the side plate **72**-side of the impeller *7a* on its air outlet side can be brought even closer to the flow speed on the main plate **73**-side.

[0094] As a consequence, as in a flow speed distribution indicated on a right side of the impeller *7a* in FIG. **8**, for example, the flow speed distribution in the rotation axis direction on the air outlet side of the impeller *7a* can be sufficiently evenly made. Improvement in efficiency of the blower **7** and restraint of noise of the blower **7** can be promoted.

[0095] Particularly, in the present embodiment, the part **711***a* of the inner peripheral edge part **711** on the one end side in the rotation axis direction is positioned further on a front side in the rotation direction R than the part **711***b* of the inner peripheral edge part **711** on the other end side in the rotation axis direction.

[0096] Accordingly, because of the increase of the flow rate of air flowing into the inter-vane spaces on the side plate **72**-side, there can be increased the flow speed (absolute inflow speed) of air flowing into the inner peripheral edge parts **711** on the side plate **72**-side. As a consequence, the incidence angle γs on the side plate **72**-side can be further reduced. Consequently, the exfoliation of the air flow on the side plate **72**-side can be restricted more effectively.

Second Embodiment

[0097] A second embodiment will be described below. In the present embodiment, an example of modification of the shape of the main plate **73** to the first embodiment will be described. In the present embodiment, explanation will be given with the description of a part similar or equivalent to the first embodiment omitted or simplified.

[0098] In an impeller **7***a* of the present embodiment, an outer peripheral diameter of a main plate **73** is made smaller than in the first embodiment as illustrated in a perspective view in FIG. **11**, a half sectional view in FIG. **12**, and a top view in FIG. **13**. Specifically, in the present embodiment, as illustrated in FIG. **13**, the outer peripheral diameter of the main plate **73** is made small such that the main plate **73** and a forward part **711***a* of an inner peripheral edge part **711** do not overlap with each other when the impeller **7***a* is viewed from the rotation axis direction.

[0099] More specifically, as illustrated in a meridian plane diagram in FIG. **14**, a distance L**1** from an axis Z of a rotation shaft **70** to an outer peripheral end of the main plate **73** is smaller than a distance L**2** from the axis Z of the rotation shaft **70** to the forward part **711***a* of the inner peripheral edge part **711**.

[0100] The other configurations are similar to the first embodiment. Thus, a blower **7** of the present embodiment produces effects similar to the first embodiment.

[0101] In the case of such a configuration (three-dimensional vane) that the forward part **711***a* of the inner peripheral edge part **711** is located on a front side of a backward part **711***b* of the inner peripheral edge part **711** in the rotation direction R, when integrally molding vanes **71**, a side plate **72**, and the main plate **73**, the forward part **711***a* may be undercut.

[0102] As measures against this, in the present embodiment, the impeller **7***a* is shaped such that the main plate **73** and a forward part **711***a* of an inner peripheral edge part **711** do not overlap with each other in the rotation axis direction by making small the outer peripheral diameter of the main plate **73**. Accordingly, when integrally-shaping at least the main plate **73** and the vanes **71** by molding, a molded article can be taken out from a mold by sliding the mold in the rotation axis direction. As a consequence, the impeller **7***a* can easily be produced to reduce the costs.

Third Embodiment

[0103] A third embodiment will be described below. In the present embodiment, an example of modification of the shape of the impeller **7***a* to the first and second embodiments will be described. In the present embodiment, explanation will be given with the description of a part similar or equivalent to the first and second embodiments omitted or simplified.

[0104] In the present embodiment, as illustrated in FIG. **15**, a ratio of an outer peripheral diameter D**1** to an inner peripheral diameter d**1** of an impeller **7***a* on a side plate **72**-side (side-plate side inner-outer diameter ratio) is larger than a ratio of an outer peripheral diameter D**2** to an inner peripheral diameter d**2** of the impeller **7***a* on a main plate **73**-side (main-plate side inner-outer diameter ratio) (D**1**/d**1**>D**2**/d**2**).

[0105] Specifically, in the present embodiment, outer peripheral edge parts **712** of vanes **71** are configured to be away from an axis Z of a rotation shaft **70** from the main plate **73**-side toward the side plate **72**-side, and inner peripheral edge parts **711** of the vanes **71** are configured to extend along the rotation axis direction. More specifically, in the impeller **7***a* of the present embodiment, the outer peripheral diameter of the impeller **7***a* on the side plate **72**-side is larger than the outer peripheral diameter of the impeller **7***a* on the main plate **73**-side, and the inner peripheral diameter of the impeller **7***a* on the side plate **72**-side and the inner peripheral diameter of the impeller **7***a* on the main plate **73**-side are equal to each other.

[0106] The other configurations are similar to the first embodiment, and the blower **7** of the present embodiment produces effects similar to the effects of the first embodiment.

[0107] In the case of the side-plate side inner-outer diameter ratio (=D**1**/d**1**) being smaller than the main-plate side inner-outer diameter ratio (D**2**/d**2**) as in the first embodiment, if the inner peripheral diameter of the impeller **7***a* on the side plate **72**-side is too large, the circumferential speed Us at the inner peripheral edge part **711** on the side plate **72**-side increases. As a result, the inflow angle βs at the inner peripheral edge part **711** on the side plate **72**-side becomes small, and the difference between the inlet angle αs and the inflow angle βs at the inner peripheral edge part **711** on the side plate **72**-side may thereby be increased.

[0108] On the other hand, in the present embodiment, since the side-plate side inner-outer diameter ratio of the impeller **7***a* is larger than the main-plate side inner-outer diameter ratio, the inner peripheral diameter of the impeller **7***a* on the side plate **72**-side is not too large, so that there can be limited the increase of the circumferential speed Us at the inner peripheral edge part **711** on the side plate **72**-side. Therefore, as a result of the configuration of the present embodiment, there can be restrained a the increase of the circumferential speed at the inner peripheral edge part **711** on the side plate **72**-side which influences the inflow angle at the inner peripheral edge part **711** on the side plate **72**-side in addition to the flow rate increase on the side plate **72**-side.

[0109] Accordingly, the inflow angle βs at the inner peripheral edge part **711** on the side plate **72**-side becomes large, so that the difference between the inlet angle αs and the inflow angle βs at the inner peripheral edge part **711** on the side plate **72**-side is reduced. As a result, the exfoliation on the side plate **72**-side can be effectively inhibited.

Fourth Embodiment

[0110] A fourth embodiment will be described below. In the present embodiment, explanation will be given with the description of a part similar or equivalent to the first to third embodiments omitted or simplified.

[0111] In the present embodiment, imaginary flow lines, whereby flow directions of air flowing into inner peripheral edge parts **711** of vanes **71** are assumed, are set, and the inlet angles α on cross-sections on the imaginary flow lines are made evenly in the entire region from a side plate **72**-side through a main plate **73**-side (e.g., angle ranging from 55 degrees to 76 degrees).

[0112] Specifically, in the present embodiment, as illustrated in FIG. **16**, first to sixth division lines Yd**1** to Yd**6** are set as the imaginary flow lines, and the inlet angles α on cross-sections on the imaginary flow lines Yd**1** to Yd**6** are made evenly over the entire range of the inner peripheral edge part **711** of the vane **71**

[0113] To explain the setting of the imaginary flow lines, the inner peripheral edge part **711** of the vane **71** is divided into a predetermined number of portions whose lengths along the inner peripheral edge part **711** are equal to set a division point Yin at the inner peripheral edge part **711**. In the present embodiment, the division point Yin at the inner peripheral edge part **711** is set as a first inner peripheral division point Yi**1**, a second inner peripheral division point Yi**2**, . . . , and a sixth inner peripheral division point Yi**6** in order from one end side of the vane **71** in the rotation axis direction.

[0114] Similarly, an outer peripheral edge part **712** of the vane **71** is divided into a predetermined number of portions whose lengths along the outer peripheral edge part **712** are equal to set a division point Yon at the outer peripheral edge part **712**. In the present embodiment, the division point Yon at the outer peripheral edge part **712** is set as a first outer peripheral division point Yo**1**, a second outer peripheral division point Yo**2**, . . . , and a sixth outer peripheral division point Yo**6** in order from one end side of the vane **71** in the rotation axis direction.

[0115] Then, a line (first to sixth division points Yd**1** to Yd**6**) that connects together the division points having the same number out of the inner peripheral division point Yin and the outer peripheral division point Yon when counted in order from one end side of the vane **71** in the rotation axis direction is set as the imaginary flow line.

[0116] The other configurations are similar to the first embodiment, and a blower **7** of the present embodiment produces effects similar to the effects of the first embodiment. Furthermore, the blower **7** of the present embodiment has the advantage that design surfaces of the vanes **71** do not intersect with each other and the vanes **71** of an impeller **7***a* are thereby easily designed.

[0117] In the present embodiment, there has been described an example of setting the six imaginary flow lines by dividing the inner peripheral edge part **711** and the outer peripheral edge part **712** of the vane **71** into six portions. However, the present disclosure is not limited to this example, and the set number of imaginary flow lines may be specified at an arbitrary number (e.g., ten).

[0118] The embodiments of the present disclosure have been described above. However, the present disclosure is not limited to these embodiments, and can be variously modified, for example, as below without departing from the scope of claims.

[0119] (1) In the above-described embodiments, it is illustrated for the shape of the vane **71** that the part **711***a* of the inner peripheral edge part **711** on the one end side in the rotation axis direction is positioned further on a front side in the rotation direction R of the impeller **7***a* than the part **711***b* of the inner peripheral edge part **711** on the other end side in the rotation axis direction. However, the present disclosure is not limited to this example. For example, there may be employed such a vane **71** that the position of the inner peripheral edge part **711** is located further on a rear side in the rotation direction R of the impeller **7***a* from the main plate **73**-side toward the side plate **72**-side.

[0120] (2) In the above embodiments, it is illustrated that the side plate **72** has an annular shape which is bent such that its part on the one end side in the rotation axis direction is located inward of the part on the other end side in the radial direction of the rotation shaft **70**. However, the present disclosure is not limited to this example. For example, as illustrated in FIG. **17**, the side plate **72** is formed in a circular ring shape extending along the rotation axis direction, and may be connected to the outer peripheral edge parts **712** of the vanes **71** located radially outward on the one end side in the rotation axis direction.

[0121] In the above embodiments, it is illustrated that the side plate **72** is connected to cover the outer peripheral edge parts **712** of the vanes **71** from a radially outward side of the rotation shaft **70**. However, the present disclosure is not limited to this example. For example, as illustrated in FIG. **18**, the side plate **72** may be connected to the parts **71***a* of the vanes **71** on the one end side in the rotation axis direction.

[0122] In a case of employment of any shape, the main plate **73** and the side plate **72** do not overlap with each other as far as possible when viewed from the rotation axis direction so that undercutting is not caused when integrally molding the impeller **7***a*. As a matter of course, as long as the impeller **7***a* can be integrally molded, the main plate **73** and the side plate **72** may overlap with each other when viewed from the rotation axis direction.

[0123] (3) In the above-described third embodiment, it is illustrated that the inner peripheral edge parts **711** of the vanes **71** extend along the rotation axis direction. However, as long as the side-plate side inner-outer diameter ratio of the impeller **7***a* is larger than the main-plate side inner-outer diameter ratio, the inner peripheral edge parts **711** of the vanes **71** may separate from the axis Z of the rotation shaft **70** from the main plate **73**-side toward the side plate **72**-side.

[0124] (4) In the above embodiments, an example of employment of a single-suction type blower for the blower **7** has been described. However, the present disclosure is not limited to this example. There may be used a double-suction type blower that suctions air from both sides in the rotation axis direction.

[0125] In this case, for example, as illustrated in FIGS. **19** and **20**, first and second impeller parts **7***aa*, **7***ab* that are configured similar to the impeller **7***a* described in the above embodiments may be provided. Main plates **73***a*, **73***b* of the impeller parts **7***aa*, **7***ab* may be connected together by a connecting member **75**.

[0126] Each vane **71** of the impeller parts **7***aa*, **7***ab* is configured such that the inlet angle α on each cross-sectional surface crossing the inner peripheral edge part **711** on the meridian plane of the impeller **7***a* in a predetermined direction is made evenly in the entire region from a side plate **72***a*, **72***b*-side through a main plate **73***a*, **73***b*-side. Moreover, the outer peripheral edge parts **712** of the vanes **71** in the impeller parts **7***aa*, **7***ab* are configured to be away from the axis Z of the rotation shaft **70** from the main plates **73***a*, **73***b*-side toward the side plates **72***a*, **72***b*-side.

[0127] (5) In the above first embodiment, it is illustrated that the inlet angle α on each cross-section perpendicular to the rotation axis direction on the meridian plane of the impeller **7***a* is made evenly in the entire region from the side plate **72**-side through the main plate **73**-side. However, the present disclosure is not limited to this example. For example, the inlet angle α on each cross-section perpendicular to the inner peripheral edge part **711** on the meridian plane of the impeller **7***a* may be made evenly in the entire region from the side plate **72**-side through the main plate **73**-side.

[0128] (6) In the above embodiments, an example of application of the blower **7** to the air-conditioning system **1** for a vehicle has been described. However, the blower **7** may be applied to another air-conditioning system as well as to the air-conditioning system **1** for a vehicle.

[0129] (7) The above embodiments can be appropriately combined together if they are not unrelated and unless the combination is obviously impossible. In the above embodiments, it goes without saying that the elements which constitute the embodiment are not necessarily essential except, for example, when clearly shown to be particularly necessary and when considered to be obviously essential in principle.

[0130] In the above embodiments, the present disclosure is not limited to a particular numeral for the component of the embodiment except, for example, when the numerical value of the component such as the number, value, amount, or range is referred to, when it is clearly shown to be particularly necessary, or when the component is obviously limited to its particular numeral in principle.

[0131] In addition, in the above embodiments, when the shape or positional relationship of the component or the like is referred to, the component is not limited to this shape or positional relationship except, for example, in the case of its particularly explicit indication or in the case of the component limited to its particular shape, positional relationship or the like in principle.

[0132] While the present disclosure has been described with reference to embodiments thereof, it is to be understood that the disclosure is not limited to the embodiments and constructions. The present disclosure is intended to cover various modification and equivalent arrangements. In addition, while the various combinations and configurations, other combinations and configurations, including more, less or only a single element, are also within the spirit and scope of the present disclosure.

What is claimed is:

1. A centrifugal multi-blade blower comprising:

a rotation shaft;

an impeller that rotates with the rotation shaft as a center of the rotation and includes:

a main plate that is coupled with the rotation shaft;

a plurality of vanes that are arranged around an axis of the rotation shaft; and

a side plate that connects together the plurality of vanes on one end side of the rotation shaft; and

a casing that accommodates the impeller and includes an inlet port which opens at least on the one end side of the rotation shaft, wherein:

the blower draws in air through the inlet port and blows out the air radially outward of the rotation shaft;

the plurality of vanes on the other end side of the rotation shaft are connected to the main plate;

the plurality of vanes are configured such that an inlet angle on a cross-sectional surface crossing each inner peripheral edge part of the plurality of vanes on a meridian plane of the impeller in a predetermined direction is evenly made in an entire region from the side plate through the main plate;

outer peripheral edge parts of the plurality of vanes are configured to separate from the axis of the rotation shaft from the main plate toward the side plate;

a ratio of an outer peripheral diameter to an inner peripheral diameter of the impeller on the side plate-side is a side-plate side inner-outer diameter ratio;

a ratio of an outer peripheral diameter to an inner peripheral diameter of the impeller on the main plate-side is a main-plate side inner-outer diameter ratio; and

the impeller is configured such that the side-plate side inner-outer diameter ratio is smaller than the main-plate side inner-outer diameter ratio.

2. The centrifugal multi-blade blower according to claim **1**, wherein each of the plurality of vanes is configured such that a part of the inner peripheral edge part on the one end side of the rotation shaft is located on a front side of a part of the inner peripheral edge part on the other end side of the rotation shaft in a rotation direction of the impeller.

3. (canceled)

4. (canceled)

5. (canceled)

6. The centrifugal multi-blade blower according to claim **1**, wherein the inlet angle of each of the plurality of vanes on each cross-section perpendicular to a direction of the rotation shaft is made evenly in the entire region from the side plate through the main plate.

7. The centrifugal multi-blade blower according to claim **1**, wherein:

the each inner peripheral edge part of the plurality of vanes is divided into a predetermined number of portions whose lengths along the inner peripheral edge part are the same;

each of the outer peripheral edge parts of the plurality of vanes is divided into the predetermined number of portions whose lengths along the each of the outer peripheral edge parts are the same;

a line that connects together an inner division point at the each inner peripheral edge part and an outer division point at the each of the outer peripheral edge parts is an imaginary flow line, the inner division point and the outer division point being located in the same order; and

each of the plurality of vanes is configured such that the inlet angle on a cross-section along each imaginary flow line is made evenly in the entire region from the side plate through the main plate.

8. (canceled)

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