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(54) RADIAL BLOWER FOR SUCTION HOODS

(57) A radial blower (1) comprises a housing (2) with a first axial suction opening (3), a second axial suction opening (4) and an outlet opening (5) in tangential direction, a conveying unit (6, 7) with an impeller (7) arranged inside the housing (2), wherein an outlet channel and the inlet opening (5) define a flow section delimited by:
- a flattened base (33) substantially parallel to the rotation axis (R) of the motor, and
- an arch-shaped delimitation (34), the ends of which are connected to the ends of the flattened base (33).

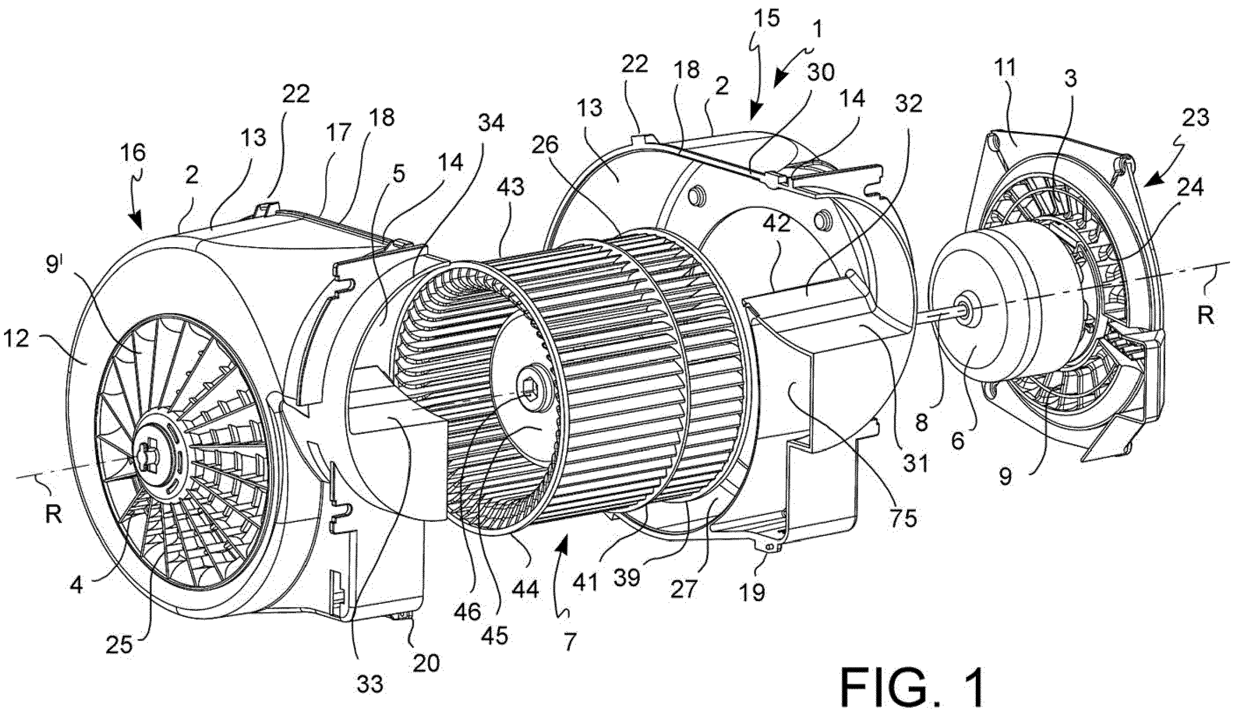


FIG. 1

EP 3 364 037 A2

Description

[0001] The present invention relates to a radial blower, in particular for suction hoods, of the type comprising a housing with two axial and opposite air suction openings and a radial air outlet opening, as well as a conveying unit with an electric motor and an impeller located inside the housing.

[0002] Radial blowers of the aforesaid type are known, for example, from EP2365224.

[0003] The blowers of the prior art have some disadvantages. They exhibit a high consumption of electrical energy and a limited maximum flow rate (the drawn electrical energy being the same), and therefore a still unsatisfactory energy efficiency.

[0004] The known blowers exhibit a high back-pressure gradient, unsteady vortexes and unplanned flow separations at the outlet opening.

[0005] At the suction openings, the known blowers exhibit resistance and losses of kinetic energy of the conveyed gas due to the sudden change of the air flow direction, with undesired flow separations and local vortexes.

[0006] It is thus the object of the present invention to provide a radial blower of the aforesaid type having features such as to solve at least some of the drawbacks mentioned with reference to the prior art.

[0007] It is a particular object of the invention to suggest a radial blower which is improved from the fluid-dynamic point of view, so as to reduce the energy consumption, the flow rate being equal, and to increase the maximum flow rate, the size and drawn electrical power being equal.

[0008] It is a further object of the invention to suggest a radial blower which exhibits low noise and vibration levels, by virtue of an improved fluid-dynamic geometry.

[0009] These and other objects are achieved by a radial blower, in particular for suction hoods, having an impeller rotation axis and comprising:

- a housing with a first axial suction opening and a second axial suction opening opposite to the first suction opening and an air outlet opening in tangential direction,
- a conveying unit arranged inside the housing and having an electric motor and an impeller connected to a rotor of the electric motor, wherein:

  according to an aspect of the invention, guide spokes are formed in at least one of the suction openings, such guide spokes extending from a radially outer zone of the suction opening towards a radially more inner zone and having a shape such as to divert the air flow entering the suction opening towards the rotation direction of the impeller.

[0010] The guide spokes form "static blades", capable of directing the flow, optimizing its trajectory, and conferring a motion in the same direction of movement as the impeller. This reduces the necessary torque and improves the energy efficiency of the blower.

[0011] According to a further aspect of the invention, a tangential outlet portion of the housing forms an outlet channel delimited by a (radially) outer wall portion and a (radially) inner wall portion opposite to the outer wall portion,

[0012] wherein a guide core formed by a peripheral wall of the housing and by the inner wall has a cusp-shaped cross section (on a section plane orthogonal to the rotation axis), converging towards a free edge and wherein said free edge is substantially rectilinear and parallel to the rotation axis.

[0013] The outlet channel and the outlet opening define a flow section delimited by:

- a flat base parallel to the rotation axis, and
- an arch-shaped delimitation, the ends of which are connected to the ends of the flat base

[0014] The tunnel-shaped configuration of the outlet channel with flat base and upper arc-shaped delimitation contributes to reducing the back-pressure gradient, which acts against the flow direction, reduces unplanned flow separations and increases both the energy efficiency and the mass flow rate, the exterior dimensions and motor type being equal.

[0015] In order to better understand the invention and appreciate the advantages thereof, some non-limiting exemplary embodiments will be described below with reference to the drawings, in which:

figure 1 is an exploded, perspective view of a radial blower according to the invention;
figure 2 is a front view of the radial blower in figure 1;
figures 3 and 4 are two opposite side views of the radial blower in figure 1;
figure 5 is a perspective view of a half-shell of the housing of the radial blower in figure 1;
figures 6 and 7 are inlet opening views of the housing of the blower in figure 1;
figures 8 and 9 are views of details of the inlet openings shown in figures 6 and 7 with indication of some characteristic geometric parameters;
figure 10 is a cross-section view (taken along a section plane X-X tangential to a circumference of the rotation axis of the motor) of a guide spoke of an air inlet opening, on the side opposite to the motor side, in a radially inner region;
figure 11 is a cross-section view (taken along a section plane XI-XI tangential to a circumference of the rotation axis of the motor) of a guide spoke of the air inlet opening, on the side opposite to the motor side, in a radially outer region;
figure 12 is a cross-section view (taken along a section plane XII-XII tangential to a circumference at the rotation axis of the motor) of a guide spoke of an air

inlet opening on motor side;

figures 13 and 14 are section views, taken according to a plane perpendicular to the rotation axis, of a sequence of blades of the impeller of the blower, with the indication of some characteristic geometric parameters, according to embodiments;

figure 15 is a radial section view of a half-shell of the housing of the blower according to an embodiment;

figure 16 is an enlarged view of a detail in figure 15;

figures 17 and 18 are side views of an inner side of a half-shell of the housing of the blower, with the indication of some characteristic geometric parameters, according to an embodiment;

figure 19 is a view of an outlet zone of the blower according to an embodiment,

figure 20 shows an impeller for the blower according to an embodiment,

[0016] A radial blower, in particular for household suction hoods, is indicated as a whole by reference numeral 1 in the figures. The blower 1 defines a rotation axis R of the impeller and the definitions of "axial", "radial", "circumferential" and "peripheral" position or orientation refer to the rotation axis R or to geometric shapes developed around the rotation axis R. Furthermore, in the present description, the expression "radially inward" means "in approximation towards the rotation axis R" and the expression "radially outward" means "moving away from the axis of rotation R".

[0017] The blower 1 comprises a housing 2 with a first axial suction opening 3 and a second axial suction opening 4, opposite to the first suction opening 3, and a radial or tangential air outlet opening 5, as well as a conveying unit arranged inside the housing 2 and having an electric motor 6 and an impeller 7 connected to the rotor and/or to a drive shaft 8 of the electric motor 6.

[0018] The electric motor 6 is fixed to the housing 2 on two opposite sides or cantilevered on one side only and integral in rotation, e.g. by means of a plurality of portions or support spokes protruding from an edge 10 of the first suction opening 3 and, in the case of motor support on both sides, by means of an additional plurality of portions or support spokes protruding from an edge 10' of the second suction opening 4.

Detailed description of the housing 2

[0019] The housing 2 has a substantially toroidal shape with two side walls 11, 12 which delimit the suction openings 3, 4, and with a peripheral wall 13 and a substantially tangential portion 14, which forms the air outlet opening 5.

[0020] The housing 2 is formed by two half-shells 15, 16, which are mutually connected along a junction line 17 in the peripheral wall 13 by complementary junction edges 18, which may be step- or groove-shaped so as to create a labyrinth connection interface, and possibly one or more alignment pins 19 protruding from the junction edge 18 of one of the half-shells 15, 16 respectively and accommodated in corresponding alignment holes 20 formed in the junction edge 18 of the other half-shell. The junction edges 18 may also comprise flanges or junction reliefs 22 protruding radially outwards from the housing 2 and having an undercut to accommodate one or more clips or junction profiles 21, in particular "Ω"- or "C"-shaped clips, or alternatively holes to receive connecting screws, which lock the two half-shells 15, 16 against each other.

[0021] This results in a simple, sturdy and particularly accurate assembly of the housing.

[0022] The suction openings 3, 4 are preferably substantially circular and coaxial with the impeller 7, which is also circular.

[0023] The housing 2 internally delimits a circumferential conveying space 27, which gradually widens in radial direction from a zone with a minimum initial section 28 to a zone with a maximum final section 29 (**Figure 18**). The radial extension with respect to the rotation axis R of the minimum initial section 28 is preferably in the range from 75 mm to 85 mm and the radial extension with respect to the rotation axis R of the maximum final section 29 is preferably in the range from 115 mm to 130 mm.

Description of the suction openings 3, 4

[0024] The suction openings 3, 4 comprise protection grids 24, 25, which can also form the structure for supporting the motor unit 6 - impeller 7.

[0025] The protection grid 24, 25 may also be formed in one piece with the respective side walls 11, 12 or with the respective half-shells 15, 16 or manufactured separately and then applied thereon.

[0026] According to an embodiment (**Figure 1**), the first suction opening 3 (motor side), the first protection grid 24 for the first suction opening 3 and a structure for supporting the motor 6 are formed by a support plate 23 that has been made separately and then connected to the first half-shell 15, e.g. by means of screws or rivets, by snap-fitting, or by other fixing means.

[0027] Advantageously, the support plate 23 and the motor 6 may be connected to each other to form a preassembled grid-motor unit, which can be mounted on the first half-shell 15.

[0028] According to an alternative embodiment, the support plate 23 is formed in one piece with the first half-shell 15, thereby obtaining in a direct support of the motor 6 on the half-shell.

[0029] The second suction opening 4 (side opposite to motor side), the second protection grid 25 for the second suction opening 4 and, if provided, an additional portion for supporting the motor 6, can be formed in one piece with and by the second half-shell 16 (**Figure 3**) or alternatively by a second plate, made separately and then connected to the second half-shell 16, e.g. by means of screws or rivets, by snap-fitting or by means of other fixing means (not shown).

[0030] One or both the protection grids 24, 29 and/or the motor supporting structure form a plurality of guide spokes 9, 9' extending from a radially outer zone of the suction opening 3, 4 towards a radially more inner zone and having a shape such as to divert the airflow which enters into the suction opening 3, 4 towards the rotation direction of the impeller 7. In this manner, the guide spokes 9, 9' form "static blades", capable of directing the flow, optimizing its trajectory, and conferring a motion in the same direction of movement as the impeller 7. This reduces the necessary torque and improves the energy efficiency of the blower 1.

[0031] According to an embodiment, the guide spokes 9, 9' form a substantially rectilinear outer edge 64 (with respect to the housing 2) to improve the uniformity of the outer shape, which is important for the protection function, and to reduce flow resistance. The guide spokes 9, 9' are preferably inclined "ahead", i.e. with the radially outer end arranged more forward than the radially inner end, observed in the rotation direction of the impeller (**Figure 3, 4**). Like rotating blades, this configuration of the "static blading" consisting of the guide spokes 9, 9' conciliates the need to minimize energy losses and flow resistance with the need to divert flow in the rotation direction of the impeller 7.

[0032] The guide spokes 9, 9' are plate-shaped with a cross section (taken along a section plane tangential to the rotation axis R) inclined with respect to the axial direction and possibly curved in the shape of an arc (**Figure 10, 11, 12**).

[0033] According to an advantageous embodiment (**Figure 12**), the guide spokes 9 of the first suction opening 3 have a concave front surface 62, facing the rotation direction of the impeller 7, a convex rear surface 63, opposite to the front surface 62, the axially outer edge 64 (preferably flat) and a surface 65 of the axially inner, preferably rounded edge. On a section plane tangential with respect to the rotation axis R,

- the front surface 62 has a concave arc shape, e.g. the arc of a circle,
- the rear surface 63 has a convex arc shape, e.g. the arc of a circle,
- possibly, the thickness of guide spoke 9 gradually tapers from the axially outer edge 64 to the axially inner edge 65.

[0034] The exit angle α_ua of the front surface 62 of the guide spoke 9 (motor side), seen in section taken along the plane tangential to the rotation axis R (the orientation angle of the front surface 62 at the axially inner end 65 in the rotation direction with respect to the axial direction) is in the range between 7° and 11°, preferably about 9°.

[0035] The exit angle a_up of the rear surface 63 of the guide spoke 9 (motor side), seen in section taken along the plane tangential to the rotation axis R (the orientation angle of the rear surface 63 at the axially inner end 65 in the rotation direction with respect to the axial direction) is in the range between 3° and 6°, preferably about 4.8°.

[0036] The entry angle α_ia of the front surface 62 of the guide spoke 9 (motor side), seen in section taken along the plane tangential to the rotation axis R (the orientation angle of the front surface 62 at the axially outer end 64 in the rotation direction with respect to the axial direction) is in the range between 60° and 74°, preferably about 67,8°.

[0037] The entry angle α_ip of the rear surface 63 of the guide spoke 9 (motor side), seen in section taken along the plane tangential to the rotation axis R (the orientation angle of the rear surface 63 at the axially outer end 64 in the rotation direction with respect to the axial direction) is in the range between 42° and 60°, preferably about 51,4° (**Figure 12**).

[0038] More generally, considering a mean line of the section profile of the guide spoke 9, the entry angle of the guide spoke 9 is greater than the exit angle of the guide spoke 9.

[0039] Advantageously, the guide spokes 9 of the first suction opening 3 (motor side) have a substantially constant section shape along their longitudinal extension, except for the radially outer and inner ends.

[0040] The axially inner end 65 of the guide spoke 9 is positioned ahead in the rotation direction with respect to the axially outer end 64 of the same guide spoke 9. The chord 66 of the spokes 9 (indicated in **Figure 12**) has a chord orientation angle 67 in the rotation direction with respect to the axial direction comprised between 33° and 43°, advantageously about 38°.

[0041] According to an advantageous embodiment (**Figure 10**, **11**), the guide spokes 9' of the second suction opening 4 (side opposite to the motor side) can have a warp or twist along a longitudinal axis thereof. Advantageously, the width of the profile of the guide spokes 9' increases from a minimum width (**Figure 10**) near the radially inner end to a maximum width (**Figure 11**) near the radially outer end.

[0042] The guide spokes 9' have a concave front surface 62', facing the rotation direction of the impeller 7, a convex rear surface 63', opposite to the front surface 62', the axially outer edge 64' (preferably flat) and a surface 65' of the (preferably rounded) axially inner edge. On a section plane tangential to the rotation axis R,

- the front surface 62' is concave in the shape of an arc,
- the rear surface 63' is convex in the shape of an arc,
- possibly, the thickness of the guide spoke 9 gradually tapers from the axially outer edge 64 to the axially inner edge 65.

[0043] The exit angle α_ua' of the front surface 62' of the guide spoke 9', seen in section taken along the plane tangential to the rotation axis R (the orientation angle of the front surface 62' at the axially inner end 65' in the rotation direction with respect to the axial direction) is comprised between 11° and 15°, preferably about 13.2°

in the radially outer region and preferably about 13.3° in the radially inner region.

[0044] The exit angle α_up' of the rear surface 63' of guide spoke 9', seen in section taken along the plane tangential to the rotation axis R (the orientation angle of the rear surface 63' at the axially inner end 65' in the rotation direction with respect to the axial direction) is in the range between 7° and 13°, preferably about 9.8° in the radially outer region and preferably about 9.9° in the radially inner region.

[0045] At the radially outer end (**Figure 11**), the entry angle α_ia' of the front surface 62' of the guide spoke 9', seen in section taken along the plane tangential to the rotation axis R (the orientation angle of the front surface 62' at the axially outer end 64' in the rotation direction with respect to the axial direction) is in the range between 39° and 49°, preferably about 44.4°.

[0046] At the same radially outer end (**Figure 11**), the entry angle α_ip' of the rear surface 63' of the guide spoke 9', seen in section taken along the plane tangential to the rotation axis R (the orientation angle of the rear surface 63' at the axially outer end 64' in the rotation direction with respect to the axial direction) is in the range between 38° and 48°, preferably about 43.7°.

[0047] More generally, considering a mean line of the section profile of the guide spoke 9', the entry angle of the guide spoke 9' is greater than the exit angle of the guide spoke 9'.

[0048] The axially inner end 65' of the guide spoke 9' is positioned ahead in the rotation direction with respect to the axially outer end 64' of the same guide spoke 9'. The chord 66' of the spokes 9' (**Figures 10 and 11**) has a chord orientation angle 67' in the rotation direction with respect to the axial direction:

- greater at the radially outer end than at the radially inner end, more particularly
- comprised between 24° and 34°, advantageously about 29° at the radially outer end (**Figure 11**),
- comprised between 15° and 25°, advantageously about 20° at the radially inner end (**Figure 10**).

[0049] The guide spokes 9, 9' are arranged at a constant pitch, e.g. 21 guide spokes 9 on the motor side and 19 guide spokes 9' on the side opposite to the motor side.

[0050] Furthermore, the guide spokes 9, 9', of each suction opening 3, 4 may be connected to one another by means of one or of a plurality of reinforcement rings 68, possibly concentric to the rotation axis R. On the motor side may be provided a single reinforcement ring 68, while on the opposite side may be provided three or two reinforcement rings 68' which also act as protection to prevent access to the impeller.

[0051] According to an embodiment (**Figure 8**) at the first suction opening 3 (motor side), the ratio between radial extension 69 of the guide spoke 9 and the outer radius 70 of the first suction opening 3 is in the range from 0.28 to 0.4, preferably about 0.34.

[0052] The guide spokes 9 can extend from an inner radius 71 of the first suction opening 3 of value from 39 mm to 48 mm, preferably about 43.3 mm, to the outer radius 70 of value from 60 mm to 72 mm, preferably about 66 mm.

[0053] The guide spokes 9 are preferably tilted "ahead", i.e. with the radially outer end arranged more ahead than the radially inner end, seen in the rotation direction of the impeller, with an inclination angle 72 with respect to the radial direction passing through the radially inner end of the guide spoke 9, from 5.8° to 7.3°, preferably about 6.7° (**Figure 8**).

[0054] According to an embodiment (**Figure 9**) at the second suction opening 4 (side opposite to the motor side), the ratio between the radial extension 69' of the guide spoke 9' and the outer radius 70' of the second suction opening 4 is comprised in the range from 0.5 to 0.7, preferably about 0.58.

[0055] The guide spokes 9 can extend from an inner radius 71' of the second suction opening 4 of value from 22 mm to 32 mm, preferably of about 27.4 mm, to an outer radius 70 mm of value from 60 mm to 72 mm, preferably about 66 mm.

[0056] The guide spokes 9' are preferably tilted "ahead", i.e. with the radially outer end arranged more ahead than the radially inner end, seen in the rotation direction of the impeller, with an inclination angle 72' with respect to the radial direction passing through the radially inner end of the guide spoke 9', from 10° to 16°, preferably about 13.6° (**Figure 9**).

[0057] According to an embodiment, the guide spokes 9, 9' also protrude axially towards the outside of housing 2, conferring an outward bulging shape, e.g. frustoconical, to the protection grid 24, 25. In this manner, a greater axial space can be exploited for diverting the flow, the actual flow section of the suction opening 3, 4 being equal.

[0058] The guide spokes 9, 9' contribute to a reduction in flow resistance, an increase in flow rate, electrical power drawn by the motor being the same, in particular at high flow rates and speeds. The guide spokes 9, 9' further contribute to a more gradual distribution of the air flow deviation, a reduction of the angle of attack between the flow entering the impeller 7 and the blades 26, 43 of the impeller 7.

Detailed description of the tangential outlet portion 14

[0059] The tangential outlet portion 14 of the housing 2 forms an exit channel delimited by a (radially) outer wall portion 30 which connects in approximately tangential manner to the peripheral wall 13 near the final section 29 of the conveying space 27 and a (radially) inner wall portion 31, opposite to the portion of the outer wall 30 and connected to the peripheral wall 13 at the initial section 28 of the conveying space 27. A guide core 32 (also known as the nose or guide tongue) is formed between the peripheral wall 13 and the inner wall 31, which guide core protrudes approximately towards the outer wall portion 30 and/or towards the peripheral wall 13 in the transition zone with the tangential portion 14 and which determines the transition from the peripheral wall 13 to the inner wall portion 31.

[0060] The air outlet opening 5 is delimited by a tubular end 35 of the tangential portion 14, which comprises an outer connection flange 38 and which defines an opening plane 36 and an outlet direction 37 possibly perpendicular to the opening plane 36.

[0061] According to an embodiment, the guide core 32 has a cross-section (on a section plane taken along the rotation axis R), possibly in the form of a cusp, converging towards a free edge 42 substantially rectilinear and parallel to the rotation axis R and, preferably, extended from the first side wall 11 to the second side wall 12.

[0062] Advantageously, the portion of the inner wall 31 extends from the free edge 42 of the guide core 32 to the tubular end 35, preferably up to the free end of the tangential portion 14 (**Figure 5, 18**), and has a section shape (on section plane parallel to the opening plane 36 or on a section plane radial to the rotation axis R) substantially rectilinear and preferably parallel to the rotation axis R, so that the outlet channel and preferably the outlet opening 5 define (starting from the free edge 42 of the core 32) a flow section delimited by:

- a flattened, possibly flat, base 33, parallel to the rotation axis R, and
- an arch-shaped delimitation 34, the ends of which are connected to the ends of the flattened base 33.

[0063] The inner wall portion 31 which forms the flattened base 33 extends from the free edge 42 of the core 32 in a gradually converging manner towards a direction parallel to the direction of the apex of the opposite outer wall portion 30, seen in a section plane perpendicular to the rotation axis R (**Figure 17, 18**). Preferably, the inner wall portion 31 and the direction of the apex of the opposite outer wall portion 30 include an opening angle 77 of less than 45°, preferably in the range from 5° to 30°, more preferably in the range from 5° to 15°, seen on a section plane perpendicular to the rotation axis R.

[0064] Advantageously, the inner wall portion 31 has a circle arc shape in longitudinal cross-section, in a section plane orthogonal to the rotation axis R, having a radius greater than the outer radius of the impeller 7, preferably from 4/3 to 6/3, advantageously about 5/3, of the outer radius of the impeller 7.

[0065] The height 73 of the flow section of the outlet channel (measured perpendicular to the base 33) increases gradually from the free edge 42 of the core 32 to the tubular end 35, but said height 73 remains less than 70%, preferably less than 65% of the outer diameter 74 of the tubular end 35 (**Figure 17**).

[0066] According to a preferred embodiment, the height 73 of the flow section is about 1/2 of the outer diameter 74 of the tubular end 35 at the free edge 42 of the core 32 is about 3/5 of the outer diameter 74 of the tubular end 35 at the latter, with a tolerance of +/- 5%.

[0067] The configuration of the outlet channel as a "tunnel with flat base and upper arc delimitation" contributes to reducing the back-pressure gradient, which acts against the flow direction, reduces unplanned flow separations and increases both the energy efficiency and the mass flow rate, the exterior dimensions and motor type being the same.

[0068] In the preferred embodiment, the tubular end 35 has a cylindrical shape with a circular cross-section and the delimitation 34 forms a stretch of the circular cross-section.

[0069] The same tubular end 35 and the portion of the inner wall 31, possibly together with other walls of housing 2, delimit an outer auxiliary compartment 75, which is separate with respect to both the outlet opening 5 and the conveying space 27. With particular advantage, this auxiliary compartment may accommodate an electric control board 76 for the motor 6. In this manner, the space in the gap between the peripheral wall 13 and the tangential section 14 is exploited, as well as a part of the same tangential portion 14 which is not used for conveying the air.

[0070] In an embodiment (**Figure 19**), the outlet opening 5 is provided with a non-return shutter flap 78, which is orientable and preferably elastically biased towards a closing position (in the direction opposite to the outlet direction of the air), and can be moved (towards the outside of the housing) to an opening position by means of the air flow thrust out of outlet opening 5. The shape and the position of the shutter flap 78 may be such as to increase, in the open position, the surface extension of the flattened base 33, extending it towards the outside of the housing This avoids the return of fumes to the fan and further reduces the formation of vortexes and flow separations.

[0071] The housing 2 is advantageously made of plastic material by injection molding, in particular in polypropylene, e.g. filled with glass fibers, glass balls, talcum, etc.

<u>Detailed description of the impeller 7</u>

[0072] The impeller 7 comprises a first plurality of blades 26 extending between a front ring 39 (motor side) and a central wall 41, as well as a second plurality of blades 43 extending between a rear ring 44 opposite to the front ring 39 and the central wall 41, in which the second plurality of blades 43 is advantageously angularly offset with respect to the first plurality of blades 26.

[0073] The blades 26, 43 are arranged at constant angular pitch, e.g. 56 blades at an angular pitch of $\beta = 6.43°$. A single "irregular" blade can be provided arranged at different distances from the adjacent blades, for example $\beta 1 = 6.93°$ and $\beta 2 = 5.93°$.

[0074] This arrangement of the blades 26, 43 prevents the impeller from reaching a resonance oscillation and thus reduces the noise and vibrations of the radial blower.

[0075] The central wall 41 is a substantially closed wall (**Figure 1**), or is provided with cooling openings 79 (for a more effective cooling of the motor 6) alternating with radial spoke shaped closed zones 80 (**Figure 20**), with a dome- or cup-shaped central portion 45 adapted to accommodate a front portion, more precisely the rotor, of the electric motor 6, and a connection seat 46 for the fixation of the impeller 7 to the drive shaft 8 or to the rotor. The connection seat 46 may comprise a co-molded metal hub with the central portion 45 made of plastic material. The impeller 7 is advantageously injection-molded and made of polypropylene or ABS.

[0076] According to an advantageous embodiment (**Figures 13, 14**), the blade 26, 43 has a concave front surface 47, facing towards the rotation direction of the impeller 7, a convex rear surface 48 opposite to the front surface 47 and a surface 49 of the radially inner edge of the blade 26, 43, in which, on a section plane perpendicular to the rotation axis R,

- the front surface 47 has a concave arc shape with a first radius of curvature 50, which increases from a minimum value in a radially inner or intermediate zone to a maximum value in a radially outer zone;
- the rear surface 48 has a convex arc shape with a second radius of curvature 51, which increases from a minimum value in a radially inner or intermediate zone to a maximum value in a radially outer zone;
- the radially inner surface 49 may have a convex arc shape, e.g. an arc of a circle having a third radius of curvature 52 lesser than the first radius 50 and lesser than the second radius 51.

[0077] The exit angle α_u of the blade 26, 43 (the orientation angle of the radially outer end of the blade 26, 43 in the rotation direction with respect to a plane radial to the rotation axis R and passing through said radially outer end) is in the range between 49° and 60°, and is advantageously about 54.3°, while the entry angle α_i of the blade 26, 43 (the orientation angle of the radially inner end of the blade 26, 43 against the rotation direction with respect to a plane radial to the rotation axis R and passing through said radially inner end) is in the range between 43° and 54° and is advantageously of about 48.7° (**Figure 13**).

[0078] Both the radially inner and radially outer ends of the blades 26, 43 are oriented in the rotation direction of the impeller 7 and the ratio α_i / α_u between the entry angle α_i and the exit angle α_u (as shown in Figure 13) is comprised in the range from 0.8 to 1.0, preferably 0.9.

[0079] This particular shape of the blades contributes to reducing the flow resistance and to a separation of the flow from the blades 26, 43 in a single and very concentrated zone at their radially outer end.

[0080] Advantageously, the ratio between the radial extension 54 of the blade 26, 43 and the outer radius 55 of the impeller 7 is in the range from 0.185 to 0.245, preferably about 0.22.

[0081] The blades 26, 43 may extend from an inner radius 56 in the range from 55 mm to 65 mm, preferably about 59.2 mm, to the aforesaid outer radius 55 in the range from 68 mm to 80 mm, preferably about 75.2 mm.

[0082] Advantageously, the blades 26, 43 have a constant cross-section shape along their axial extension with the exception of rounded end portions and a slight tapering from the central wall 41 axially outwards to facilitate the removal from the mold.

[0083] The radially outer end of the blade 26, 43 is positioned ahead in the rotation direction with respect to the radially inner end of the same blade 26, 43. The chord 57 of the blades 26, 43 (indicated in **Figure 14**) has an inner chord orientation angle 58 in the rotation direction with respect to a plane radial to the rotation axis R and passing through the radially inner edge of the blade) comprised between 17° and 23°, advantageously about 19.9°, as well as an outer orientation chord angle 59 in rotation direction with respect to a plane radial to the rotation axis R and passing through the radially outer end of the blade) comprised between 12.5° and 18.5°, advantageously about 15.6°.

[0084] The maximum thickness 50 of the blades 26, 43 is advantageously chosen in the range from 2 mm to 3.3 mm, preferably about 2.8 mm.

[0085] The maximum distance 51 between the chord 57 and the rear surface 48 of the blades 26, 43 is advantageously chosen in the range from 5.7 mm to 6.5 mm, preferably about 6.1 mm.

[0086] The maximum thickness 50 and also the maximum chord distance 51 of the blade are in a central stretch having a third of the total radial extension of the blade.

[0087] The shape and arrangement of the components of the impeller 7, in particular of the blades 26, 43, also contribute to an improvement towards an optimization of the performance of the blower 1. The air flow follows the entire profile of the blades 26, 43 without recirculation and without the formation of unplanned flow separation zones, which would increase the noise levels and imply higher electrical energy consumption.

[0088] As a whole, the invention allows to create a very compact, silent and energy-efficient blower, the conveying performance (flow rate, speed, pressure) being the same.

Claims

1. Radial blower (1), in particular for suction hoods, having an impeller rotation axis (R) and comprising:

   - a housing (2) with a first axial suction opening (3) and a second axial suction opening (4) opposite the first suction opening (3) and an outlet opening (5) in tangential direction,

- a conveying unit (6, 7) arranged in a conveying space (27) inside the housing (2) and having an electric motor (6) and an impeller (7) connected to a rotor of the electric motor (6),

wherein a tangential outlet portion (14) of the housing (2) forms an outlet channel delimited by an outer wall portion (30) and an inner wall portion (31) opposite the outer wall portion (30),
wherein the outlet channel and the outlet opening (5) define a flow section delimited by:

- a flattened base (33) substantially parallel to the rotation axis (R), and
- a delimitation (34) in the shape of an arc, the ends of which are connected to the ends of the flattened base (33).

2. Blower (1) according to claim 1, wherein a guide core (32) formed between a peripheral wall (13) of the housing (2) and the inner wall portion (31) has a cusp-shaped cross section, converging in a free edge (42), seen in a section plane orthogonal to the rotation axis (R), wherein said free edge (42) is substantially rectilinear and parallel to the rotation axis (R).

3. Blower (1) according to claim 2, wherein the flattened base (33) of the outlet channel extends from the free edge (42) of the core (32) in a gradually converging manner towards a direction parallel to the direction of the apex of the outer wall portion (30), seen in a section plane perpendicular to the rotation axis (R).

4. Blower (1) according to one of the preceding claims, wherein the inner wall portion (31) and the direction of the apex of the outer wall portion (30) include an opening angle (77) of less than 45°, or in the range from 5° to 30°, seen in a section plane perpendicular to the rotation axis (R).

5. Blower (1) according to one of the preceding claims, wherein the inner wall portion (31) has a circle arc shape in a longitudinal cross-section, in a section plane orthogonal to the rotation axis (R), having a radius greater than the outer radius of the impeller (7), or in the range from 4/3 to 6/3 of the outer radius of the impeller (7).

6. Blower (1) according to one of the preceding claims, wherein a height (73) of the flow section of the outlet channel is less than 65% of the outer diameter (74) of the tubular end (35).

7. Blower (1) according to one of the preceding claims, wherein the tubular end (35) and the inner wall portion (31) delimit at least one part of an auxiliary compartment (75) outside the outlet channel and the conveying space (27), wherein the auxiliary compartment receives an electrical control board (76) for controlling the motor (6).

8. Blower (1) according to one of the preceding claims, wherein guide spokes (9, 9') are formed in at least one of the suction openings (3, 4), such spokes extending from a radially outer area of the suction opening (3, 4) towards a radially more internal zone and having a shape and inclination such as to divert the airflow entering the suction opening (3, 4) towards the direction of rotation of the impeller (7).

9. Blower (1) according to claim 8, wherein the guide spokes (9,9') form an axially outer edge (64) substantially rectilinear and are inclined "forward", with the radially outer end arranged further forward than the radially inner end, seen in the direction of rotation of the impeller.

10. Blower (1) according to claim 8 or 9, wherein the guide spokes (9, 9') are plate-shaped with a cross section, according to a section plane tangent to the rotation axis (R), that is curved in the shape of an arc and inclined with respect to the axial direction.

11. Blower (1) according to claim 10, wherein the guide spokes (9, 9') have a concave front surface (62, 62'), facing in the rotation direction of the impeller (7), and a convex rear surface (63, 63') opposite the front surface (62, 62'), an axially outer edge (64) and a rounded axially inner edge (65), wherein in a section plane tangent to the rotation axis (R),

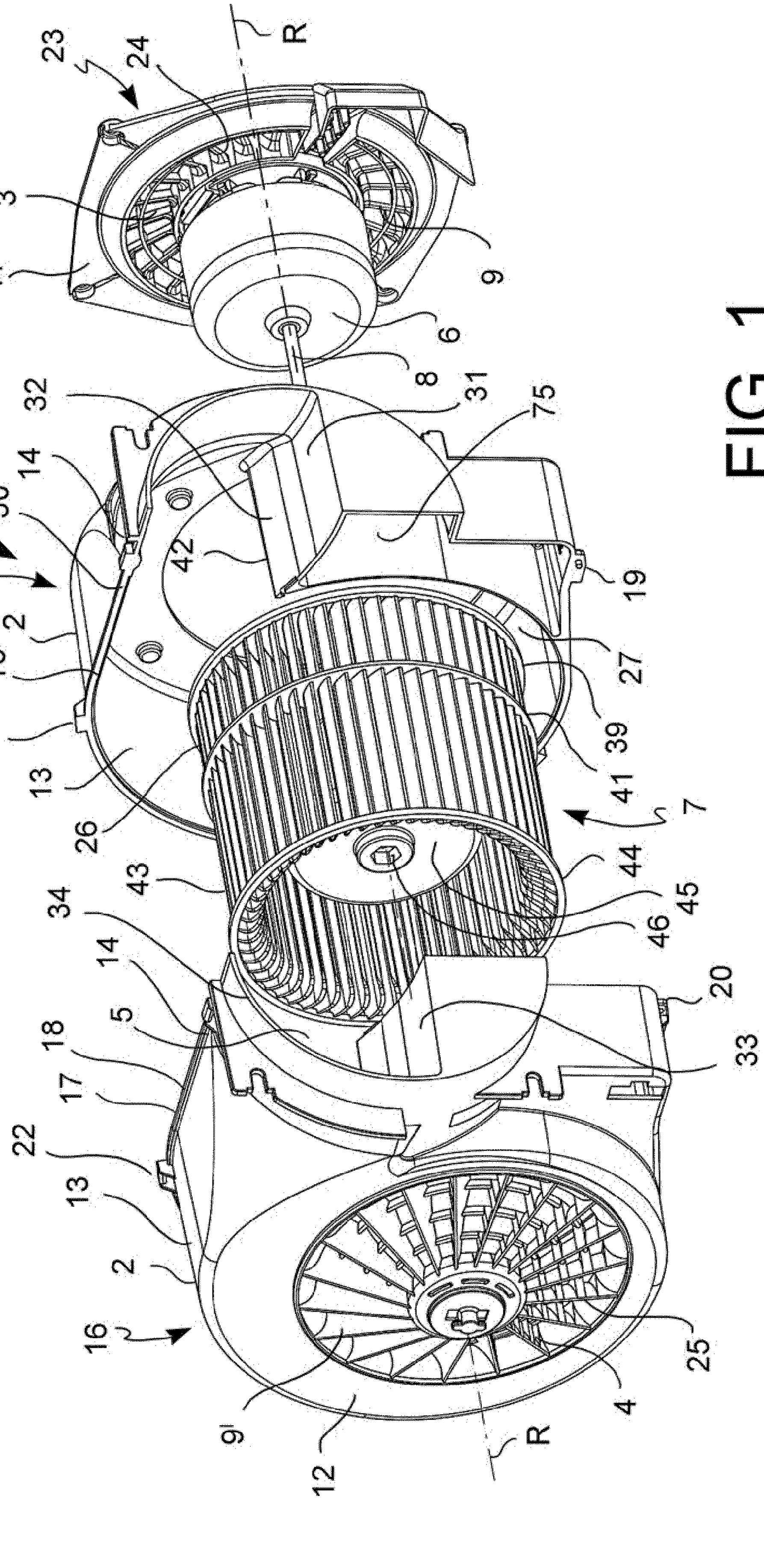
- the front surface (62, 62') has a concave arc shape,
- the rear surface (63, 63') has a convex arc shape,
- the thickness of the guide spoke (9, 9') gradually tapers from the axially outer edge (64, 64') towards the axially inner edge (65, 65').

12. Blower (1) according to claim 11, wherein in cross section according to a section plane tangent to the rotation axis (R), the entry angle of the guide spoke (9, 9') with respect to the axial direction is greater than the exit angle of the guide spoke (9, 9') with respect to the axial direction.

13. Blower (1) according to one of the claims from 8 to 12, wherein an axially inner edge (65, 65') of the guide spoke (9, 9') is positioned forward in the rotation direction of the impeller (7) with respect to the axially outer edge (64) of the same guide spoke (9).

14. Blower (1) according to one of the claims from 8 to 12, wherein the guide spokes (9') of the second suction opening (4) on a side opposite the motor (6) side have a torsion along their longitudinal extension and the profile width of the guide spokes (9') increases from a minimum width in the vicinity of the radially inner end to a maximum width in the vicinity of the radially outer end, and/orwherein the guide spokes (9, 9') axially project towards the outside of the housing (2), forming a protection grid (24, 25) bulging outwardly.

15. Blower (1) according to one of the preceding claims, wherein a non-return closure flap (78) is connected to the outlet opening (5), such flap being orientable and elastically urged towards a closed position and displaceable into an open position by the thrust of the airflow exiting the outlet opening (5), wherein the closure flap (78) has a flat shape and a position such as to increase, in the open position, the surface extension of the flattened base (33), by lengthening it towards the outside of the housing.


R
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9I
12
R

FIG. 1

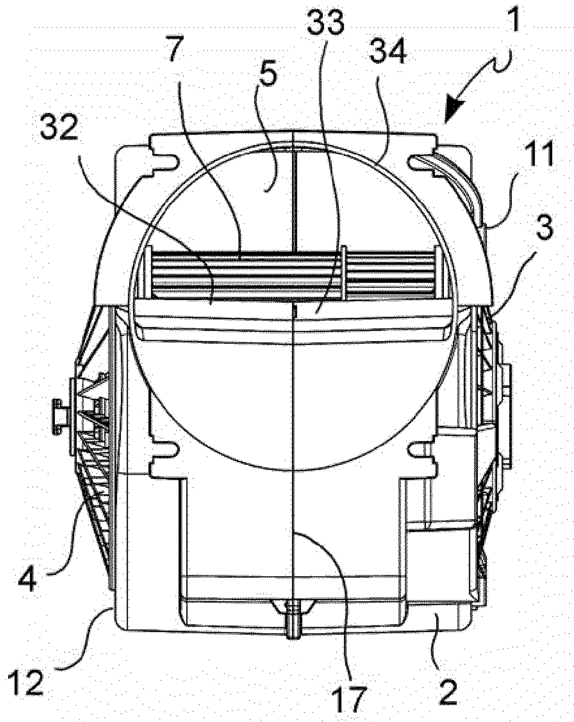

FIG. 2

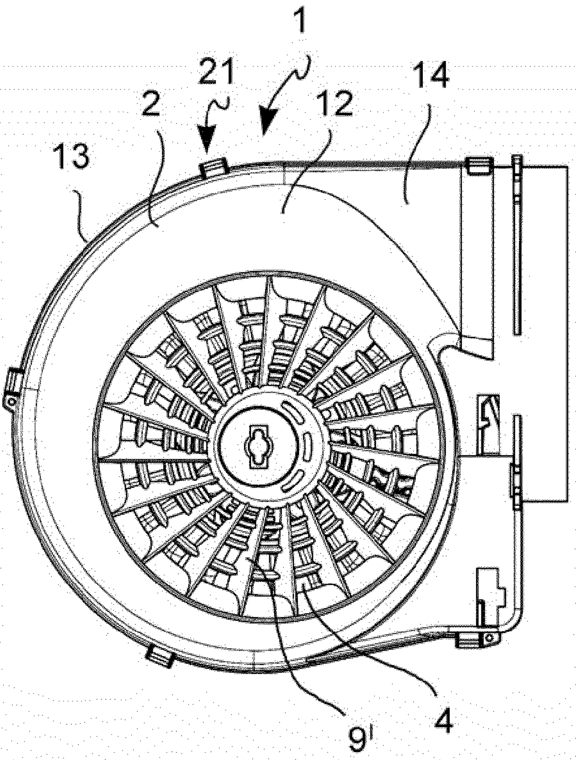

FIG. 3

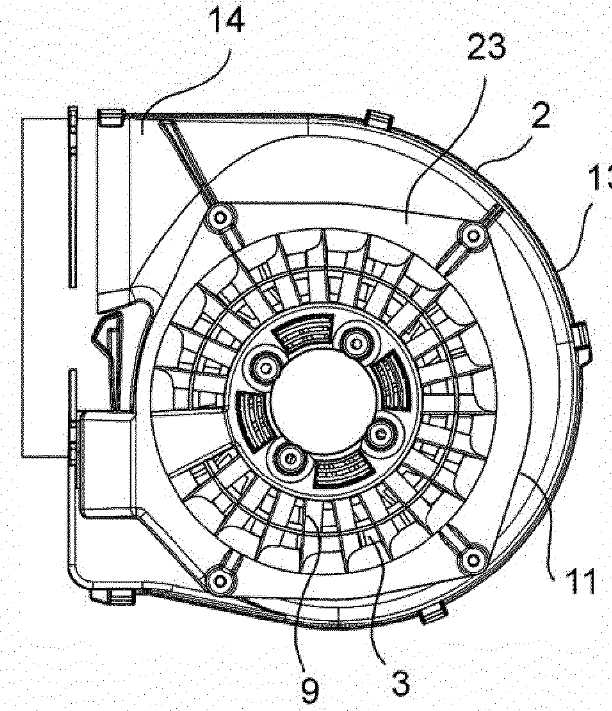

FIG. 4

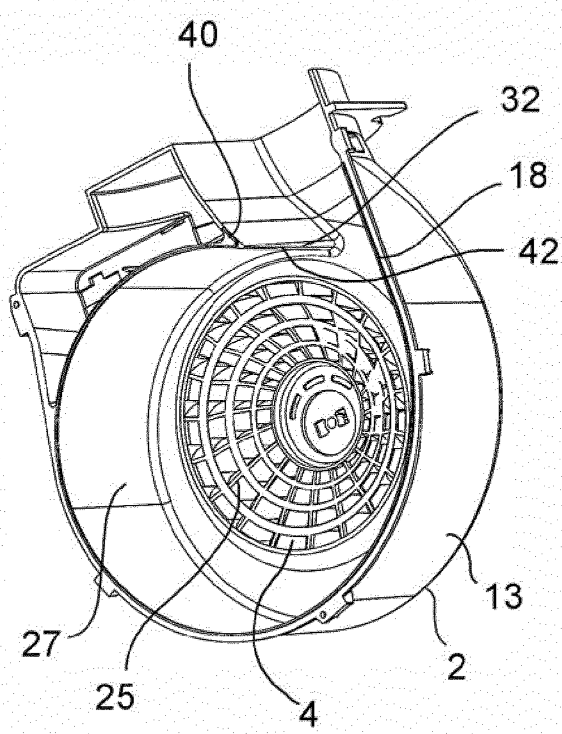

FIG. 5

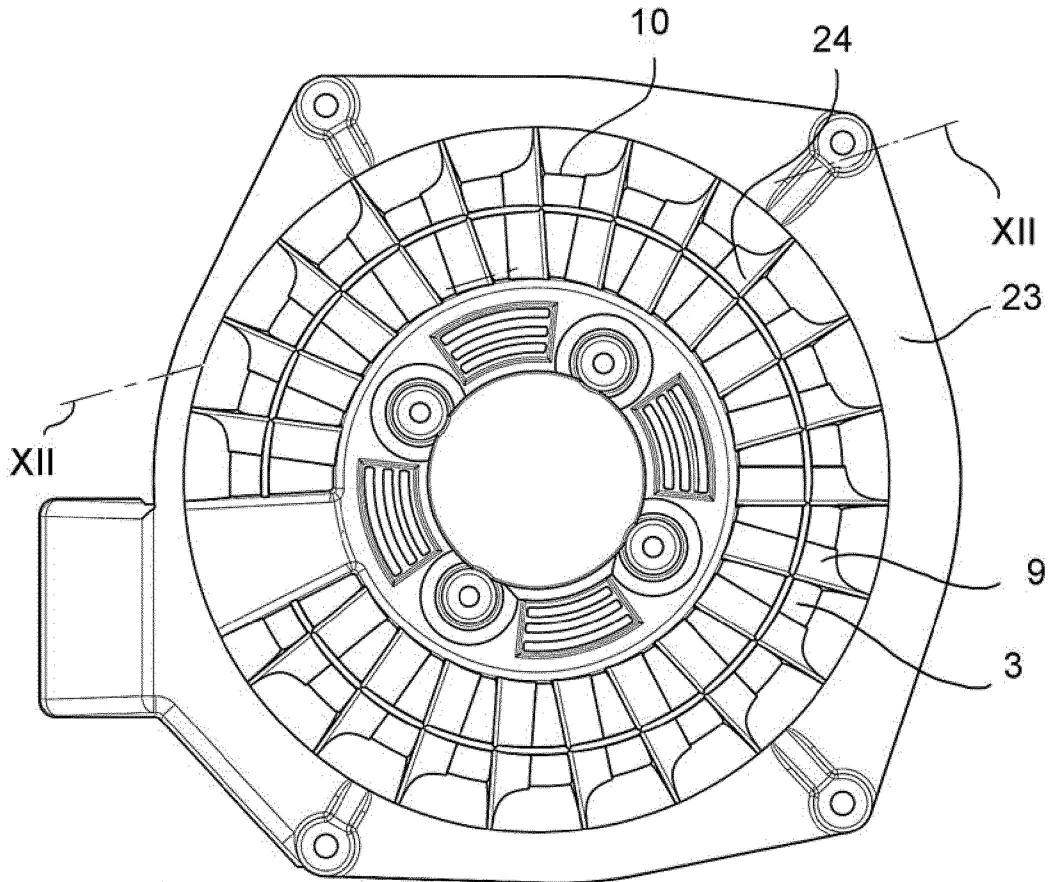

FIG. 6

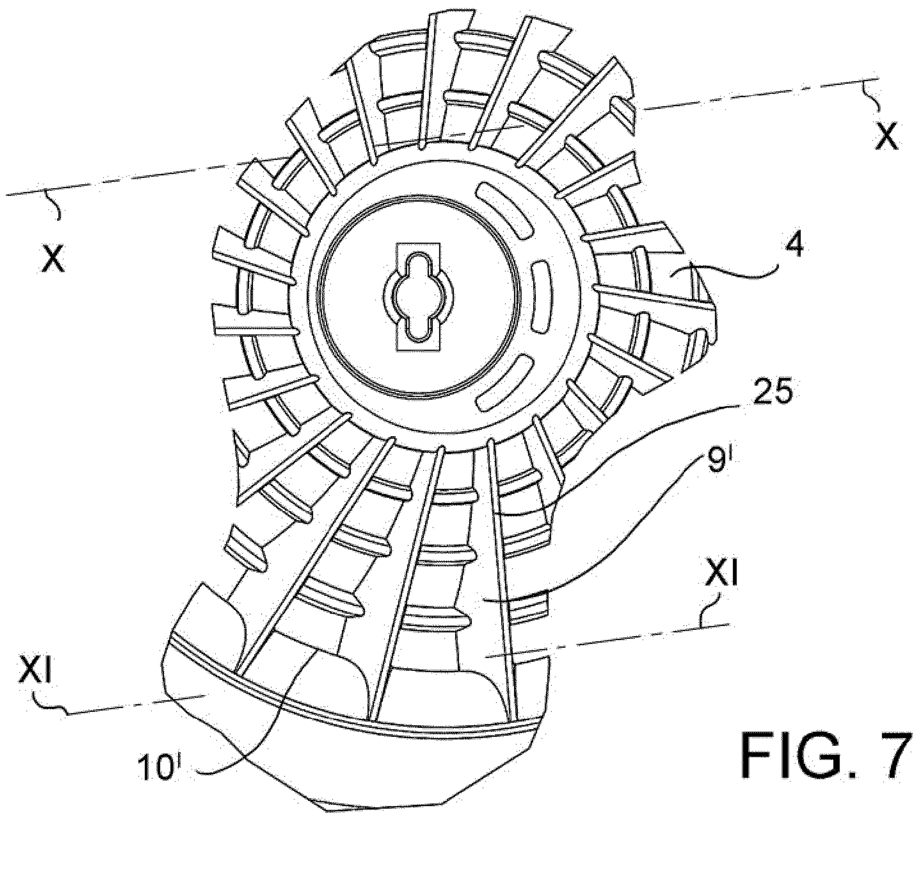

FIG. 7

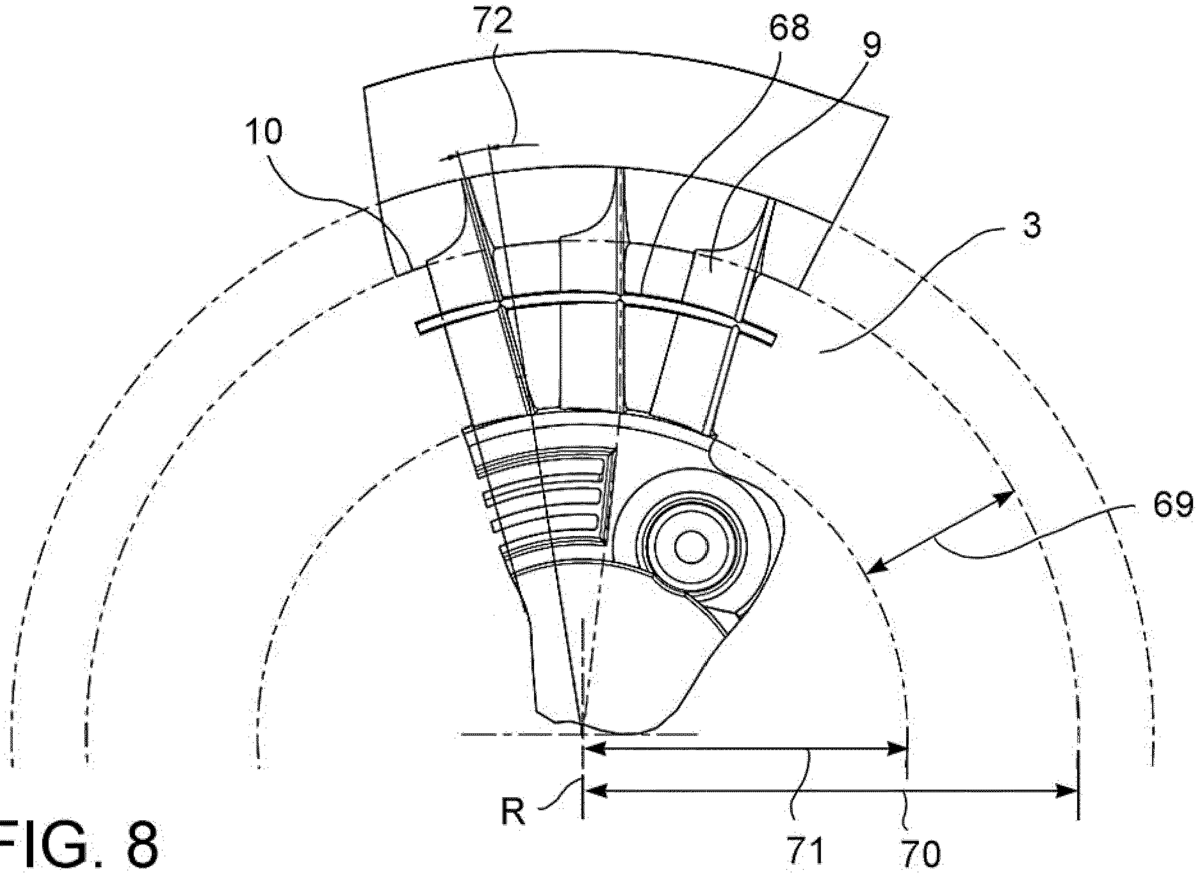

FIG. 8

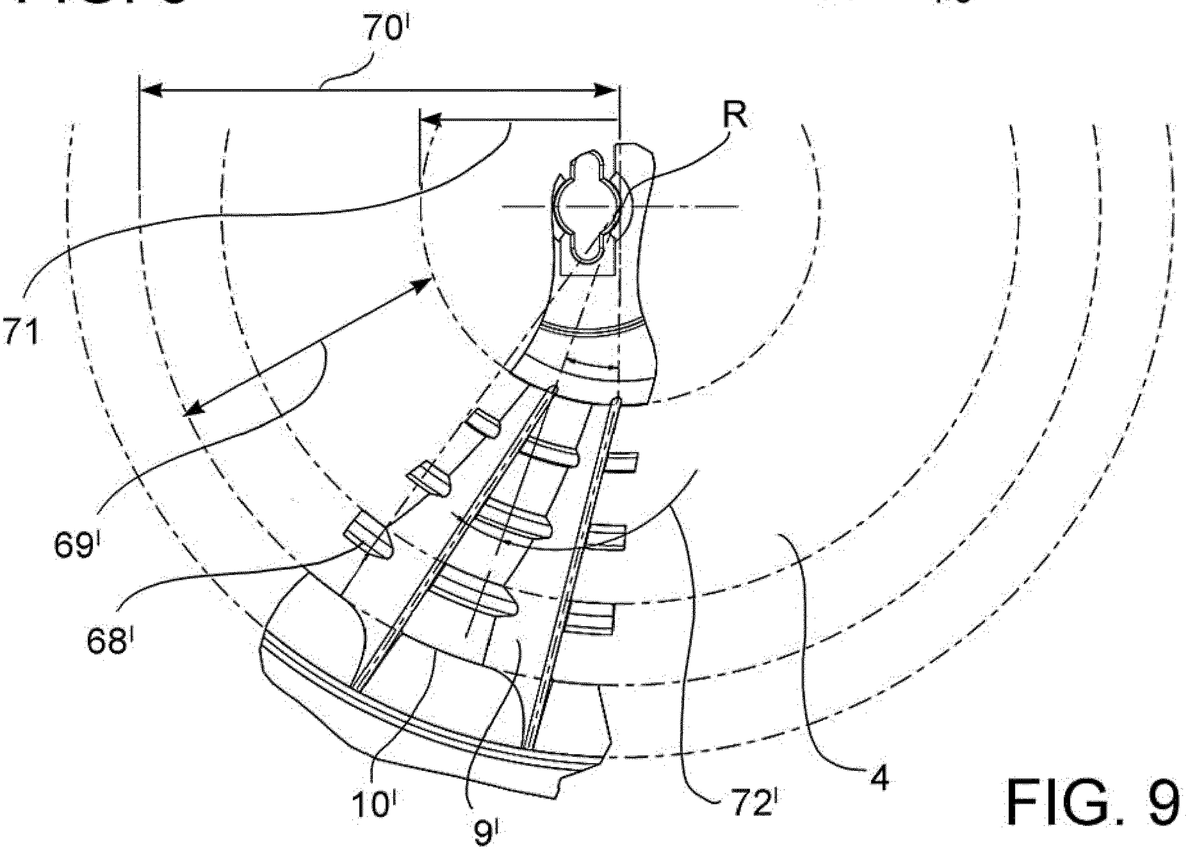

FIG. 9

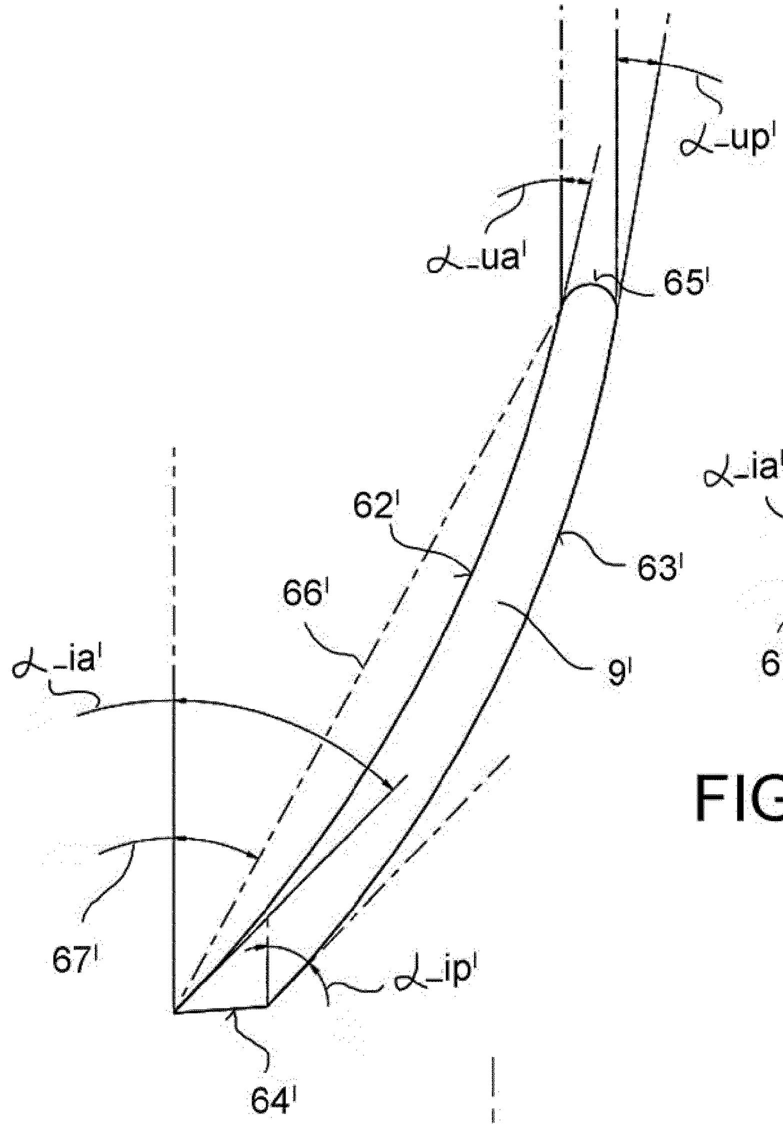

FIG. 11

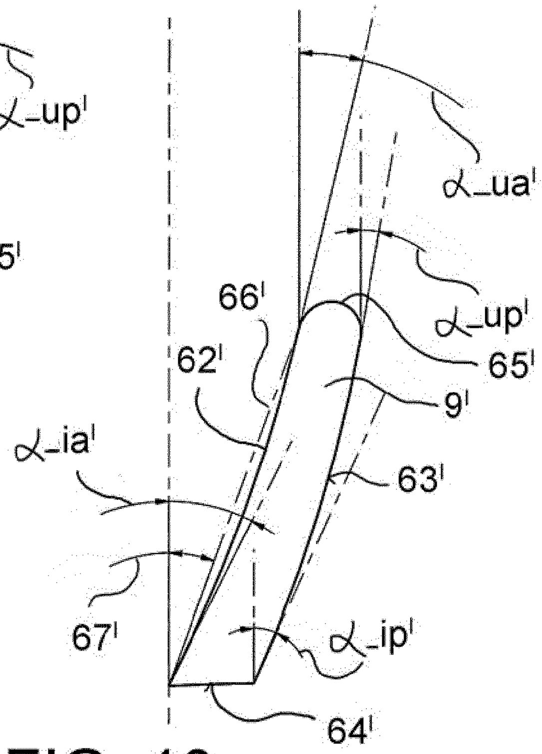

FIG. 10

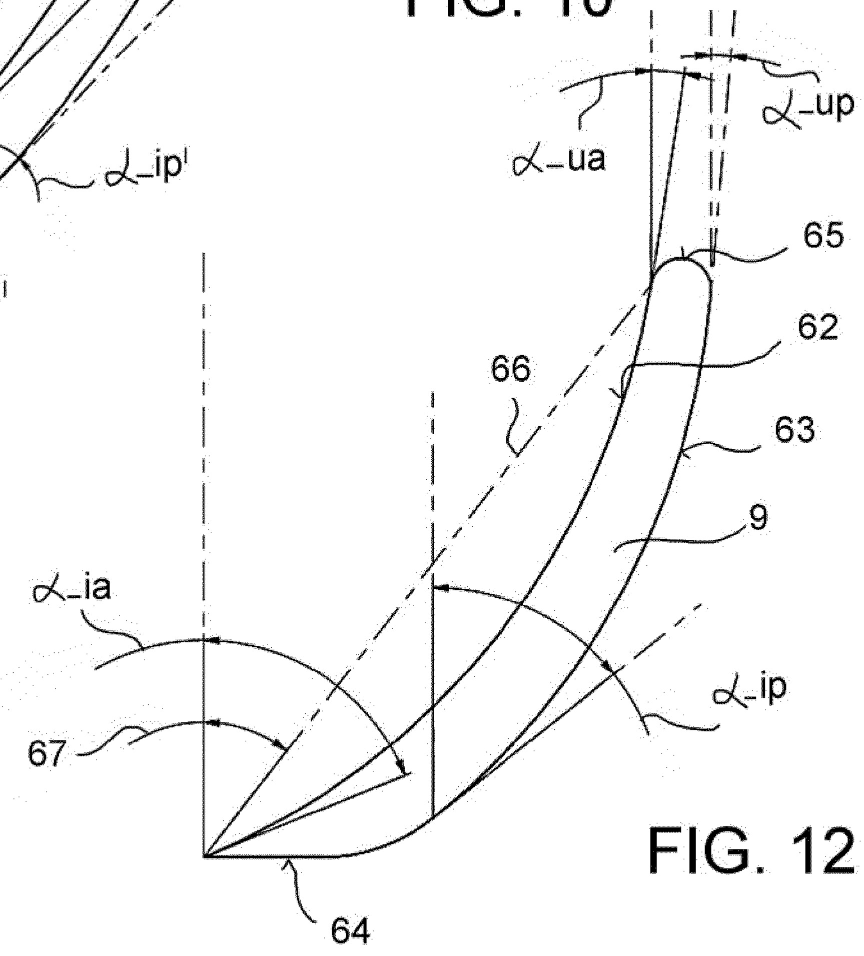

FIG. 12

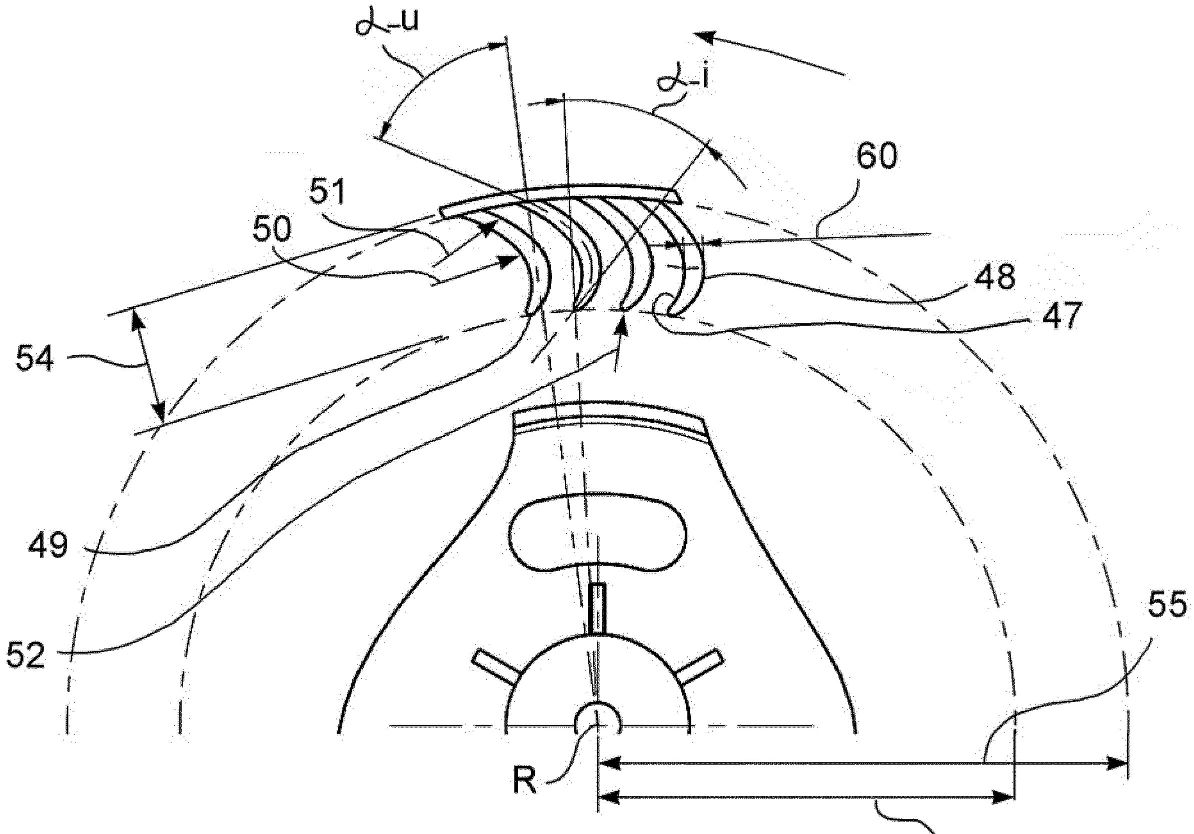

FIG. 13

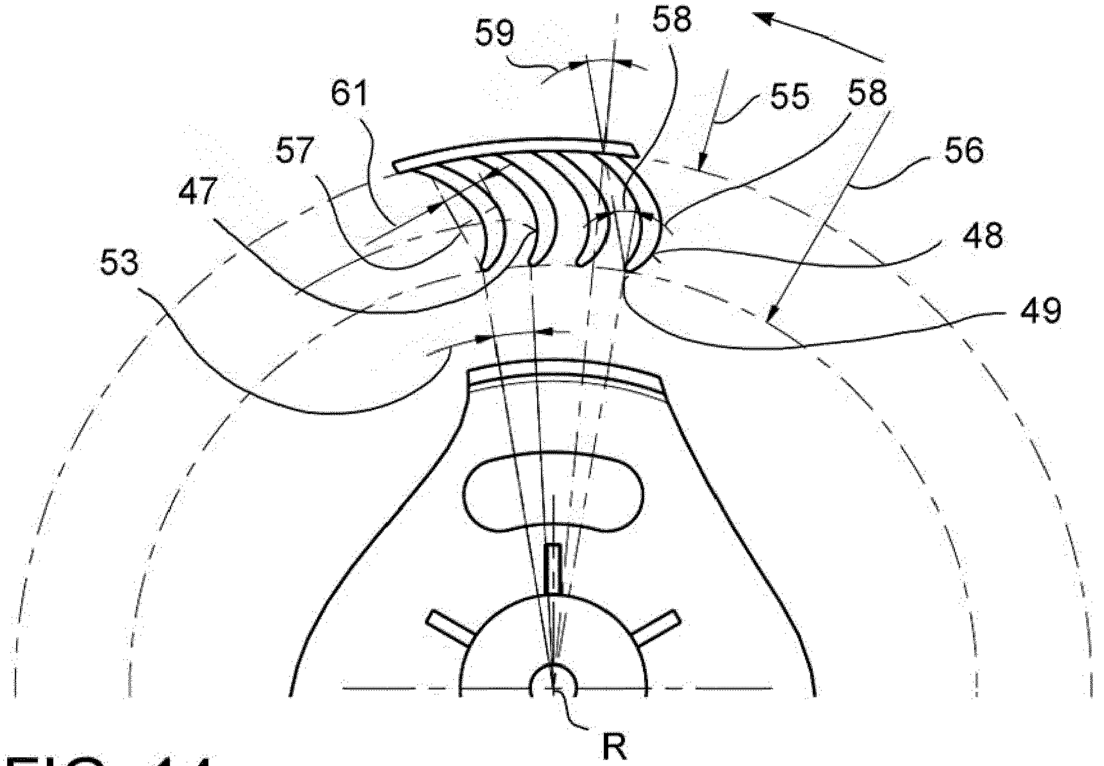

FIG. 14

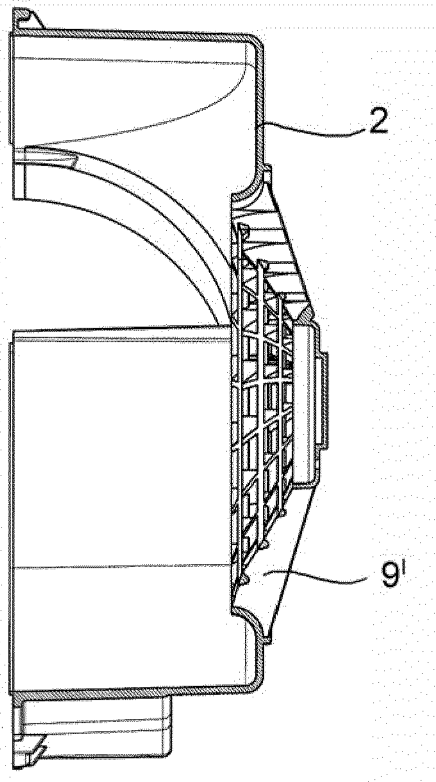

FIG. 15

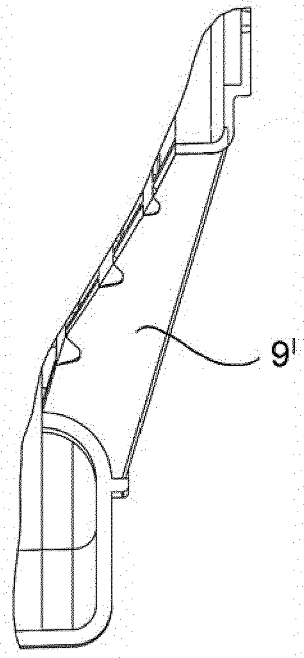

FIG. 16

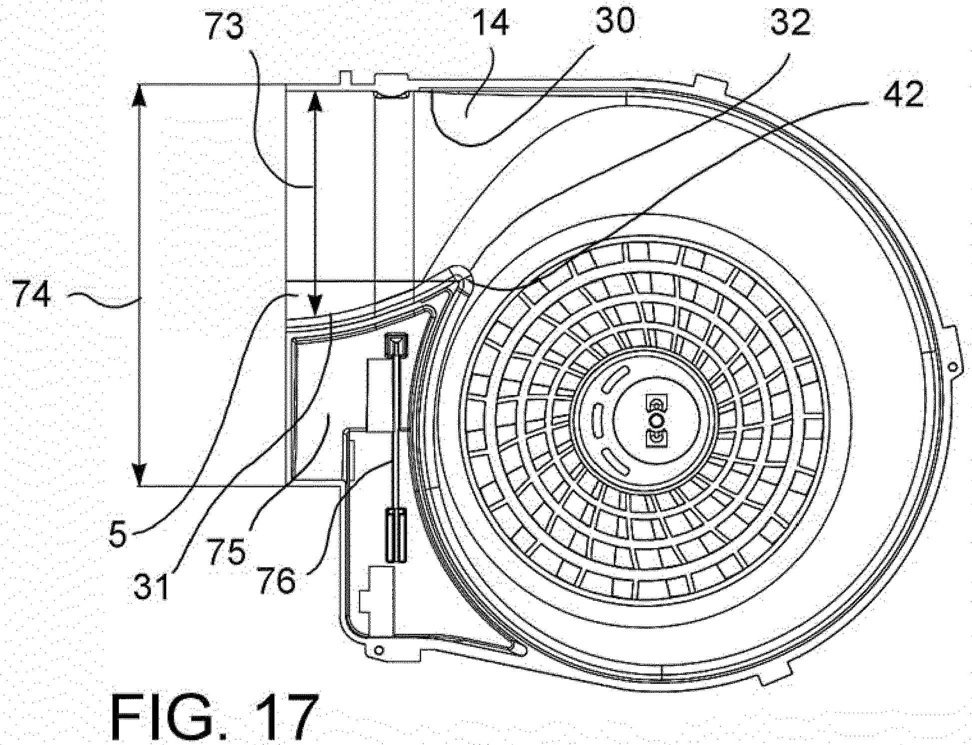

FIG. 17

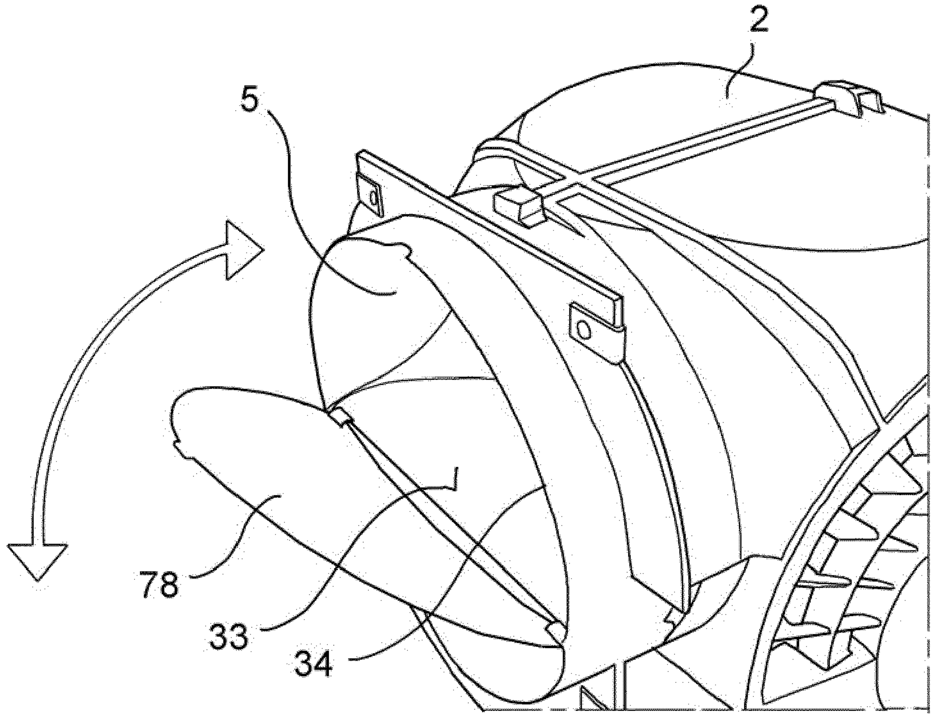

FIG. 19

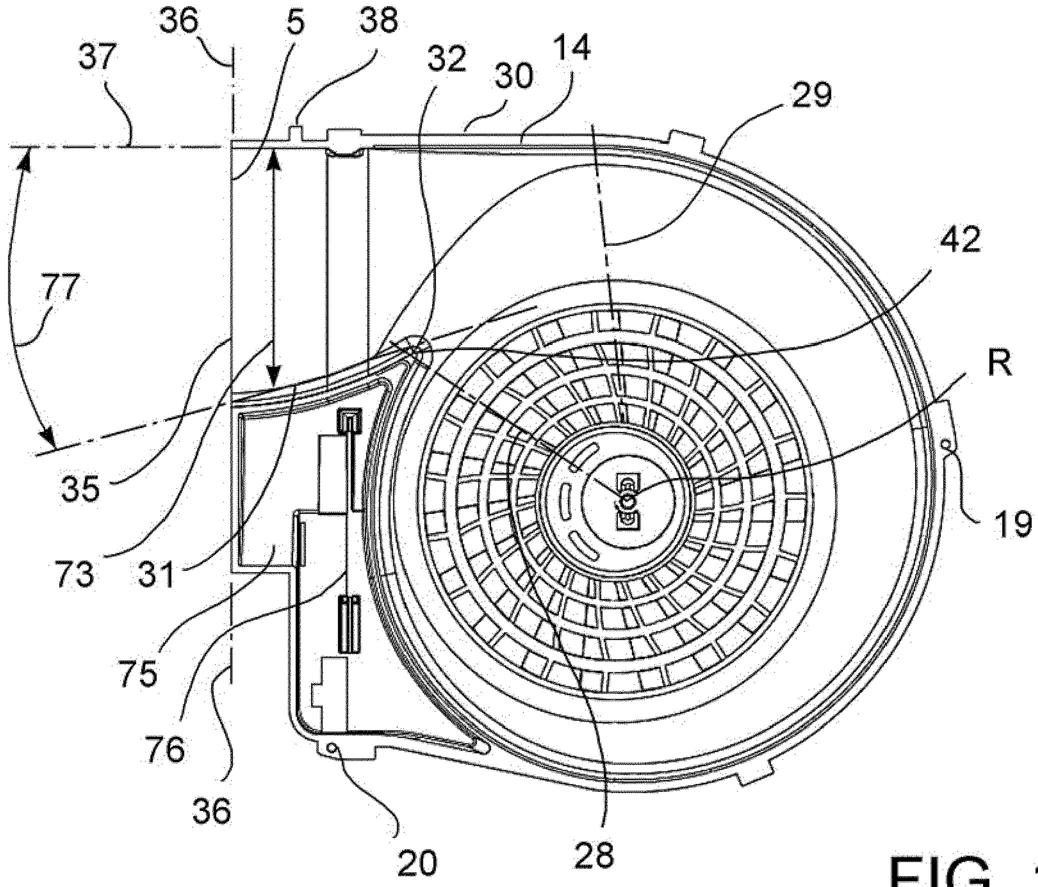

FIG. 18

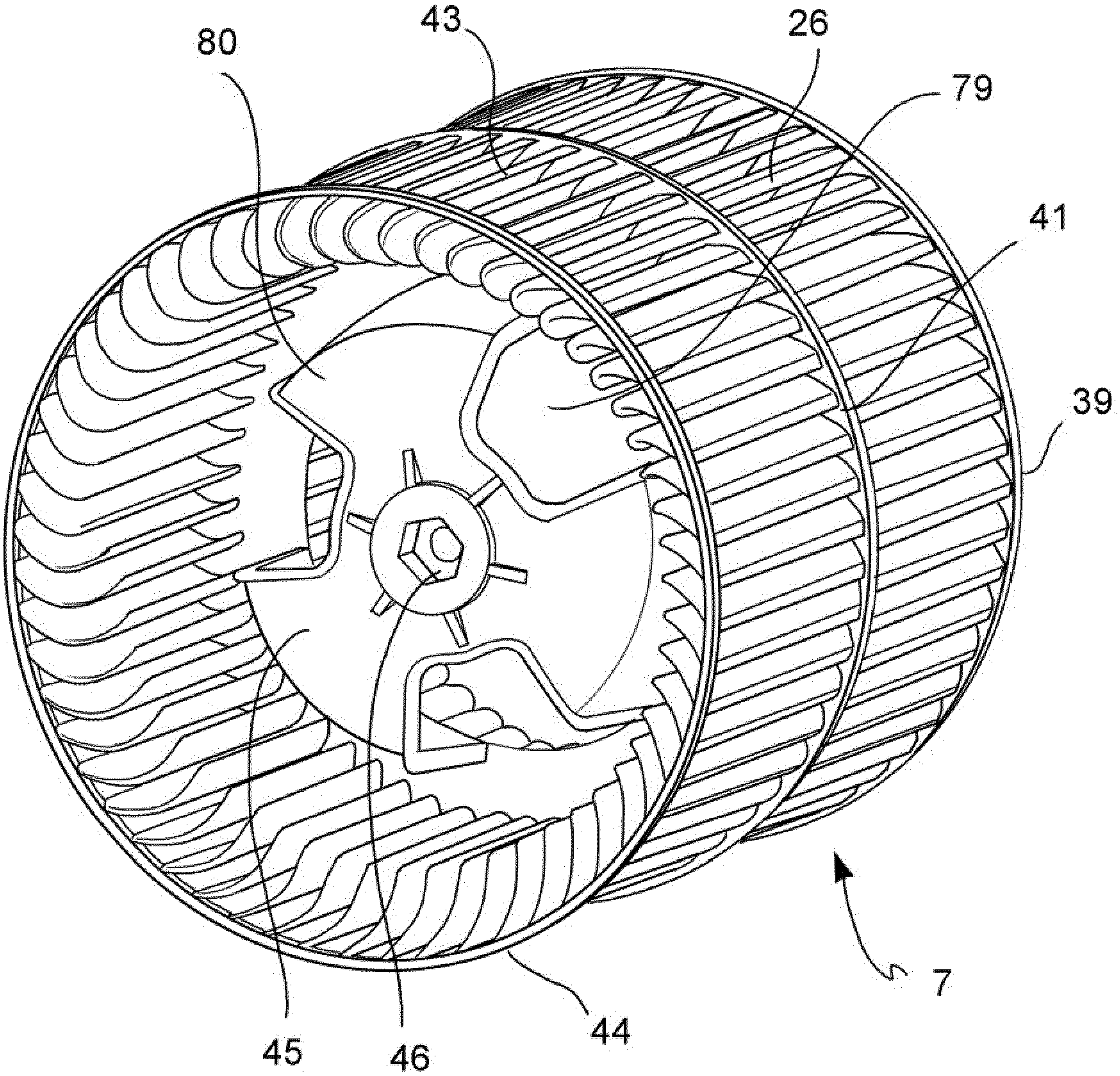

FIG. 20

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- EP 2365224 A **[0002]**