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(54) ELECTRICAL CENTRIFUGAL FAN WITH SPECIAL GEOMETRIC DIMENSIONS

(57) A centrifugal electrical fan (1) comprises a rotor (3) disposed in a body (2) with a deflector (5) in an inlet mouth (22); the rotor (3) has a radius (R0) and a center (P0) that is the origin of a system of two Cartesian axes (X, Y); the internal surface (55) of the deflector has a (54) circular arc section having a radius of curvature (R4) and

a center (P4) spaced from said center (P0) of the rotor in the direction of the axis of abscissas (X) towards the reflector (5), the ratio between the radius of curvature (R4) of the circular arc section (54) of the deflector and the radius (R0) of the rotor is given by $R_D = R4/R0 = 1.053 \pm 5\%$.

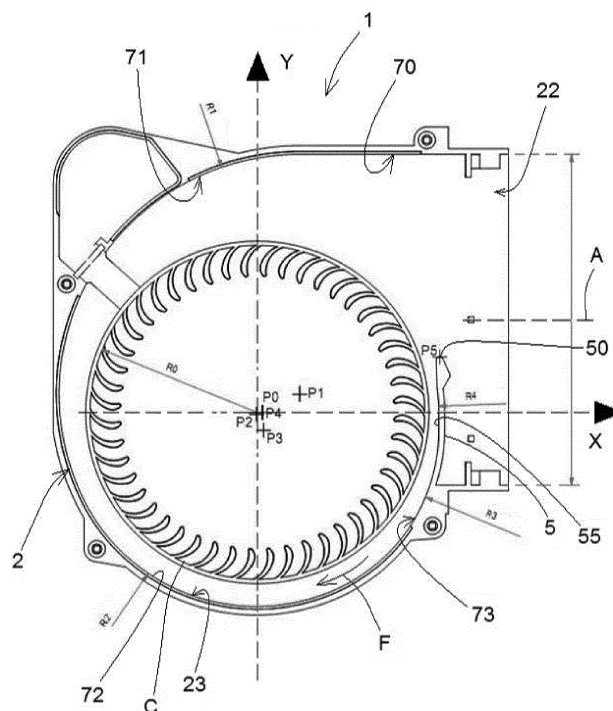


FIG. 5

Description

[0001] The present patent application relates to a centrifugal electrical fan capable of optimizing an air extraction process and therefore especially suitable for being used in extractor hoods.

[0002] As it is known, extractor hoods generally use centrifugal electrical fans.

[0003] With reference to Figs. 1 - 3 a centrifugal electrical fan of the prior art is shown, which is generally indicated with reference numeral 100.

[0004] With reference to Figs. 1 and 2, the electrical fan (100) comprises a body (2). A rotor (3) is revolvingly mounted inside the body (2) and is driven into rotation by an electrical motor (4) in such a way that the rotor (3) rotates around an axis of rotation (Z).

[0005] Two inlet mouths (20, 21) are obtained in the casing (2) in opposite position. The air enters the inlet mouths (20, 21) in opposite directions, i.e. in the direction of the arrows (I1, I2) along the direction of the axis of rotation (Z) of the rotor. The inlet mouths (20, 21) are generally covered with grills.

[0006] In the casing (2) an outlet mouth (22) is obtained, generally having a circular shape, which defines an opening from which air is emitted in the direction of the arrow (U), along an outlet direction (A) orthogonal to the axis of rotation (Z) of the rotor and orthogonal to a flat surface defined by the outlet mouth.

[0007] The rotor (3) comprises a plurality of blades that are configured in a way to axially extract air axially along the axis of rotation (Z) of the rotor and send air radially towards the exterior of the rotor, by centrifugal action, in a way that the air hits the internal surface of the casing (2) and is conveyed towards the outlet mouth (22).

[0008] With reference to Fig. 3 the rotation of the rotor (3) in the direction (M) generates a centrifugal radial flow (R) that directed in peripheral direction with respect to the rotor (3).

[0009] In order to increase the air circulation efficiency of the electrical fan (100) the use of a deflector (5) is known, it being disposed in the outlet mouth (22) in a way to cover approximately half of the opening defined by the outlet mouth (22). In other words, the deflector (5) is an extension of the casing (2) and the deflector (5) has an edge (50) that basically extends in correspondence of a diameter of the outlet mouth (22).

[0010] According to the prior art, in order to facilitate the air flow peripherally to the rotor (3), the casing (2) as well as the deflector (5) are shaped as an auger; in other words, the profile of the internal surface of the casing (2) and of the internal surface of the deflector (5) is shaped as a spiral.

[0011] With reference to Fig. 3, inside the casing (2) a peripheral channel (6) is formed between a circumference passing through the peripheral ends of the rotor (3) and the spiral-shaped internal surface of the casing (2) and of the deflector (5). Considering that the rotor (3) rotates in the direction of the arrow (M), an air flow flows in the peripheral channel (6) in the direction of the arrow (F), i.e. from the deflector (5) towards the outlet mouth (22).

[0012] Considering that the internal surface of the casing and of the deflector have a spiral-shaped profile, the peripheral channel (6) has a gradually increasing width going from the edge (50) of the deflector to an ending part (24) of the casing in proximal position to the outlet mouth (22).

[0013] The deflector (5) is used to increase the speed of the rotor in such a way to increase the extraction capacity of the entire fan (100). In fact, the higher is the speed of the rotor, the higher the amount of extracted air will be.

[0014] By inserting the deflector (5) in the outlet mouth (22) of the fan, the load torque on the driving shaft of the motor (4) is decreased. Considering that the motor (4) is an asynchronous motor, upon decreasing the load torque on the driving shaft, the rotational speed of the driving shaft increases.

[0015] However, the increase in the speed of the rotor (3) caused by the presence of the deflector (5) does not automatically improve the aerodynamic extraction process in a significant way, without a correct positioning and dimensioning of the deflector (5). In fact, if not positioned and dimensioned correctly, said deflector would obstruct the air flow coming out from the outlet mouth (22), without causing any significant improvement, on the contrary worsening the fluid-dynamic efficiency.

[0016] DE1050015 discloses a centrifugal electrical fan comprising a casing and a rotor revolvingly mounted in the casing in such a way to rotate around an axis of rotation. Such an electrical fan comprises an inlet mouth obtained in the casing to let air flows enter the casing along the direction of the axis of rotation of the rotor, and an outlet mouth obtained in the casing to let an air flow exit along an outlet direction orthogonal to the axis of rotation of the rotor. A deflector is mounted in the outlet mouth of the casing.

[0017] The purpose of the present invention is to eliminate the drawbacks of the prior art by devising an electrical fan with a high fluid dynamic efficiency (FDE).

[0018] Another purpose is to provide an electrical fan with small dimensions and volume that can be easily adapted to the limited space that is available in a special type of hoods known as "pull out" and/or "free-standing" hoods.

[0019] These purposes are achieved by the present invention with the characteristics of the independent claim 1.

[0020] Advantageous embodiments appear from the dependent claims.

[0021] The centrifugal electrical fan according to the invention is applied to extractor hoods, in particular to the extractor hoods known as "pull-out" and/or "free-standing" extractor hoods.

[0022] Following to studies on the aerodynamics and air circulation of different prototypes of the deflector geometry, the applicant has devised a solution that increases the fluid-dynamic efficiency of the electrical fan of the present invention by approximately 10%.

[0023] Additional features of the invention will appear manifest from the detailed description below, which refers to merely a illustrative, not limiting embodiment, as illustrated in the attached figures, wherein:

Fig. 1 is a perspective view of an electrical fan according to the prior art;

Fig. 2 is a front view of the electrical fan of Fig. 1;

Fig. 3 is a diagrammatic sectional view of the electrical fan of Fig. 1 along a sectional plane orthogonal to the axis of rotation of the rotor;

Fig. 4 is a perspective view of the electrical fan of the invention;

Fig. 5 is a sectional view of the electrical fan according to the invention along a sectional plane orthogonal to the axis of rotation of the rotor;

Fig. 5A in an enlarged detail of Fig. 5;

Fig. 5B is a view of an enlarged detail of Fig. 5A;

Fig. 6 is a table showing the results of the tests carried out on an electrical fan of the prior art;

Fig. 7 is a table showing the results of the tests carried out on an electrical fan according to the present invention.

[0024] In the following description the parts that are identical or correspond to the parts described with reference to the prior art are identified with the same numerals, omitting their detailed description.

[0025] With reference to Figs. 4 and 5, the electrical fan (1) according to the invention comprises:

- a body (2),
- a rotor (3) revolvingly mounted in the body to rotate around an axis of rotation (Z),
- an electrical motor (4) connected to the rotor (3) to drive it into rotation,
- at least one inlet mouth (20, 21) obtained in the body (2) to let in air flows (I1, I2) in the direction of the axis of rotation (Z) of the rotor,
- an outlet mouth (22) obtained in the body to let out an air flow (U) in an outlet direction (A) orthogonal to the axis of rotation (Z) of the rotor, and orthogonal to a flat surface defined by the outlet mouth (22), and
- a deflector (5) mounted in the outlet mouth (22) to deviate the air flow (U) coming out from the outlet mouth (22).

[0026] The outlet mouth (22) has a circular shape with a diameter (ϕ) comprised between 105 and 125 mm, preferably 116 mm. The outlet direction (A) is considered as the axis of the outlet mouth, i.e. the straight line orthogonal to the plane defined by the outlet mouth passing through the center of the outlet mouth.

[0027] The casing (2) has an internal surface (23) facing the rotor (3). The deflector (5) has an edge (50). The deflector (5) has an internal surface (55) facing the rotor (3). The internal surface (55) of the deflector is an extension of the internal surface (23) of the casing (2).

[0028] In view of the above, inside the casing (2) a peripheral channel (6) is formed, which is defined between a circumference (C) passing through the peripheral ends of the rotor (3) and the internal surface (22) of the casing (2) and the internal surface (55) of the deflector (5). In the peripheral channel (6) an air flow (F) flows, which is directed towards the outlet mouth (22).

[0029] The internal surface (23) of the casing has a spiral section along a sectional plane orthogonal to the axis of rotation (Z) of the rotor.

[0030] With reference to Fig. 5, the rotor (3) has a center (P0) disposed on the axis of rotation (Z) and a radius (R0). The radius (R0) of the rotor is considered as the radius of the circumference (C) passing through the peripheral ends of the blades of the rotor.

[0031] Fig. 5 shows a pair of Cartesian axes (X, Y) having the origin in the center (P0) of the rotor. The axis of abscissas (X) is parallel to the outlet direction (A), wherein the outlet direction (A) is the axis of the outlet mouth (22).

[0032] Therefore, in the system of Cartesian axes (X, Y) the center (P0) of the rotor has the following coordinates (0; 0).

[0033] The radius (R0) of the rotor is comprised between 55 and 65 mm, preferably 58.5 mm.

[0034] Starting from an upper part of the outlet mouth (22), the internal surface (22) of the casing has a rectilinear section (70) that is joined with a first circular arc section (71) having a radius of curvature R1 and a center P1 disposed in the first quadrant of the Cartesian system (X, Y). The distance between P0 and P1 is 15 - 18 mm. The straight line passing through P0 and P1 has an angle of approximately 15°-30° with respect to the axis of abscissas (X). More precisely, the center P1 has coordinates P1 (14.8; 6.4) expressed in millimeters.

[0035] The ratio between the radius R1 of the first circular arc section (71) of the casing and the radius R0 of the circumference (C) defined by the ends of the blades of the rotor is given by $R_A = R1/R0 = 1.4$ with a tolerance of $\pm 5\%$, i.e. $R_A = 1.33 - 1.47$. The radius R1 of the first section (71) is comprised between 80 and 90 mm, preferably 84.1 mm.

[0036] The first circular arc section (71) is joined to a second circular arc section (72) with radius of curvature R2 and a center P2 disposed in the third quadrant of the system of Cartesian axes (X, Y), in proximal position to the point of origin P0, i.e. the distance between P2 and P0 is lower than 1 mm. More precisely, the center P2 has coordinates P2 (-0.3; -0.6) expressed in millimeters.

[0037] The ratio between the radius R2 of the second circular arc section (72) of the casing and the radius R0 of the circumference (C) defined by the ends of the blades of the rotor is given by $R_B = R2/R0 = 1.15$ with a tolerance of $\pm 5\%$. The radius R2 of the second section is comprised between 63 and 70 mm, preferably 67.4 mm.

[0038] The second circular arc section (72) is joined to a third circular arc section (73) with radius of curvature R3 and a center P3 disposed in the fourth quadrant of the system of Cartesian axes (X, Y). The distance between P0 and P3 is 6 - 7 mm. The straight line passing through P0 and P3 has an angle of approximately 65° - 80° with respect to the axis of abscissas (X). More precisely, the center P3 has coordinates P2 (-0.3; - 0.6) expressed in millimeters.

[0039] The ratio between the radius R3 of the third circular arc section (73) of the casing and the radius R0 of the circumference (C) defined by the ends of the blades of the rotor is given by $R_C = R3/R0 = 1.053$ with a tolerance of $\pm 5\%$. The radius R3 of the third section (73) is comprised between 57 and 65 mm, preferably 61.3 mm.

[0040] With reference to Fig. 5A, the internal surface (55) of the deflector (5) has a first circular arc section (53) joined to the third section (73) of the internal surface of the casing. The first section (53) of the deflector has the same radius of curvature R3 and the same center P3 as the third section (73) of the casing.

[0041] The first circular arc section (53) of the deflector is joined to a second circular arc section (54) of the deflector with radius of curvature R4 and a center P4 disposed in the axis (X) of the system of Cartesian axes (X, Y), between the first and the fourth quadrant. The distance between P0 and P4 is 1.5 - 2.1 mm. More precisely, the center P4 has coordinates P4 (1.8; 0) expressed in millimeters.

[0042] The ratio between the radius R4 of the second circular arc section (54) of the casing and the radius R0 of the circumference (C) defined by the ends of the blades of the rotor is given by $R_D = R4/R0 = 1.053$ with a tolerance of $\pm 5\%$. The radius R4 of the third section (73) is comprised between 57 and 65 mm, preferably 61.6 mm.

[0043] Such a ratio $R_D = R4/R0 = 1.053 \pm 5\%$ is the most important of all. In fact, the ratio R_D affects the fluid dynamic efficiency (FDE) of the fan to the greater extent. Several experimental tests have shown that the maximum fluid dynamic efficiency is obtained with $R_D = R4/R0 = 1.053 \pm 5\%$.

[0044] With reference to Fig. 5B, the second circular arc section (53) of the internal surface (55) of the deflector (5) is joined with an end portion (51). In the internal surface of the deflector a discontinuity line (E) is visible between the second section (53) of the deflector and the end portion (51) of the deflector. In such a way, the deflector has an end portion (51) defined between the discontinuity line (E) and the edge (50) of the deflector.

[0045] The end portion (51) has an internal surface with a rectilinear section along a sectional plane orthogonal to the axis of rotation (Z) of the rotor. Such a rectilinear section of the end portion (51) of the deflector forms an angle (α) comprised between 80° and 100° , preferably approximately 90° with respect to the outlet direction (A) orthogonal to the flat surface defined by the outlet mouth (22).

[0046] In such a way, a distance (W1) exists between the discontinuity line (P) and the rotor (3). Instead, a distance (W2) exists between the edge (50) and the rotor (3), which is higher than the distance (W1) between the discontinuity line (P) and the rotor (3).

[0047] Consequently, between the internal surface (55) of the deflector and the peripheral end of the rotor (3) a first channel (V1) is formed, extending from the casing to the discontinuity line (E), and an ending channel (V2) extending from the discontinuity line (E) to the edge (50) of the deflector. In other words, the ending channel (V2) is in correspondence of the end portion (51).

[0048] The first channel (V1) has a decreasing width going from the casing to the discontinuity line (E). The ending channel (V2) has an increasing width going from the discontinuity line (P) to the edge (50). Therefore, the widest part of the ending channel (V2) is exactly in correspondence of the edge (50).

[0049] The end portion (51) has a length (L) equal to approximately $1/4 - 1/3$ of the total length of the deflector (5). In other words, if the deflector (5) has a total length of 50 mm, the end portion (51) of the deflector has a length (L) comprised between 12.5 and 16.7 mm.

[0050] With reference to Fig. 5A, in the system of Cartesian axes (X, Y), the edge (50) of the deflector is situated in a point P5 with P5 coordinates (63.75; 19.4).

COMPARATIVE TESTS

[0051] Comparative tests were carried out on an electrical fan of the prior art and an electrical fan according to the invention.

[0052] Fig. 6 shows a table with the results of the tests carried out on an electrical fan of the known art called "Blower 2", such as the one shown in Figs. 1, 2 and 3.

[0053] Fig. 7 shows a table with the results of the tests carried out on a fan according to the invention called "HEI-S",

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having an outlet mouth (22) with a diameter $\phi = 116$ mm and the geometrical dimensions shown in the following Table 1.

Table 1

RADIUS	COORDINATES
R0 = 58.5	P0 (0, 0)
R1 = 84.1	P1 (14.8; 6.4)
R2 = 67.4	P2 (-0.3; -0.6)
R3 = 61, 3	P3 (2.2; - 6.25)
R4 = 61.6	P4 (1.8; 0)
	P5 (63.75; 19.4)

[0054] Obviously, with said geometrical dimensions, the aforesaid dimensional ratios are respected:

$$R_A = R1/R0 = 1.4 \pm 5\%$$

$$R_B = R2/R0 = 1.15 \pm 5\%$$

$$R_C = R3/R0 = 1.053 \pm 5\%$$

$$R_D = R4/R0 = 1.053 \pm 5\%$$

[0055] As shown by the results of the tests, the fluid dynamic efficiency (FDE) of the fan was increased by more than 9% (approximately 10%), passing from a FDE value of 18.22% to a value of approximately 27.41%.

[0056] Having used the same electrical motor and the same rotor in both tests, it is evident that the improvement only and exclusively depends on the special geometry of the deflector. Therefore, the most important innovation lies in the design of the deflector, by means of which the air flow coming out from the fan can be conveyed in perpendicular direction to the outlet plane of the outlet mouth.

[0057] In order to compare the values of volumetric flow rate, static pressure and active electrical power, the following normalized values were used:

Ambient Temperature: 20 [°C]

Atmospheric Pressure: 1013.25 [mBar]

Relative Humidity: 50 [%]

[0058] The tests have shown than both fans have the same maximum volumetric flow rate, i.e. approximately 390 m³/h.

[0059] However, a higher static pressure value is obtained with the use of the special geometry of the deflector of the fan according to the present invention.

[0060] Comparing the static pressure value with the B.E.P. (Best Efficiency Point - darker line), a value of approximately 193 [Pa] is obtained in "Blower 2" and a value of approximately 308 [Pa] is obtained in "HEI-S".

[0061] Such an increment of the static pressure value is also found in the maximum pressure point, increasing the maximum static pressure value from 295 [Pa] of "Blower 2" to 345 [Pa] of "HEI-S".

[0062] Not only the static pressure value, but also the active electrical power is increased with "HEI-S".

[0063] An increase of approximately 23 m³/h of the volumetric flow rate value is obtained at the B.E.P.

[0064] The fluid dynamic efficiency value (FDE) is calculated with the following formula:

$$FDE = \frac{Q^* \times P^*}{W_{BEP}} \times 100$$

wherein

W(Bep):	Value of active electrical power measured in maximum efficiency point	[Watt]
FDE:	Fluid Dynamic Efficiency	[%]
Q*:	Volumetric air flow rate measured in maximum efficiency point	[m ³ / s]

(continued)

P*:	Static Pressure measured in maximum efficiency point	[Pa]
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5 **[0065]** Therefore, upon analyzing the data, it can be noted that the increase of the active electrical power obtained with the use of "HEI-S" is caused by the increase of the static pressure and of the volumetric flow rate.

[0066] The increase of the static pressure value and of the volumetric flow rate value of the air flow permits a total increase of the FDE value of approximately 10%.

10 **[0067]** The increase of the aerodynamic parameters is made possible by introducing the deflector in the special Cartesian configuration as described above. A generic position of the deflector would obstruct the air flow coming out of the fan, for such a reason it is necessary to design and prototype a special geometry of the deflector, which takes into account the ratios between the external radius (R0) of the rotor and the radius (R1, R2, R3, R4) of the circumferences used to build the auger composed of the casing and the deflector.

15 **[0068]** Numerous variations and modifications can be made to the present embodiment of the invention, which are within the reach of an expert of the field, falling in any case within the scope of the invention as disclosed by the attached claims.

20 Claims

1. Centrifugal electrical fan (1) comprising:

- a body (2),
- a rotor (3) revolvingly mounted in the body to rotate around an axis of rotation (Z);
- an electrical motor (4) connected to the rotor (3) to drive it into rotation;
- at least one inlet mouth (20, 21) obtained in the body (2) to let in air flows (I1, I2) in the direction of the axis of rotation (Z) of the rotor,
- an outlet mouth (22) obtained in the body to let out an air flow (U) in an outlet direction (A) orthogonal to the axis of rotation (Z) of the rotor, and orthogonal to a flat surface defined by the outlet mouth (22), and
- a deflector (5) mounted in the outlet mouth (22) and having an internal surface (55) facing towards the rotor (3),

wherein

said rotor (3) has a radius (R0) starting from a center (P0) disposed on said axis of rotation (Z), said center (P0) of the rotor being the origin of a Cartesian system with two axes (X, Y) wherein the axis of abscissas (X) is parallel to said outlet direction (A) that is orthogonal to a flat surface defined by the outlet mouth (22),

said internal surface (55) of the deflector has a circular arc section (54) having a radius of curvature (R4) and a center (P4) spaced from said center (P0) of the rotor in the direction of the axis of abscissas (X) towards the deflector (5),

characterized in that

the ratio between the radius of curvature (R4) of said circular arc section (54) of the deflector and the radius (R0) of the rotor is given by $RD = R4/R0 = 1.053 + 5\%$,

said internal surface (55) of the deflector has a first circular arc section (53) that is joined with said circular arc section (54),

said first circular arc section (53) has a radius of curvature (R3) and a center (P3) spaced from said center (P0) of the rotor and lying in the fourth quarter of said systems of two Cartesian axes (X, Y),

the ratio between the radius of curvature (R3) of said first circular arc section (53) of the deflector and the radius (R0) of the rotor is given by $Rc = R3/R0 = 1.053 + 5\%$.

2. The electrical fan (1) of claim 1, wherein the distance between the center (P0) of the rotor and the center (P4) of said section of the deflector is 1.5 - 2.1 mm.

3. The electrical fan (1) of claim 1 or 2, wherein the radius (R0) of the rotor is 55-65 mm.

4. The electrical fan (1) of any one of the preceding claims, wherein the radius of curvature (R4) of said circular arc section (54) of the deflector is 57 - 65 mm.

5. The electrical fan (1) of any one of the preceding claims, wherein the distance between the center (P0) of the rotor

and the center (P3) of said section (53) of the deflector is 6 - 7 mm and the straight line passing through the center (P0) of the rotor and the center (P3) of said first section (53) of the deflector has an angle of approximately 65-80° with respect to the axis of the abscissas (X).

- 5 **6.** The electrical fan (1) of any one of the preceding claims, wherein the radius of curvature (R3) of said first circular arc section (53) of the deflector is 57 - 65 mm.
- 10 **7.** The electrical fan (1) of any one of the preceding claims, wherein starting from the outlet mouth (22) said internal surface (55) of the body has a rectilinear section (70) that is joined with a first circular arc section (71),
said first circular arc section (71) of the body has a radius of curvature (R1) and a center (P1) spaced from said center (P0) of the rotor and lying in the first quadrant of said Cartesian system with two axes (X, Y),
the ratio between the radius of curvature (R1) of said first circular arc section (71) of the body and the radius (R0) of the rotor is given by $R_A = R1/R0 = 1.4 + 5\%$.
- 15 **8.** The electrical fan (1) of claim 7, wherein the distance between the center (P0) of the rotor and the center (P1) of said first section (71) of the body is 15 - 18 mm and the straight line passing through the center (P0) of the rotor and the center (P3) of said first section (71) of the body has an angle of approximately 15°-30° with respect to the axis of abscissas (X).
- 20 **9.** The electrical fan (1) of claim 7 or 8, wherein the radius of curvature (R1) of said first circular arc section (71) of the body is 80 - 90 mm.
- 25 **10.** The electrical fan (1) of any one of claims 7 to 9, wherein said internal surface (55) of the body has a second circular arc section (72) that is joined with said first circular arc section (71) of the body,
said second circular arc section (72) of the body has a radius of curvature (R2) and a center (P2) spaced from said center (P0) of the rotor and lying in the third quadrant of said Cartesian system with two axes (X, Y),
the ratio between the radius of curvature (R2) of said second circular arc section (72) of the body and the radius (R0) of the rotor is given by $R_B = R2/R0 = 1.15 + 5\%$.
- 30 **11.** The electrical fan (1) of claim 11, wherein the distance between the center (P0) of the rotor and the center (P2) of said second section (72) of the body is 6 - 7 mm and the straight line passing through the center (P0) of the rotor and the center (P2) of said second section (71) of the body has an angle of approximately 65°-80°.
- 35 **12.** The electrical fan (1) of claim 7 or 8, wherein the radius of curvature (R2) of said second circular arc section (72) of the body is 63 - 70 mm.
- 40 **13.** The electrical fan (1) of any one of claims 10 to 12, wherein said internal surface (55) of the body has a third circular arc section (73) that is joined with said second circular arc section (72) of the body and to said first circular arc section (53) of the deflector,
said third circular arc section (73) of the body has a radius of curvature (R3) and a center (P3) respectively coinciding with the radius of curvature (R3) and the center (P3) of said first circular arc section (53) of the deflector.
- 45 **14.** The electrical fan (1) of any one of the preceding claims, wherein the internal surface (55) of the deflector (5) has a discontinuity line (E), in such manner that an end portion (51) of the deflector is defined between the discontinuity line (E) and an edge (50) of the deflector,
an ending channel (V2) being defined between the internal surface of said end portion (51) of the deflector and the rotor (3), said ending channel (V2) having an increasing width going from the discontinuity line (E) to the edge (50) of the deflector.

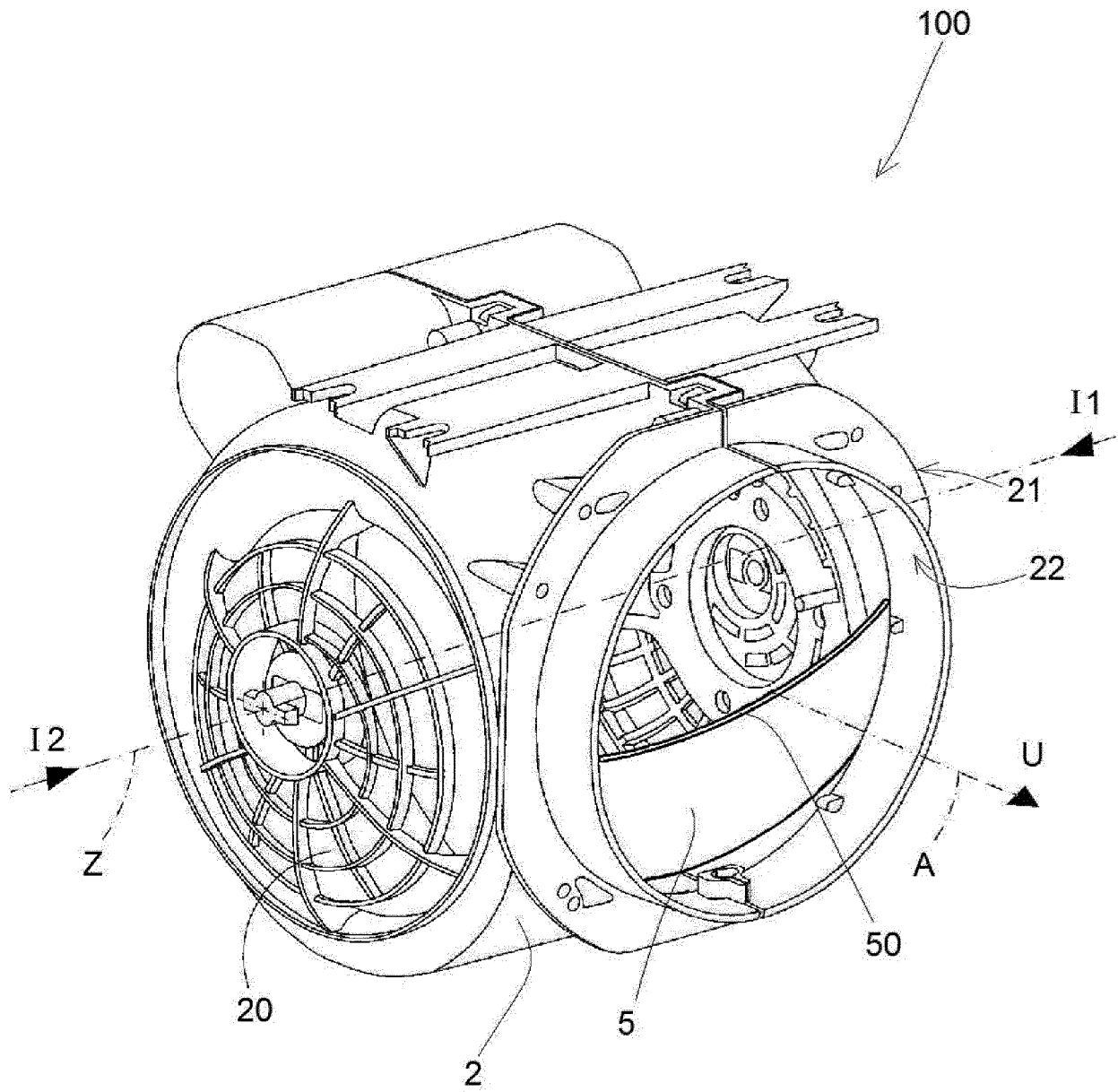


FIG. 1

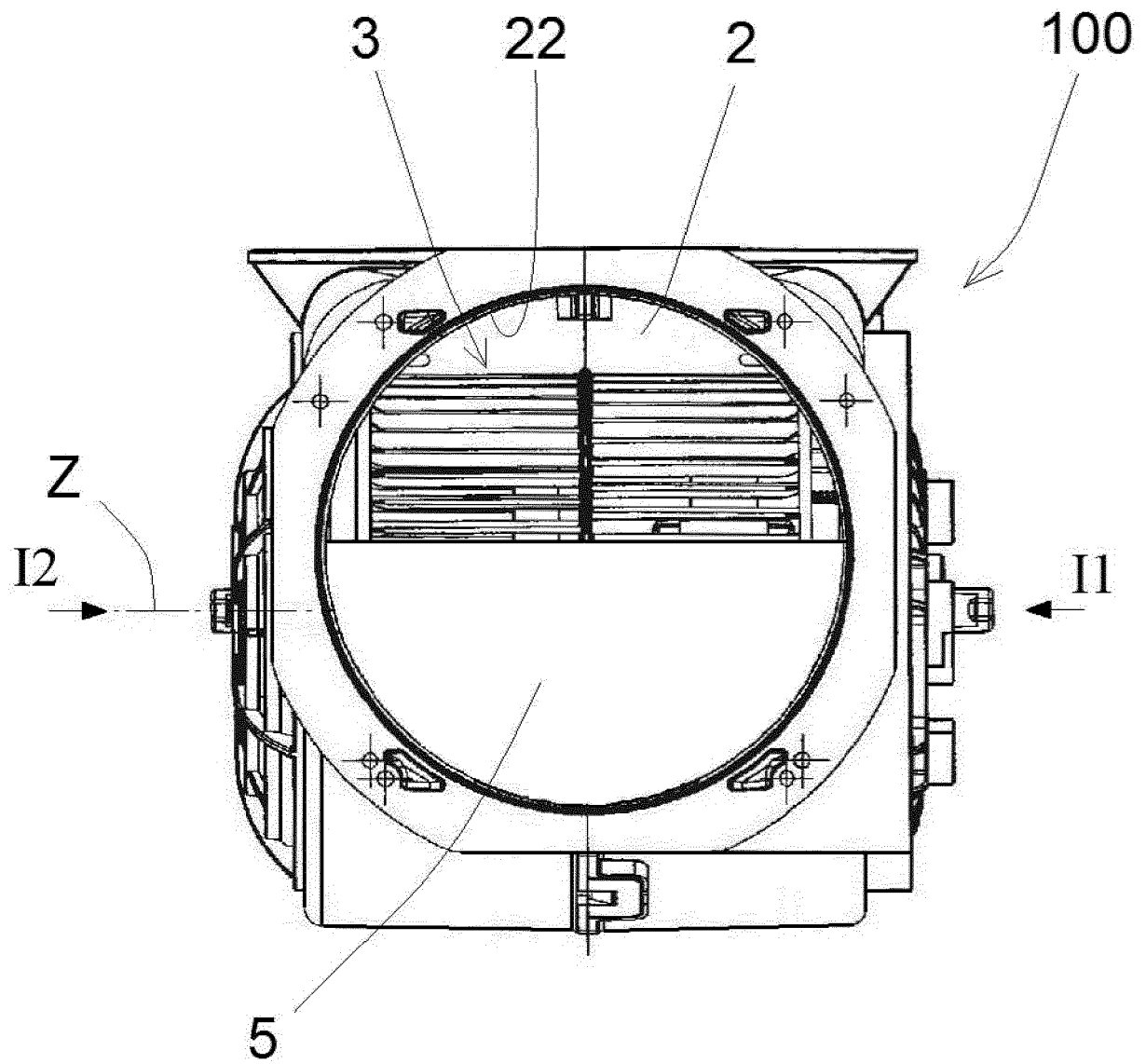


FIG. 2

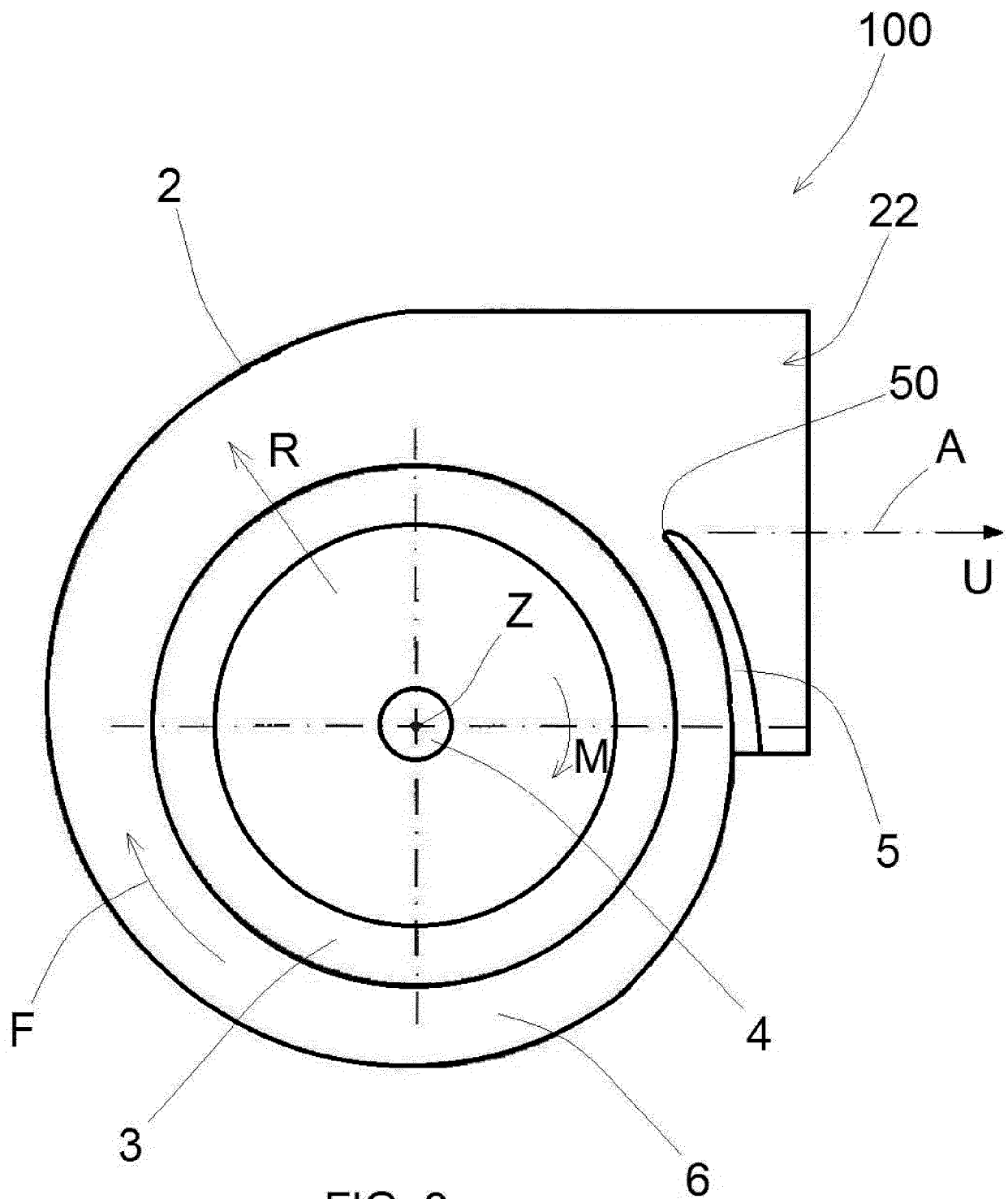


FIG. 3

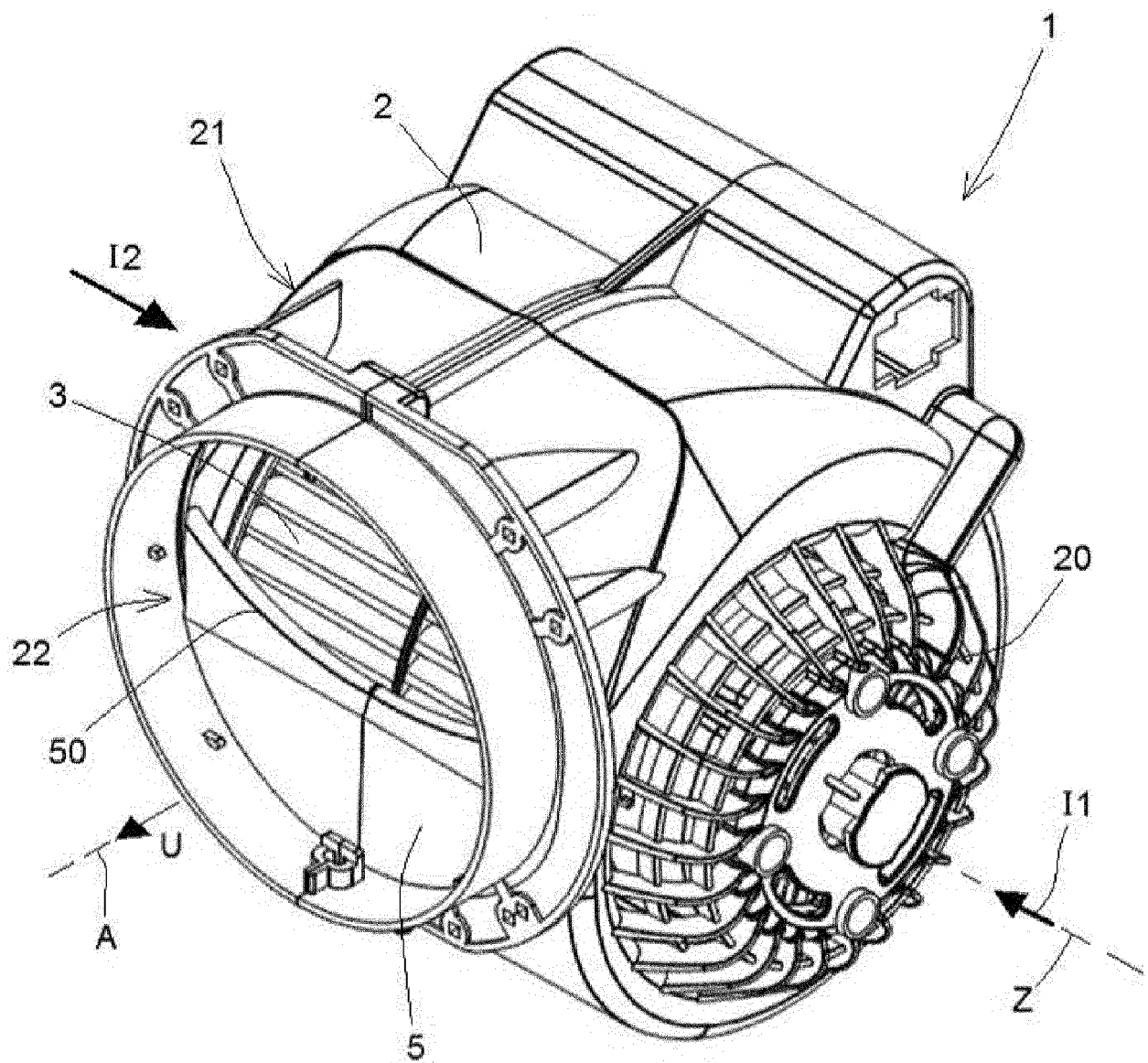


FIG. 4

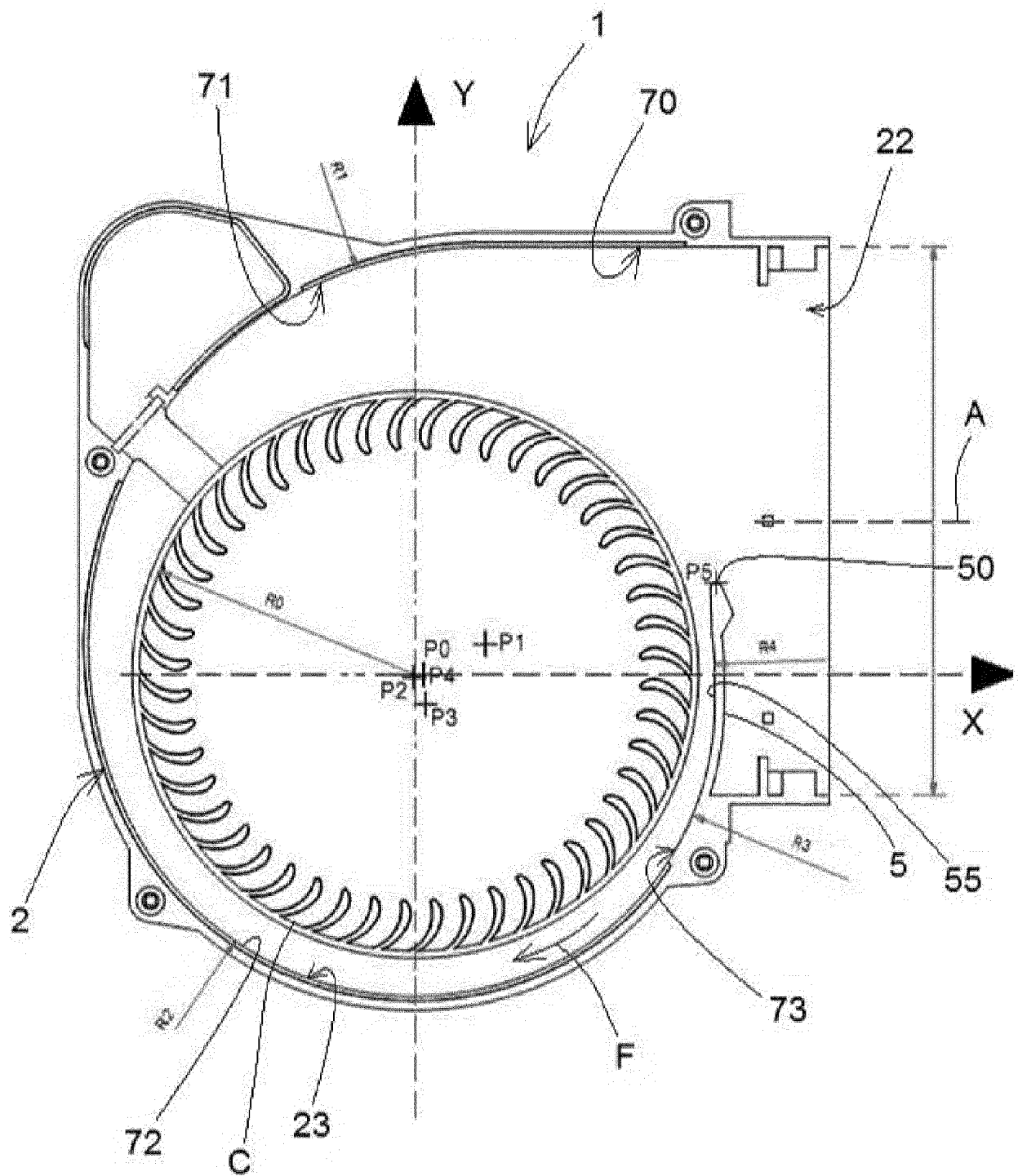


FIG. 5

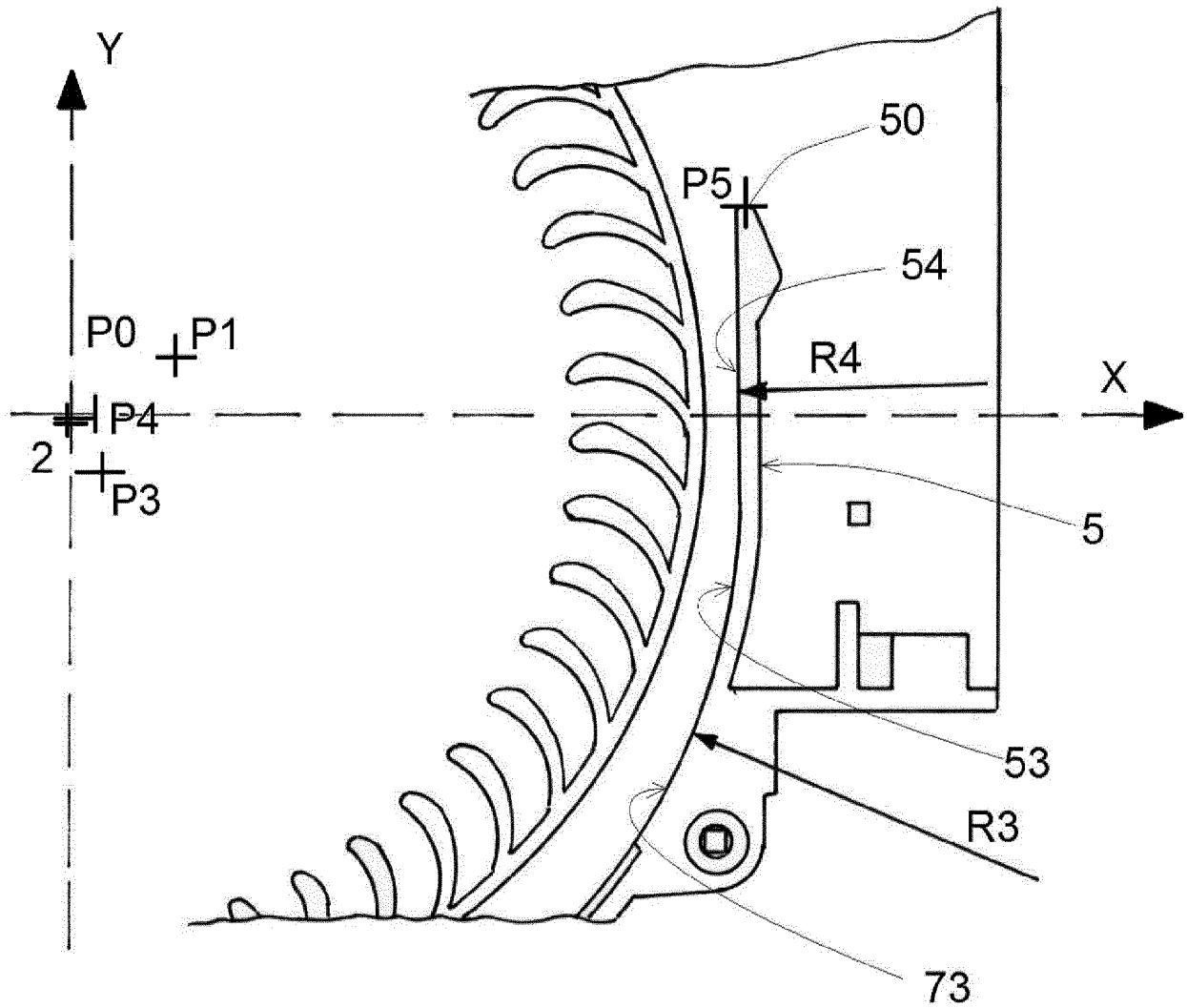


FIG. 5A

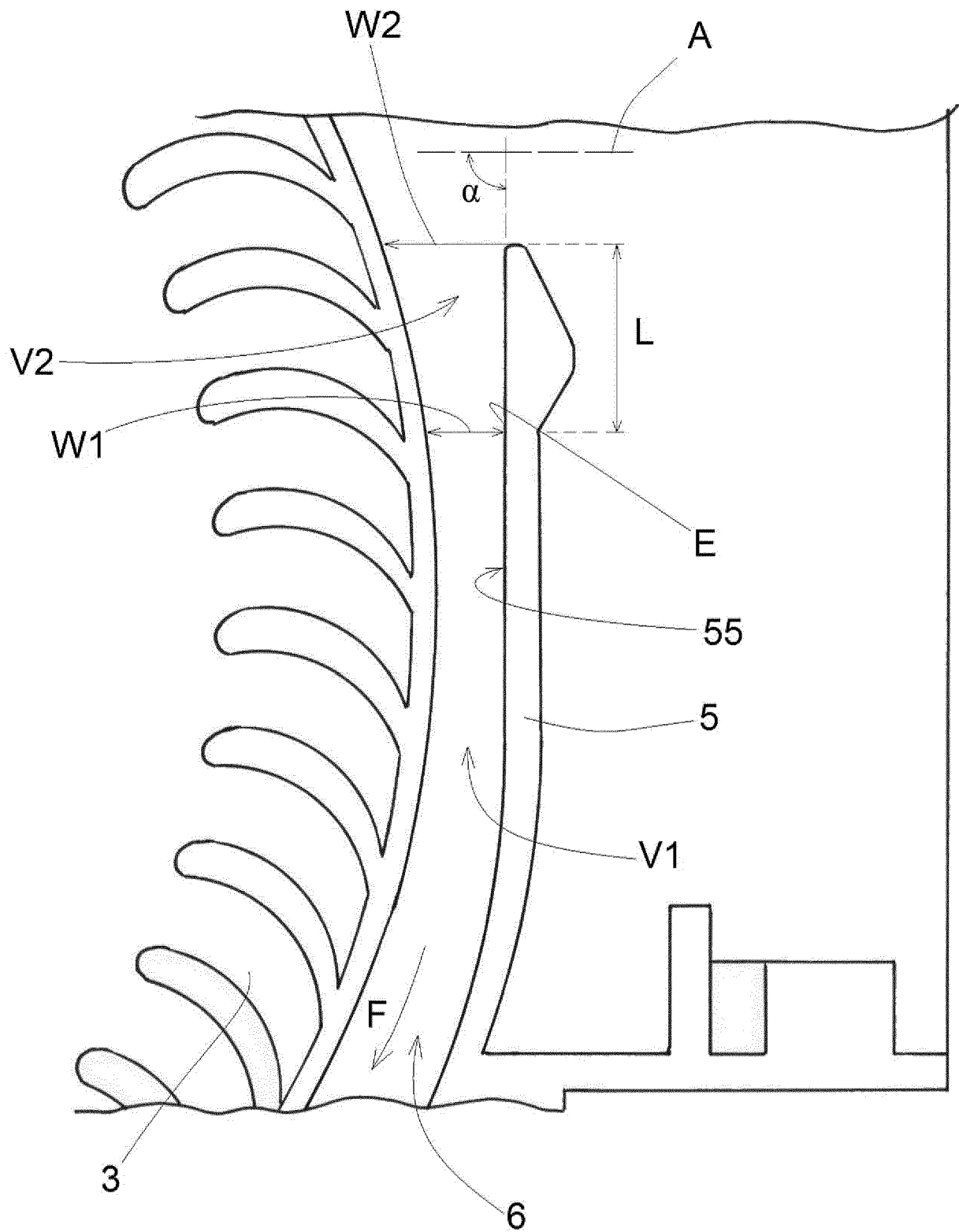


FIG. 5B

Product:		Blower 2					
Speed	Max	Voltage [V]		Temperature T [°C]		Normalized Temperature T [°C]	
		Frequency [Hz]		Atmospheric Pressure [mBar]		Normalized Atmospheric Pressure [mBar]	
				Relative Humidity [%]		Normalized Relative Humidity [%]	
				Density of the fluid ρ [Kg/m³]		Normalized Density of the fluid ρ [Kg/m³]	
		230	18,6				
		50	1013,1				
			53				
			1,205				
		</					

Test method: Performance test, according with international Standard ISO 61591.

Current	Power	P.F.	Rotational Speed	Static Pressure	Differential Pressure	Air Speed	Volume Flow Rate	Mass Flow Rate	Volume Flow Rate	Static Pressure	Differential Pressure	FDE	FDE	Normalized Values		
														Volume Flow Rate	Static Pressure	Power
[A]	[W]		[Rpm]	[mmH ₂ O]	[mmH ₂ O]	[m/s]	[m ³ /s]	[kg/s]	[m ³ /h]	[Pa]	[Pa]	[%]	[%]	[m ³ /h]	[Pa]	[W]
0.195	44.8	0.99	2880	30.0	0.0	0.000	0.000	0.000	0.000	294.200	0.000	0.00	0.00	0.00	295.57	45.01
0.205	47.0	0.99	2870	27.1	1.5	1.490	0.026	0.032	94.815	265.760	14.710	14.89	14.96	95.26	267.00	47.22
0.215	49.2	0.99	2850	25.3	2.2	1.805	0.032	0.038	114.826	248.108	21.575	16.08	16.16	115.36	249.26	49.43
0.232	53.3	1.00	2810	21.8	3.2	2.177	0.038	0.046	138.486	213.785	31.381	15.43	15.50	139.13	214.78	53.55
0.240	55.3	1.00	2800	21.4	4.8	2.565	0.047	0.057	169.609	209.862	47.072	17.88	17.96	170.40	210.84	55.56
0.255	59.0	1.00	2770	19.6	6.7	3.150	0.056	0.067	200.386	192.210	65.705	18.13	18.22	201.32	193.10	59.27
0.370	82.4	1.00	2740	17.7	8.6	3.569	0.063	0.076	227.028	173.578	84.337	17.54	17.62	228.08	174.38	82.69
0.285	65.5	1.00	2710	15.7	10.6	3.962	0.070	0.084	252.047	153.964	103.950	16.46	16.53	253.22	154.68	65.80
0.294	67.8	1.00	2685	14.0	12.2	4.250	0.075	0.090	270.402	137.293	119.641	15.21	15.28	271.66	137.93	68.12
0.313	72.4	1.00	2640	11.0	14.9	4.697	0.083	0.100	298.829	107.873	146.119	12.37	12.43	300.22	108.37	72.74
0.335	77.3	1.00	2585	7.6	18.3	5.206	0.092	0.111	331.173	74.531	179.462	8.87	8.91	332.71	74.88	77.66
0.352	81.0	1.00	2535	4.9	21.2	5.503	0.099	0.119	356.449	48.053	207.901	5.87	5.90	358.11	48.28	81.38
0.361	83.2	1.00	2510	3.3	22.6	5.785	0.102	0.123	368.030	32.362	221.630	3.98	3.99	369.74	32.51	83.59
0.380	87.1	1.00	2445	0.0	25.2	6.109	0.108	0.130	388.624	0.000	247.128	0.00	0.00	390.43	0.00	87.51

FIG. 6

Product:		BLOWER EMC HEI-S					
Speed	Max	Voltage [V]		Temperature T [°C]		Normalized Temperature T [°C]	
		230		11,1		20,0	
		Frequency [Hz]		Atmospheric Pressure [mBar]		Normalized Atmospheric Pressure [mBar]	
		50		1030		1013,25	
				Relative Humidity [%]		Normalized Relative Humidity [%]	
				43,7		50	
				Density of the fluid ρ [kg/m³]		Normalized Density of the fluid ρ [kg/m³]	
				1,260		1,199	

Test method: Performance test, according with International Standard ISO 61591.

Current	Power	P.F.	Rotational Speed	Static Pressure [P]	Differential Pressure [Δp]	Air Speed V ₁	Volume Flow Rate	Mass Flow Rate	Volume Flow Rate	Static Pressure [Pa]	Differential Pressure	FDE	FDE	Normalized Values		
														[W]	[m ³ /h]	[Pa]
0,190	44,0	1,00	2590	33,3	0,0	0,000	0,000	0,000	0,000	326,561	0,000	0,00	0,00	0,00	0,00	342,35
0,214	49,0	1,00	2545	32,8	3,5	2,226	0,039	0,050	141,630	321,658	34,323	25,83	27,07	148,48	337,21	51,37
0,275	63,8	1,00	2730	31,4	6,4	3,010	0,053	0,067	191,518	307,929	62,763	25,68	26,92	200,78	322,82	66,89
0,279	64,8	1,00	2720	30,8	7,0	3,148	0,056	0,070	200,295	302,045	68,647	25,93	27,19	209,98	316,65	67,93
0,286	66,5	1,00	2700	30,0	7,9	3,345	0,059	0,074	212,781	294,200	71,473	26,15	27,41	223,07	308,43	69,72
0,292	68,0	1,00	2680	29,1	8,4	3,449	0,061	0,077	219,412	285,374	82,376	25,58	26,81	230,02	299,17	71,29
0,303	70,0	1,00	2650	27,7	9,7	3,706	0,065	0,083	235,780	271,644	95,125	25,42	26,65	247,18	284,78	73,39
0,319	74,0	1,00	2610	25,9	11,4	4,018	0,071	0,089	255,607	253,992	111,796	24,37	25,55	267,97	266,28	77,58
0,329	76,2	1,00	2575	24,5	12,7	4,241	0,075	0,094	269,788	240,263	124,544	23,63	24,77	282,83	251,88	79,88
0,348	80,0	1,00	2515	21,4	14,7	4,563	0,081	0,102	290,254	209,862	144,158	21,15	22,17	304,29	220,01	83,87
0,374	85,0	1,00	2420	18,2	17,5	4,978	0,088	0,111	316,694	178,481	171,616	18,26	19,14	332,01	187,11	90,16
0,418	95,0	1,00	2235	13,0	21,1	5,466	0,097	0,122	347,745	127,486	206,920	12,96	13,59	364,56	133,65	99,59
0,435	100,0	1,00	2120	11,4	22,3	5,620	0,099	0,125	357,497	111,796	218,688	11,10	11,64	374,79	117,20	104,84
0,463	110,0	0,99	1800	3,3	23,8	5,805	0,103	0,129	369,325	32,362	233,398	3,02	3,16	387,19	33,93	115,32
0,500	113,5	0,98	1650	0,0	24,0	5,830	0,103	0,130	370,874	0,000	235,360	0,00	0,00	388,81	0,00	118,99

FIG. 7



EUROPEAN SEARCH REPORT

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Place of search Munich		Date of completion of the search 13 June 2017	Examiner de Martino, Marcello
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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