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(71) Applicant: **Gmerit Holdings Ltd**
Foshan City, Guangdong Province (CN)

(72) Inventor: **Zhang, Weiwei**
Foshan City (CN)

(74) Representative: **RVDB Nantes**
2, rue Crucy
CS 60515
44005 Nantes Cedex 1 (FR)

(54) **A VOLUTE WITH DOUBLE AIR INLET AND VARIABLE OPENING DEGREE**

(57) The invention relates to a volute with double air inlets and variable opening degree. The volute comprises a volute body (1), a volute tongue (2) and an impeller (3). The volute body comprises a spiral part (11) and an extension part (12). The impeller is located in a central part of the spiral part, with a through hole passing through the spiral part to form an air inlet. The volute tongue (2) comprises a connecting part (21) connected to the spiral part, and an expanding part (22) connected to the connecting part (21), wherein the expanding and extension parts form an air outlet. Upper blades with a height H1, a baffle plate forming an upper air inlet and a lower air inlet, and lower blades with a height H2 are arranged on the impeller (3), wherein H1 is less than H2.

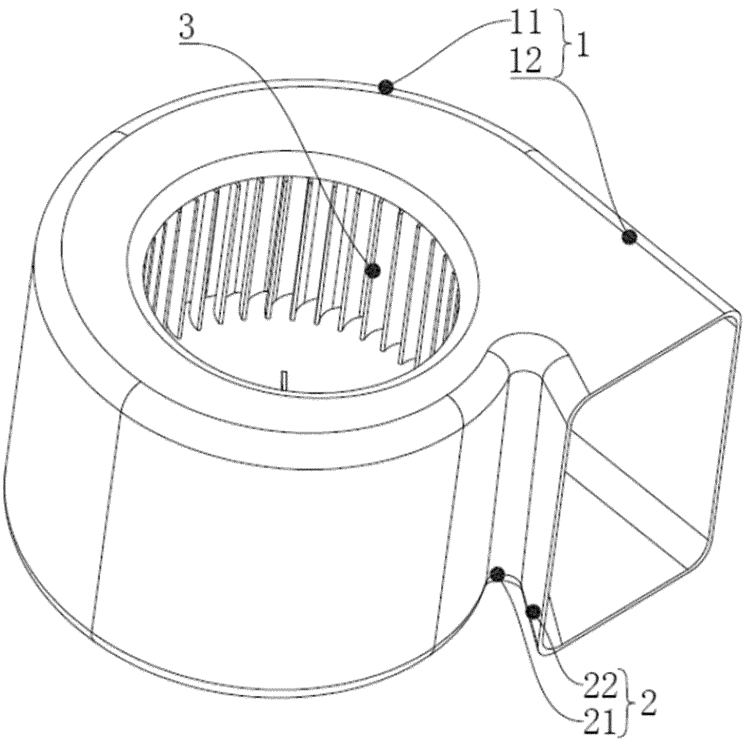

FIG.1

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Description

Technical background

[0001] The present application relates to the technical field of centrifugal fan, in particular to a volute for a centrifugal fan. The present application concerns in particular a volute with double air inlets and variable opening degree.

Background

[0002] An air-conditioning ventilation system is usually provided with a centrifugal fan. The centrifugal fan comprises a volute and an impeller, whereby the impeller is generally installed in the air knife inside the volute, and the air is sucked into the air duct by the centrifugal fan and circumferentially transported out of the air duct by the impeller to achieve air supply of the air conditioner.

[0003] It is known to use a volute with equal opening degree and an air wheel with double air inlets for a centrifugal fan. It has however been observed that the performances of such volutes are not always satisfactory. Conventional volutes tend to have insufficient diffusion and too high volute tongue, and they tend to generate high-frequency noise that is not desirable.

Summary of the invention

[0004] An object of the present invention is to solve at least one of the disadvantages or deficiencies of the prior art, as described above and in further detail below.

[0005] Another object of the present invention is to provide a volute for a centrifugal fan allowing high performances with limited noise.

[0006] Another object of the present invention is to provide a volute, and a corresponding centrifugal fan comprising such a volute, allowing high performances with limited high-frequency noise.

[0007] To the end, the present invention provides a volute with double air inlet and variable opening degree. The different flows on both sides of a baffle plate can be diffused by proper opening degree at the air outlet. The volute with double air inlets and variable opening degree according to present invention can achieve noise reduction and higher fan efficiency, which then solves the problem about the loud noise caused by mismatching between the air flow and the opening degree of the conventional centrifugal fan.

[0008] According to a first aspect, the invention provides a volute with double air inlets and variable opening degree, said volute comprising a volute body, a volute tongue and an impeller; the volute body and the volute tongue being integrated and hollow; and wherein:

- the volute body comprises a spiral part and an extension part connected with one end of the spiral part, wherein the impeller is located in a central part of the spiral part, said central part comprising a through hole passing through two ends of the spiral part to form an air inlet;
- the volute tongue comprises a connecting part connected with one end of the spiral part, and an expanding part connected with one end of the connecting part away from the spiral part, wherein the expanding part and the extension part form an air outlet;
- upper blades with a height H1, a baffle plate forming an upper air inlet and a lower air inlet, and lower blades with a height H2 are arranged on the impeller, wherein H1 is less than H2;
- the volute linear opening degree A1 for the upper air inlet and the volute linear opening degree A2 for the lower air inlet are such that A1 < A2;
- the air inlet comprises a trapezoid cross section.

[0009] In a particular embodiment, the impeller diameter is D, the upper blade height H1 is such that $H1 \leq 0{,}8 \cdot D$, and the lower blade height H2 is such that $H2 \leq 0{,}8 \cdot D$.

[0010] In a particular embodiment, the ratio t1 of the upper blade height H1 relative to the lower blade height H2 is defined by $t1 = H2/H1$, wherein $1 \leq t1 \leq 9$.

[0011] In a particular embodiment, the ratio t2 of the volute linear opening degree of the upper air inlet relative to the volute linear opening degree of the lower air inlet is defined by $t2 = A2/A1$, wherein $1 \leq t2/t1 \leq 1{,}5$.

[0012] In a particular embodiment, the rotation angles α of the upper blades and the lower blades are defined such that $\alpha = 180°/N$, wherein N is the number of upper and lower blades, respectively.

[0013] In a particular embodiment, the volute tongue radius R1 for the upper air inlet is such that $0{,}03 \cdot D \leq R1 \leq 0{,}06 \cdot D$, and the volute tongue radius R2 for the lower air inlet is such that $0{,}03 \cdot D \leq R2 \leq 0{,}06 \cdot D$. The ratio of volute tongue radius may be such that $t3 = R1/R2$, wherein $0{,}5 \leq t3 \leq 1$.

[0014] In a particular embodiment, a diffusion angle $\theta 1$ for the upper air inlet and a diffusion angle $\theta 2$ for the lower air inlet are such that $6° < \theta 1 < 35°$ and $6° < \theta 2 < 35°$.

[0015] According to a second aspect, the invention provides a centrifugal fan comprising the volute of the first aspect.

[0016] The technical solution provided by the present invention provides various advantages, among which the ones described herebelow.

[0017] The different flows on both sides of a baffle plate can be advantageously diffused by proper opening degree at the air outlet. The volute with double air inlets and variable opening degree according to the present invention can advantageously achieve significant noise reduction and higher fan efficiency, thereby solving the problem of loud noise caused by a mismatch between the air flow and the opening degree of conventional centrifugal fans.

[0018] A suitable volute tongue radius can be used on both sides of the baffle plate to advantageously reduce the noise of the volute tongue and effectively solve the problem of high noise of the centrifugal fan.

Description of the drawings

[0019]

Fig. 1 shows a schematic diagram of the volute provided in an embodiment according to the utility model;

Fig. 2 shows a schematic diagram of the volute provided in an embodiment according to the utility model;

Fig. 3 shows a top view of the volute provided in an embodiment according to the utility model;

Fig. 4 shows the enlarged view of the location A shown in Fig. 3.

[0020] Where: 1. Volute; 11. Spiral part; 12. Extension part; 2. Volute tongue; 21.Connecting part; 22. Expanding part; 3. Impeller; 31. Upper blades; 32. Baffle plate; and 33. Lower blades.

Description of particular embodiments of the invention

[0021] It is known to use a volute with equal opening degree and an air wheel with double air inlets for a centrifugal fan. It has however been observed that problems may arise in a case where the blade height is not equal on two sides of the impeller. In such a case, the high side of the blades is the high flow side, and the lower side of the blades is the low flow side. Because the opening degree is equal on both sides of the volute, the high flow air does not match the opening degree of the volute. This problem of mismatch can lead the air to separate from the volute tongue, thereby resulting in separation noise. This is because when the air flowing out of the wind turbine is diverted through the snail tongue, it can generate airflow diffusion instead of flowing along the wall of the snail tongue, thus producing diffusion noise that is not desirable. It has been observed that the mismatch between the large air flow and the opening degree of the volute easily causes insufficient diffusion and too high volute tongue, thus resulting in high-frequency noise.

[0022] The present invention intends to address at least the above-described drawbacks and insufficiencies of the conventional volutes and associated systems. The technical solution provided by the present invention is detailed hereinafter by the embodiments and the figures.

[0023] The present invention concerns a volute (or volute-type structure, or volute-shaped device) with a specific design, as well as a centrifugal fan comprising such a volute.

[0024] In the following detailed description, numerous specific details are set forth by way of examples in order to provide a thorough understanding of the relevant teachings. However, it should be apparent to those skilled in the art that the present teachings may be practiced without such details. In other instances, well known elements or components are described at a relatively high-level, without detail, in order to avoid unnecessarily obscuring aspects of the present teachings.

[0025] The following description of the exemplary embodiments refers to the accompanying drawings. The following detailed description does not limit the invention. Instead, the scope of the invention is defined by the appended claims. Various embodiments of a volute according to the present invention are described herebelow.

[0026] In the description of the present invention, it should be understood that, the terms "length", "middle", "up", "down", "left", "right", "top", "bottom", etc. indicate a orientation or location relations based on the orientation or location shown in the figures, and only used for simplifying the description of the utility model, but not indicate or imply that the device or element must have a specific orientation, or must be constructed and operated in a specific orientation, and therefore cannot be understood as a limitation of the present invention.

[0027] In addition, the terms "first" and "second" are used for descriptive purposes only and must not be considered to indicate or imply relative importance or implicitly indicate the quantity of technical features. Thus, a feature numbered with "first" or "second" may explicitly or implicitly that one or more of the features are included. In the description of the present invention, "plurality" means two or more, unless otherwise expressly specified.

[0028] In the description of the present invention, it should be noted that, unless otherwise expressly specified and limited, the terms "installation", "splicing" and "connection" shall be broadly understood to cover, for example, fixed connection, detachable connection, or integrated connection; directly connection, or indirect connection through an intermediate medium, and internal connection of two components. Those skilled in the ark may understand the specific meaning of the above terms used in in the present invention according to specific circumstances.

[0029] A volute with double air inlet and variable opening according to particular embodiments of the present invention is described hereinbelow with reference to Figs. 1 to 4.

[0030] As shown in figs. 1 to 4, a volute (also called a volute-type structure or volute-shaped device) with double air inlets and variable opening degree, comprises a volute body 1, a volute tongue 2 and an impeller 3. The volute body 1 and the volute tongue 2 are integrated and hollow.

[0031] In the present example, the volute body 1 comprises a spiral part 11 and an extension part 12 connected with one end of the spiral part 11, wherein the impeller 3 is located in the center, i.e. in a central part, of the spiral part 11. This central part of the spiral part 11 comprises a through hole passing through two ends (from one side to another, opposite, side) of the spiral part 11 to form an air inlet (Fig. 1). The volute tongue 2 comprises a connecting part 21 connected with one end of the spiral part 11, and an expanding part 22 connected with one end of the connecting part 21 away from the spiral part 11, wherein the expanding part 22 and the extension part 12 form an air outlet. In other words, the connecting part 21 comprises two opposite, so-called first and second, ends. The first end of the connecting part 21 is connected with (or attached to) one end of the spiral part 11 while the second end of the connecting part 21 is connected with (or attached to) the expanding part 22.

[0032] In the present example, upper blades 31 with (or having) the height of H1, a baffle plate 32 by which an upper air inlet and a lower air inlet are formed, and lower blades 33 with (or having) the height of H2 are arranged on the impeller 3. The baffle plate 32 thus forms two air inlets, namely the upper air inlet and the lower air inlet, that are configured to let air enter the impeller 3. As a result, the air inlet of the volute comprises the upper and lower air inlets formed by the baffled plate 32. The upper blades 31 and lower blades 33 are configured such that the eight H1 is less than H2 (Fig. 2). The volute linear opening degree is referenced as A1 for the upper air inlet and A2 for the lower air inlet (Fig. 3), wherein A1<A2, such that the air inlet (defined by the upper and lower air inlets) comprises (or form) a trapezoid cross section.

[0033] In the volute with double air inlet and variable opening according to the present embodiment of the invention, the height H1 of the upper blades 31 is less (lower) than the height H2 of the lower blades 33 so that the upper layer of the baffle plate 32 is the small-flow side, and the lower layer of the baffle plate 32 is the high-flow side (Fig. 2). In use, the small-flow air enters the impeller 3 from (or through) the upper air inlet and is circumferentially transported out of the air outlet by the impeller 3 through the spiral part 11 and extension part 12 (Figs. 1 and 3); and the high-flow air enters the impeller 3 from (through) the lower air inlet and is circumferentially transported out of the air outlet by the impeller 3 through the spiral part 11 and extension part 12 (Figs. 1 and 3), so as to achieve the effect of two-way air intake.

[0034] It is worth noting that the distance between, on the one hand, the tangent point at the junction (or connection) between the connecting part 21 and the spiral part 11 (Figs. 3 and 4) and, on the other hand, the extension part 12, is (or defines) the volute linear opening degree of the volute. This tangent point can be defined as the point where the first derivative (i.e., the slope) of the curve representing the connecting part 21 is equal to the first derivative of the curve representing the spiral part 11.

[0035] As shown by way of an example in Figs. 3 and 4, the tangent point at the junction between the connecting part 21 and the spiral part 11 refers to the location on the curve of this junction where the curvature of the connecting part 21 and the spiral part 11 meet and share a common tangent line. This tangent point differs for the upper and lower air inlets: the first tangent point between the connecting part 21 and the spiral part 11 for the upper air inlet is noted P1; the second tangent point between the connecting part 21 and the spiral part 11 for the lower air inlet is noted P2 (Figs. 3 and 4). At these tangent points P1 and P2, the direction of the curve transitions smoothly between the connecting part 21 and the spiral part 11.

[0036] The volute linear opening degree is A1 (distance between the tangent point P1 and the extension part 12) for the upper air inlet and is noted A2 (distance between tangent point P2 and the extension part 12) for the lower air inlet (Figs. 3), whereby the respective values of A1 and A2 are set to achieve A1 < A2, so that the air outlet (formed by the expanding part 22 and the extension part 12) gradually becomes larger from top to bottom, in a trapezoidal shape, to form the volute with variable opening degree according to the present embodiment of the invention.

[0037] In the present example, the volute linear opening degree of the high-flow side is greater than that on the small-flow side so that the different air flows on both sides of a baffle plate 32 can advantageously be diffused by proper opening degree at the air outlet. The volute with double air inlets and variable opening degree according to the present invention can advantageously achieve noise reduction and higher fan efficiency, which allows in particular solving the problem of loud noise caused by a mismatch between the air flow and the opening degree of conventional centrifugal fans.

[0038] The diameter of the impeller 3 is noted D (Fig. 2). In a particular example, the height H1 of the upper blades 31 is such that $H1 \leq 0,8 \cdot D$; and the height H2 of the lower blades 33 is such that $H2 \leq 0,8 \, . \, D$.

[0039] In a particular example, while other parameters may remain unchanged, the ratio H/D may be changed to test the power and noise of the centrifugal fan. When H/D is for instance set within the range of 0-0,8, the fan power may reach 32W to 47W, and the noise may be reduced to 32.9-37 dB, which shows that the fan has relatively small power and low noise in that particular case.

[0040] The ratio t1 of the height H1 of the upper blades 31 relative to the height H2 of the lower blades 33 can be expressed as follows: $t1 = H2/H1$, wherein $1 \leq t1 \leq 9$.

[0041] When the height of the blades on both sides of the baffle plate 32 is within this ratio range, the air inlet conditions can be advantageously optimized and the work efficiency of the impeller 3 can be advantageously improved. Moreover, the centrifugal fan causes small displacement frequency noise during operation.

[0042] In a particular example, the ratio t2 of the volute linear opening degree of the upper air inlet relative to the volute linear opening degree of the lower air inlet can be expressed as follows: $t2 = A2/A1$, wherein $1 \leq t2/t1 \leq 1,5$.

[0043] The ratio t2 of A2 to A1 can thus be limited. When the ratio t2 is set within the range 1-1,5, significant noise reduction can be advantageously achieved, and the problem of high power and loud noise caused by non optimal design of the traditional volute structure with double air inlet and equal opening degree can be solved.

[0044] In a particular example, the rotation angles, noted α, of the upper blades 31 and the lower blades 33 are defined such that α = 180°/N, where N is the number of upper and lower blades, respectively. The central angle can thus be divided into N parts, for instance N equal angular parts.

[0045] By limiting the rotation angles of the upper blades 31 and the lower blades 33, the noise generated during the operation of the volute with double air inlet and variable opening degree can be advantageously further reduced.

[0046] In a particular example illustrated in figure 2, the upper blades 31 and lower blades 33 are spatially arranged so that there is an angular offset between said upper and lower blades. As a result, the upper and lower blades are angularly misaligned relative to each other. In other words, the respective angular positions of the upper blades are offset, or staggered, relative to the respective angular positions of the lower blades. By phasing out the airflows flowing out respectively from the upper and lower blades, it is thus advantageously possible to limit or prevent air turbulence and associated turbulent noise that could otherwise occur. It has indeed been observed that the two air flows are prone to interfere with each other when the upper and lower blades are aligned.

[0047] In a particular example, the volute tongue radius is noted R1 for the upper air inlet, wherein R1 is set such that $0{,}03 \cdot D \leq R1 \leq 0{,}06 \cdot D$, and R2 is the volute tongue radius for the lower air inlet, wherein R2 is set such that $0{,}03 \cdot D \leq R2 \leq 0{,}06 \cdot D$ (Fig. 4). The volute tongue radius R1 and R2 can be defined as the radius of the curve formed by the connecting part 21 for respectively the upper and lower air inlets.

[0048] The radius ratio t3 of the radius R1 of the snail tongue 2 at the upper inlet relative to the radius R2 of the snail tongue 2 at the lower inlet (see figure 4) can be expressed as follows: $t3 = R1/R2$, wherein $0{,}5 \leq t3 \leq 1$. The suitable radius of volute tongue 2 is used on both sides of the baffle plate 32 to reduce the noise of the volute tongue 2 and effectively solve the problem of high noise of the centrifugal fan.

[0049] In a particular example, the diffusion angle is $\theta 1$ for the upper air inlet and $\theta 2$ for the lower air inlet, wherein these diffusions angles are set such that $6° < \theta 1 < 35°$ and $6° < \theta 2 < 35°$ (Fig. 3). It is worth noting that the angle defined by the respective directions (or orientations) of the expanding part 22 and the extension part 12 is the diffusion angle θ. This diffusion angle θ differs for the upper and lower air inlets since the volute tongue radius R1 and R2 are different. According to experimental calculations, when the diffusion angle θ is set withing the range 0°-35°, the fan power can be comprised within the range 31.2W-32.4W with small increase amplitude. If, however, the diffusion angle θ is greater than 35°, the fan power can be greater than 33W, and may increase with the diffusion angle θ, with gradually increased amplitude. Therefore, by setting the diffusion angle θ between 0° and 35°, the fan can advantageously have small power and low noise, and the power and the noise of the fan has smaller increase amplitude with the increases of the diffusion angle θ, so as to solve the problem of high power and loud noise of the traditional fan.

[0050] In a particular embodiment, the present invention provides a centrifugal fan comprising a volute as previously described.

[0051] The technical principle of the present invention is described above by specific embodiments. These descriptions are intended only to explain the principles of the present invention and should not in any way be interpreted as limiting the protection scope of the invention. Based on the explanation provided herein, those skilled in the art may think of other modes of carrying out the present invention without creative labor, which will fall within the protection scope of the claims.

Claims

1. A volute with double air inlets and variable opening degree, comprising a volute body (1), a volute tongue (2) and an impeller (3); wherein the volute body and the volute tongue are integrated and hollow and wherein:

    - the volute body comprises a spiral part (11) and an extension part (12) connected with one end of the spiral part, wherein the impeller is located in a central part of the spiral part, said central part comprising a through hole passing through two ends of the spiral part to form an air inlet;
    - the volute tongue (2) comprises a connecting part (21) connected with one end of the spiral part, and an expanding part (22) connected with one end of the connecting part away from the spiral part, wherein the expanding part and the extension part form an air outlet;
    - upper blades (31) with a height H1, a baffle plate (32) forming an upper air inlet and a lower air inlet, and lower blades (33) with a height H2 are arranged on the impeller, wherein H1 is less than H2;
    - the volute linear opening degree A1 for the upper air inlet and the volute linear opening degree A2 for the lower air inlet are such that A1 < A2; and
    - the air inlet comprises a trapezoid cross section.

2. The volute according to Claim 1, wherein the impeller diameter is D, the upper blade height H1 is such that $H1 \leq 0{,}8 \cdot D$, and the lower blade height H2 is such that $H2 \leq 0{,}8 \cdot D$.

3. The volute according to Claim 1 or 2, wherein a ratio t1 of the upper blade height H1 relative to the lower blade height H2 is defined by $t1 = H2/H1$, wherein $1 \leq t1 \leq 9$.

4. The volute according to any one of the preceding Claims, wherein the ratio t2 of the volute linear opening degree of the upper air inlet relative to the volute linear opening degree of the lower air inlet is defined by $t2 = A2/A1$, wherein $1 \leq t2/t1 \leq 1,5$.

5. The volute according to any one of the preceding Claims, wherein the rotation angles α of the upper blades and the lower blades are defined such that $\alpha = 180°/N$ blades, where N is the number of upper and lower blades, respectively.

6. The volute according to any one of the preceding Claims, wherein the volute tongue radius R1 at the upper air inlet is such that $0,03 \cdot D \leq R1 \leq 0,06 \cdot D$, and the volute tongue radius R2 at the lower air inlet is such that $0,03 \cdot D \leq R2 \leq 0,06 \cdot D$,
wherein a ratio of volute tongue radius t3 is defined by $t3 = R1/R2$, wherein $0,5 \leq t3 \leq 1$.

7. The volute according to any one of the preceding Claims, wherein a diffusion angle $\theta 1$ for the upper air inlet and a diffusion angle $\theta 2$ for the lower air inlet are such that $6° < \theta 1 < 35°$ and $6° < \theta 2 < 35°$.

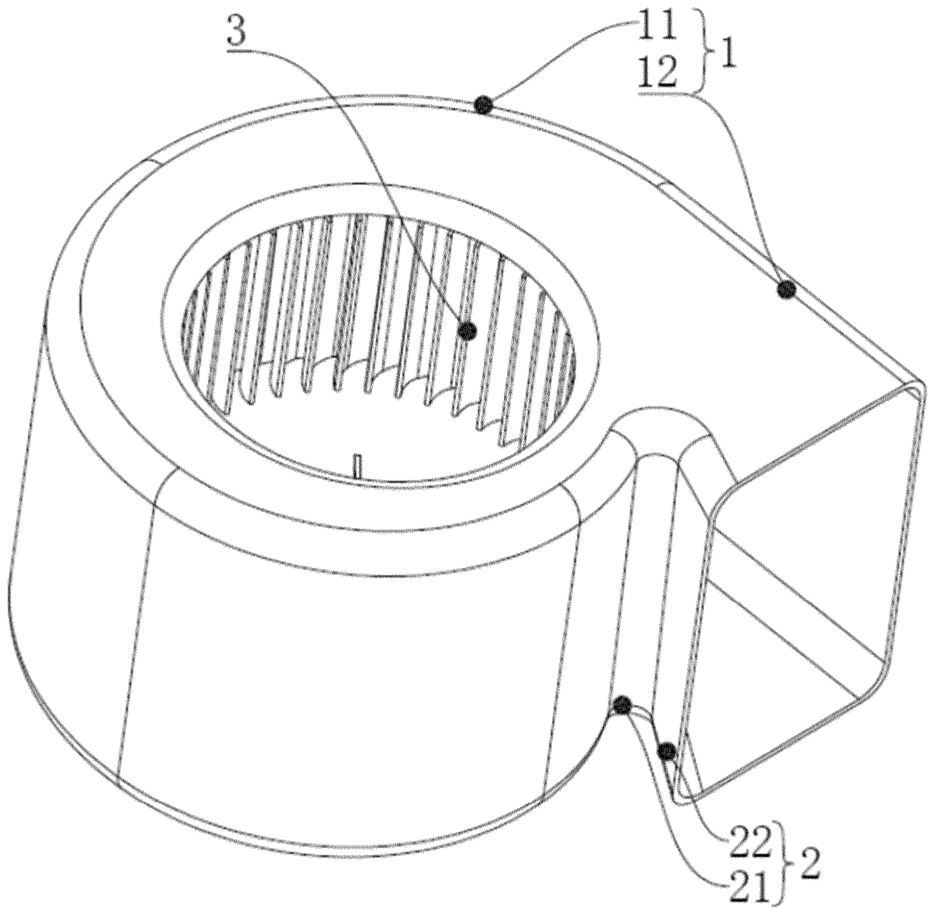

FIG.1

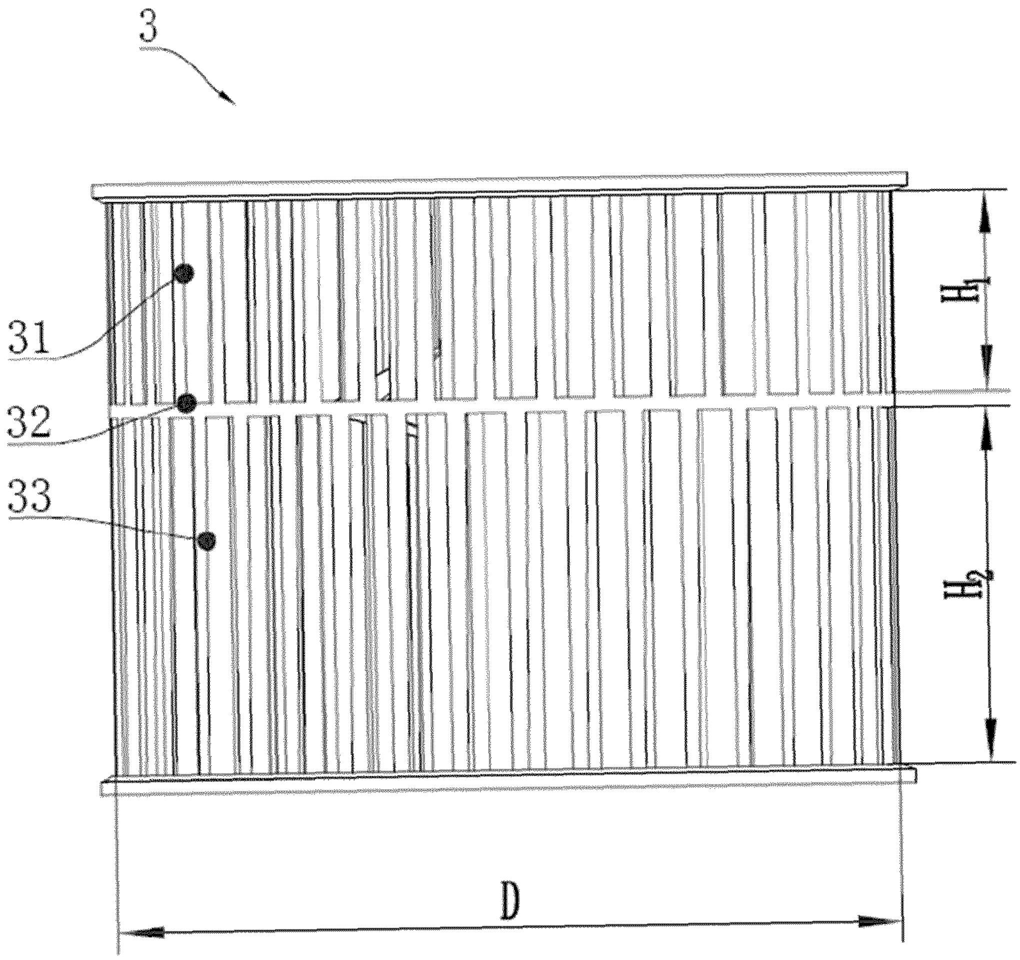

FIG.2

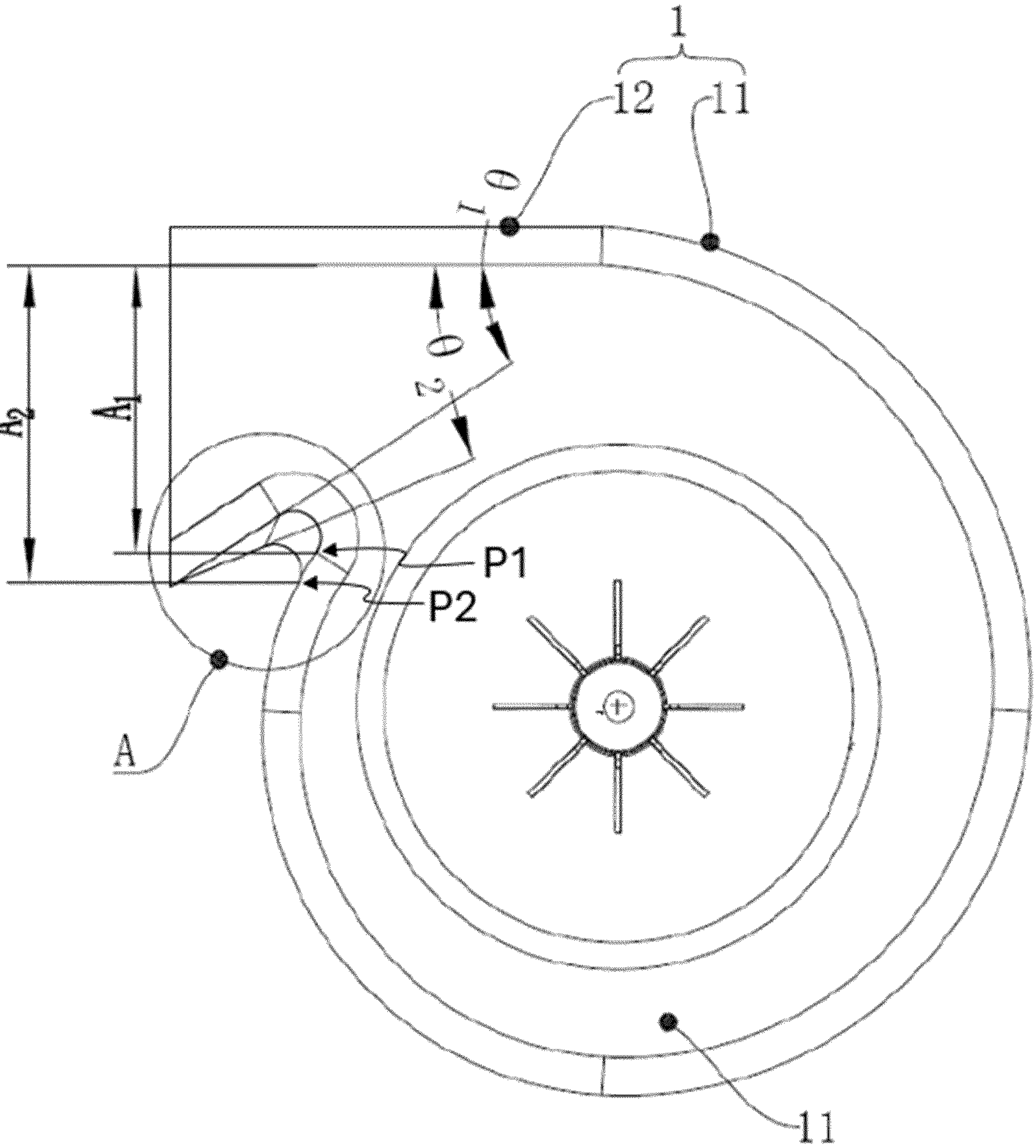

FIG.3

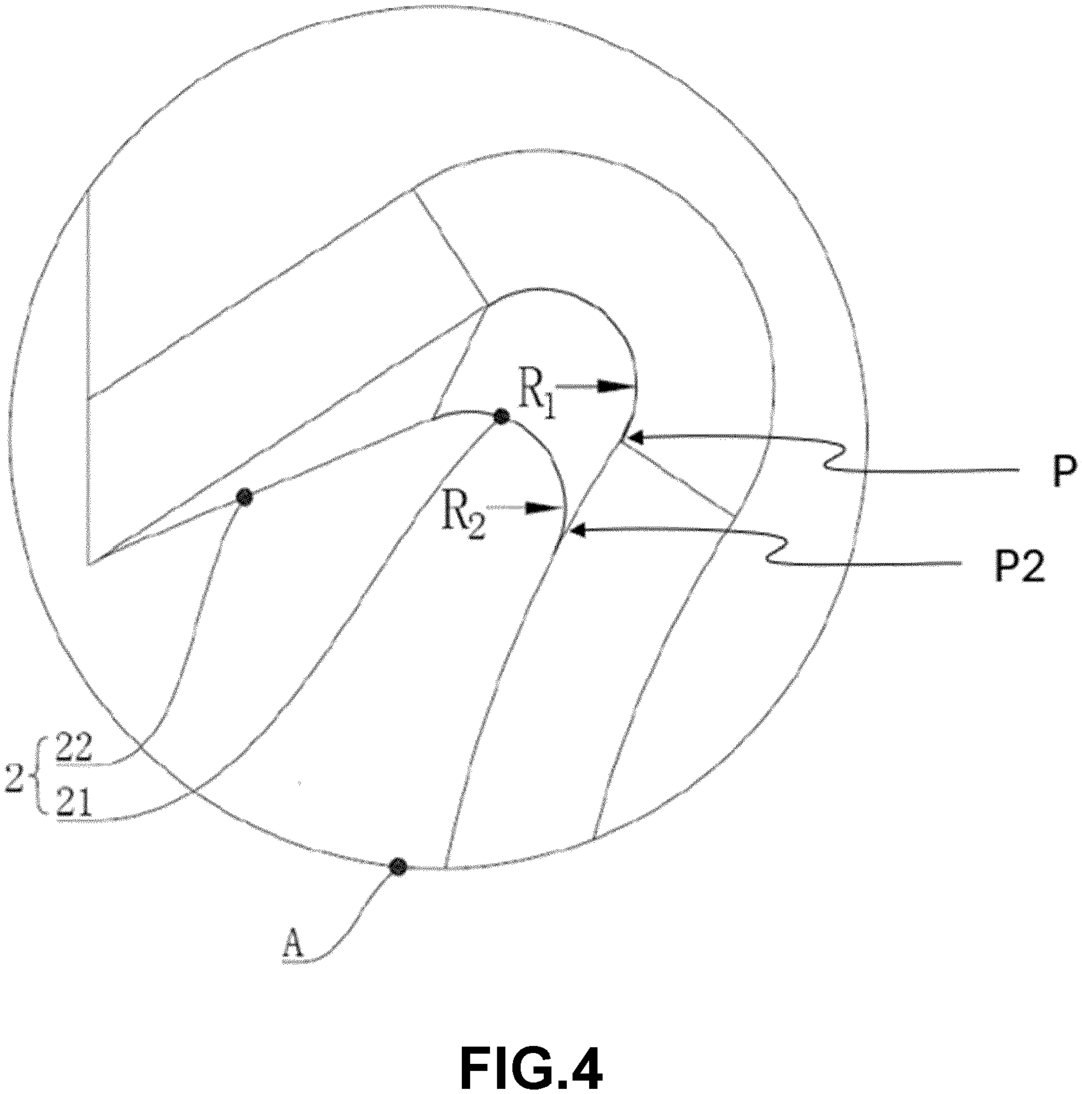

FIG.4

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EUROPEAN SEARCH REPORT

Application Number
EP 24 21 1257

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	CN 103 742 453 A (NINGBO FOTILE KITCHEN WARE CO) 23 April 2014 (2014-04-23) * figures 1-3, 6-8 * -----	1-7	INV. F04D29/28 F04D29/42
A	US 6 254 336 B1 (AHN CHEOL-O [KR]) 3 July 2001 (2001-07-03) * figures 4,5 * -----	1	

TECHNICAL FIELDS SEARCHED (IPC)

F04D

The present search report has been drawn up for all claims

2

Place of search	Date of completion of the search	Examiner
The Hague	11 April 2025	Brouillet, Bernard

CATEGORY OF CITED DOCUMENTS

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
CN 103742453 A	23-04-2014	NONE	
US 6254336 B1	03-07-2001	NONE	

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