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(54) **FLOW GUIDING RING STRUCTURE, AXIAL FLOW FAN AND AIR-CONDITIONER**

(57) Disclosed are a flow guiding ring structure, an axial flow fan and an air conditioner, relating to the field of noise reduction, and used for reducing the pneumatic noise of the axial flow fan during use on the premise of guaranteeing the air outflow amount of the fan. The flow guiding ring structure includes a ring body (1). The ring body (1) includes a closed cavity (11) and a through hole (12). A minimum diameter position of the ring body (1) is provided with an opening (13). The cavity (11) communicates with the through hole (12) via the opening (13). A fluid in the through hole (12) is able to enter the cavity (11) through the opening (13). According to the above technical solutions, on the premise of guaranteeing the Venturi tube effect of the flow guiding ring structure, an opening structure is added on a surface, and turbulent energy of a blade top airflow is transmitted out of a fan area in a radial direction, so that the aim of noise reduction is achieved.

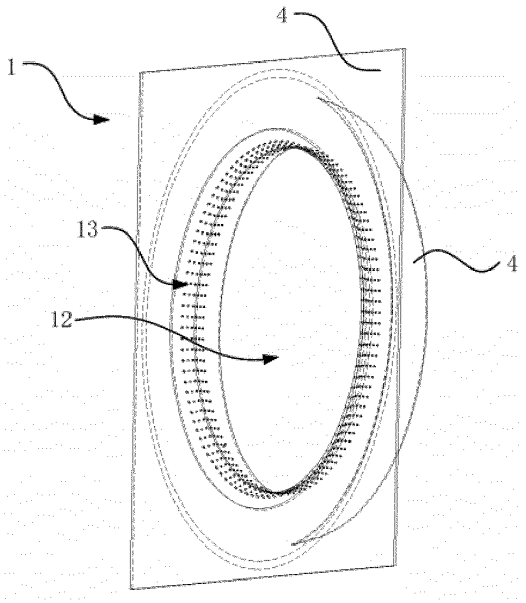

Fig. 1

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Description

[0001] The present invention claims benefit of Chinese Patent Application No. 201610917189.X, filed on October, 20, 2016, entitled "Flow Guiding Ring Structure, Axial Flow Fan and Air Conditioner", the contents of which are hereby incorporated by reference in its entirety.

Technical Field

[0002] The present invention relates to the field of noise reduction, and in particular to a flow guiding ring structure, an axial flow fan and an air conditioner.

Background

[0003] A pneumatic noise of an axial flow fan used in an air conditioner external unit is a noise source second only to a compressor vibration noise. Therefore, fan noise reduction is one of the key research topics in the optimization of a fan. The pneumatic noise of the axial flow fan is mainly from the vicinity of a blade, especially a blade top area. Because the area has the strongest power capability, a wind speed is maximum and a blade top leakage vortex mainly occurs in this area, an airflow vortex is serious, which is the largest source of the pneumatic noise.

[0004] In a conventional art, a fan noise is reduced in the following manner: adding a plurality of concave circumferential groove structures at a minimum diameter position of a flow guiding ring of an axial flow fan to increase a gap between the flow guiding ring and a blade top of a fan blade to reduce the noise.

[0005] The inventors have found that at least the following problems exist in the conventional art: the above method has great limitations, and slotting increases the distance between the blade top of the air blade and the flow guiding ring, thereby increasing the leakage space and reducing the air outflow amount and fan efficiency of the fan.

Summary

[0006] Some embodiments of the present invention is to provide a flow guiding ring structure, an axial flow fan and an air conditioner, used for reducing the pneumatic noise of the axial flow fan during use on the premise of guaranteeing the air outflow amount of the fan.

[0007] To achieve the above object, the present invention provides the technical solutions as follows.

[0008] An embodiment of the present invention provide a flow guiding ring structure, which may include a ring body. The ring body may include a closed cavity and a through hole. A minimum diameter position of the ring body may be provided with an opening. The cavity may communicate with the through hole via the opening, wherein a fluid in the through hole is able to enter the cavity through the opening.

[0009] In an exemplary embodiment, the ring body has at least one curved plate for defining the cavity.

[0010] In an exemplary embodiment, the ring body may include a first curved plate, a second curved plate and a flat plate defining the cavity and the through hole. The first curved plate may be located inside the ring body, the second curved plate may be located outside the ring body, and the first curved plate and the second curved plate may be rounded off and sealed. An end of the first curved plate away from the second curved plate and the flat plate may be rounded off and sealed. An end of the second curved plate away from the first curved plate and the flat plate may be rounded off and sealed, wherein the opening is provided in the first curved plate.

[0011] In an exemplary embodiment, the first curved plate may include a first segment and a second segment having different curvatures. The first segment may be located between the flat plate and the second segment. The opening may be provided in the first segment.

[0012] In an exemplary embodiment, a curvature of the first segment may be greater than a curvature of the second segment.

[0013] In an exemplary embodiment, a junction of the second curved plate and the flat plate may be configured such that airflow is able to be guided to the through hole of the ring body.

[0014] In an exemplary embodiment, there may be at least two openings, the openings being arranged along a circumference of the ring body.

[0015] In an exemplary embodiment, the opening may have a diameter of 1 mm to 3mm.

[0016] In an exemplary embodiment, a distance between two adjacent openings may be 2.5 to 4 times a diameter of each of the openings.

[0017] In an exemplary embodiment, the outline of the opening may be circular or elliptical.

[0018] In an exemplary embodiment, an axis of the opening may be perpendicular to a surface of the ring body at a location of the opening.

[0019] In an exemplary embodiment, the opening may be located on an air outflow side of the ring body.

[0020] Another embodiment of the present invention provides an axial flow fan, which may include the flow guiding ring structure provided by any one technical solution of the present invention.

[0021] Yet another embodiment of the present invention provides an air conditioner, which may include the axial flow fan provided by any one technical solution of the present invention.

[0022] Based on the above technical solutions, the embodiments of the present invention may at least have the following technical effects.

[0023] The flow guiding ring structure provided by the above technical solutions adopts a ring body with a closed cavity, and an airflow flowing through a through hole of the flow guiding ring structure is able to enter the closed cavity through an opening, a static pressure returned by each opening is able to be automatically bal-

anced and comprehensively processed inside a annular cavity, and a comprehensive value is finally achieved, that is, the imbalance of the circumferential static pressure of a flow guiding ring may be adjusted, the circumferential turbulence of the airflow in the flow guiding ring is reduced, and the effect of noise reduction is achieved. Since the cavity is closed, gas flowing into the cavity through the opening does not leak, so the air volume of the axial flow fan cannot be reduced. It is able to be seen that the above technical solutions can reduce the noise of the axial flow fan without reducing the air volume of the axial flow fan, can solve the problem that the air volume of the axial flow fan has to be reduced if the noise is reduced, and can reduce the noise on the premise of guaranteeing the air volume of the axial flow fan. That is, according to the above technical solutions, on the premise of guaranteeing the Venturi tube effect of the flow guiding ring structure, an opening structure is added on a surface, and turbulent energy of a blade top airflow is transmitted out of a fan area in a radial direction, so that the aim of noise reduction is achieved.

Brief Description of the Drawings

[0024] The accompanying drawings described herein are used to provide a further understanding of the present invention, and constitute a part of the present invention, and the exemplary embodiments of the present invention and the description thereof are used to explain the present invention, but do not constitute improper limitations to the present invention. In the drawings:

Fig. 1 schematically shows a stereogram of a flow guiding ring structure according to an embodiment of the present invention;

Fig. 2 schematically shows a cross-sectional view of a flow guiding ring structure in a side view direction according to an embodiment of the present invention;

Fig. 3 schematically shows an air guiding view of a flow guiding ring structure according to an embodiment of the present invention; and

Fig. 4 schematically shows a front view of a flow guiding ring structure according to an embodiment of the present invention.

Description of the reference signs:

[0025] 1, Ring body; 2, First curved plate; 3, Second curved plate; 4, Flat plate; 5, Air-conditioning axial-flow fan blade side; 6, Air outflow side; 11, Cavity; 12, Through hole; 13, Opening; 21, First segment; 22, Second segment.

Detailed Description of the Embodiments

[0026] The technical solutions provided by the present invention will be described in more detail below with reference to Fig. 1 to Fig. 4.

[0027] Referring to Fig. 1 and Fig. 2, the embodiments of the present invention provide a flow guiding ring structure, which includes a ring body 1. The ring body 1 includes a through hole 12 and a closed cavity 11. A minimum diameter position of the ring body 1 is provided with an opening 13. The cavity 11 communicates with the through hole 12 via the opening 13. A fluid in the through hole 12 is able to enter the cavity 11 through the opening 13.

[0028] The ring body 1 is provided with a closed cavity 11. A minimum diameter position (that is, an inner wall position of the through hole 12 for passage of an airflow of an axial flow fan in the middle of the ring body 1) of the ring body 1 is provided with an opening 13. The opening 13 communicates with the closed cavity 11. The opening 13 is a micro-hole, relatively small in size. There are one or more openings 13, and when multiple openings 13 are provided, one row or multiple rows may be provided. The openings 13 between one row and another row may be distributed in any misalignment.

[0029] An airflow flowing through the flow guiding ring structure spatially communicates with the closed cavity 11 in a flow guiding ring through the openings 13. Thus, the airflow flowing through the through hole 12 may partially enter the closed cavity 11 along each of the openings 13. This flow allows each of the openings 13 to transmit a static pressure at this position into an annular closed cavity 11. The static pressure returned by each of the openings 13 is able to be automatically balanced and comprehensively processed inside the annular cavity, and a comprehensive value is finally achieved, that is, the imbalance of the circumferential static pressure of a flow guiding ring may be adjusted, the circumferential turbulence of the airflow in the flow guiding ring is reduced, and the effect of noise reduction is achieved, as shown in Fig. 4. In addition, each of the openings 13 communicates with the closed cavity 11 to further add a micro-opening structure on a surface of the closed cavity 11, radial turbulent energy of an outer ring is able to be transmitted into the closed cavity, and resonance silencing with the cavity 11 occurs in the cavity, that is, the Helmholtz silencing mechanism is used to reduce the pneumatic noise of the airflow of the outer ring.

[0030] An outline of the opening 13 is circular, elliptical or shaped like other rounded arcs. This allows gas to smoothly enter the cavity 11.

[0031] Specifically, the ring body 1 has at least one curved plate for defining the cavity 11. The curved plate has a good flow guiding effect.

[0032] Referring to Fig. 1 and Fig. 2, in the present embodiment, the ring body 1 includes a first curved plate 2, a second curved plate 3 and a flat plate 4, defining the cavity 11 and the through hole 12. The first curved plate 2 forms an inner wall surface of the cavity 11, and the second curved plate 3 forms an outer wall surface of the cavity 11. In Fig. 2, the left portion of an elliptical dotted line of an air-conditioning panel is referred to as an in-

extension segment, where the segment and the flat plate 4 are rounded off. The positions of an air outflow side 6 and an axial-flow fan blade side 5 of an air conditioner are as shown in Fig. 2. The part A illustrates a rounding-off position.

[0033] The closed space defined by the first curved plate 2, the second curved plate 3 and the flat plate 4 is the above cavity 11, and an opening defined thereby is a through hole 12. The first curved plate 2 is located inside the ring body 1, the second curved plate 3 is located outside the ring body 1, and the first curved plate 2 and the second curved plate 3 are rounded off and sealed. An end of the first curved plate 2 away from the second curved plate 3 and the flat plate 4 are rounded off and sealed. An end of the second curved plate 3 away from the first curved plate 2 and the flat plate 4 are rounded off and sealed, wherein the openings 13 are provided in the first curved plate 2. The ring body 1 of this structure is easy to process and install. The inside and the outside referred to in the present embodiment are opposite, the inside is close to the center of the ring body 1, and the outside is away from the center of the ring body 1.

[0034] Referring to Fig. 2, the first curved plate 2 and the second curved plate 3 are rounded off and sealed. An end of the first curved plate 2 away from the second curved plate 3 and the flat plate 4 are rounded off and sealed. An end of the second curved plate 3 away from the first curved plate 2 and the flat plate 4 are rounded off and sealed. The in-extension segment of the flow guiding ring is rounded off and closed, which can guide the airflow outside the flow guiding ring to smoothly enter an outlet of the flow guiding ring, reduce the vortex in the area and reduce the wind resistance. The flow direction of the fluid is shown in Fig. 3.

[0035] Referring to Fig. 2, the first curved plate 2 includes a first segment 21 and a second segment 22 having different curvatures, the first segment 21 being located between the flat plate 4 and the second segment 22, and the openings 13 being provided in the first segment 21. This arrangement allows the openings 13 to be located entirely on the air outflow side, which is effective in reducing noise.

[0036] Further, a curvature of the first segment 21 is greater than a curvature of the second segment 22. The intersection of the first segment 21 and the second segment 22 is an inflection point, and the openings 13 are all located in the first segment 21, so that the openings 13 are all located on the air outflow side, which can effectively reduce the noise of the axial flow fan.

[0037] Referring to Fig. 1 and Fig. 2, a junction of the second curved plate 3 and the flat plate 4 is configured such that airflow is able to be guided to an inlet of the ring body 1. That is, a junction is rounded off, and the orientation of arcs meets the requirements for guiding the airflow.

[0038] Referring to Fig. 2, a junction of the second curved plate 3 and the flat plate 4 is curved, and the arc is oriented toward the outside of the flow guiding ring structure, so that the airflow is able to be guided to the through hole 12 of the flow guiding ring structure. The flow guiding direction is shown by a curved arrow in Fig. 3.

[0039] Optionally, there are at least two openings 13, the openings 13 being arranged along a circumference of the ring body 1.

[0040] In the present embodiment, each of the openings 13 has a diameter of 1mm to 3mm. Since the flow velocity of the airflow near a wall surface area of the flow guiding ring is large, a diameter of each of the openings 13 is required. If the aperture is too large, the whistling sound is easily caused by the airflow scouring, which aggravates the pneumatic noise. If the aperture is too small, the processing difficulty is large, and the ability of transferring energy into the annular cavity is also reduced, thereby reducing the ability to diffuse and silence.

[0041] In the present embodiment, a distance between two adjacent openings 13 is 2.5 to 4 times a diameter of the opening 13.

[0042] A specific embodiment is described below.

[0043] The flow guiding ring structure provided by the embodiments of the present invention is applied to a novel flow guiding ring on a household air conditioner external unit, which can increase the air volume of the external unit, improve the heat exchange speed, smooth out the wind direction and reduce the pneumatic noise of the whole machine. The flow guiding ring structure includes a ring body 1. The ring body 1 includes a cavity 11, a through hole 12 and openings 13 for communicating the cavity 11 with the through hole 12. The cavity 11 of the annular cavity is an annular closed cavity surrounding a ventilation side formed by riveting and closed adhesion after a cantilever segment is extended, expanded outward and bent back to a front panel of an air conditioner namely a flat plate 4 on the basis of the existing in-extension flow guiding ring. The riveting part of the bending segment and the panel is rounded off as much as possible, so that the airflow in the area is able to be effectively guided into an effective circulation area of the flow guiding ring through the bending surface.

[0044] The ring body 1 has an air outflow side and an air inflow side, wherein the air inflow side refers to a side to which air directly blows. Only micro openings 13 are provided on the air outflow side, and the openings 13 are not provided on the air inflow side, because each of the micro openings 13 is perpendicular to the surface of the flow guiding ring structure during processing. If the openings 13 are processed on a wall body of the air inflow side, each of the openings 13 and the flow direction of the airflow form an acute angle, the airflow is easy to directly impact the micro hole to cause a sharp abnormal noise (such as whistling), so processing of the through hole 12 on the inlet side does not achieve noise reduction. Of course, the above problem can also be improved by changing the direction of the openings 13.

[0045] Each of the micro opening 13 is a single row or multiple rows of circular holes connecting a closed space in a fluid flowing space domain at a minimum diameter

position in the flow guiding ring. Each of the opening 13 has a diameter R1 of 1 mm to 3mm, and distance of two openings 13 is controlled at D1=2.5 to 4R1. Since the flow velocity of the airflow near a wall surface area of the flow guiding ring is large, a diameter of the opening is strictly controlled. If the aperture is too large, the whistling sound is easily caused by the airflow scouring, which aggravates the pneumatic noise. If the aperture is too small, the processing difficulty is large, and the ability of transferring energy into the annular cavity is also reduced, thereby reducing the ability to diffuse and silence.

[0046] After the airflow acts through an axial-flow fan blade, there are different degrees of vortex turbulence in the circumferential direction, axial direction and radial direction. Because the blade top is the most powerful, the gas flow energy in the gap between the blade top and the flow guiding ring is maximum. The turbulent energy is also maximum. According to the flow guiding ring structure provided by the embodiments of the present invention, the turbulent energy of the airflow portion enters the annular cavity 11 through the openings 13, and two kinds of noise elimination effects are generated inside: one is that by the large space dissipation of vortex energy, the energy level is reduced and absorbed by the wall surface, and the other one is that through the circular effect, the circumferential turbulent energy of the airflow cancels each other uniformly, so as to achieve uniform kinetic energy in the circumferential direction and reduce the circumferential flowing energy of the external airflow, thereby maximizing the uniform forward air outflow of the flow guiding ring and reducing the pneumatic noise. Through the simulation of CFD fluid mechanics, the results show that the flow guiding ring has a large effect on the external unit performance, the air volume is increased by 137m3/h, and the broadband noise is reduced by 0.8dB(A).

[0047] According to the above technical solutions, the through-hole structure is adopted on the air outflow side of the flow guiding ring based on the Helmholtz principle, and the radial and circumferential turbulent energy of the wall airflow is introduced into the closed wall body for diffusion, thereby reducing the turbulent energy and achieving the sound absorbing effect.

[0048] The embodiments of the present invention also provide an axial flow fan, including the flow guiding ring structure provided by any one technical solution of the present invention.

[0049] The embodiments of the present invention further provide an air conditioner, including the axial flow fan provided by any one technical solution of the present invention.

[0050] In the descriptions of the present invention, it is to be understood that an orientation or positional relationship indicated by the terms "center", "longitudinal", "transverse", "front", "back", "left", "right", "vertical", "horizontal", "top", "bottom", "inside", "outside" and the like is an orientation or positional relationship shown in the drawings, and is merely for the convenience of describing the present invention and simplifying the description, rather than indicating or implying that the device or elements referred to have a particular orientation, and configure and operate for the particular orientation. Thus, it cannot be construed as limiting the scope of protection of the present invention.

[0051] Finally, it is to be noted that the above embodiments are only used to illustrate the technical solutions of the present invention, and are not limited thereto. Although the present invention has been described in detail with reference to the foregoing embodiments, those skilled in the art should understand that the technical solutions described in the foregoing embodiments are modified, or some technical features are equivalently replaced, but the modifications and replacements do not make the essence of the corresponding technical solutions depart from the spirit and scope of the technical solutions of various embodiments of the present invention.

Claims

1. A flow guiding ring structure, comprising a ring body (1), the ring body (1) comprising a closed cavity (11) and a through hole (12), a minimum diameter position of the ring body (1) being provided with an opening (13), the cavity (11) communicating with the through hole (12) via the opening (13), wherein a fluid in the through hole (12) is able to enter the cavity (11) through the opening (13).

2. The flow guiding ring structure as claimed in claim 1, wherein the ring body (1) has at least one curved plate for defining the cavity (11).

3. The flow guiding ring structure as claimed in claim 2, wherein the ring body (1) comprises a first curved plate (2), a second curved plate (3) and a flat plate (4) defining the cavity (11) and the through hole (12); the first curved plate (2) is located inside the ring body (1), the second curved plate (3) is located outside the ring body (1), and the first curved plate (2) and the second curved plate (3) are rounded off and sealed; an end of the first curved plate (2) away from the second curved plate (3) and the flat plate (4) are rounded off and sealed; and an end of the second curved plate (3) away from the first curved plate (2) and the flat plate (4) are rounded off and sealed, the opening (13) being provided in the first curved plate (2).

4. The flow guiding ring structure as claimed in claim 3, wherein the first curved plate (2) comprises a first segment (21) and a second segment (22) having different curvatures, the first segment (21) being located between the flat plate (4) and the second segment (22), and the opening (13) being provided in the first

segment (21).

5. The flow guiding ring structure as claimed in claim 4, wherein a curvature of the first segment (21) is greater than a curvature of the second segment (22).

6. The flow guiding ring structure as claimed in claim 3, wherein a junction of the second curved plate (3) and the flat plate (4) is configured such that airflow is able to be guided to the through hole (12) of the ring body (1).

7. The flow guiding ring structure as claimed in any one of claims 1 to 6, wherein there are at least two openings (13), the openings (13) being arranged along a circumference of the ring body (1).

8. The flow guiding ring structure as claimed in any one of claims 1 to 6, wherein the opening (13) has a diameter of 1mm to 3mm.

9. The flow guiding ring structure as claimed in any one of claims 1 to 6, wherein a distance between two adjacent openings (13) is 2.5 to 4 times a diameter of each of the openings (13).

10. The flow guiding ring structure as claimed in any one of claims 1 to 6, wherein the outline of the opening (13) is circular or elliptical.

11. The flow guiding ring structure as claimed in any one of claims 1 to 6, wherein an axis of the opening (13) is perpendicular to a surface of the ring body (1) at a location of the opening (13).

12. The flow guiding ring structure as claimed in any one of claims 1 to 6, wherein the opening (13) is located on an air outflow side of the ring body (1).

13. An axial flow fan, comprising the flow guiding ring structure as claimed in any one of claims 1 to 12.

14. An air conditioner, comprising the axial flow fan as claimed in claim 13.

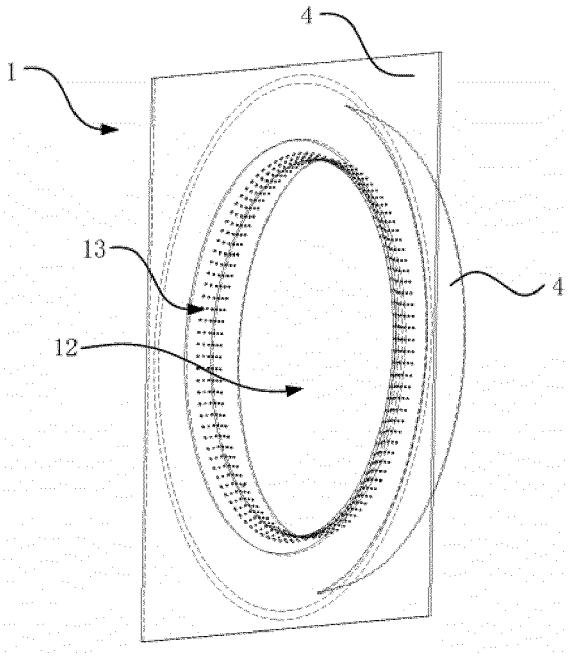


Fig. 1

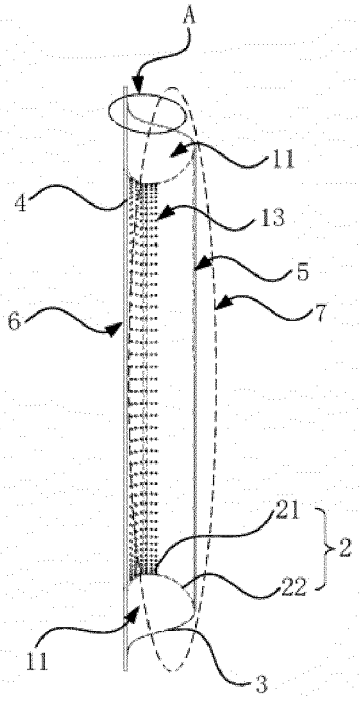
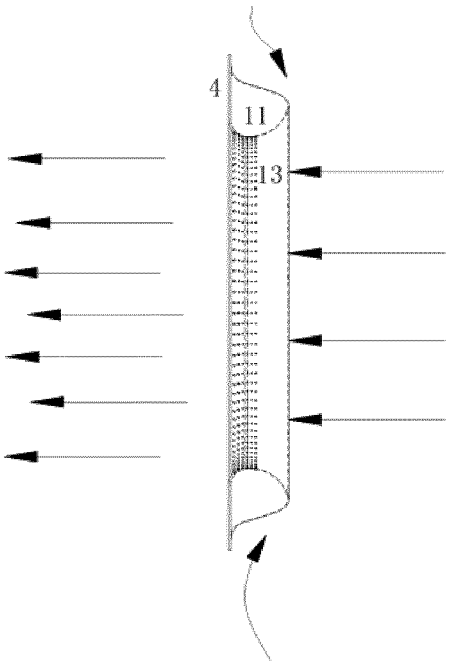


Fig. 2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13

Fig. 3

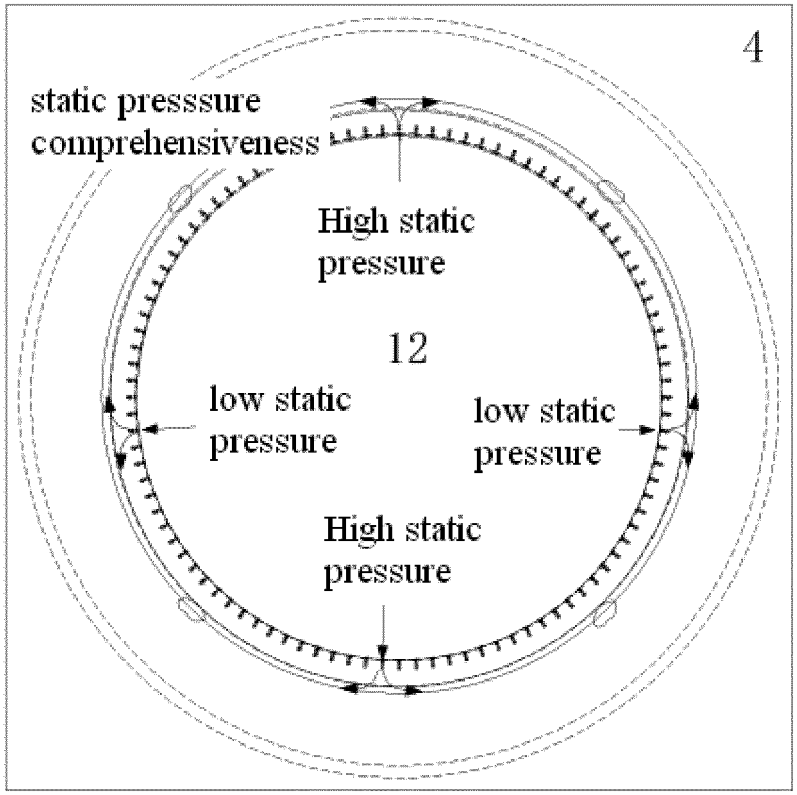
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Fig. 4

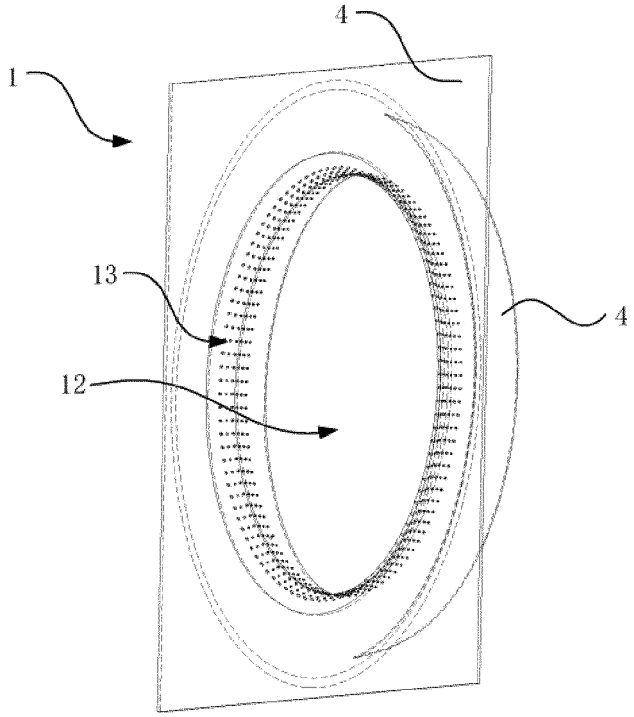

Fig. 5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2017/106279

A. CLASSIFICATION OF SUBJECT MATTER

F04D 29/54 (2006.01) i; F04D 29/66 (2006.01) i
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F04D; F24F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
CNABS, DWPI, VEN, CN/EP/WO/USTXT: 导流圈, 环, 腔, 孔, 连通, 降噪, guiding ring, deflector ring, chamber, cavity, room, opening, hole, bore, orifice, communicate, noise, sound

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
PX	CN 106321520 A (GREE ELECTRIC APPLIANCES, INC. OF ZHUHAI), 11 January 2017 (11.01.2017), description, paragraphs 31-53, and figures 1-4	1-14
A	CN 204880627 U (GREE ELECTRIC APPLIANCES, INC. OF ZHUHAI), 16 December 2015 (16.12.2015), description, paragraphs 5-51, and figures 1-7	1-14
A	CN 203023138 U (GREE ELECTRIC APPLIANCES, INC. OF ZHUHAI), 26 June 2013 (26.06.2013), entire document	1-14
A	CN 204880603 U (GUANGDONG MIDEA AIR-CONDITIONING EQUIPMENT CO., LTD. et al.), 16 December 2015 (16.12.2015), entire document	1-14
A	CN 202789746 U (GUANGDONG MIDEA HEATING & VENTILATION EQUIPMENT CO., LTD.), 13 March 2013 (13.03.2013), entire document	1-14
A	CN 202547038 U (GREE ELECTRIC APPLIANCES, INC. OF ZHUHAI), 21 November 2012 (21.11.2012), entire document	1-14
A	CN 106016651 A (GREE ELECTRIC APPLIANCES, INC. OF ZHUHAI), 12 October 2016 (12.10.2016), entire document	1-14
A	CN 201259294 Y (GREE ELECTRIC APPLIANCES, INC. OF ZHUHAI), 17 June 2009 (17.06.2009), entire document	1-14

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

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Date of the actual completion of the international search	Date of mailing of the international search report
05 January 2018	23 January 2018

Name and mailing address of the ISA	Authorized officer
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Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2017/106279

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2002071765 A1 (HONEYWELL INT INC.), 13 June 2002 (13.06.2002), entire document	1-14
A	TW 201402956 A (JAGUAR PREC INDUSTRY CO., LTD.), 16 January 2014 (16.01.2014), entire document	1-14

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2017/106279

Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
CN 106321520 A	11 January 2017	None	
CN 204880627 U	16 December 2015	None	
CN 203023138 U	26 June 2013	None	
CN 204880603 U	16 December 2015	None	
CN 202789746 U	13 March 2013	None	
CN 202547038 U	21 November 2012	None	
CN 106016651 A	12 October 2016	None	
CN 201259294 Y	17 June 2009	None	
US 2002071765 A1	13 June 2002	WO 0248550 A9	31 December 2003
		US 6623239 B2	23 September 2003
		AU 3263202 A	24 June 2002
		WO 0248550 A2	20 June 2002
		WO 0248550 A3	05 December 2002
TW 201402956 A	16 January 2014	TW I525257 B	11 March 2016

Form PCT/ISA/210 (patent family annex) (July 2009)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- CN 201610917189X **[0001]**