(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 3 211 247 A1**

(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 153(4) EPC

(43) Date of publication:
30.08.2017 Bulletin 2017/35

(21) Application number: **14904616.1**

(22) Date of filing: **22.10.2014**

(51) Int Cl.:
F04D 29/52 *(2006.01)* ***F04D 29/66*** *(2006.01)*
F04D 25/08 *(2006.01)*

(86) International application number:
PCT/CN2014/089118

(87) International publication number:
WO 2016/061747 (28.04.2016 Gazette 2016/17)

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME

(71) Applicant: **Guangdong Fans-tech Electric Co., Ltd.**
Foshan, Guangdong 528300 (CN)

(72) Inventors:
- **HE, Shuhua**
  Foshan
  Guangdong 528300 (CN)
- **CHEN, Weidong**
  Foshan
  Guangdong 528300 (CN)

(74) Representative: **Gramm, Lins & Partner**
Patent- und Rechtsanwälte PartGmbB
Freundallee 13a
30173 Hannover (DE)

(54) **DIAGONAL FLOW FAN**

(57) A diagonal flow fan, comprising an airflow duct (8), a motor (6), an impeller (2), a blade (4), an airflow guide ring (1) and a hub (3); one end of the airflow guide ring (1) is connected to the airflow duct (8); the blade (4) and the hub (3) are located inside the impeller (2); one end of the blade (4) is connected to the hub (3), and the other end is connected to the impeller (2); the motor (6) is located inside and connected to the hub (3); the other end of the airflow guide ring (1) is located at an inner side of the impeller (2), and a gap exists between the airflow guide ring (1) and the impeller (2); a motor shaft matches the impeller (2), employing a concentric positioning configuration; and a balance component (9) is fixedly installed at a peripheral surface of the impeller (2), thereby achieving dynamic balancing. The diagonal flow fan has a compact structure and a dramatically improved overall efficiency.

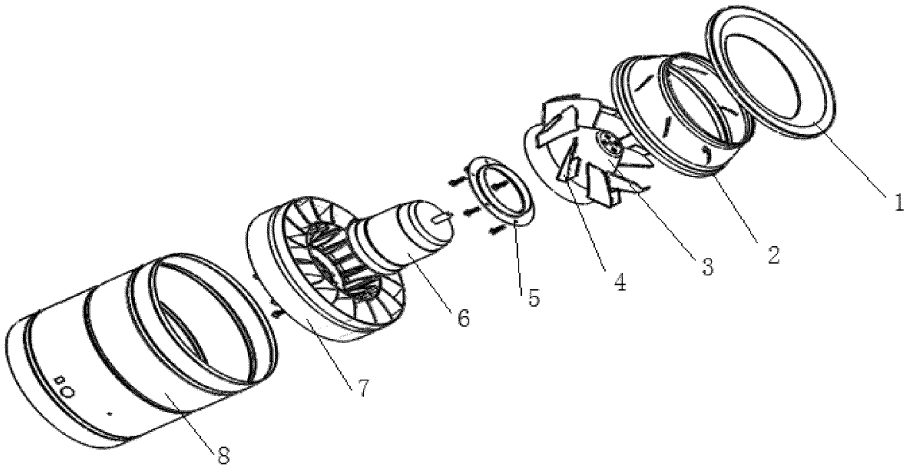

Figure 3

EP 3 211 247 A1

Description

FIELD

[0001] This application relates to a ventilation apparatus, and particularly relates to a diagonal flow fan.

BACKGROUND

[0002] A diagonal flow fan in the conventional technology is shown in Figures 1 and 2, which includes a motor 6, a fan wheel 2, a blade 4, and a balancing component 9. The balancing component 9 is configured to maintain dynamic balance of the diagonal flow fan and is fixedly mounted at the blade 4, and the dynamic balancing effect is inferior, causing that the diagonal flow fan has defects such as having a low efficiency, a high noise, and being difficult to debug the dynamic balance. Further, in the conventional technology, an air inlet cover of the diagonal flow fan is not provided with an air guiding ring, resulting in a large amount of air loss at an air inlet of the air inlet cover and a low energy efficiency of the fan.

[0003] In addition, design requirements for energy-related products set by the European Union (ErP Directive) is issued in 2009, and aims to require that energy consuming products reach a 20-20-20 design requirement for protecting environment, that is, 20% less energy consumption, 20% of the energy, in the used material, coming from renewables by year 2020.

[0004] The European Union stipulates lowest energy efficiency standards respectively for different types of fans in a power range from 0.125KW to 500KW, and these standards are stipulated according to the types of fans, a measurement device and an electric power consumed. The ErP Directive is implemented in two stages in 2013 and 2015. A new standard ERP2015 requires that the ErP Directive is implemented comprehensively in 2015, and the energy efficiency requirements for fans will be more stringent.

[0005] According to the regulation of European Union, a calculation formula of a standard energy efficiency of a diagonal flow fan with a power range from 0.125KW to 10KW is:

$$\text{a lowest energy efficiency } \eta_{min}=4.56\times Ln(P)-10.5+N]\ (\%)$$

where:

P is an input power, and the unit of P is kilowatt; and

N is a constant, and as set by the European Union, N in an energy efficiency index of 2013 is 47, and N in an energy efficiency index of 2015 is 50.

[0006] According to the above calculation, the energy efficiency limit in the ErP Directive set by the European Union is rather stringent, and even in the first stage, 30% of all the existing fans will fail to comply with the new regulation. With the implementation of the second stage started from 2015, 20% more of the existing products will fail to comply with the energy efficiency requirement.

SUMMARY

[0007] A technical issue to be addressed by the present application is to provide a diagonal flow fan which has a compact structure and a high efficiency.

[0008] To address the above technical issues, the following technical solutions are provided according to the present application.

[0009] A diagonal flow fan includes an air duct, a motor, a fan wheel, a blade, an air guiding ring, and a wheel hub, the air guiding ring has one end connected to the air duct, and the blade and the wheel hub are located inside the fan wheel, the blade has one end connected to the wheel hub and another end connected to the fan wheel, wherein the motor is located inside the wheel hub and connected to the wheel hub, the air guiding ring has another end located at an inner side of the fan wheel, and a gap exists between the air guiding ring and the fan wheel.

[0010] Optionally, the air guiding ring is in a trumpet shape, and the end of the air guiding ring that is connected to the air duct is flared outwards.

[0011] Optionally, a size S of the gap is $0mm<S\leq 10mm$.

[0012] Optionally, a balancing component configured to maintain dynamic balance of the diagonal flow fan is fixedly

mounted at an outer peripheral surface of the fan wheel.

[0013] Optionally, the balancing component is a balance nail.

[0014] Optionally, the blade and the wheel hub are formed as an integral structure.

[0015] Optionally, a protrusion is provided on the blade, and the protrusion is fitted into a locking slot of the fan wheel, and the protrusion and the fan wheel are welded by ultrasonic welding process.

[0016] Optionally, the motor is an outer rotor type motor, and an outer rotor shaft of the motor is inserted into a central hole of the wheel hub.

[0017] Optionally, the diagonal flow fan further includes a steel ring, wherein the steel ring is fixedly connected to the motor and the wheel hub respectively.

[0018] Optionally, the steel ring is fixedly connected to the wheel hub by a screw, and the steel ring is fixedly connected to the motor by riveting and/or welding.

[0019] According to the above technical solutions, the present application has the following advantages.

[0020] A diagonal flow fan is provided according to an embodiment of the present application, which includes an air duct, a motor, a fan wheel, a blade, an air flow guide ring, and a wheel hub, and a gap exists between the fan wheel and the air guiding ring. The airflow flowing through the air guiding ring is guided by the gap, and the backflow loss of airflow can be reduced by controlling the size of the gap, thus, the working efficiency of the diagonal flow fan is improved. The smaller the gap, the higher the efficiency.

[0021] Further, the balancing component is fixedly mounted at an outer peripheral surface of the fan wheel to achieve dynamic balance of the diagonal flow fan, thus addressing the issues of low efficiency and inferior dynamic balance of the diagonal flow fan in the conventional technology in which dynamic balance is achieved by using a balance clip.

[0022] Further, the blade is fixed to the fan wheel by ultrasonic welding, thus, the issue of inferior appearance caused by fusion welding is addressed, and also the issue of scraps falling into the fan resulted from the sputtering of a hot melt adhesive in welding is avoided.

[0023] Further, the outer rotor of the motor and the steel ring are connected by riveting and/or welding, thus the steel ring is not apt to fall off. The motor shaft and the fan wheel are cooperated with each other in a concentric positioning configuration, thus, the issue that an overly large dynamic imbalance caused by a poor assembling concentricity between the fan wheel and the steel ring is addressed.

BRIEF DESCRIPTION OF THE DRAWINGS

[0024] For more clearly illustrating the technical solutions in embodiments of the present application, drawings referred to describe the embodiments will be briefly described one by one hereinafter. Apparently, the drawings in the following description are some embodiments of the present application, and for the person skilled in the art, other drawings may be obtained based on these drawings without any creative efforts.

Figure 1 is a structural view of a diagonal flow fan in the conventional technology;

Figure 2 is a structural view of a blade and a balance clip in the diagonal flow fan in the conventional technology;

Figure 3 is an exploded view of a diagonal flow fan according to an embodiment of the present application;

Figure 4 is a structural view of the diagonal flow fan in Figure 3 in a state that a fan wheel is assembled;

Figure 5 is a sectional view showing the structure of the diagonal flow fan in Figure 3 in an assembled state;

Figure 6 is a schematic view showing the cooperation between the fan wheel and an air guiding ring of the diagonal flow fan in Figure 3; and

Figure 7 is a schematic view showing the position of a balancing component of the diagonal flow fan in Figure 3.

Reference Numerals:

1	air guiding ring,	2	fan wheel,
3	wheel hub,	4	blade,
5	steel ring,	6	motor,
7	rear guide vane,	8	air duct, and
9	balancing component.		

DETAILED DESCRIPTION

[0025] The basic concept of the present application is to provide a diagonal flow fan, to address the technical issues that a diagonal flow fan in the conventional technology has a low efficiency. The diagonal flow fan according to the present application includes an air duct, a motor, a fan wheel, a blade, an air guiding ring, and a wheel hub. The air guiding ring has one end connected to the air duct. The blade and the wheel hub are located inside the fan wheel, and the blade has one end connected to the wheel hub and another end connected to the fan wheel. The motor is located inside the wheel hub and connected to the wheel hub. The air guiding ring has another end located at an inner side of the fan wheel, and a gap exists between the air guiding ring and the fan wheel.

[0026] For making the objects, features and advantages of the present application clear and easy to understand, the technical solutions according to embodiments of the present application are described clearly and completely hereinafter in conjunction with the drawings in the embodiments of the present application. Apparently, the described embodiments are only a part of the embodiments of the present application, rather than all embodiments. Based on the embodiments in the present application, all of other embodiments, made by the person skilled in the art without any creative efforts, fall into the scope of the present application.

[0027] Referring to Figures 3 to 7, a diagonal flow fan is provided according to an embodiment of the present application.

[0028] The diagonal flow fan includes an air duct 8, a motor 6, a fan wheel 2, a blade 4, an air guiding ring 1, and a wheel hub 3. The air guiding ring 1 has one end connected to the air duct 8. The blade 4 and the wheel hub 3 are located inside the fan wheel 2, and the blade 4 has one end connected to the wheel hub 3 and another end connected to the fan wheel 2. The motor 6 is located inside the wheel hub 3 and connected to the wheel hub 3. The air guiding ring 1 has another end located at an inner side of the fan wheel 2, and a gap exists between the air guiding ring 1 and the fan wheel 2. It is to be noted that, in this embodiment, the air guiding ring 1 is connected to the air duct 8 by electric welding, and in other embodiments, the air guiding ring 1 and the air duct 8 may also be fixedly connected by other connecting methods.

[0029] As shown in Figures 5 and 6, the air guiding ring 1 of the diagonal flow fan has a trumpet-shaped structure with a flared mouth facing outwards. The air guiding ring 1 has one end flared outwards, and an outwardly rolled edge is formed at a tail end of the outwards flared end, and another end of the air guiding ring 1 is located at the inner side of the fan wheel 2. The outwardly rolled edge at the outwards flared end of the air guiding ring 1 is connected to the air duct 8. By providing the air guiding ring 1, the inlet air loss can be reduced, and the outlet air amount can be increased, and the efficiency of the diagonal flow fan can be improved. In addition, the outwards flaring of the air guiding ring 1 makes the air guiding effect better, thus improving the overall performance of the diagonal flow fan.

[0030] As shown in Figure 6, another end of the air guiding ring 1 is located at the inner side of the fan wheel 2, and a gap exists between the air guiding ring 1 and the fan wheel 2. The gap has a size S, and $0mm<S\leq 10mm$, the backflow loss of airflow can be reduced by controlling the size of the gap, thus improving the energy efficiency of the fan. The smaller the gap, the higher the efficiency of the fan. It is concluded by repeated tests that, the best processing size of the gap between the air guiding ring 1 and the fan wheel 2 is 2.5mm, and with this best processing size, the energy efficiency can be higher than ERP2015 requirement by 6% to 8%.

[0031] It must be noted that, in this embodiment, the blade 4 and the wheel hub 3 are embodied as an integral structure, and are mainly formed integrally by injection molding, to prevent loosening of the blade 4 and the wheel hub 3.

[0032] As shown in Figure 4, in this embodiment, the blade 4 and the wheel hub 3 are arranged inside the fan wheel 2. The blade 4 is provided with a protrusion, and the fan wheel 2 is provided with a locking slot configured to engage with the protrusion of the blade 4. The protrusion of the blade 4 can be fitted into the locking slot of the fan wheel 2, to fixedly connect the blade 4 to the fan wheel 2. After the protrusion is fitted into the locking slot of the fan wheel 2, the protrusion can be welded to a portion, close to the periphery of the locking slot, of the fan wheel by ultrasonic welding, to allow the fixed connection between the blade 4 and the fan wheel 2 to be more reliably. The number of the blade 4 is more than two, and multiple blades 4 are twisted in the same direction, and the twisting direction of the blades 4 is almost the same as the rotation direction of the fan wheel.

[0033] As shown in Figure 7, a balancing component 9 is provided on an outer peripheral surface of the fan wheel 2 in a range of 360 degrees to achieve dynamic balance. In this embodiment, the dynamic balance is achieved by mounting a balance nail 9 on an upper side and a lower side of the outer peripheral surface of the fan wheel 2 in a range of 360 degrees, and multiple balance nails 9 may be provided according to the requirement for achieving dynamic balance. In this embodiment, the balance nail is employed to achieve dynamic balance, which addresses the issues of low efficiency and inferior dynamic balance of the diagonal flow fan in the conventional technology in which dynamic balance is achieved by using a balance clip. The diagonal flow fan in the conventional technology has a dynamic balancing efficiency ranging from 10minutes per set to 20minutes per set and requires eight to twelve balance clips. The diagonal flow fan according to this embodiment has a dynamic balancing efficiency ranging from 3minutes per set to 5minutes per set and requires four to six balance nails.

[0034] In this embodiment, the balance nail is employed as the balancing component, it may be appreciated that, in

other embodiments, other balancing components such as a balance clamp, a balance pin may also be employed to achieve dynamic balance of the diagonal flow fan.

[0035] As shown in Figures 4 and 5, five holes are provided in a top end of the wheel hub 3, one of the five holes is located in the center of the wheel hub 3, and an outer rotor shaft of the motor is inserted into the central hole of the wheel hub, to achieve a concentric positioning configuration of the motor shaft and the fan wheel. A steel ring 5 is fixed on the wheel hub 3, and an inner wall of the wheel hub 3 is provided with a reinforcing rib configured to support the steel ring 5 and the motor 6. The wheel hub 3 and the steel ring 5 are fixed to each other by screw, and the steel ring 5 and the rotor of the motor 6 are connected by riveting and/or welding, thus preventing the steel ring from falling off. In addition, the motor shaft and the fan wheel employ a concentric positioning configuration, thus addressing the issue that an overly large dynamic imbalance is caused by a poor assembling concentricity between the fan wheel and the steel ring. A rotor of the motor 6 employs an electro-coating process, thus preventing the service life of the motor from being reduced by rusting of the rotor.

[0036] As shown in Figure 5, the motor 6 employs an outer rotor type motor configuration, and the outer rotor type motor 6 is mounted inside the wheel hub 3, and the outer rotor shaft of the motor 6 is mounted in the central hole of the wheel hub 3, the motor shaft and the fan wheel 2 are cooperated with each other in a concentric positioning configuration, thus addressing the issue that an overly large dynamic imbalance is caused by a poor assembling concentricity between the fan wheel 2 and the steel ring 5. An initial imbalance amount of the fan wheel in the diagonal flow fan in the conventional technology ranges from 5grams to 10grams, and an initial imbalance amount of the fan wheel of the diagonal flow fan in this embodiment ranges from 2grams to 4grams.

[0037] As shown in Figure 5, in a direction from away from the air guiding ring 1 to close to the air guiding ring 1, the shape of the wheel hub 3 changes from a cylindrical shape to a conical shape. A central part of a rear guide vane 7 is fixedly connected to the motor 6, a rear end of the rear guide vane 7 is connected to the air duct 8, and the rear guide vane 7 is concentrically sleeved into the air duct 8, and the rear guide vane 7 and the air duct 8 are fixed by a screw.

[0038] As set by the European Union, a calculation formula of a standard energy efficiency of a diagonal flow fan with a power range from 0.125KW to 10KW is:

$$\text{a lowest energy efficiency: } \eta_{min}=4.56\times Ln(P)-10.5+N\ (\%),$$

where, P is an input power, the unit of P is kilowatt, and N is a constant, and N in an energy efficiency index of standard 2013 is 47, and N in an energy efficiency index of standard 2015 is 50.

[0039] The actual energy efficiency is mainly based on the efficiency under a static pressure, and the calculation formula of the actual energy efficiency is:

$$\text{an actual energy efficiency: } \eta_{\text{static pressure}}=\text{static pressure (Pa)}\times\text{flow rate (m}^3\text{/s)/power (W) X100\%}.$$

[0040] Generally, the unit of the flow rate obtained from testing an airflow amount of a fan is m^3/h, thus, the unit of the flow rate needs to be converted into m^3/s when calculating actual energy efficiency under a static pressure.

[0041] Hereinafter, tests and calculations of energy efficiency indexes are performed for diagonal flow fans with fan wheel diameters of 10inche and 12inches in the conventional technology and diagonal flow fans with fan wheel diameters of 10inches and 12inches employing the structure according to the present application. The test and calculation results are as follows.

[0042] Table 1 is a comparison table between actual energy efficiency values of the conventional diagonal flow fans and lowest energy efficiency values required by the European Union standard.

Table 1

serial number	fan wheel diameter (In.)	voltage/ frequency	static pressure (Pa)	full pressure (Pa)	flow rate (m^3/h)	power (W)	ERP2013 lowest requirement	ERP2015 lowest requirement	actual energy efficiency (static pressure)
1	10	230V/50Hz	264.0	271.0	586.2	148.9	27.80%	30.8%	28.9%
2	12	230V/50Hz	352.0	355.3	660.1	260.0	30.40%	33.4%	24.8%

[0043] Table 2 is a comparison table between actual energy efficiency values of diagonal flow fans according to the present application and the lowest energy efficiency values required by the European Union standard.

Table 2

serial number	fan wheel diameter (In.)	voltage/ frequency	static pressure (Pa)	full pressure (Pa)	flow rate (m^3/h)	Power (W)	ERP2013 lowest requirement	ERP2015 lowest requirement	actual energy efficiency (static pressure)
1	10	230V/50Hz	217.4	246.4	751.6	140.8	27.6%	30.6%	32.2%
2	12	230V/50Hz	302.6	316.6	1234.6	251.7	30.2%	33.2%	41.2%

[0044] Table 3 is a comparison table between the actual energy efficiency values of the diagonal flow fans according to the present application and the actual energy efficiency values of the conventional diagonal flow fans.

Table 3

serial number	fan wheel diameter (In.)	voltage/ frequency	ERP2013 lowest requirement	ERP2015 lowest requirement	actual energy efficiency (static pressure)
1	10(conventional technology)	230V/50Hz	Pass	No	28.9%
	10(the present application)	230V/50Hz	Pass	Pass	32.2% (increased by 3.3% under the same condition)
2	12(conventional technology)	230V/50Hz	No	No	24.8%
	12(the present application)	230V/50Hz	Pass	Pass	41.2% (increased by 16.4% under the same condition)

[0045] According to the above test and calculation results, compared with the diagonal flow fans in the conventional technology, the improved diagonal flow fan according to the present application has a significantly improved energy efficiency, and complies with the energy efficiency standards set by the European Union (Data in accordance with ErP Directive 327/2011 of the European Parliament).

[0046] A diagonal flow fan according to the present application is described in detail hereinbefore. The principle and the embodiments of the present application are illustrated herein by specific examples. The above description of examples is only intended to help the understanding of the method and the spirit of the present application. It should be noted that, for the person skilled in the art, a few of modifications and improvements may be made to the present application without departing from the principle of the present application, and these modifications and improvements are also deemed to fall into the scope of the present application defined by the claims.

Claims

1. A diagonal flow fan, comprising an air duct, a motor, a fan wheel, a blade, an air guiding ring, and a wheel hub, the air guiding ring having one end connected to the air duct, and the blade and the wheel hub being located inside the fan wheel, the blade having one end connected to the wheel hub and another end connected to the fan wheel, wherein the motor is located inside the wheel hub and connected to the wheel hub, the air guiding ring has another end located at an inner side of the fan wheel, and a gap exists between the air guiding ring and the fan wheel.

2. The diagonal flow fan according to claim 1, wherein the air guiding ring is in a trumpet shape, and the end of the air guiding ring that is connected to the air duct is flared outwards.

3. The diagonal flow fan according to claim 1, wherein a size S of the gap is $0mm<S\leq 10mm$.

4. The diagonal flow fan according to any one of claims 1 to 3, wherein a balancing component configured to maintain dynamic balance of the diagonal flow fan is fixedly mounted at an outer peripheral surface of the fan wheel.

5. The diagonal flow fan according to claim 4, wherein the balancing component is a balance nail.

6. The diagonal flow fan according to claim 1, wherein the blade and the wheel hub are formed as an integral structure.

7. The diagonal flow fan according to claim 1, wherein a protrusion is provided on the blade, and the protrusion is fitted into a locking slot of the fan wheel, and the protrusion and the fan wheel are welded by ultrasonic welding process.

8. The diagonal flow fan according to claim 1, wherein the motor is an outer rotor type motor, and an outer rotor shaft of the motor is inserted into a central hole of the wheel hub.

9. The diagonal flow fan according to claim 1, further comprising a steel ring, wherein the steel ring is fixedly connected to the motor and the wheel hub respectively.

10. The diagonal flow fan according to claim 9, wherein the steel ring is fixedly connected to the wheel hub by a screw, and the steel ring is fixedly connected to the motor by riveting and/or welding.

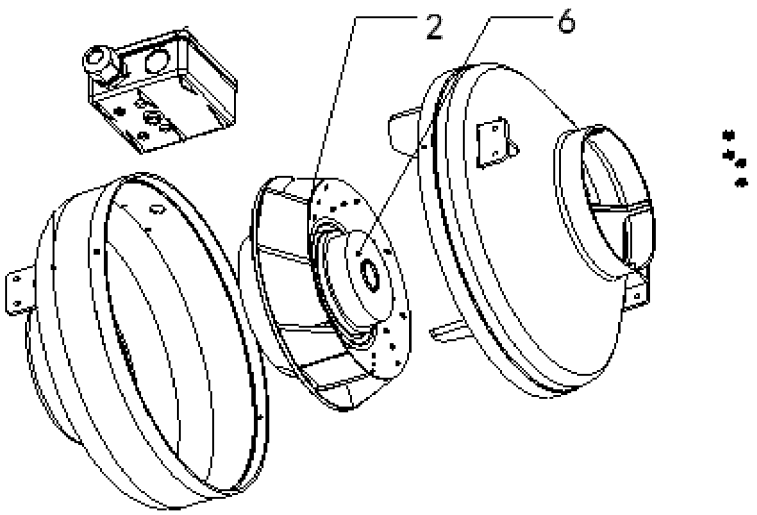

Figure 1

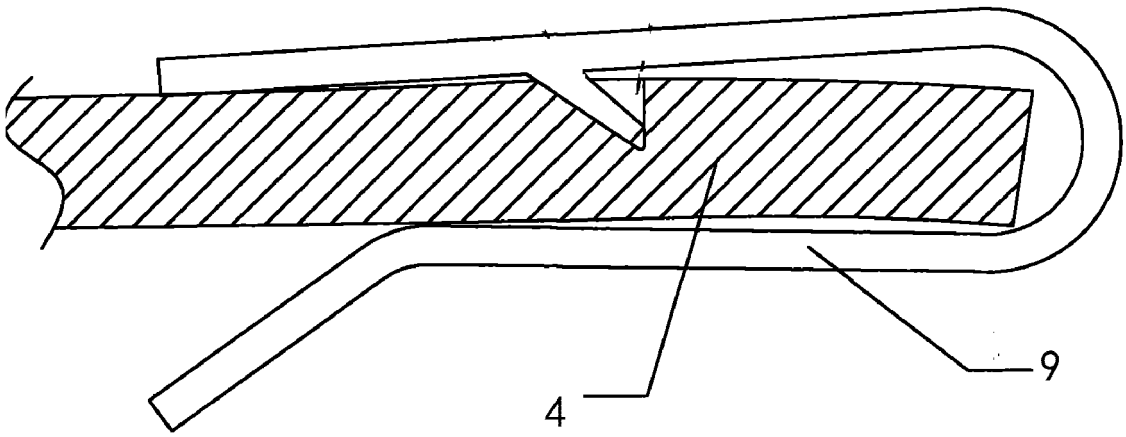

Figure 2

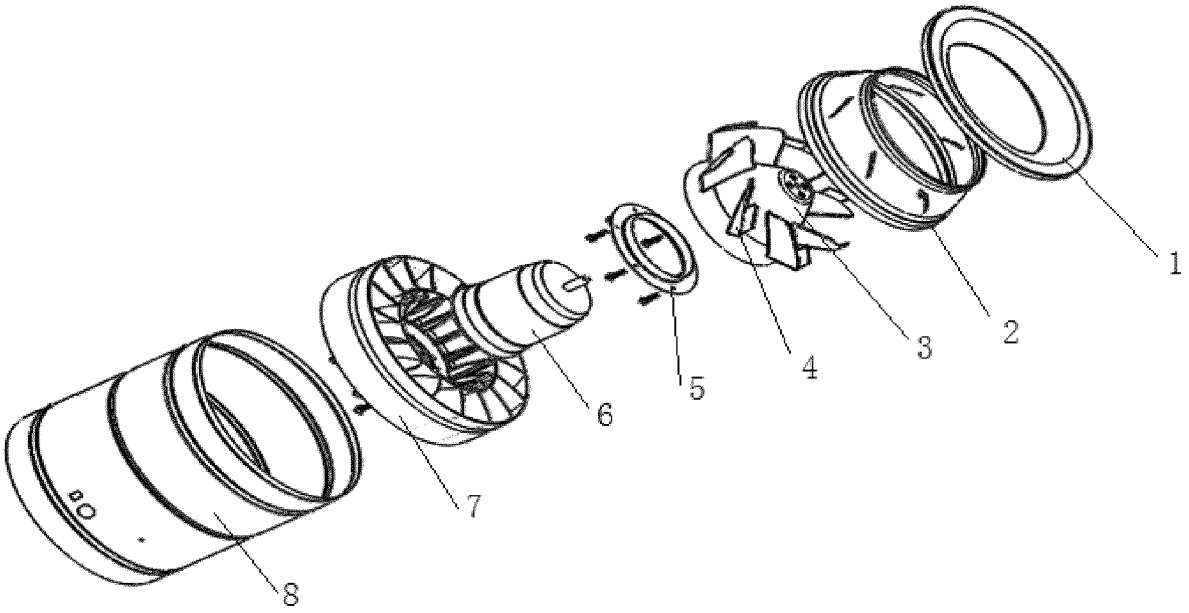

Figure 3

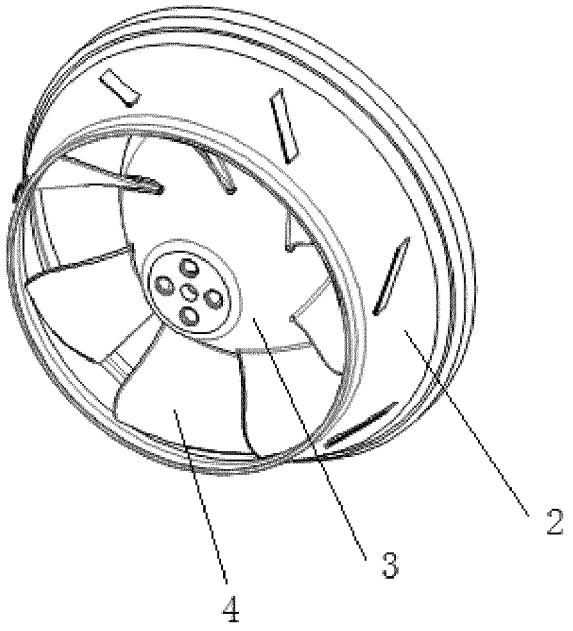

Figure 4

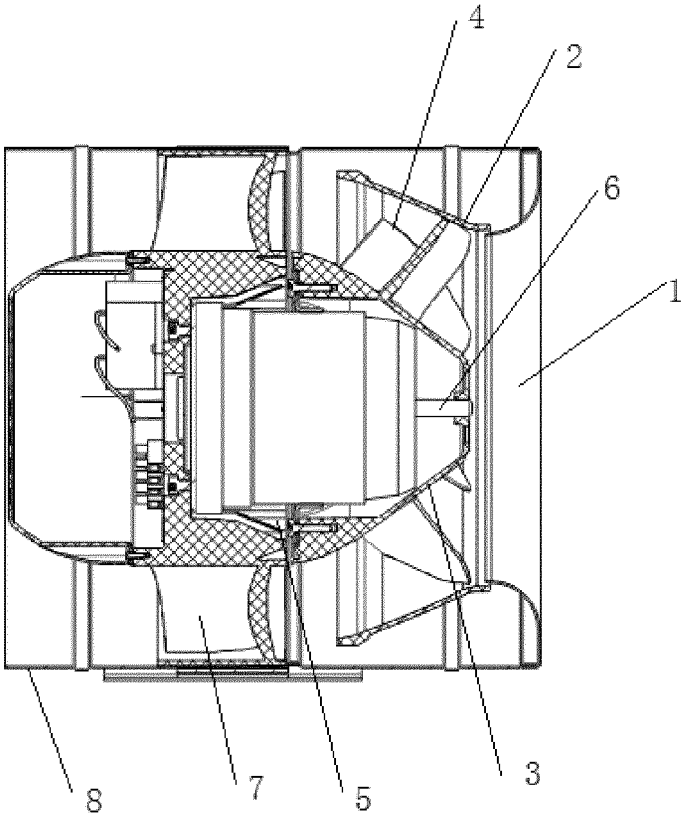

Figure 5

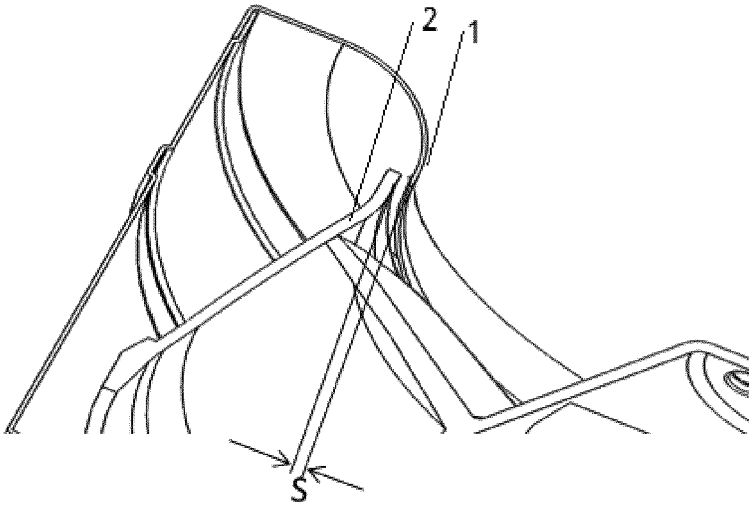

Figure 6

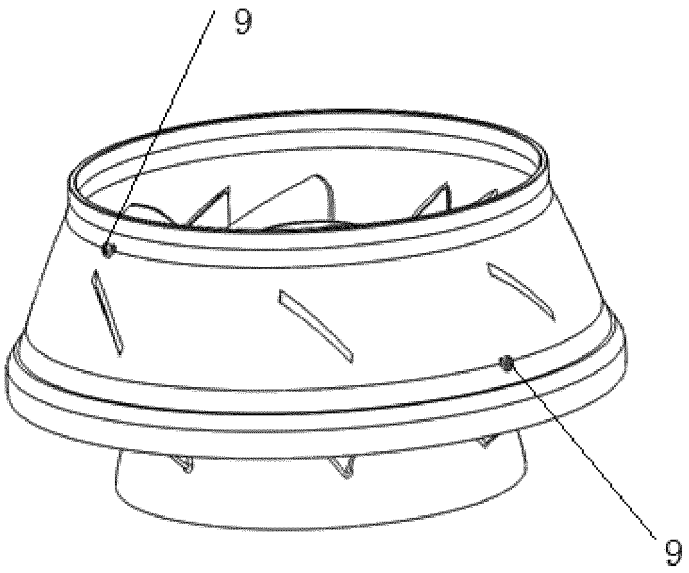

Figure 7

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2014/089118

A. CLASSIFICATION OF SUBJECT MATTER

F04D 29/52 (2006.01) i; F04D 29/66 (2006.01) i; F04D 25/08 (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

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, SIPOABS, CNKI: diagonal flow, inclined flow, oblique flow, mixed flow, fan, flow, guid+

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	CN 102705910 A (GUANGDONG MEDIA REFRIGERATION EQUIPMENT CO LTD) 03 October 2012 (03.10.2012) description, paragraphs [0042]-[0049], figures 1-12	1-10
Y	CN 202734057 U (GUANGDONG MEDIA REFRIGERATION EQUIPMENT CO LTD) 13 February 2013 (13.02.2013) description, paragraphs [0042]-[0049], figures 1-12	1-10
Y	US 2013121822 A1 (LIU WEN-HAO et al.) 16 May 2013 (16.05.2013) description, paragraphs[0028]-[0035], figures 2-5	1-10
Y	US 6547517 B1 (ELTA FANS LTD) 15 April 2003 (15.04.2003) description, column 3, lines 32 to column 4, lines 14, figure 8	1-10

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

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&"document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
18 June 2015	09 July 2015
Name and mailing address of the ISA State Intellectual Property Office of the P. R. China No. 6, Xitucheng Road, Jimenqiao Haidian District, Beijing 100088, China Facsimile No. (86-10) 62019451	Authorized officer CHEN, Cunjing Telephone No. (86-10) 62085240

Form PCT/ISA /210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2014/089118

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 2012177515 A1 (SCHMID HARALD et al.) 12 July 2012 (12.07.2012) the whole document	1-10
A	CN 102865254 A (ZHUZHOU NAT ENGINEERING RES CT OF CONVERTERS CO., LTD.) 09 January 2013 (09.01.2013) the whole document	1-10

Form PCT/ISA /210 (continuation of second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2014/089118

Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
CN 102705910 A	03 October 2012	None	
CN 202734057 U	13 February 2013	None	
US 2013121822 A1	16 May 2013	US 8936433 B2	20 January 2015
US 6547517 B1	15 April 2003	DK 0843787 T3	18 February 2002
		GB 2304157 A	12 March 1997
		GB 2304157 B	13 August 1997
		DE 69616562 T2	29 May 2002
		EP 0843787 A1	27 May 1998
		CA 22277575 A1	20 February 1997
		CA 22277575 C	14 January 2003
		GB 9516398 D0	11 October 1995
		ES 2167595 T3	16 May 2002
		WO 9706369 A1	20 February 1997
		HK 1001844 A1	10 July 1998
		AU 6746696 A	05 March 1997
		AJ 699643 B2	10 December 1998
		DE 69616562 D1	06 December 2001
		EP 0843787 B1	31 October 2001
US 2012177515 A1	12 July 2012	EP 2453138 A2	16 May 2012
		DE 202010015749 U1	15 February 2012
		DE 102011118656 A1	16 May 2012
		US 8974199 B2	10 March 2015
CN 102865254 A	09 January 2013	None	

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