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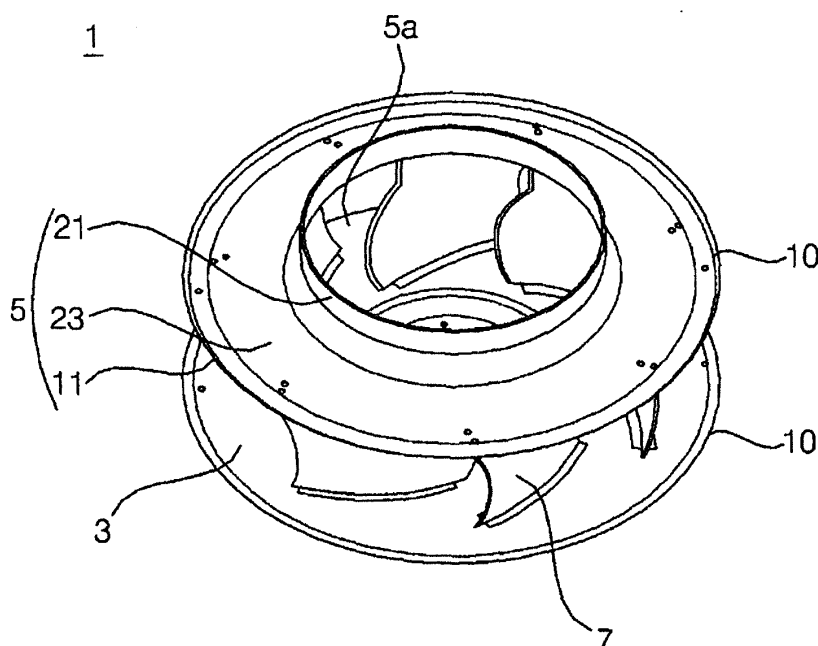
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(54) **CENTRIFUGAL FAN**

(57) Disclosed is a centrifugal fan. The centrifugal fan according to an embodiment of the present invention includes a main plate connected to a rotating shaft of a motor, a shroud having a suction opening through which air is introduced, a plurality of blades arranged between

the main plate and the shroud, and a rim portion acquired by bending an outer circumference of at least one of the main plate and the shroud in a longitudinal direction of the rotating shaft, the rim portion having an inclination.

FIG. 2



Description

[Technical Field]

[0001] The present invention relates to a centrifugal fan and, more particularly, to a centrifugal fan having increased rigidity and efficiency.

[Background Art]

[0002] A centrifugal fan is a device that discharges air in a circumferential direction from inside of a blade under the influence of centrifugal force via rotation of the blade. The centrifugal fan does not require a duct because air is naturally introduced inward and discharged outward and is frequently applied to a relatively large product, such as a ceiling attachment type air conditioner or the like.

[0003] FIG. 1 is a perspective view showing a conventional centrifugal fan 40. Referring to FIG. 1, in the conventional centrifugal fan 40, to endure stress of high static pressure and high air volume, generally, a shroud 45 has a thickness of 2.5 mm and a main plate 43 has a thickness of 4.5 mm. However, these thicknesses problematically cause excessive material cost and management inconvenience and power consumption increase due to heavy weight.

[Disclosure]

[Technical Problem]

[0004] It is one object of the present invention to reduce thicknesses of a main plate and a shroud while increasing rigidity of the same.

[0005] It is another object of the present invention to increase performance of a centrifugal fan by reducing weights of a main plate and a shroud.

[0006] Objects of the present invention are not limited to the aforementioned objects and other objects not mentioned herein will be clearly understood from the following description by those skilled in the art.

[Technical Solution]

[0007] In accordance with one embodiment of the present invention, the above and other objects can be accomplished by the provision of a centrifugal fan including a main plate connected to a rotating shaft of a motor, a shroud having a suction opening through which air is introduced, a plurality of blades arranged between the main plate and the shroud, and a rim portion acquired by bending an outer circumference of at least one of the main plate and the shroud, the rim portion having an inclination.

[0008] In accordance with another embodiment of the present invention, there is provided a centrifugal fan including a shroud having a suction opening through which

air is introduced, a main plate connected to a rotating shaft of a motor, a plurality of blades arranged between the main plate and the shroud, and a corner portion formed at the main plate and/or the shroud to come into contact with air discharged between the plural blades, the corner portion being an angled portion located the same distance from a rotation center.

[0009] Details of other embodiments are included in the following detailed description and the drawings.

[Advantageous Effects]

[0010] According to the present invention, one or more effects as follows are accomplished.

[0011] Firstly, material cost may be advantageously reduced owing to increased rigidity.

[0012] Secondly, reduced thicknesses of a shroud and a main plate may advantageously result in reduced power consumption.

[0013] Thirdly, a centrifugal fan having a reduced weight may advantageously achieve increased efficiency.

[0014] Fourthly, rigidity of the centrifugal fan may be increased via a relatively simple process.

[0015] Effects of the present invention are not limited to the aforementioned effects and other effects not mentioned herein will be clearly understood from the claims by those skilled in the art.

[Description of Drawings]

[0016]

FIG. 1 is a perspective view showing a conventional centrifugal fan.

FIG. 2 is a perspective view showing a centrifugal fan according to one embodiment of the present invention.

FIG. 3 is a longitudinal section view showing an outer circumference and a rim portion of the centrifugal fan according to one embodiment of the present invention.

FIG. 4 is a perspective view and a longitudinal sectional view of a main plate according to one embodiment of the present invention.

FIG. 5 is a graph showing performance of the centrifugal fan according to one embodiment of the present invention and performance of a centrifugal fan according to the related art.

[Best Mode]

[0017] Advantages and features of the present invention and a method of achieving the same will be more clearly understood from embodiments described below in detail with reference to the accompanying drawings. However, the present invention is not limited to the following embodiments and may be implemented in various

different forms. The embodiments are provided merely to complete disclosure of the present invention and to provide those skilled in the art of the present invention with the category of the invention. The invention is defined only by the claims. Wherever possible, the same reference numbers will be used throughout the specification to refer to the same or like parts.

[0018] Hereinafter, the present invention will be described with reference to the accompanying drawings to explain a centrifugal fan according to the embodiments of the present invention.

[0019] FIG. 2 is a perspective view showing a centrifugal fan according to one embodiment of the present invention. FIG. 3 is a longitudinal section view showing an outer circumference and a rim portion of the centrifugal fan according to one embodiment of the present invention.

[0020] Referring to FIGs. 2 and 3, the centrifugal fan 1 according to one embodiment of the present invention includes a main plate 3 connected to a rotating shaft of a motor; a shroud 5 having a suction opening 5a through which air is introduced; a plurality of blades 7 arranged between the main plate 3 and the shroud 5; and a rim portion 10 acquired by bending an outer circumference of at least one of the main plate 3 and the shroud 5, the rim portion 10 having an inclination.

[0021] The shroud 5 has the suction opening 5a. A bell mouse (not shown) may be inserted into and fixed in the shroud 5. The bell mouse serves to guide air to the suction opening 5a. A diameter of the bell mouse is reduced with decreasing distance to the suction opening 5a. The shroud 5 is spaced apart from the bell mouse so as to be rotated while maintaining a gap with the bell mouse. The bell mouse is inserted through the suction opening 5a. A lower end of the shroud 5 is connected to the blades 7.

[0022] The main plate 3 is connected to the motor that applies torque. The rotating shaft of the motor is connected to the main plate 3.

[0023] The blades 7 are arranged between the main plate 3 and the shroud 5. The blades 7 may be radially arranged or may be spirally arranged. The plural blades 7 are spaced apart from one another. Preferably, the blades 7 are arranged at a constant interval. Each blade 7 defines an air inlet for introduction of air and an air outlet 9 for discharge of air with the other neighboring blades 7. The air inlet is open toward a rotation axis. That is, the air inlet is open toward the center of the main plate 3. The air outlet 9 is open toward the circumference of the main plate 3. Air introduced through the suction opening 5a passes through the air inlet and is discharged from the air outlet 9.

[0024] The rim portion 10 may be formed at the main plate 3 and/or at the shroud 5. The rim portion 10 is bent by a given inclination. The rim portion 10 is formed by bending the main plate 3 and/or the shroud 5 in a longitudinal direction of the rotation axis such that an outer circumference thereof is inclined. Distances d1 and d2

from an extension of the rotation axis O-O' to the rim portion 10 may be equal.

[0025] Bending of the rim portion 10 according to one embodiment of the present invention is implemented by plastic working. Plasticity is the nature of a material that is permanently deformed upon receiving external force, rather than returning to the original state thereof, even after removal of the external force. The shroud 5 and the main plate 3 are formed of a plastic deformable material. For example, the shroud 5 and the main plate 3 are formed of a metal sheet or sheet metal.

[0026] Plastic working is a processing method using plasticity. Pressing is a processing method for implementation of compression, deformation, shearing, bending, deep drawing or the like using various press machines. The shroud 5 and/or the rim portion 10 may be formed by pressing. The rim portion 10 may be formed by bending.

[0027] The rim portion 10 according to one embodiment of the present invention is bent in a diagonal direction. The rim portion 10 has different upper and lower diameters. A diameter of one end of the rim portion 10 may be less than that of the other end as the diameter of the rim portion is gradually increased from one end to the other end. The rim portion 10 may have a tapered side cross section.

[0028] The rim portion 10 according to one embodiment of the present invention may have a constant bending angle. The rim portion 10 may be bent by a constant angle. Preferably, the rim portion 10 has a constant height.

[0029] A bending angle of the rim portion 10 according to one embodiment of the present invention may be 45 degrees. Although a side surface of the rim portion 10 may have various inclination angles, preferably, the side surface is inclined by 45 degrees. The side surface of the rim portion 10 may be a tapered surface having an angle of 45 degrees. The bending angle may be an angle between the extension of the rotation axis O-O' and a bending direction of the rim portion 10. The bending angle may be an angle between a plane perpendicular to the extension of the rotation axis O-O' and the rim portion 10.

[0030] According to one embodiment of the present invention, two rim portions 10 are formed respectively at the main plate 3 and the shroud 5 and the rim portions 10 are bent in different directions. The suction opening 5a is formed at the center of the shroud 5. The shroud 5 may include a protrusion 21 which protrudes toward the bell mouse and internally defines the suction opening 5a. The shroud 5 may further include an expanded portion 23 connected to the protrusion 21, the blades 7 being erected downward from the expanded portion 23. The rim portion 10 may be located at an end of the expanded portion 23.

[0031] The rim portions 10 may include a shroud rim portion 11 defining an outer circumference of the shroud 5 and a main plate rim portion 13 defining an outer circumference of the main plate 3. The shroud rim portion

11 is located at the end of the expanded portion 23. The end of the expanded portion 23 is connected to the shroud rim portion 11. The shroud rim portion 11 may be erected in a protruding direction of the protrusion 21. An inner end of the expanded portion 23 is connected to the protrusion 21 and an outer end of the expanded portion 23 is connected to the shroud rim portion 11. The expanded portion 23 may be curved so as to be connected to the protrusion 21. As a curvature of the expanded portion 23 is reduced outward, the expanded portion 23 may become almost flat with decreasing distance to the outer end thereof.

[0032] The centrifugal fan 1 according to one embodiment of the present invention has the air outlet 9 for discharge of air between the main plate 3 and the shroud 5 and the rim portion 10 is bent outward of the air outlet 9 so as not to prevent flow of air discharged through the air outlet 9. Air is introduced through the suction opening 5a and discharged outward through gaps between the plural blades 7. The air outlet 9 is defined between the main plate 3 and the shroud 5. The outer circumferences of the main plate 3 and the shroud 5 define the air outlet 9.

[0033] The shroud 5 and the main plate 3 according to one embodiment of the present invention have the same thickness. The shroud 5 and the main plate 3 may be formed of the same sheet. According to one embodiment of the present invention, a thickness of the shroud 5 and the main plate 3 may be 1.6 mm.

[0034] The rim portion 10 according to one embodiment of the present invention protrudes in a circular form. The rim portion 10 may protrude in a given direction and have a circular shape. The rim portion 10 is bent to achieve a desired height. The rim portion 10 may have different upper and lower diameters. The shroud rim portion 11 includes a first border portion defining the outer circumference of the shroud 5 and a first connection portion connected to the expanded portion 23.

[0035] The main plate rim portion 13 includes a second border portion defining the outer circumference of the main plate 3 and a second connection portion connected to a mounting portion 31. Preferably, a diameter of the first border portion is greater than a diameter of the first connection portion and a diameter of the second border portion is greater than a diameter of the second connection portion. The diameter of the first connection portion and the diameter of the second connection portion may be equal to each other. The diameter of the first border portion and the diameter of the second border portion may be equal to each other.

[0036] The centrifugal fan 1 according to one embodiment of the present invention includes the shroud 5 having the suction opening 5a through which air is introduced; the main plate 3 connected to the rotating shaft of the motor; the plurality of blades 7 arranged between the main plate 3 and the shroud 5; and a corner portion 15 formed at the main plate 3 and/or the shroud 5 to come into contact with air discharged between the plural blades 7, the corner portion being an angled portion located the

same distance from the rotation center O-O'.

[0037] The air outlet 9 for discharge of air is defined between the main plate 3 and the shroud 5. The air outlet 9 is defined between the outer circumference of the main plate 3 and the outer circumference of the shroud 5. The corner portion 15 is located farther from the rotation center than the blades 7.

[0038] The corner portion 15 is formed at a distal end of the rim portion 10. The corner portion 15 is a connection portion between the rim portion 10 and the expanded portion 23. The corner portion 15 is also a connection portion between the rim portion 10 and the mounting portion 31. The corner portion 15 may be angled by 45 degrees or 135 degrees. A distance from the rotation center O-O' to the corner portion 15 may be designated by d1 or d2. The corner portion 15 formed at the shroud 5 may be located the same distance d1 from the rotation center O-O'.

[0039] The corner portion 15 formed at the main plate 3 may be arranged the same distance from the rotation center O-O'. The corner portion 15 is circularly formed about the rotation center O-O'. A radius of a circle defined by the corner portion 15 may be d1 or d2. Here, d1 and d2 may be equal.

[0040] FIG. 4 is a perspective view and a longitudinal sectional view of a main plate according to one embodiment of the present invention. Referring to FIG. 4, the main plate 3 according to one embodiment of the present invention includes a boss portion 33 connected to the rotating shaft; and the mounting portion 31 connected to the boss portion 33, the blades 7 being erected from the mounting portion and the rim portion 10 being placed around the mounting portion. The boss portion 33 protrudes toward the suction opening 5a.

[0041] The mounting portion 31 is connected to the blades 7. Upper ends of the blades 7 are connected to the shroud 5 and lower ends of the blades 7 are connected to the main plate 3. The boss portion 33 is connected to the rotating shaft. The boss portion 33 may protrude toward the motor, or may protrude toward the shroud 5. The mounting portion 31 may be a flat portion. An outer end of the mounting portion 31 may be connected to the rim portion 10. More specifically, the main plate rim portion 13 may be placed at an outer end of the mounting portion 31. The main plate rim portion 13 may protrude in a direction opposite to the boss portion 33. The shroud rim portion 11 may protrude in the same direction as the boss portion 33.

[0042] Operation of the centrifugal fan 1 according to the present invention having the above-described configuration will be described below.

[0043] The rim portion 10 may be formed by bending a rim of the shroud and/or the main plate. As the rim portion serves to increase rigidity of the shroud and the main plate, the centrifugal fan may be thinner than the conventional centrifugal fan 40. In addition, referring to FIG. 1, although a thickness of the conventional shroud 45 is 2.5 mm and a thickness of the conventional main

plate 43 is 4.5 mm, according to one embodiment of the present invention, thicknesses of the shroud 5 and the main plate 3 may be reduced to 1.6 mm, which results in considerable weight reduction. Accordingly, reduction of material cost and reduction of power consumption owing to reduced shaft power are possible.

[0044] Meanwhile, the rim portion 10 is formed by plastic working and thus has higher dimensional accuracy than casting. In addition, through improvement in the crystalline structure of a metal, stronger properties than that in casting and cutting processes may be accomplished and high productivity may be accomplished via mass production of uniform products. In addition, there occurs no generation of chips differently from cutting and almost the entire material may be used. In addition, since the rim portion 10 is integrally formed with the shroud 5 and/or the main plate 3 without welding, a clean curved surface may be acquired, which causes reduced flow resistance, resulting in smooth airflow and less flow separation.

[0045] FIG. 5 is a graph showing performance of the centrifugal fan according to one embodiment of the present invention and performance of a centrifugal fan according to the related art. In FIG. 5, a solid line represents performance of the centrifugal fan according to the embodiment of the present invention and a dotted line represents performance of the centrifugal fan according to the related art. In FIG. 5(a) showing a static pressure curve, the abscissa represents air volume Q and the ordinate represents static pressure P_s . In FIG. 5(b) showing an efficiency curve, the abscissa represents air volume Q and the ordinate represents efficiency (%). The efficiency of the centrifugal fan may be calculated by $(\text{Air Volume (m}^3/\text{min)} \times \text{Static Pressure (mmAq)}) / (6120 \times \text{shaft power (kW)}) \times 100\%$.

[0046] Referring to FIG. 5, the centrifugal fan 1 according to the embodiment of the present invention has a maximum efficiency of about 79%, the air volume corresponding to the efficiency is about 180 CMM (m^3/min), and the static pressure corresponding to the air volume of 180 m^3/min is about 120 mmAq. On the other hand, the centrifugal fan according to the related art has a maximum efficiency of about 75%, the air volume corresponding to the efficiency is about 140 m^3/min , and the static pressure corresponding to the air volume of 140 m^3/min is about 130 mmAq.

[0047] Accordingly, according to the present invention, the air volume may be increased by about 30% than that in the related art and the static pressure at the maximum efficiency point may be reduced by about 7% than that in the related art. In addition, since generation of noise is minimized near the maximum efficiency point, the centrifugal fan 1 of the present invention causes less noise than that of the related art based on the same air volume.

[0048] Although the exemplary embodiments of the present invention have been illustrated and described, the present invention is not limited to the above-described particular embodiments, various modifications

are possible by those skilled in the art without departing from the scope and spirit of the invention as disclosed in the accompanying claims and these modifications should not be understood separately from the scope and spirit of the invention.

Claims

1. A centrifugal fan comprising:
 - a main plate connected to a rotating shaft of a motor;
 - a shroud having a suction opening through which air is introduced;
 - a plurality of blades arranged between the main plate and the shroud; and
 - a rim portion acquired by bending an outer circumference of at least one of the main plate and the shroud, the rim portion having an inclination.
2. The centrifugal fan according to claim 1, wherein bending of the rim portion is implemented by plastic working.
3. The centrifugal fan according to claim 1, wherein the rim portion is bent in a diagonal direction.
4. The centrifugal fan according to claim 1, wherein the rim portion has a constant bending angle.
5. The centrifugal fan according to claim 4, wherein the bending angle of the rim portion is 45 degrees.
6. The centrifugal fan according to claim 1, wherein the rim portion is formed at each of the main plate and the shroud, and wherein the rim portion of the main plate and the rim portion of the shroud are bent in different directions.
7. The centrifugal fan according to claim 1, wherein the rim portion is a circular protruding portion.
8. The centrifugal fan according to claim 1, wherein the main plate includes:
 - a boss portion connected to the rotating shaft; and
 - a mounting portion connected to the boss portion, the blades being erected on the mounting portion and the rim portion being placed around the mounting portion, and
 - wherein the boss portion protrudes toward the suction opening.
9. The centrifugal fan according to claim 1, wherein an air outlet for discharge of air is defined between the main plate and the shroud, and

wherein the rim portion is bent outward of the air outlet so as not to prevent flow of air discharged through the air outlet.

10. The centrifugal fan according to claim 1, wherein the shroud and the main plate have the same thickness. 5

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FIG. 1

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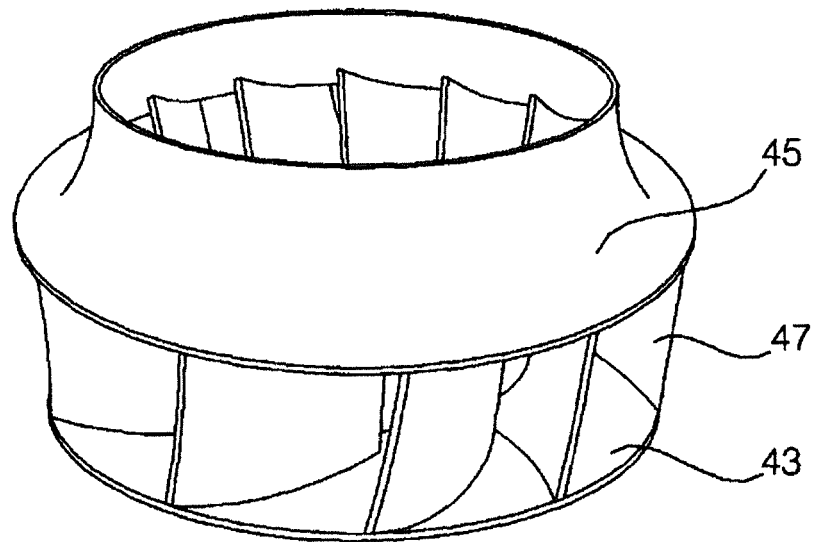


FIG. 2

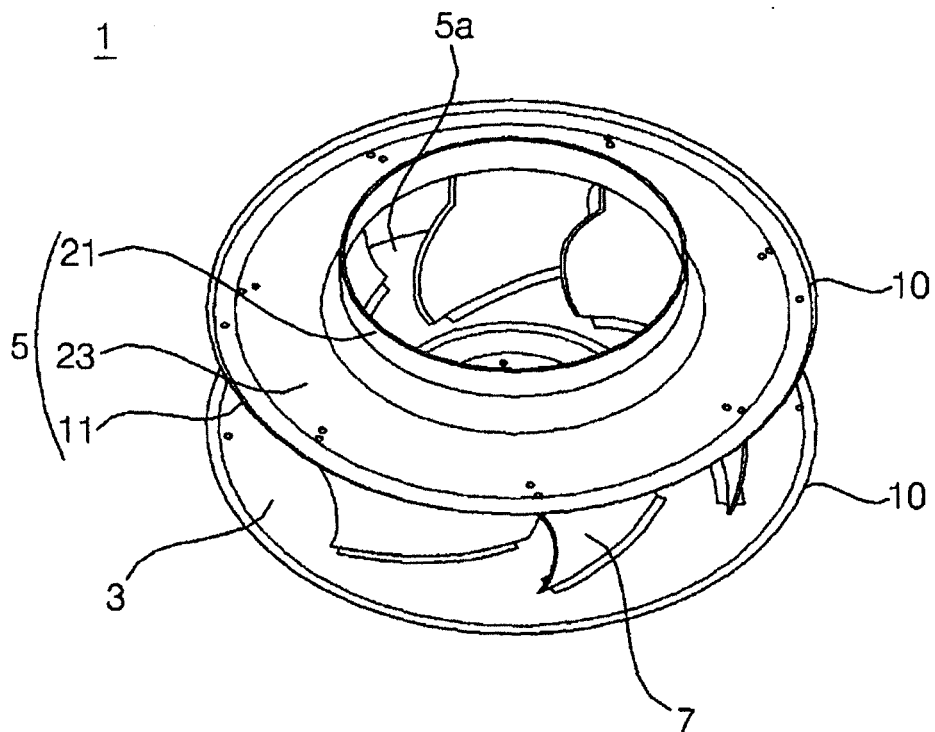


FIG. 3

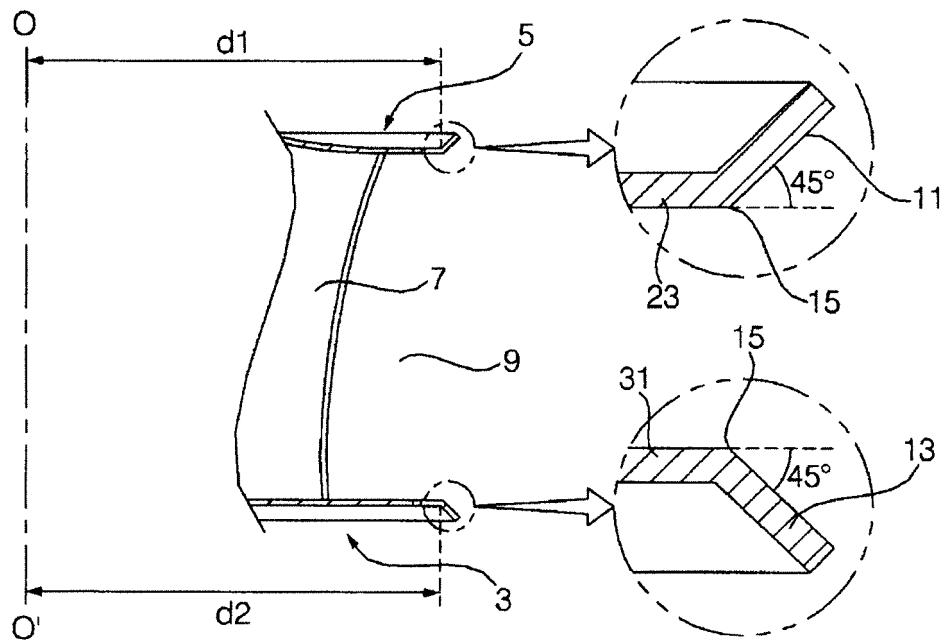


FIG. 4

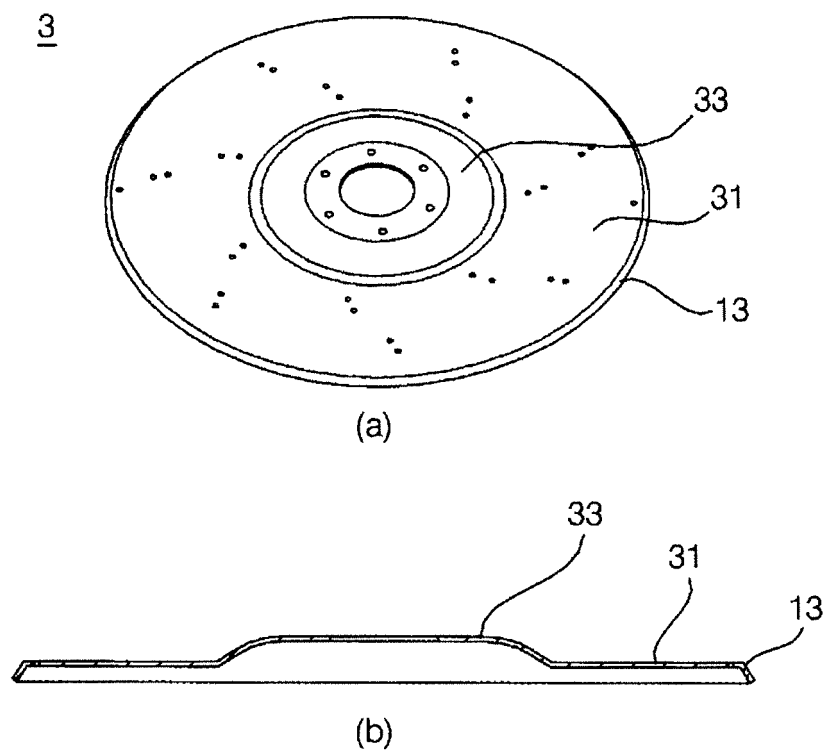
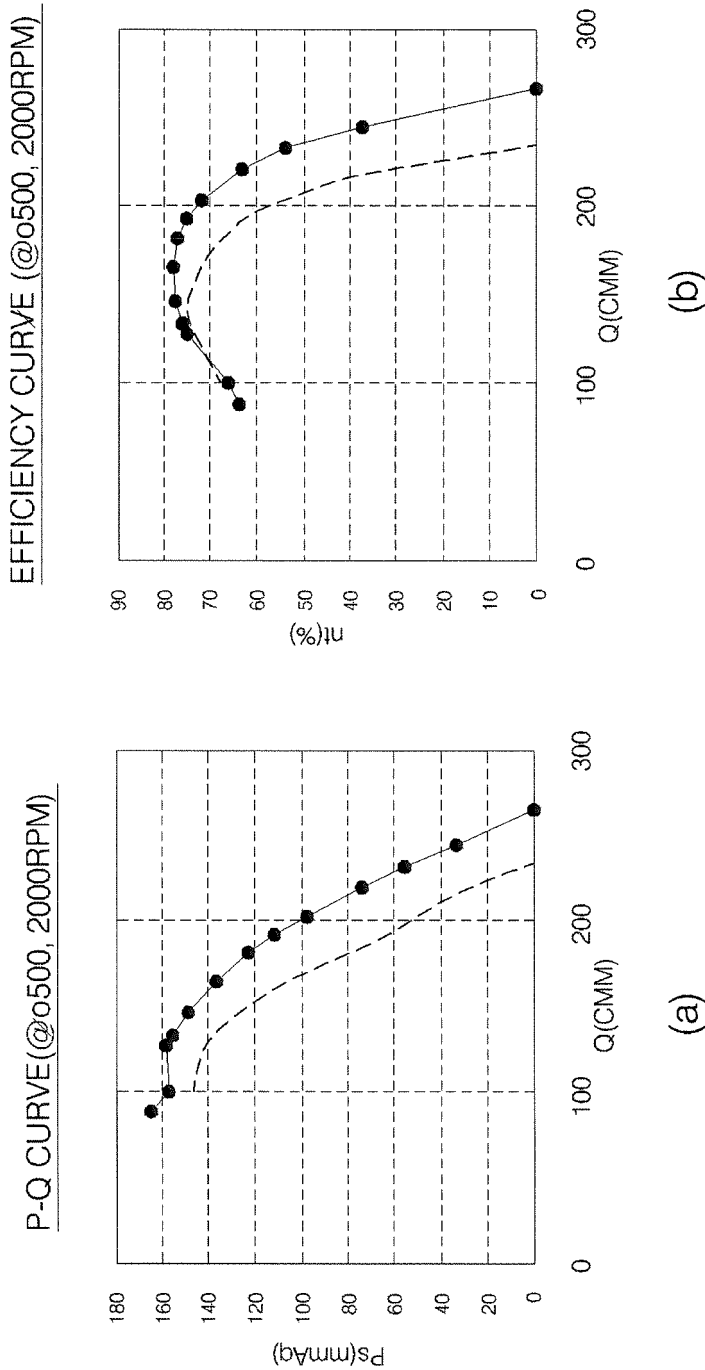


FIG. 5



INTERNATIONAL SEARCH REPORT

International application No.

PCT/KR2014/003920

A. CLASSIFICATION OF SUBJECT MATTER

F04D 29/28(2006.01)i, F04D 29/44(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 29/28; F01D 5/22; F04D 29/44; F04D 29/30; B63H 1/28; F04D 29/08

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

Korean Utility models and applications for Utility models: IPC as above

Japanese Utility models and applications for Utility models: IPC as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKOMPASS (KIPO internal) & Keywords: centrifugal fan, mainplate, shroud, blade, rim part

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2006-0228212 A1 (SADI, Omar) 12 October 2006 See paragraphs [0030], [0031], [0037], [0038] and figures 1-5.	1-10
A	US 6039539 A (BERG, Gunnar) 21 March 2000 See column 2, line 19 - column 3, line 3 and figures 2-4.	1-10
A	US 5336050 A (GUIDA, Joseph et al.) 09 August 1994 See column 4, lines 31-58 and figures 2, 8.	1-10
A	JP 2011-058442 A (PANASONIC CORP.) 24 March 2011 See paragraphs [0034]-[0036] and figures 1, 4, 5.	1-10
A	US 5249927 A (VERA, Jean-Claude) 05 October 1993 See column 2, lines 19-46 and figures 1, 2A, 2B, 2C.	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

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

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"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

04 SEPTEMBER 2014 (04.09.2014)

Date of mailing of the international search report

04 SEPTEMBER 2014 (04.09.2014)

Name and mailing address of the ISA/KR


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Authorized officer

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/KR2014/003920

Patent document cited in search report	Publication date	Patent family member	Publication date
US 2006-0228212 A1	12/10/2006	AT 492729 T	15/01/2011
		CA 2517994 A1	16/09/2004
		CA 2517994 C	09/08/2011
		CN 100458178 C	04/02/2009
		CN 1756908 A	05/04/2006
		DE 502004012024 D1	03/02/2011
		EP 1455094 A1	08/09/2004
		EP 1608875 A1	28/12/2005
		EP 1608875 B1	22/12/2010
		ES 2355822 T3	31/03/2011
		FI 20060060 U0	07/02/2006
		FI 20060060 V0	07/02/2006
		FI 7321U1	30/11/2006
		JP 2006-519336 A	24/08/2006
		RU 2321775 C1	10/04/2008
US 6039539 A	21/03/2000	SI 1608875T1	29/04/2011
		WO 2004-079201 A1	16/09/2004
		EP 0848788 A1	19/06/2002
		EP 0848788 B1	22/01/2003
		JP 11-512164 A	19/10/1999
US 5336050 A	09/08/1994	WO 97-09535 A1	13/03/1997
		NONE	
JP 2011-058442 A	24/03/2011		
		CN 102022349 A	20/04/2011
		CN 201851371 U	01/06/2011
		EP 2295817 A2	16/03/2011
		EP 2295817 A3	14/03/2012
		JP 04894900 B2	14/03/2012
		TW 201109532 A	16/03/2011
US 05249927 A	05/10/1993	TW 1418709 B	11/12/2013
		EP 0541429 A1	12/05/1993
		EP 0541429 B1	09/04/1997