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

(11) EP 1 366 299 B1

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
24.05.2006 Bulletin 2006/21

(21) Application number: **02703644.1**

(22) Date of filing: **05.03.2002**

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

(86) International application number:
PCT/FI2002/000170

(87) International publication number:
WO 2002/070902 (12.09.2002 Gazette 2002/37)

(54) **AIR IMPELLER AND A HOUSING FOR SUCH AN IMPELLER**

LUFT-LAUFRAD UND GEHÄUSE FÜR EIN SOLCHES LAUFRAD

SOUFFLANTE ET SON BOITIER

(84) Designated Contracting States:
DE ES FR GB IT SE

(30) Priority: **05.03.2001 FI 20010432**

(43) Date of publication of application:
03.12.2003 Bulletin 2003/49

(73) Proprietor: **Fläkt Woods AB**
55184 Jönköping (SE)

(72) Inventors:
- **KOHONEN, Reijo**
  FIN-02200 Espoo (FI)
- **HYVÄRINEN, Juhani**
  FIN-02230 Espoo (FI)
- **WAINIO, Sami**
  FIN-00700 Helsinki (FI)
- **IKONEN, Ilkka, T.**
  FIN-65230 Vaasa (FI)
- **FORSMAN, Kimmo**
  FIN-65320 Vaasa (FI)
- **PÖYHÖNEN, Matti**
  FIN-65610 Mustasaari (FI)
- **RINTA-VALKAMA, Jorma**
  FIN-65350 Vaasa (FI)

(74) Representative: **Järveläinen, Pertti Tauno Juhani et al**
Oy Heinänen Ab,
Annankatu 31-33 C
00100 Helsinki (FI)

(56) References cited:
US-A- 5 474 429

EP 1 366 299 B1

Description

[0001] The present invention relates to an air impeller as defined in the preamble of claim 1, comprising a bladed wheel for generating a substantially axial gas flow, an alternating-current motor for rotating the bladed wheel, said alternating-current motor having a fixed stator and a rotating rotor, and a frequency converter or inverter for the control of the alternating-current motor. The invention also relates to a housing for an axial impeller.

[0002] Various axial impellers designed for different uses have been known for years. Traditional axial impellers have a separate electric motor, which is coupled via a power transmission system to the bladed wheel of the air impeller to rotate it. Power transmission is implemented e.g. via a belt drive or a shaft-clutch-shaft transmission. The motor used is either an altemating-current motor or a direct-current motor. An altemating-current motor is simpler in construction and is therefore in many cases better suited for use as the drive motor of an air impeller. In addition, the rotational speed of an altemating-current motor can be controtted steplessly and accurately by means of a frequency converter, so the motor drive has a good performance and a simple structure. Moreover, as the frequency converter produces a sinusoidal output voltage, the motor drive is relatively disturbance-free and quiet.

[0003] In prior art, axial impellers are known in which the rotor of an electric motor is combined with a bladed wheel, in which case the air impeller and the motor have a frame and a housing in common, thus obviating the need to provide separate bearings and shafts for the air impeller and the motor. US patent specification 5,474,429 discloses an axial impeller of this type, in which the stator of an electric motor drives a bladed wheel and a rotor disposed on its outer rim. The motor may be a synchronous motor magnetized by permanent magnets integrated with the stator. In this case, the motor may be implemented using relatively small air gaps, thus improving the performance of the motor. In addition, as the rotor is disposed on the outer rim of the bladed wheel, the bearing of the bladed wheel is not heated unnecessarily by the heat produced by the electric motor, as it would if the electric motor were mounted near the bearing. Placing the rotor and stator on the outer rim eliminates the fast wear of the bearing caused by bearing currents. The bearing is thus potential-free.

[0004] A drawback with prior-art axial impellers is their complex structure, large size and therefore a large space requirement especially in the axial direction. This is due in particular to the fact that the air impeller and the frequency converter of its motor drive are separate components. A further problem with prior-art axial impellers is their relatively poor reliability and difficulty of installation, because, for example, installing a frequency converter in the particular air impeller in question and connecting it to it takes plenty of time and is a relatively difficult operation. In many cases, the installation work has to be carried out in a tight space, so the work needed to install separate extra components significantly increases the installation time as well as the installation costs.

[0005] The object of the present invention is to eliminate the drawbacks of prior-art solutions and to achieve a new type of integral impeller provided with a frequency converter, in which all structural parts of the air impeller are integrated in a single unit. Another object of the invention is to achieve a new type of housing structure for an axial impeller, in which all components of the impeller are disposed in the same housing.

[0006] The details of the features characteristic of the axial impeller of the invention and its housing are presented in the claims below.

[0007] The primary advantage provided by the invention is that a very compact construction is achieved with no need for separate components, which means that the axial impeller of the invention can be installed quickly and in a simple manner. Moreover, the axial impeller of the invention has a very short axial dimension, and the unitary housing structure means that the impeller is well protected, and therefore manufacturing impeller structures consistent with different IP classifications is relatively easy.

[0008] In the following, the invention will be described in detail by the aid of an example with reference to the attached drawings, wherein

Fig. 1 presents an axial impeller according to the invention and one half of its housing, and

Fig. 2 presents an exploded view of an axial impeller according to the invention.

[0009] Fig. 1 and 2 present an axial impeller according to the invention, designed for use e.g. in air conditioning systems and producing an axial air flow. The axial impeller has a plastic housing consisting of two halves, a front cover 1 and a back cover 2, fastened together e.g. by means of screws, the housing also serving as the frame of the impeller. Fitted in the front and back covers 1, 2 is a shaft joumal 3, with a plastic impeller wheel 4 mounted on said shaft journal. The impeller wheel 4 has in its center a hole 41 for a shaft and impeller blades 42 fitted around it between an inner cylindrical part 43 and a second, outer cylindrical annular part 44.

[0010] The impeller wheel 4 is rotated by an electric motor drive comprising a synchronous motor 5 and a frequency converter 6 or inverter controlling it and connected to a three-phase alternating-current network or a medium-level direct-current network, said frequency converter or inverter producing a sinusoidal output voltage with controlled frequency variation.

[0011] In the axial impeller of the invention, the stator of the motor is mounted in the housing around the outer rim of the impeller wheel 4 and the rotor is integrated with the impeller wheel so that it consists of permanent magnets 51 fitted to the circumference of the outer annular

part 44. The stator again consists of four stator segments placed symmetrically at even distances around the impeller wheel 4, each segment comprising a stator frame 52 and stator windings 54 wound in holes 53 at the curved inner rim of the stator segment. Each stator segment forms a segment of about 45° on the circumference of the impeller wheel 4.

[0012] The permanent magnets 51 are curved permanent magnet pieces mounted on the circumference of the cylindrical part 44. An iron ring on the rim prevents magnetic particles from adhering to the inner rim of the impeller wheel from the air flow. The curved permanent magnets 51 can thus be placed on the very rim of the bladed wheel 4, without requiring any insulation of plastic or other material between it and the stator. The curvature of the magnet 51 is determined by the curvature of the outer rim of the bladed wheel 4. As the magnet is placed near the stator and no insulating plastic material is used in the air gap, the same power can be achieved with a smaller magnetic mass. This allows savings in the material costs, reduces the gyratory forces generated by the rotation of the bladed wheel and reduces the need for stabilization.

[0013] The stator segments 52 again have outer edges parallel to the vertical and horizontal edges of the impeller housing and extending only slightly outside the plane tangential to the outer rim of the rotor 4 to minimize the space required by the stator. In addition, the stator segments 52 may be provided with mounting holes to allow the stator segments to be fastened to mounting pins provided in the housing.

[0014] Moreover, the housing part is provided with mounting pins 21 for attachment to the second housing part, and it has below the stator a space 23 for a frequency converter 6, said space being placed in the same plane perpendicular to the axial direction determined by the longitudinal axis A, separated by a partition 22 from the two stator segments. Thus, the entire axial impeller is integrated in the same housing 1, 2, which is very thin because all components are placed in the same plane perpendicular to the axial direction. In addition, the housing 1, 2 also functions as a mounting base, on which the various fixed components can be mounted and fastened as described above. It has fastening elements for the stator, the bearings and the frequency converter or inverter. Moreover; the mounting base functions as a lead-through element for the motor conductors from the motor space into the housing of the frequency converter or inverter.

[0015] It is obvious to the person skilled in the art that different embodiments of the invention are not limited to the example described above, but that they may be varied within the scope of the following claims. Thus, the axial impeller of the invention can be provided with guides, by means of which the direction of the air flow obtained from the impeller is changed as desired.

Claims

1. Air impeller, comprising a frame, a bladed wheel (4) provided with blades (42) for producing a substantially axial flow of a gaseous medium, an alternating-current motor (5) for rotating the bladed wheel, said alternating-current motor comprising a fixed stator (52-54) and a rotating rotor, and a frequency converter (6) or inverter for controlling the alternating-current motor, and
in which the rotor of the alternating-current motor is integrated with the bladed wheel (4), being placed on its outer rim, and the stator is placed in the frame of the air impeller outside the rotor so that the stator produces rotation of both the rotor and the bladed wheel,
characterized in that the frequency converter (6) or inverter is integrated with the stator or a part of it to form a unitary, frequency-converter or inverter-controlled air impeller structure.

2. Air impeller as defined in claim 1, **characterized in that** the frequency converter (6) or inverter is disposed in substantially the same plane perpendicular to the axial direction (A) with the stator or stator part, e.g. below the stator or stator part.

3. Air impeller as defined in claim 1, **characterized in that** the stator is divided into four segments, which are arranged symmetrically outside the rotor.

4. Air impeller as defined in claim 3, **characterized in that** the frame (52) of the stator comprises substantially straight outer edges parallel to the outer edges of the air impeller and extending only slightly outside the plane defined by a tangent to the outer rim of the bladed wheel.

5. Air impeller as defined in claim 1, in which the motor is a synchronous motor provided with permanent magnets, **characterized in that** the permanent magnets (51) are disposed on the circumference of the bladed wheel.

6. Air impeller as defined in claim 5, **characterized in that** the permanent magnets (51) are of a curved shape.

7. Housing for an air impeller, said air impeller comprising a frame, a bladed wheel (4) provided with blades (42) for producing a substantially axial flow of a gaseous medium, an altemating-current motor (5) for rotating the bladed wheel, said altemating-current motor comprising a fixed stator (52-54) and a rotating rotor, and a frequency converter (6) or inverter for controlling the altemating-current motor, and
in which the rotor of the electric motor is integrated with the bladed wheel (4), being placed on its cir-

cumference, and the stator is placed in the frame of the air impeller outside the rotor so that the stator produces rotation of both the rotor and the bladed wheel,
characterized in that the housing forms the frame of the air impeller,
that it accommodates the shaft (3) of the bladed wheel, and
that it comprises a space (23) for the frequency converter or inverter so that the frequency converter (6) or inverter is integrated with the stator or a part of it to form a unitary, self-contained frequency-converter or inverter-controlled air impeller structure.

8. Housing as defined in claim 7, **characterized in that** the housing consists of two halves attached to each other, preferably a front half and a back half (1, 2).

9. Housing as defined in claim 7, **characterized in that** the housing forms a mounting base having fastening elements for the stator, the bearings and the frequency converter or inverter, said mounting base functioning as a lead-through element for the motor conductors from the motor space into the housing of the frequency converter or inverter.

Patentansprüche

1. Luftlaufrad, aufweisend einen Rahmen, ein mit Flügeln (42) versehenes Flügelrad zum Erzeugen einer im wesentlichen axialen Strömung eines gasförmigen Mediums, einen Wechselstrommotor (5) zum Drehen des Flügelrades, wobei der Wechselstrommotor einen festen Stator (52 - 54) und einen rotierenden Rotor umfaßt, und einen Frequenzkonverter (6) oder -Inverter zur Steuerung des Wechselstrommotors, wobei der Rotor des Wechselstrommotors an der äußeren Kante des Flügelrades (4) angeordnet und in dieses integriert ist und der Stator in dem Rahmen des Luftlaufrades außerhalb des Rotors angeordnet ist, so daß der Stator eine Rotation sowohl des Rotors als auch des Flügelrades erzeugt,
dadurch gekennzeichnet,
daß der Frequenzkonverter (6) oder -inverter in den Stator oder in einen Teil von diesem integriert ist, um eine einheitliche, Frequenzkonverter- oder -inverter-gesteuerte Luftlaufradstruktur auszubilden.

2. Luftlaufrad nach Anspruch 1, **dadurch gekennzeichnet, daß** der Frequenzkonverter (6) oder -inverter im wesentlichen in der gleichen Ebene senkrecht zur axialen Richtung (A) des Stators oder eines Teils des Stators angeordnet ist, z. B. unterhalb des Stators oder eines Teils des Stators.

3. Luftlaufrad nach Anspruch 1, **dadurch gekennzeichnet, daß** der Stator in vier Segmente unterteilt ist, die symmetrisch außerhalb des Rotors angeordnet sind.

4. Luftlaufrad nach Anspruch 3, **dadurch gekennzeichnet, daß** der Rahmen (52) des Stators im wesentlichen gerade äußere Kanten parallel zu den Außenkanten des Luftlaufrades umfaßt, die sich nur leicht außerhalb der durch eine Tangente durch die äußere Kante des Flügelrades definierten Ebene erstrecken.

5. Luftlaufrad nach Anspruch 1, in dem der Motor ein mit Permanentmagneten versehener Synchronmotor ist, **dadurch gekennzeichnet, daß** die Permanentmagneten (51) an dem Umfang des Flügelrades angeordnet sind.

6. Luftlaufrad nach Anspruch 5, **dadurch gekennzeichnet, daß** die Permanentmagneten (51) von gebogener Gestalt sind.

7. Gehäuse für ein Luftlaufrad, wobei das Luftlaufrad einen Rahmen, ein mit Flügeln (42) versehenes Flügelrad (4) zum Erzeugen einer im wesentlichen axialen Strömung eines gasförmigen Mediums, einen Wechselstrommotor (5) zum Rotieren des Flügelrades, wobei der Wechselstrommotor einen festen Stator (52 - 54) und einen rotierenden Rotor aufweist, und einen Frequenzkonverter (6) oder -inverter zur Steuerung des Wechselstrommotors aufweist, wobei der Rotor des Elektromotors am Umfang des Flügelrades (4) angeordnet und in dieses integriert ist und der Stator in den Rahmen des Luftlaufrades außerhalb des Rotors angeordnet ist, so daß der Stator eine Rotation sowohl des Rotors als auch des Flügelrades erzeugt, **dadurch gekennzeichnet, daß** das Gehäuse den Rahmen des Luftlaufrades ausbildet, daß es die Achse (3) des Flügelrades aufnimmt und daß es einen Raum (23) für den Frequenzkonverter oder -inverter umfaßt, so daß der Frequenzkonverter (6) oder -inverter in den Stator oder einen Teil von diesem integriert ist, um eine einheitliche, in sich geschlossene Frequenz-Konverter- oder -Inverter-gesteuerte Luftlaufradstruktur auszubilden.

8. Gehäuse nach Anspruch 7, **dadurch gekennzeichnet, daß** das Gehäuse aus zwei miteinander verbundenen Hälften besteht, vorzugsweise einer vorderen Hälfte und einer hinteren Hälfte (1, 2).

9. Gehäuse nach Anspruch 7, **dadurch gekennzeichnet, daß** das Gehäuse eine Befestigungsbasis mit Befestigungselementen für den Stator, die Lager und den Frequenzkonverter oder -inverter ausbildet, wobei die Befestigungsbasis als ein durchleitendes Element für die Motorleitungen von dem Motorraum in das Gehäuse für den Frequenzkonverter oder -in-

verter dient.

Revendications

1. Soufflante, comprenant un châssis, une roue à aubes (4) munie d'aubes (42) pour produire un flux de fluide gazeux sensiblement axial, un moteur à courant alternatif (5) pour faire tourner la roue à aubes, ledit moteur à courant alternatif comprenant un stator fixe (52-54) et un rotor rotatif et un convertisseur de fréquence (6) ou inverseur pour contrôler le moteur à courant alternatif, et
dans laquelle le rotor du moteur à courant alternatif est intégré dans la roue à aubes (4), étant placé sur son rebord extérieur, et le stator est placé dans le châssis de la soufflante à l'extérieur du rotor de sorte que le stator produit la rotation à la fois du rotor et de la roue à aubes,
caractérisée en ce que le convertisseur de fréquence (6) ou inverseur est intégré dans le stator ou dans une partie de celui-ci pour former une structure de soufflante unitaire contrôlée par le convertisseur de fréquence ou inverseur.

2. Soufflante selon la revendication 1, **caractérisée en ce que** le convertisseur de fréquence (6) ou inverseur est disposé sensiblement dans le même plan perpendiculaire à la direction axiale (A) que le stator ou la partie de stator, par exemple sous le stator ou la partie de stator.

3. Soufflante selon la revendication 1, **caractérisée en ce que** le stator est divisé en quatre segments qui sont agencés symétriquement à l'extérieur du rotor.

4. Soufflante selon la revendication 3, **caractérisée en ce que** le châssis (52) du stator comprend des bords extérieurs sensiblement droits parallèles aux bords extérieurs de la soufflante et s'étendant seulement légèrement à l'extérieur du plan défini par une tangente au bord extérieur de la roue à aubes .

5. Soufflante selon la revendication 1, dans laquelle le moteur est un moteur synchrone muni d'aimants permanents, **caractérisée en ce que** les aimants permanents (51) sont disposés sur la circonférence de la roue à aubes.

6. Soufflante selon la revendication 5, **caractérisée en ce que** les aimants permanents (51) ont une forme incurvée.

7. Boîtier pour une soufflante, ladite soufflante comprenant un châssis, une roue à aubes (4) munie d'aubes (42) pour produire un flux de fluide gazeux sensiblement axial, un moteur à courant alternatif (5) pour faire tourner la roue à aubes, ledit moteur à courant alternatif comprenant un stator fixe (52-54) et un rotor rotatif, et un convertisseur de fréquence (6) ou inverseur pour contrôler le moteur à courant alternatif, et
dans lequel le rotor du moteur électrique est intégré dans la roue à aubes (4), étant placé sur son rebord extérieur, et le stator est placé dans le châssis de la soufflante à l'extérieur du rotor de sorte que le stator produit la rotation à la fois du rotor et de la roue à aubes,
caractérisé en ce que le boîtier forme le châssis de la soufflante,
en ce qu'il reçoit l'arbre (3) de la roue à aubes, et
en ce qu'il comprend un espace (23) pour le convertisseur de fréquence (6) ou inverseur de sorte que le convertisseur de fréquence (6) ou inverseur est intégré dans le stator ou dans une partie de celui-ci pour former une structure de soufflante unitaire autonome contrôlée par le convertisseur de fréquence ou inverseur.

8. Boîtier selon la revendication 7, **caractérisé en ce que** le boîtier est constitué de deux moitiés fixées l'une à l'autre, de préférence une moitié avant et une moitié arrière (1, 2).

9. Boîtier selon la revendication 7, **caractérisé en ce que** le boîtier forme une base de montage comportant des éléments de fixation pour le stator, les paliers et le convertisseur de fréquence ou inverseur, ladite base de montage servant d'élément de passage pour les conducteurs du moteur depuis l'espace du moteur jusqu'au boîtier du convertisseur de fréquence ou inverseur.

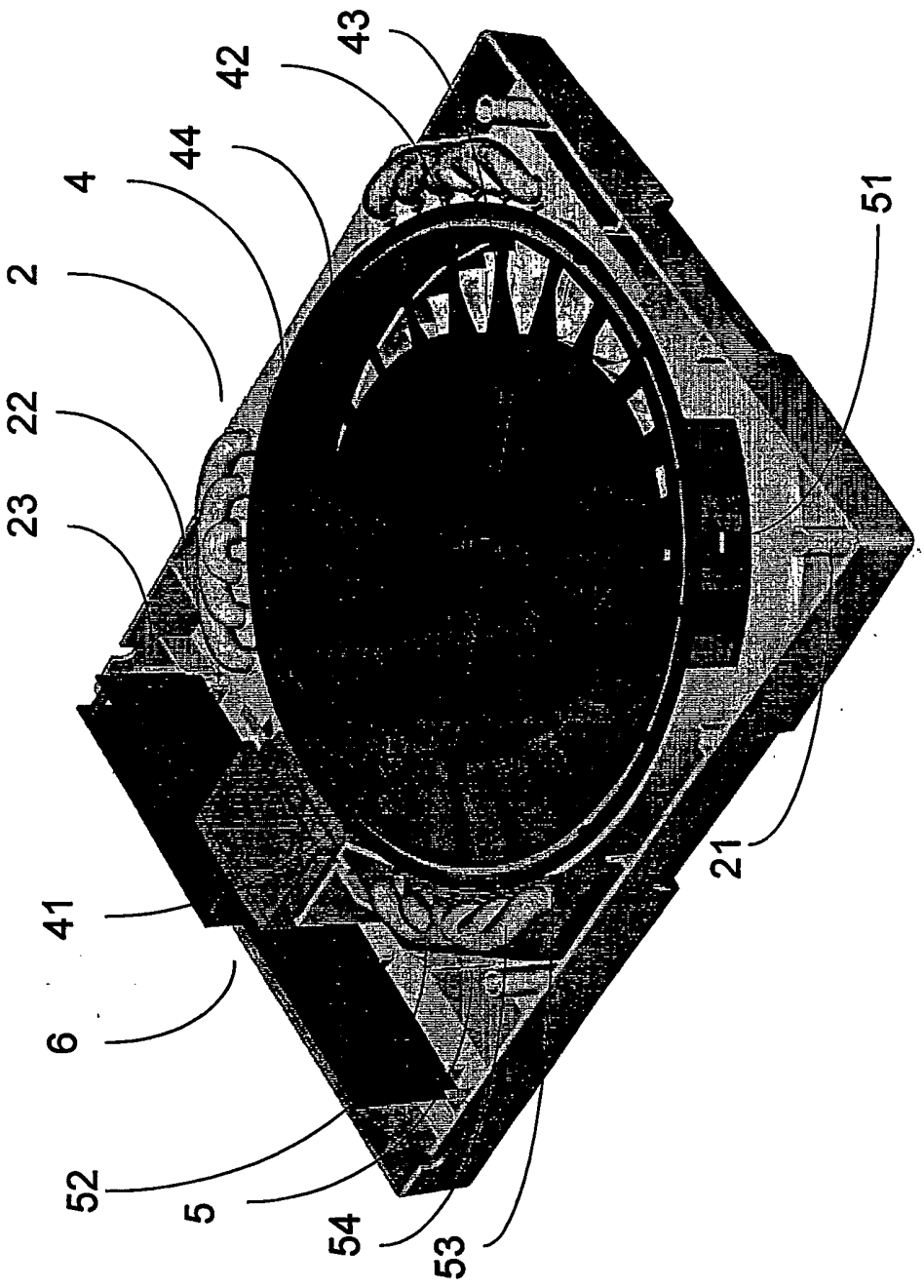

Fig. 1

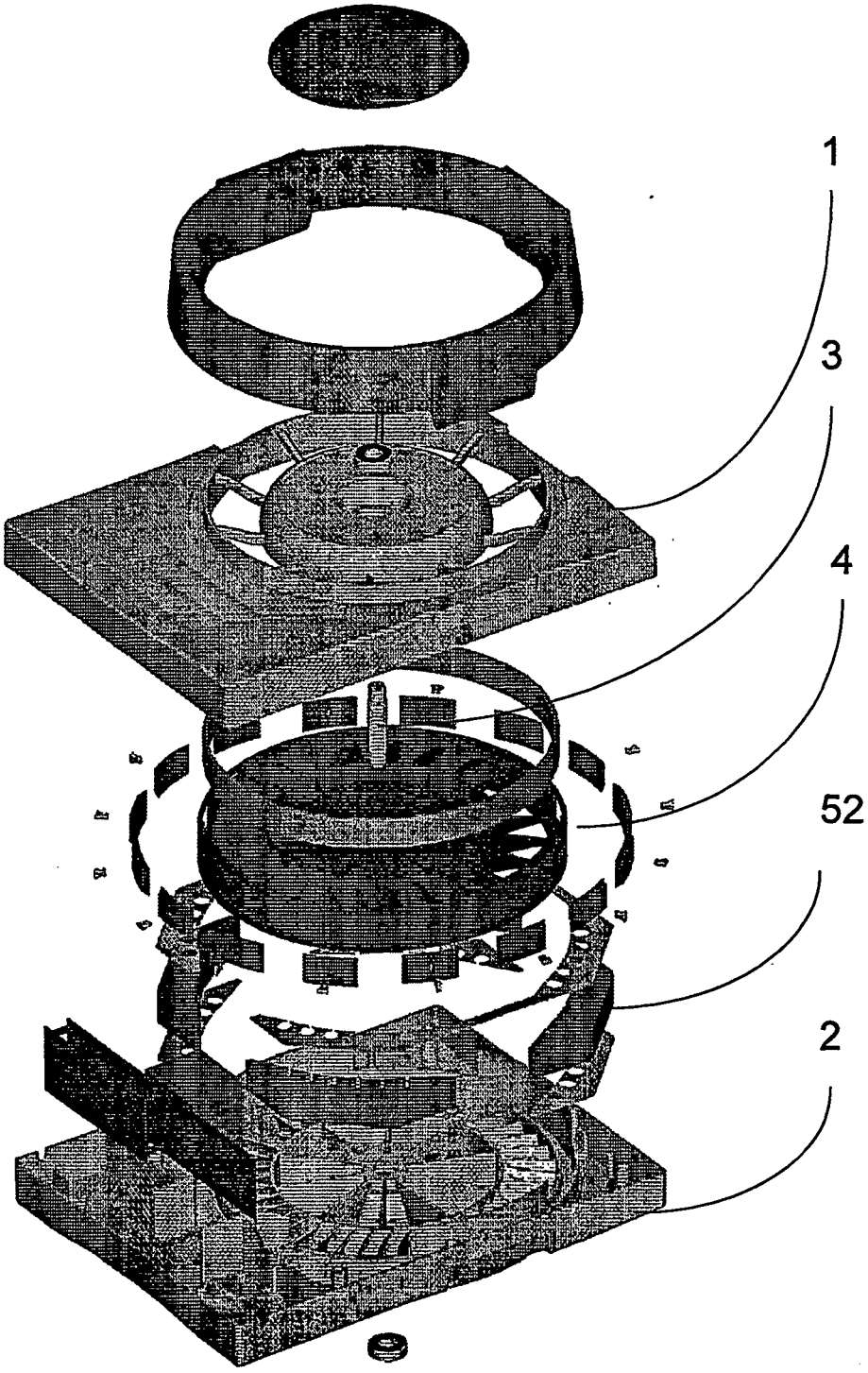

Fig. 2